Chapter 1—Introduction

MULTIPLE CHOICE

1. Since 1983 the standard meter has been defined in terms of which of the following?

a. specific alloy bar housed at Sevres, France
b. wavelength of light emitted by krypton-86
c. distance from the Earth's equator to the North Pole
d. the distance light travels in a certain fraction of a second

ANS: D PTS: 1 DIF: 1
TOP: 1.1 Standards of Length, Mass, and Time

2. Since 1967 the standard definition for the second has been based on which of the following?

a. characteristic frequency of the cesium-133 atom
b. average solar day
c. sidereal day
d. Greenwich Civil Time

ANS: A PTS: 1 DIF: 1
TOP: 1.1 Standards of Length, Mass, and Time

3. In mechanics, physicists use three basic quantities to derive additional quantities. Mass is one of the three quantities. What are the other two?

a. length and force
b. power and force
c. length and time
d. force and time

ANS: C PTS: 1 DIF: 1
TOP: 1.1 Standards of Length, Mass, and Time

4. The prefixes which are abbreviated p, n, and G represent which of the following?

a. 10^{-2}, 10^{-6}, and 10^{15}
b. 10^{-9}, 10^{6}, and 10^{10}
c. 10^{-12}, 10^{-9}, and 10^{9}
d. 10^{-15}, 10^{-6}, and 10^{12}

ANS: C PTS: 1 DIF: 1
TOP: 1.1 Standards of Length, Mass, and Time

5. The ratio M/m of the prefixes M and m has what value?

a. 10^{3}
b. 10^{6}
c. 10^{9}
d. 10^{18}

ANS: C PTS: 1 DIF: 2
TOP: 1.1 Standards of Length, Mass, and Time

6. One year is about ____ seconds while one day is exactly ____ seconds.

a.□3.16 ´ 10^7, 86 400
b.□5.26 ´ 10^5, 86 400
c.□3.16 ´ 10^7, 8 640
d.□1.04 ´ 10^6, 36 000

ANS: A PTS: 1 DIF: 2
TOP: 1.1 Standards of Length, Mass, and Time

7. The nuclei of atoms contain

a.□electrons only.
b.□neutrons only.
c.□protons and electrons.
d.□protons and neutrons.

ANS: D PTS: 1 DIF: 1
TOP: 1.2 The Building Blocks of Matter

8. When was the existence of the neutron confirmed?

a.□in ancient times
b.□in 1895
c.□in 1932
d.□in 1969

ANS: C PTS: 1 DIF: 1
TOP: 1.2 The Building Blocks of Matter

9. The proton contains which of the following combination of quarks?

a.□two up quarks and one down quark
b.□one up quark and two down quarks
c.□one top quark and two bottom quarks
d.□two top quarks and one bottom quark

ANS: A PTS: 1 DIF: 2
TOP: 1.2 The Building Blocks of Matter

10. Which formula is dimensionally consistent with an expression yielding a value for velocity? (*a* is acceleration, *x* is distance, and *t* is time)

a.□v/t^2
b.□vx^2
c.□v^2/t
d.□at

ANS: D PTS: 1 DIF: 1 TOP: 1.3 Dimensional Analysis

11. Which expression is dimensionally consistent with an expression that would yield a value for time^{-1}? (*v* is velocity, *x* is distance, and *t* is time)

a. v/x
b. v^2/x
c. x/t
d. v^2t

ANS: A PTS: 1 DIF: 1 TOP: 1.3 Dimensional Analysis

12. If the displacement of an object, *x*, is related to velocity, *v*, according to the relation $x = Av$, the constant, *A*, has the dimension of which of the following?

a. acceleration
b. length
c. time
d. area

ANS: C PTS: 1 DIF: 1 TOP: 1.3 Dimensional Analysis

13. The speed of a boat is often given in knots. If a speed of 5 knots were expressed in the SI system of units, the units would be:

a. m.
b. s.
c. m/s.
d. kg/s.

ANS: C PTS: 1 DIF: 1 TOP: 1.3 Dimensional Analysis

14. If *a* is acceleration, *v* is velocity, *x* is position, and *t* is time, then which equation is not dimensionally correct?

a. $t = x/v$
b. $a = v^2/x$
c. $v = a/t$
d. $t^2 = 2x/a$

ANS: C PTS: 1 DIF: 1 TOP: 1.3 Dimensional Analysis

15. Suppose an equation relating position, *x*, to time, *t*, is given by $x = b\,t^3 + c\,t^4$, where *b* and *c* are constants. The dimensions of *b* and *c* are respectively:

a. T^3, T^4.
b. $1/T^3$, $1/T^4$.
c. L/T^3, L/T^4.
d. $L^2 \times T^3$, $L^2 \times T^4$.

ANS: C PTS: 1 DIF: 2 TOP: 1.3 Dimensional Analysis

16. Areas always have dimensions _____ while volumes always have dimensions _____.

a. m^2, m^3
b. L^2, L^3
c. Both a and b are correct.
d. No answer is correct because of the "always."

ANS: B PTS: 1 DIF: 1 TOP: 1.3 Dimensional Analysis

17. Which one of the choices below represents the preferred practice regarding significant figures when adding the following: 12.4 + 11 + 67.37 + 4.201?

a. 94.971
b. 94.97
c. 95.0
d. 95

ANS: D PTS: 1 DIF: 1
TOP: 1.4 Uncertainty in Measurement and Significant Figures

18. Which one of the choices below represents the preferred practice regarding significant figures when multiplying the following: 10.5 ´ 8.8 ´ 3.14?

a. 290
b. 290.136
c. 290.1
d. 300

ANS: A PTS: 1 DIF: 1
TOP: 1.4 Uncertainty in Measurement and Significant Figures

19. Calculate (0.82 + 0.042) ´ (4.4 ´ 10^3), keeping only significant figures.

a. 3 800
b. 3 784
c. 3 793
d. 3 520

ANS: A PTS: 1 DIF: 1
TOP: 1.4 Uncertainty in Measurement and Significant Figures

20. The length and width of a standard sheet of paper is measured, and then the area is found by calculation to be 93.50 in^2. The number of significant figures in the width measurement must be at least:

a. 1.
b. 2.
c. 3.
d. 4.

ANS: D PTS: 1 DIF: 1
TOP: 1.4 Uncertainty in Measurement and Significant Figures

21. The number 0.000 17 has how many significant figures?

a. 2
b. 3
c. 5
d. 6

ANS: A PTS: 1 DIF: 2
TOP: 1.4 Uncertainty in Measurement and Significant Figures

22. Multiplying a 2 significant figure number by a 3 significant figure number and then dividing the product by a six significant figure number yields a number with how many significant figures?

a.	5/6
b.	1
c.	2
d.	11

ANS: C PTS: 1 DIF: 3
TOP: 1.4 Uncertainty in Measurement and Significant Figures

23. Assume when using a meter stick measuring can be done so that the last significant figure is in the tenth of a millimeter digit. If you are measuring an object with length between 6 and 7 cm, how many significant figures will result if you only use the part of the meter stick between the 1-cm and 9-cm positions?

a.	2
b.	3
c.	4
d.	more than 4

ANS: B PTS: 1 DIF: 1
TOP: 1.4 Uncertainty in Measurement and Significant Figures

24. Assume when using a meter stick measuring can be done so that the last significant figure is in the tenth of a millimeter digit. If you are measuring an object with length between 6 and 7 cm, how many significant figures will result if you only use the part of the meter stick between the 82- and 95-cm positions?

a.	2
b.	3
c.	4
d.	more than 4

ANS: B PTS: 1 DIF: 2
TOP: 1.4 Uncertainty in Measurement and Significant Figures

25. Assume when using a meter stick measuring can be done so that the last significant figure is in the tenth of a millimeter digit. If you are measuring an object with length between 25 and 57 cm, how many significant figures will result if you only use the part of the meter stick between the 2- and 95-cm positions?

a.	2
b.	3
c.	4
d.	more than 4

ANS: C PTS: 1 DIF: 2
TOP: 1.4 Uncertainty in Measurement and Significant Figures

26. How many significant figures does the number 1 700 have?

a.	2
b.	3
c.	4

d. One cannot tell with certainty when the number is written in the given form, but it will be one of the other given answers.

ANS: D PTS: 1
TOP: 1.4 Uncertainty in Measurement and Significant Figures

27. In the text are the following conversion factors:
i. 1 mi = 1 609 m
ii. 1 m = 39.37 in.
iii. 1 ft = 30.48 cm
iv. 1 in. = 2.54 cm
The 1 on the left hand side is assumed to have the same number of significant figures as the number on the right hand side of each of these equations. However, 2 of these conversion factors are exact, and this means they have the equivalent of an unlimited number of significant figures when used in calculations. Which 2 are the exact conversion factors?

a. i and ii
b. i and iii
c. ii and iii
d. iii and iv

ANS: D PTS: 1
TOP: 1.4 Uncertainty in Measurement and Significant Figures | 1.5 Conversion of Units

28. On planet Q the standard unit of volume is called the guppy. Space travelers from Earth have determined that one liter = 38.2 guppies. How many guppies are in 150 liters?

a. 5 730 guppies
b. 0.255 guppies
c. 3.93 guppies
d. 188 guppies

ANS: A PTS: 1 DIF: 1 TOP: 1.5 Conversion of Units

29. On planet Z, the standard unit of length is the foose. Ann the Astronaut is 5.90 feet tall on earth. She lands on planet Z and is measured to be 94 foosi tall. Her partner Rachael is 88 foosi tall. How tall is Rachael on Earth?

a. 5.2 feet
b. 5.5 feet
c. 5.8 feet
d. 6.3 feet

ANS: B PTS: 1 DIF: 2 TOP: 1.5 Conversion of Units

30. A furlong is a distance of 220 yards. A fortnight is a time period of two weeks. A race horse is running at a speed of 5.00 yards per second. What is his speed in furlongs per fortnight?

a. 27 500 furlongs/fortnight
b. 13 700 furlongs/fortnight
c. 6 220 furlongs/fortnight
d. 2 750 furlongs/fortnight

ANS: A PTS: 1 DIF: 2 TOP: 1.5 Conversion of Units

31. A cereal box has the dimensions of 0.19 m ´ 0.28 m ´ 0.070 m. If there are 3.28 feet per meter, then what is the volume of the box in cubic feet?

a.□0.13 cubic feet
b.□0.040 cubic feet
c.□0.012 cubic feet
d.□0.003 7 cubic feet

ANS: A PTS: 1 DIF: 1 TOP: 1.5 Conversion of Units

32. The distance to the Andromeda Galaxy is estimated at about 2 ´ 10^{6} light years. A light year is the distance traveled by light in one year; if the speed of light is 3 ´ 10^{8} m/s, about how far is it from our galaxy to Andromeda? (1 year = 3.15 ´ 10^{7} s)

a.□10 ´ 10^{15} m
b.□1 ´ 10^{18} m
c.□2 ´ 10^{22} m
d.□6 ´ 10^{12} m

ANS: C PTS: 1 DIF: 2 TOP: 1.5 Conversion of Units

33. A cement truck can pour 20 cubic yards of cement per hour. Express this in ft^3/min.

a.□1/3 ft^3/min
b.□1.0 ft^3/min
c.□3 ft^3/min
d.□9 ft^3/min

ANS: D PTS: 1 DIF: 1 TOP: 1.5 Conversion of Units

34. Water flows into a swimming pool at the rate of 8.0 gal/min. The pool is 16 ft wide, 32 ft long and 8.0 ft deep. How long does it take to fill? (1 U.S. gallon = 231 cubic inches)

a.□32 hours
b.□64 hours
c.□48 hours
d.□24 hours

ANS: B PTS: 1 DIF: 2 TOP: 1.5 Conversion of Units

35. When NASA was communicating with astronauts on the moon, the time from sending on the Earth to receiving on the moon was 1.28 s. Find the distance from Earth to the moon. (The speed of radio waves is 3.00 ´ 10^{8} m/s.)

a.□240 000 km
b.□384 000 km
c.□480 000 km
d.□768 000 km

ANS: B PTS: 1 DIF: 2 TOP: 1.5 Conversion of Units

36. The mass of the sun is 2.0 ´ 10^{30} kg, and the mass of a hydrogen atom is 1.67 ´ 10^{-27} kg. If we assume that the sun is mostly composed of hydrogen, how many atoms are there in the sun?

a.□1.2 ´ 10^{56} atoms

b. 3.4×10^{56} atoms
c. 1.2×10^{57} atoms
d. 2.4×10^{57} atoms

ANS: C PTS: 1 DIF: 2 TOP: 1.5 Conversion of Units

37. The information on a one-gallon paint can is that the coverage, when properly applied, is 450 ft^2. One gallon is 231 in^3. What is the average thickness of the paint in such an application?

a. 0.003 6 in
b. 0.009 0 in
c. 0.043 in
d. 0.051 in

ANS: A PTS: 1 DIF: 3 TOP: 1.5 Conversion of Units

38. Assume everyone in the United States consumes one soft drink in an aluminum can every two days. If there are 270 million Americans, how many tons of aluminum need to be recycled each year if each can weighs 1/16 pound and one ton = 2000 pounds?

a. 750 000 tons
b. 1.5 million tons
c. 1.75 million tons
d. 3 million tons

ANS: B PTS: 1 DIF: 2
TOP: 1.6 Estimates and Order-of-Magnitude Calculations

39. A physics class in a large lecture hall has 150 students. The total mass of the students is about ____ kg.

a. 10^2
b. 10^3
c. 10^4
d. 10^5

ANS: C PTS: 1 DIF: 2
TOP: 1.6 Estimates and Order-of-Magnitude Calculations

40. An apartment has 1100 ft^2 of floor space. What is the approximate volume of the apartment?

a. 10^3 ft^3
b. 10^4 ft^3
c. 10^5 ft^3
d. 10^6 ft^3

ANS: B PTS: 1 DIF: 2
TOP: 1.6 Estimates and Order-of-Magnitude Calculations

41. Which point is nearest the *x*-axis?

a. (- 3, 4)
b. (4, 5)
c. (- 5, 3)
d. (5, - 2)

ANS: D PTS: 1 DIF: 2 TOP: 1.7 Coordinate Systems

42. Each edge of a cube has a length of 25.4 cm. What is the length of a diagonal of the cube going through the center of the cube?

a. 25.4 in
b. 17.3 in
c. 14.4 in
d. 10.0 in

ANS: B PTS: 1 DIF: 3 TOP: 1.7 Coordinate Systems

43. If point A is located at coordinates (5, 3) and point B is located at coordinates (- 3, 9), what is the distance from A to B if the units of the coordinated system are meters?

a. 14 m
b. 10 m
c. 8 m
d. 17 m

ANS: B PTS: 1 DIF: 2 TOP: 1.7 Coordinate Systems

44. A high fountain of water is in the center of a circular pool of water. You walk the circumference of the pool and measure it to be 150 meters. You then stand at the edge of the pool and use a protractor to gauge the angle of elevation of the top of the fountain. It is 55°. How high is the fountain?

a. 17 m
b. 23 m
c. 29 m
d. 34 m

ANS: D PTS: 1 DIF: 3 TOP: 1.8 Trigonometry

45. A right triangle has sides 5.0 m, 12 m, and 13 m. The smallest angle of this triangle is nearest:

a. 21°.
b. 23°.
c. 43°.
d. Not attainable since this is not a right triangle.

ANS: B PTS: 1 DIF: 2 TOP: 1.8 Trigonometry

46. If $\varphi = 90° - \theta$, what is the value of $\sin^2\varphi + \sin^2\theta$?

a. 0
b. 1
c. - 1
d. The answer depends on θ.

ANS: B PTS: 1 DIF: 2 TOP: 1.8 Trigonometry

47. A triangle has sides of length 7.0 cm and 25 cm. If the triangle is a right triangle, which of the following could be the length of the third side?

a. 18 cm

b. 24 cm
c. 27 cm
d. 32 cm

ANS: B PTS: 1 DIF: 2 TOP: 1.8 Trigonometry

48. A train slowly climbs a 500-m mountain track which is at an angle of 10.0° with respect to the horizontal. How much altitude does it gain?

a. 86.8 m
b. 88.2 m
c. 341 m
d. 492 m

ANS: A PTS: 1 DIF: 2 TOP: 1.8 Trigonometry

49. Note the expression: $y = x^2$. Which statement is most consistent with this expression?

a. If y doubles, then x quadruples.
b. y is greater than x.
c. If x doubles, then y doubles.
d. If x doubles, then y quadruples.

ANS: D PTS: 1 DIF: 1 TOP: Additional Problems

50. Note the expression: $y = A/x^3$. Which statement is most consistent with this expression?

a. y is less than A.
b. If x is halved, y is multiplied by eight.
c. If x is doubled, y is multiplied by a factor of 8.
d. y is greater than x.

ANS: B PTS: 1 DIF: 1 TOP: Additional Problems

51. For which of the values below is $x > x^3$?

a. $x = -1.5$
b. $x = 0$
c. $x = 1.0$
d. $x = 1.5$

ANS: A PTS: 1 DIF: 1 TOP: Additional Problems

52. Modern electroplaters can cover a surface area of 60.0 m^2 with one troy ounce of gold (volume = 1.611 cm^3). What is the thickness of the electroplated gold?

a. 2.68×10^{-8} m
b. 1.34×10^{-9} m
c. 1.67×10^{-6} m
d. 3.33×10^{-7} m

ANS: A PTS: 1 DIF: 2 TOP: Additional Problems

53. The basic function of an automobile's carburetor is to atomize the gasoline and mix it with air to promote rapid combustion. Assume that 30 cm^3 of gasoline is atomized into *N* spherical droplets. Each droplet has a radius of 2.0 ´ 10^{-5} m. Find the total surface area of these *N* spherical droplets.

a. 2 100 cm^2
b. 15 000 cm^2
c. 18 000 cm^2
d. 45 000 cm^2

ANS: D PTS: 1 DIF: 3 TOP: Additional Problems

54. A circle has an area of 2.0 m^2. A second circle has double the radius of the first. The area of the second circle is _____ times that of the first.

a. 0.50
b. 2.0
c. 4.0
d. 8.0

ANS: C PTS: 1 DIF: 2 TOP: Additional Problems

55. Doubling the radius of a sphere results in increasing its volume by a factor of

a. 2
b. 4
c. 8
d. 8 p

ANS: C PTS: 1 DIF: 2 TOP: Additional Problems

56. A room in a house has a floor area of 120 ft^2. Which of the following is most likely the approximate volume of the room?

a. 3 m^3
b. 30 m^3
c. 300 m^3
d. 3 000 m^3

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Problems

57. When SI units are plugged into an equation, it is found that the units balance. Which of the following can we expect to be true for this equation?

a. The equation will be dimensionally correct.
b. The equation will be dimensionally correct except sometimes in cases when the right hand side of the equation has more than one term.
c. The equation will not be dimensionally correct.
d. All constants of proportionality will be correct.

ANS: A PTS: 1 DIF: 1 TOP: Conceptual Problems

58. How long has it been that scientists have accepted that the nucleus of the atom consists of neutrons and protons? Think of your answers in terms of order of magnitude.

a. about a decade
b. about a century
c. about a thousand years
d. since Aristotle

ANS: B PTS: 1 DIF: 1 TOP: Conceptual Problems

59. Consider the sine of any angle between 30° and 40°. If the angle were doubled, what would happen to the sine of the angle?

a. It would double.
b. It would more than double.
c. It would increase but be less than double.
d. In different cases, it could do any of the above.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

60. There are other ways of expressing uncertainty besides significant figures. For example, suppose a quantity is known to have a value between 20.4 and 20.0, and our best estimate of the value is midrange at 20.2. We could write the number as 20.2 +/- 0.2 and say that the number has a 1% uncertainty. We would also say it has 3 significant figures. If we square a number with 1% uncertainty (i.e., 2 parts in about 200) and 3 significant figures, what results?

a. A number with 1% uncertainty and 3 significant figures.
b. A number with 2% uncertainty and 3 significant figures.
c. A number with 2% uncertainty and 2 significant figures.
d. A number with 1% uncertainty and 2 significant figures.

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Problems

Chapter 2—Motion in One Dimension

MULTIPLE CHOICE

1. A change in a physical quantity w having initial value w_i and final value w_f is given by which of the following?

a.	$w_i - w_f$
b.	$w_f - w_i$
c.	$(w_f + w_i)/2$
d.	none of the above

ANS: B PTS: 1 DIF: 1 TOP: 2.1 Displacement

2. Displacement is which of the following types of quantities?

a.	vector
b.	scalar
c.	magnitude
d.	dimensional

ANS: A PTS: 1 DIF: 1 TOP: 2.1 Displacement

3. A truck moves 70 m east, then moves 120 m west, and finally moves east again a distance of 90 m. If east is chosen as the positive direction, what is the truck's resultant displacement?

a.	40 m
b.	- 40 m
c.	280 m
d.	- 280 m

ANS: A PTS: 1 DIF: 2 TOP: 2.1 Displacement

4. Which of the following is not a vector quantity?

a.	temperature
b.	velocity
c.	acceleration
d.	displacement

ANS: A PTS: 1 DIF: 1 TOP: 2.1 Displacement

5. In one-dimensional motion, the average speed of an object that moves from one place to another and then back to its original place has which of the following properties?

a.	It is positive.
b.	It is negative.
c.	It is zero.
d.	It can be positive, negative, or zero.

ANS: A PTS: 1 DIF: 2 TOP: 2.2 Velocity

6. In one-dimensional motion where the direction is indicated by a plus or minus sign, the average velocity of an object has which of the following properties?

a. It is positive.
b. It is negative.
c. It is zero.
d. It can be positive, negative, or zero.

ANS: D PTS: 1 DIF: 1 TOP: 2.2 Velocity

7. An object moves 20 m east in 30 s and then returns to its starting point taking an additional 50 s. If west is chosen as the positive direction, what is the sign associated with the average velocity of the object?

a. +
b. -
c. 0 (no sign)
d. any of the above

ANS: C PTS: 1 DIF: 1 TOP: 2.2 Velocity

8. An object moves 20 m east in 30 s and then returns to its starting point taking an additional 50 s. If west is chosen as the positive direction, what is the average speed of the object?

a. 0.50 m/s
b. - 0.50 m/s
c. 0.73 m/s
d. 0 m/s

ANS: A PTS: 1 DIF: 2 TOP: 2.2 Velocity

9. A bird, accelerating from rest at a constant rate, experiences a displacement of 28 m in 11 s. What is the average velocity?

a. 1.7 m/s
b. 2.5 m/s
c. 3.4 m/s
d. zero

ANS: B PTS: 1 DIF: 1 TOP: 2.2 Velocity

10. A cheetah can run at approximately 100 km/hr and a gazelle at 80.0 km/hr. If both animals are running at full speed, with the gazelle 70.0 m ahead, how long before the cheetah catches its prey?

a. 12.6 s
b. 25.2 s
c. 6.30 s
d. 10.7 s

ANS: A PTS: 1 DIF: 2 TOP: 2.2 Velocity

11. A cheetah can maintain its maximum speed of 100 km/hr for 30.0 seconds. What minimum distance must a gazelle running 80.0 km/hr be ahead of the cheetah to escape?

a. 100 m
b. 167 m
c. 70.0 m
d. 83.0 m

ANS: B PTS: 1 DIF: 3 TOP: 2.2 Velocity

12. Jeff throws a ball straight up. For which situation is the vertical velocity zero?

a. on the way up
b. at the top
c. on the way back down
d. none of the above

ANS: B PTS: 1 DIF: 1 TOP: 2.2 Velocity

13. A railroad train travels forward along a straight track at 80.0 m/s for 1 000 m and then travels at 50.0 m/s for the next 1 000 m. What is the average velocity?

a. 65.0 m/s
b. 61.5 m/s
c. 63.7 m/s
d. 70.0 m/s

ANS: B PTS: 1 DIF: 2 TOP: 2.2 Velocity

14. The distance of the Earth from the sun is 93 000 000 miles. If there are 3.15×10^{7} s in one year, find the speed of the Earth in its orbit about the sun.

a. 9.28 miles/s
b. 18.6 miles/s
c. 27.9 miles/s
d. 37.2 miles/s

ANS: B PTS: 1 DIF: 2 TOP: 2.2 Velocity

15. A ball is thrown vertically upwards at 19.6 m/s. For its complete trip (up and back down to the starting position), its average velocity is:

a. 19.6 m/s.
b. 9.80 m/s.
c. 4.90 m/s.
d. not given.

ANS: D PTS: 1 DIF: 2 TOP: 2.2 Velocity

16. Changing the positive direction in a reference frame to the opposite direction does not change the sign of which of the following quantities?

a. velocity
b. average velocity
c. speed
d. displacement

ANS: C PTS: 1 DIF: 1 TOP: 2.2 Velocity

17. On a position versus time graph, the slope of the straight line joining two points on the plotted curve that are separated in time by the interval Δt, is which of the following quantities?

a. average steepness
b. average velocity

c.□instantaneous velocity
d.□average acceleration

ANS: B PTS: 1 DIF: 1 TOP: 2.2 Velocity

18. Consider the magnitude of the average speed, , and the magnitude of the average velocity, , for the same trip. Which of the following is always true?

a.□
b.□
c.□
d.□none of the above

ANS: B PTS: 1 TOP: 2.2 Velocity

19. A European sports car dealer claims that his car will accelerate at a constant rate from rest to 100 km/hr in 8.00 s. If so, what is the acceleration? *(Hint:* First convert speed to m/s.)

a.□3.47 m/s^2
b.□6.82 m/s^2
c.□11.4 m/s^2
d.□17.4 m/s^2

ANS: A PTS: 1 DIF: 2 TOP: 2.3 Acceleration

20. A European sports car dealer claims that his product will accelerate at a constant rate from rest to a speed of 100 km/hr in 8.00 s. What is the speed after the first 5.00 s of acceleration? (*Hint:* First convert the speed to m/s.)

a.□34.7 m/s
b.□44.4 m/s
c.□28.7 m/s
d.□17.4 m/s

ANS: D PTS: 1 DIF: 2 TOP: 2.3 Acceleration

21. An x vs. t graph is drawn for a ball moving in one direction. The graph starts at the origin and at t = 5 s the velocity of the ball is zero. We can be positive that at t = 5 s,

a.□the slope of the curve is non-zero.
b.□the ball has stopped.
c.□the acceleration is constant.
d.□the curve is at x = 0, t = 0.

ANS: B PTS: 1 DIF: 1 TOP: 2.3 Acceleration

22. A v vs. t graph is drawn for a ball moving in one direction. The graph starts at the origin and at t = 5 s the acceleration of the ball is zero. We know that at t = 5 s,

a.□the slope of the curve is non-zero.
b.□the velocity of the ball is not changing.
c.□the curve is not crossing the time axis.
d.□the curve is at v = 0, t = 0.

ANS: B PTS: 1 DIF: 1 TOP: 2.3 Acceleration

23. The value of an object's acceleration may be characterized in equivalent words by which of the following?

a.	displacement
b.	rate of change of displacement
c.	velocity
d.	rate of change of velocity

ANS: D PTS: 1 DIF: 1 TOP: 2.3 Acceleration

24. A 50-g ball traveling at 25.0 m/s is bounced off a brick wall and rebounds at 22.0 m/s. A high-speed camera records this event. If the ball is in contact with the wall for 3.50 ms, what is the average acceleration of the ball during this time interval?

a.	13 400 m/s^2
b.	6 720 m/s^2
c.	857 m/s^2
d.	20 m/s^2

ANS: A PTS: 1 DIF: 2 TOP: 2.3 Acceleration

25. An object is dropped from a height. Once it is moving, which of the following statements is true, at least at one point?

a.	Its velocity is more than its acceleration.
b.	Its velocity is less than its acceleration.
c.	Its velocity is the same as its acceleration.
d.	Its velocity is never equal to its acceleration.

ANS: D PTS: 1 DIF: 2 TOP: 2.3 Acceleration

26. The slope of the acceleration vs. time curve represents:

a.	the velocity.
b.	the rate of change of acceleration.
c.	the rate of change of displacement.
d.	the area under the position vs. time curve.

ANS: B PTS: 1 DIF: 2 TOP: 2.3 Acceleration

27. A strobe photograph shows equally spaced images of a car moving along a straight road. If the time intervals between images is constant, which of the following cannot be positive?

a.	the speed of the car
b.	the average velocity of the car
c.	the acceleration of the car
d.	the direction of motion of the car

ANS: C PTS: 1 DIF: 2 TOP: 2.4 Motion Diagrams

28. A strobe photograph of a car moving along a straight road shows the interval between each successive image to be diminishing. If the direction of motion of the car is taken as positive, which of the following are negative?

a.	the speed of the car
b.	the average velocity of the car

c. the average acceleration of the car
d. all of the above

ANS: C PTS: 1 DIF: 2 TOP: 2.4 Motion Diagrams

29. A ball is pushed with an initial velocity of 4.0 m/s. The ball rolls down a hill with a constant acceleration of 1.6 m/s^2. The ball reaches the bottom of the hill in 8.0 s. What is the ball's velocity at the bottom of the hill?

a. 10 m/s
b. 12 m/s
c. 16 m/s
d. 17 m/s

ANS: D PTS: 1 DIF: 2
TOP: 2.5 One-Dimensional Motion with Constant Acceleration

30. A cart is given an initial velocity of 5.0 m/s and experiences a constant acceleration of 2.0 m/s^2. What is the magnitude of the cart's displacement during the first 6.0 s of its motion?

a. 10 m
b. 55 m
c. 66 m
d. 80 m

ANS: C PTS: 1 DIF: 2
TOP: 2.5 One-Dimensional Motion with Constant Acceleration

31. A vehicle designed to operate on a drag strip accelerates from zero to 30 m/s while undergoing a straight line path displacement of 45 m. What is the vehicle's acceleration if its value may be assumed to be constant?

a. 2.0 m/s^2
b. 5.0 m/s^2
c. 10 m/s^2
d. 15 m/s^2

ANS: C PTS: 1 DIF: 2
TOP: 2.5 One-Dimensional Motion with Constant Acceleration

32. When a drag strip vehicle reaches a velocity of 60 m/s, it begins a negative acceleration by releasing a drag chute and applying its brakes. While reducing its velocity back to zero, its acceleration along a straight line path is a constant - 7.5 m/s^2. What displacement does it undergo during this deceleration period?

a. 40 m
b. 80 m
c. 160 m
d. 240 m

ANS: D PTS: 1 DIF: 2
TOP: 2.5 One-Dimensional Motion with Constant Acceleration

33. A bird, accelerating from rest at a constant rate, experiences a displacement of 28 m in 11 s. What is the final velocity after 11 s?

a.	1.8 m/s
b.	3.2 m/s
c.	5.1 m/s
d.	zero

ANS: C PTS: 1 DIF: 2
TOP: 2.5 One-Dimensional Motion with Constant Acceleration

34. A bird, accelerating from rest at a constant rate, experiences a displacement of 28 m in 11 s. What is its acceleration?

a.	0.21 m/s^2
b.	0.46 m/s^2
c.	0.64 m/s^2
d.	0.78 m/s^2

ANS: B PTS: 1 DIF: 2
TOP: 2.5 One-Dimensional Motion with Constant Acceleration

35. A European sports car dealer claims that his product will accelerate at a constant rate from rest to a speed of 100 km/hr in 8.00 s. What distance will the sports car travel during the 8 s acceleration period? (*Hint:* First convert speed to m/s.)

a.	55.5 m
b.	77.7 m
c.	111 m
d.	222 m

ANS: C PTS: 1 DIF: 2
TOP: 2.5 One-Dimensional Motion with Constant Acceleration

36. Norma releases a bowling ball from rest; it rolls down a ramp with constant acceleration. After half a second it has traveled 0.75 m. How far has it traveled after two seconds?

a.	1.2 m
b.	4.7 m
c.	9.0 m
d.	12 m

ANS: D PTS: 1 DIF: 2
TOP: 2.5 One-Dimensional Motion with Constant Acceleration

37. An automobile driver puts on the brakes and decelerates from 30.0 m/s to zero in 10.0 s. What distance does the car travel?

a.	150 m
b.	196 m
c.	336 m
d.	392 m

ANS: A PTS: 1 DIF: 2
TOP: 2.5 One-Dimensional Motion with Constant Acceleration

38. A drag racer starts from rest and accelerates at 10 m/s^2 for the entire distance of 400 m (1/4 mile). What is the velocity of the race car at the end of the run?

a. 45 m/s
b. 89 m/s
c. 130 m/s
d. 180 m/s

ANS: B PTS: 1 DIF: 2
TOP: 2.5 One-Dimensional Motion with Constant Acceleration

39. A Cessna aircraft has a lift-off speed of 120 km/hr. What minimum constant acceleration does this require if the aircraft is to be airborne after a take-off run of 240 m?

a. 2.31 m/s^2
b. 3.63 m/s^2
c. 4.63 m/s^2
d. 5.55 m/s^2

ANS: A PTS: 1 DIF: 2
TOP: 2.5 One-Dimensional Motion with Constant Acceleration

40. If the displacement of an object is given in SI units by $\Delta x = -3\,t + 4\,t^2$, at $t = 2$ s its velocity and acceleration are, respectively:

a. positive, positive.
b. positive, negative.
c. negative, negative.
d. negative, positive.

ANS: A PTS: 1 DIF: 3
TOP: 2.5 One-Dimensional Motion with Constant Acceleration

41. In the case of constant acceleration, the average velocity equals the instantaneous velocity:

a. at the beginning of the time interval.
b. at the end of the time interval.
c. half-way through the time interval.
d. three-fourths of the way through the time interval.

ANS: C PTS: 1 DIF: 2
TOP: 2.5 One-Dimensional Motion with Constant Acceleration

42. Two students are working on the same constant acceleration problem involving a car undergoing constant acceleration, having started from rest and after a certain time having traveled a distance of 108 m. The students are to find the average velocity. Both students are required to show their work and round any intermediate answers as well as the final answer properly to 3 significant figures. Each rounded answer is to be used in the next step of calculation as they proceed. For the final answer, Student A uses the formula getting the result 7.26 m/s, and Student B uses the formula getting the result 7.29 m/s. Assuming neither student makes a mistake, which student has the better answer?

a. Student A
b. Student B
c. Under significant figure rounding, both answers are equally as good.
d. The described result cannot happen; this is

physics after all.

ANS: C PTS: 1 DIF: 2
TOP: 2.5 One-Dimensional Motion with Constant Acceleration

43. A rock is thrown straight down with an initial velocity of 14.5 m/s from a cliff. What is the rock's displacement after 2.0 s? (Acceleration due to gravity is 9.80 m/s^2.)

a. 28 m
b. 49 m
c. 55 m
d. 64 m

ANS: B PTS: 1 DIF: 2 TOP: 2.6 Freely-Falling Objects

44. A rock is thrown straight up with an initial velocity of 24.5 m/s. What maximum height will the rock reach before starting to fall downward? (Take acceleration due to gravity as 9.80 m/s^2.)

a. 9.80 m
b. 19.6 m
c. 24.5 m
d. 30.6 m

ANS: D PTS: 1 DIF: 2 TOP: 2.6 Freely-Falling Objects

45. A rock is thrown straight up with an initial velocity of 19.6 m/s. What time interval elapses between the rock's being thrown and its return to the original launch point? (Acceleration due to gravity is 9.80 m/s^2.)

a. 4.00 s
b. 5.00 s
c. 8.00 s
d. 10.0 s

ANS: A PTS: 1 DIF: 2 TOP: 2.6 Freely-Falling Objects

46. Two objects of different mass are released simultaneously from the top of a 20-m tower and fall to the ground. If air resistance is negligible, which statement best applies?

a. The greater mass hits the ground first.
b. Both objects hit the ground together.
c. The smaller mass hits the ground first.
d. No conclusion can be made with the information given.

ANS: B PTS: 1 DIF: 2 TOP: 2.6 Freely-Falling Objects

47. A baseball catcher throws a ball vertically upward and catches it in the same spot when it returns to his mitt. At what point in the ball's path does it experience zero velocity and non-zero acceleration at the same time?

a. midway on the way up
b. at the top of its trajectory
c. the instant it leaves the catcher's hand
d. the instant before it arrives in the catcher's mitt

ANS: B PTS: 1 DIF: 1 TOP: 2.6 Freely-Falling Objects

48. A baseball is released at rest from the top of the Washington Monument. It hits the ground after falling for 6.0 s. What was the height from which the ball was dropped? (g = 9.8 m/s^2 and assume air resistance is negligible)

a.	1.5×10^2 m
b.	1.8×10^2 m
c.	1.1×10^2 m
d.	2.1×10^2 m

ANS: B PTS: 1 DIF: 2 TOP: 2.6 Freely-Falling Objects

49. A rock, released at rest from the top of a tower, hits the ground after 1.5 s. What is the speed of the rock as it hits the ground? (g = 9.8 m/s^2 and air resistance is negligible)

a.	15 m/s
b.	20 m/s
c.	31 m/s
d.	39 m/s

ANS: A PTS: 1 DIF: 2 TOP: 2.6 Freely-Falling Objects

50. Omar throws a rock down with speed 12 m/s from the top of a tower. The rock hits the ground after 2.0 s. What is the height of the tower? (air resistance is negligible)

a.	20 m
b.	24 m
c.	44 m
d.	63 m

ANS: C PTS: 1 DIF: 2 TOP: 2.6 Freely-Falling Objects

51. Gwen releases a rock at rest from the top of a 40-m tower. If g = 9.8 m/s^2 and air resistance is negligible, what is the speed of the rock as it hits the ground?

a.	28 m/s
b.	30 m/s
c.	56 m/s
d.	784 m/s

ANS: A PTS: 1 DIF: 2 TOP: 2.6 Freely-Falling Objects

52. John throws a rock down with speed 14 m/s from the top of a 30-m tower. If g = 9.8 m/s^2 and air resistance is negligible, what is the rock's speed just as it hits the ground?

a.	12 m/s
b.	28 m/s
c.	350 m/s
d.	784 m/s

ANS: B PTS: 1 DIF: 2 TOP: 2.6 Freely-Falling Objects

53. Human reaction time is usually about 0.20 s. If your lab partner holds a ruler between your finger and thumb and releases it without warning, how far can you expect the ruler to fall before you catch it? The nearest value is:

a. 4.0 cm.
b. 9.8 cm.
c. 16 cm.
d. 20 cm.

ANS: D PTS: 1 DIF: 2 TOP: 2.6 Freely-Falling Objects

54. At the top of a cliff 100 m high, Raoul throws a rock upward with velocity 15.0 m/s. How much later should he drop a second rock from rest so both rocks arrive simultaneously at the bottom of the cliff?

a. 5.05 s
b. 3.76 s
c. 2.67 s
d. 1.78 s

ANS: D PTS: 1 DIF: 3 TOP: 2.6 Freely-Falling Objects

55. Maria throws two stones from the top edge of a building with a speed of 20 m/s. She throws one straight down and the other straight up. The first one hits the street in a time t_1. How much later is it before the second stone hits?

a. 5 s
b. 4 s
c. 3 s
d. Not enough information is given to work this problem.

ANS: B PTS: 1 DIF: 3 TOP: 2.6 Freely-Falling Objects

56. Mt. Everest is more than 8 000 m high. How fast would an object be moving if it could free fall to sea level after being released from an 8000-m elevation? (Ignore air resistance.)

a. 396 m/s
b. 120 m/s
c. 1 200 m/s
d. 12 000 m/s

ANS: A PTS: 1 DIF: 2 TOP: 2.6 Freely-Falling Objects

57. A basketball player can jump 1.6 m off the hardwood floor. With what upward velocity did he leave the floor?

a. 1.4 m/s
b. 2.8 m/s
c. 4.2 m/s
d. 5.6 m/s

ANS: D PTS: 1 DIF: 2 TOP: 2.6 Freely-Falling Objects

58. A water rocket, launched from the ground, rises vertically with acceleration of 30 m/s^2 for 1.0 s when it runs out of "fuel." Disregarding air resistance, how high will the rocket rise?

a.	15 m
b.	31 m
c.	61 m
d.	120 m

ANS: C PTS: 1 DIF: 3 TOP: 2.6 Freely-Falling Objects

59. A parachutist jumps out of an airplane and accelerates with gravity to a maximum velocity of 58.8 m/s in 6.00 seconds. She then pulls the parachute cord and after a 4.00-second constant deceleration, descends at 10.0 m/s for 60.0 seconds, reaching the ground. From what height did the parachutist jump?

a.	914 m
b.	1 130 m
c.	1 520 m
d.	1 750 m

ANS: A PTS: 1 DIF: 3 TOP: 2.6 Freely-Falling Objects

60. A ball is thrown vertically upwards at 19.6 m/s. For its complete trip (up and back down to the starting position), its average speed is:

a.	19.6 m/s.
b.	9.80 m/s.
c.	4.90 m/s.
d.	not given.

ANS: B PTS: 1 DIF: 2 TOP: 2.6 Freely-Falling Objects

61. A ball of relatively low density is thrown upwards. Because of air resistance the acceleration while traveling upwards is - 10.8 m/s^2. On its trip downward the resistance is in the opposite direction, and the resulting acceleration is - 8.8 m/s^2. When the ball reaches the level from which it was thrown, how does its speed compare to that with which it was thrown?

a.	It is greater than the original speed upward.
b.	It is the same as the original speed upward.
c.	It is less than the original speed upward.
d.	Without knowing the original speed, this problem cannot be solved.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

62. Starting from rest, a car accelerates down a straight road with constant acceleration a_1 for a time t_1, then the acceleration is changed to a different constant value a_2 for an additional time t_2. The total elapsed time is $t_1 + t_2$. Can the equations of kinematics be used to find the total distance traveled?

a.	No, because this is not a case of constant acceleration.
b.	Yes, use $(a_1 + a_2)/2$ as the average acceleration and the total time in the calculation.
c.	Yes, use $a_1 + a_2$ as the acceleration and the average time $(t_1 + t_2)/2$ in the calculation.
d.	Yes, break the problem up into 2 problems, one with the conditions for the first time interval and the other with the conditions for the second

time interval, noting that for the second time interval the initial velocity is that from the end of the first time interval. When done, add the distances from each of the time intervals.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Problems

63. Starting from rest, a car accelerates down a straight road with constant acceleration a for a time t, then the direction of the acceleration is reversed, (i.e., it is - a), and the car comes to a stop in an additional time t, the time for the whole trip being 2t. At what time, or times, is the average velocity of the car for the trip equal to its instantaneous velocity during the trip?

a. There is no such time.
b. It is at the halfway point at t.
c. This occurs at 2 times, 0.5 t and 1.5 t.
d. This occurs at 2 times, 0.707 t and 1.293 t.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

64. A ball rolls down an incline, starting from rest. If the total time it takes to reach the end of the incline is T, how much time has elapsed when it is halfway down the incline?

a. 0.5 T
b. < 0.5 T
c. > 0.5 T
d. More information is needed.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

65. In which of the following cases is the displacement's magnitude half the distance traveled?

a. 10 steps east followed by 3 steps west
b. 22 steps east followed by 11 steps west
c. 5 steps east followed by 10 steps west
d. 15 steps east followed by 5 steps west

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Problems

Chapter 3—Vectors and Two-Dimensional Motion

MULTIPLE CHOICE

1. Which type of quantity is characterized by both magnitude and direction?

a. scalar
b. vector
c. trigonometric
d. algebraic variable

ANS: B PTS: 1 DIF: 1
TOP: 3.1 Vectors and Their Properties

2. Which of the following is an example of a vector quantity?

a. velocity
b. temperature
c. volume
d. mass

ANS: A PTS: 1 DIF: 1
TOP: 3.1 Vectors and Their Properties

3. When we subtract a velocity vector from another velocity vector, the result is:

a. another velocity.
b. an acceleration.
c. a displacement.
d. a scalar.

ANS: A PTS: 1 DIF: 1
TOP: 3.1 Vectors and Their Properties

4. When we add a displacement vector to another displacement vector, the result is:

a. a velocity.
b. an acceleration.
c. another displacement.
d. a scalar.

ANS: C PTS: 1 DIF: 1
TOP: 3.1 Vectors and Their Properties

5. A student adds two vectors with magnitudes of 200 and 40. Which one of the following is the only possible choice for the magnitude of the resultant?

a. 100
b. 200
c. 260
d. 40

ANS: B PTS: 1 DIF: 1
TOP: 3.1 Vectors and Their Properties

6. Vector points north, and vector points east. If = - , then vector points:

a.	north of east.
b.	south of east.
c.	north of west.
d.	south of west.

ANS: B PTS: 1 DIF: 2
TOP: 3.1 Vectors and Their Properties

7. The first displacement is 6 m, and the second displacement is 3 m. They cannot add together to give a total displacement of:

a.	2 m.
b.	3 m.
c.	6 m.
d.	9 m.

ANS: A PTS: 1 DIF: 1
TOP: 3.1 Vectors and Their Properties

8. Vector is 3 m long, and vector is 4 m long. The length of the sum of the vectors must be:

a.	5 m.
b.	7 m.
c.	12 m.
d.	some value from 1 m to 7 m.

ANS: D PTS: 1 DIF: 2
TOP: 3.1 Vectors and Their Properties

9. When three vectors are added graphically and form a closed triangle, the largest enclosed angle between any two of the vectors cannot be greater than:

a.	60°.
b.	90°.
c.	180°.
d.	No maximum exists.

ANS: C PTS: 1 DIF: 2
TOP: 3.1 Vectors and Their Properties

10. A runner circles a track of radius 100 m one time in 100 s at a constant rate. The greatest change in his velocity from his starting velocity:

a.	occurs one-fourth of the way around the track.
b.	occurs one-half of the way around the track.
c.	occurs three-fourths of the way around the track.
d.	Both a and c are correct.

ANS: B PTS: 1 DIF: 2
TOP: 3.1 Vectors and Their Properties

11. An object, initially moving in the negative x-direction, is subjected to a change in velocity in the positive y-direction. If the resulting velocity vector is drawn from the origin, into which quadrant does this vector point?

a. 1^{st}
b. 2^{nd}
c. 3^{rd}
d. None, since the object is now moving in the y-direction.

ANS: B PTS: 1 DIF: 1 TOP: 3.2 Components of a Vector

12. A car is initially moving at 20 m/s east, and a little while later it is moving at 10 m/s north. Which of the following best describes the orientation of the average acceleration during this time interval?

a. northeast
b. northwest
c. west
d. north of west

ANS: D PTS: 1 DIF: 2 TOP: 3.2 Components of a Vector

13. A hiker walks 200 m west and then walks 100 m north. In what direction is her resulting displacement?

a. north
b. west
c. northwest
d. None of the answers is correct.

ANS: D PTS: 1 DIF: 2 TOP: 3.2 Components of a Vector

14. An object moves at a constant velocity of 11 m/s to the southwest for an interval of 20 s. Halfway through this interval, what is the magnitude of its instantaneous velocity?

a. It can be any value from 0 to 22 m/s.
b. 11 m/s
c. 5.5 m/s
d. More information is needed.

ANS: B PTS: 1 DIF: 1 TOP: 3.2 Components of a Vector

15. In a 2-dimensional Cartesian coordinate system the *x-component* of a given vector is equal to that vector's magnitude multiplied by which trigonometric function, with respect to the angle between vector and *x*-axis?

a. sine
b. cosine
c. tangent
d. cotangent

ANS: B PTS: 1 DIF: 1 TOP: 3.2 Components of a Vector

16. In a 2-dimensional Cartesian coordinate system the *y-component* of a given vector is equal to that vector's magnitude multiplied by which trigonometric function, with respect to the angle between vector and *y-axis*?

a. sine
b. cosine
c. tangent
d. cotangent

ANS: B PTS: 1 DIF: 2 TOP: 3.2 Components of a Vector

17. In a 2-dimensional Cartesian system, the *x-component* of a vector is known, and the angle between vector and *x*-axis is known. Which operation is used to calculate the magnitude of the vector? (taken with respect to the *x-component*)

a. dividing by cosine
b. dividing by sine
c. multiplying by cosine
d. multiplying by sine

ANS: A PTS: 1 DIF: 2 TOP: 3.2 Components of a Vector

18. A taxicab moves five blocks due north, five blocks due east, and another two blocks due north. Assume all blocks are of equal size. What is the magnitude of the taxi's displacement, start to finish?

a. 12 blocks
b. 9.8 blocks
c. 9.2 blocks
d. 8.6 blocks

ANS: D PTS: 1 DIF: 2 TOP: 3.2 Components of a Vector

19. The following force vectors act on an object: *i*) 50.0 newtons at 45.0° north of east and *ii*) 25.0 newtons at 30.0° south of east. Which of the following represents the magnitude of the resultant and its angle relative to the easterly direction?

a. 75.0 newtons 7.50°
b. 61.4 newtons 21.8°
c. 23.4 newtons 18.3°
d. 12.8 newtons 37.5°

ANS: B PTS: 1 DIF: 2 TOP: 3.2 Components of a Vector

20. Find the resultant of the following two vectors: *i*) 50 units due east and *ii*) 100 units 30° north of west.

a. 100 units 30° north of west
b. 62 units 15° north of west
c. 87 units 60° north of west
d. 62 units 54° north of west

ANS: D PTS: 1 DIF: 2 TOP: 3.2 Components of a Vector

21. Arvin the Ant is on a picnic table. He travels 30 cm eastward, then 25 cm northward, and finally 15 cm westward. What is the magnitude of Arvin's net displacement?

a. 70 cm
b. 57 cm
c. 52 cm

d. 29 cm

ANS: D PTS: 1 DIF: 2 TOP: 3.2 Components of a Vector

22. Arvin the Ant travels 30 cm eastward, then 25 cm northward, and finally 15 cm westward. What is Arvin's direction of displacement with respect to his original position?

a. 59° N of E
b. 29° N of E
c. 29° N of W
d. 77° N of E

ANS: A PTS: 1 DIF: 2 TOP: 3.2 Components of a Vector

23. A string attached to an airborne kite is maintained at an angle of 40° with the horizontal. If a total of 120 m of string is reeled in while bringing the kite back to the ground, what is the horizontal displacement of the kite in the process? (Assume the kite string doesn't sag.)

a. 100 m
b. 84 m
c. 77 m
d. 92 m

ANS: D PTS: 1 DIF: 2 TOP: 3.2 Components of a Vector

24. Jack pulls a sled across a level field by exerting a force of 110 N at an angle of 30° with the ground. What are the parallel and perpendicular components, respectively, of this force with respect to the ground?

a. 64 N, 190 N
b. 190 N, 64 N
c. 95 N, 55 N
d. 55 N, 95 N

ANS: C PTS: 1 DIF: 2 TOP: 3.2 Components of a Vector

25. Vector is 3.0 units in length and points along the positive *x-axis*; vector is 4.0 units in length and points along a direction 150° from the positive *x-axis*. What is the magnitude of the resultant when vectors and are added?

a. 7.0
b. 6.7
c. 4.7
d. 2.1

ANS: D PTS: 1 DIF: 2 TOP: 3.2 Components of a Vector

26. Vector is 3.0 units in length and points along the positive *x-axis*; vector is 4.0 units in length and points along a direction 150° from the positive *x-axis*. What is the direction of the resultant with respect to the positive *x-axis*?

a. 77°
b. 13°
c. 86°
d. 103°

ANS: D PTS: 1 DIF: 2 TOP: 3.2 Components of a Vector

27. I walk six miles in a straight line in a direction north of east, and I end up two miles east and several miles north. How many degrees north of east have I walked?

a.	19°
b.	45°
c.	60°
d.	71°

ANS: D PTS: 1 DIF: 2 TOP: 3.2 Components of a Vector

28. Five boys are pushing on a snowball, and each is pushing with a force of 10.0 N. However, each boy is pushing in a different direction. They are pushing north, northeast, east, southeast, and south. (Each boy is pushing at an angle of 45.0° relative to his neighbor.) What is the magnitude of the total force on the ball?

a.	0
b.	17.1 N
c.	24.1 N
d.	27.1 N

ANS: C PTS: 1 DIF: 2 TOP: 3.2 Components of a Vector

29. A jogger runs halfway around a circular path with a radius of 60 m. What, respectively, are the magnitude of the displacement and the distance jogged?

a.	60 m, 188 m
b.	120 m, 188 m
c.	0 m, 377 m
d.	120 m, 377 m

ANS: B PTS: 1 DIF: 1
TOP: 3.3 Displacement, Velocity and Acceleration in Two Dimensions

30. A runner circles a track of radius 100 m in 100 s moving at a constant rate. If the runner was initially moving north, what has been the runner's average acceleration when halfway around the track?

a.	At a constant rate, the average acceleration would be zero.
b.	2 m/s^2, west
c.	0.25 m/s^2, south
d.	No answer is correct.

ANS: C PTS: 1 DIF: 2
TOP: 3.3 Displacement, Velocity and Acceleration in Two Dimensions

31. John throws a baseball from the outfield from shoulder height, at an initial velocity of 29.4 m/s at an initial angle of 30.0° with respect to the horizontal. The ball is in its trajectory for a total interval of 3.00 s before the third baseman catches it at an equal shoulder-height level. (Assume air resistance negligible.) What is the ball's horizontal displacement?

a.	76.4 m
b.	38.2 m
c.	57.3 m
d.	zero

ANS: A PTS: 1 DIF: 2
TOP: 3.4 Motion in Two Dimensions

32. A baseball thrown from the outfield is released from shoulder height at an initial velocity of 29.4 m/s at an initial angle of 30.0° with respect to the horizontal. If it is in its trajectory for a total of 3.00 s before being caught by the third baseman at an equal shoulder-height level, what is the ball's net vertical displacement during its 3-s trajectory?

a. 11.0 m
b. 9.80 m
c. 22.1 m
d. zero

ANS: D PTS: 1 DIF: 2
TOP: 3.4 Motion in Two Dimensions

33. A baseball thrown from the outfield is released from shoulder height at an initial velocity of 29.4 m/s at an initial angle of 30.0° with respect to the horizontal. What is the maximum vertical displacement that the ball reaches during its trajectory?

a. 11.0 m
b. 9.80 m
c. 22.1 m
d. 44.1 m

ANS: A PTS: 1 DIF: 2
TOP: 3.4 Motion in Two Dimensions

34. A baseball is thrown by the center fielder (from shoulder level) to home plate where it is caught (on the fly at an equal shoulder level) by the catcher. At what point is the ball's speed at a minimum? (air resistance is negligible)

a. just after leaving the center fielder's hand
b. just before arriving at the catcher's mitt
c. at the top of the trajectory
d. speed is constant during entire trajectory

ANS: C PTS: 1 DIF: 2
TOP: 3.4 Motion in Two Dimensions

35. A baseball is thrown by the center fielder (from shoulder level) to home plate where it is caught (on the fly at shoulder level) by the catcher. At what point is the magnitude of the acceleration at a minimum? (air resistance is negligible)

a. just after leaving the center fielder's hand
b. just before arriving at the catcher's mitt
c. at the top of the trajectory
d. acceleration is constant during entire trajectory

ANS: D PTS: 1 DIF: 1
TOP: 3.4 Motion in Two Dimensions

36. A baseball is thrown by the center fielder (from shoulder level) to home plate where it is caught (on the fly at shoulder level) by the catcher. At what point does the magnitude of the vertical component of velocity have its minimum value? (air resistance is negligible)

a. just after leaving the center fielder's hand
b. just before arriving at the catcher's mitt
c. at the top of the trajectory
d. magnitude of vertical component of velocity is constant

ANS: C PTS: 1 DIF: 1
TOP: 3.4 Motion in Two Dimensions

37. A helicopter is traveling at 40 m/s at a constant altitude of 100 m over a level field. If a wheel falls off the helicopter, with what speed will it hit the ground? (g = 9.8 m/s^2 and air resistance negligible)

a. 40 m/s
b. 50 m/s
c. 60 m/s
d. 70 m/s

ANS: C PTS: 1 DIF: 3
TOP: 3.4 Motion in Two Dimensions

38. A ball is rolled horizontally off a table with an initial speed of 0.24 m/s. A stopwatch measures the ball's trajectory time from table to the floor to be 0.30 s. What is the height of the table? (g = 9.8 m/s^2 and air resistance is negligible)

a. 0.11 m
b. 0.22 m
c. 0.33 m
d. 0.44 m

ANS: D PTS: 1 DIF: 2
TOP: 3.4 Motion in Two Dimensions

39. A ball is rolled horizontally off a table with an initial speed of 0.24 m/s. A stop watch measures the ball's trajectory time from table to the floor to be 0.30 s. How far away from the table does the ball land? (g = 9.8 m/s^2 and air resistance is negligible)

a. 0.055 m
b. 0.072 m
c. 1.2 m
d. 1.9 m

ANS: B PTS: 1 DIF: 2
TOP: 3.4 Motion in Two Dimensions

40. A stone is thrown at an angle of 30° above the horizontal from the top edge of a cliff with an initial speed of 12 m/s. A stop watch measures the stone's trajectory time from top of cliff to bottom to be 5.6 s. What is the height of the cliff? (g = 9.8 m/s^2 and air resistance is negligible)

a. 58 m
b. 154 m
c. 120 m

d. 197 m

ANS: C PTS: 1 DIF: 3
TOP: 3.4 Motion in Two Dimensions

41. A stone is thrown at an angle of 30° above the horizontal from the top edge of a cliff with an initial speed of 12 m/s. A stop watch measures the stone's trajectory time from top of cliff to bottom to be 5.6 s. How far out from the cliff's edge does the stone travel horizontally? (g = 9.8 m/s^2 and air resistance is negligible)

a. 58 m
b. 154 m
c. 120 m
d. 197 m

ANS: A PTS: 1 DIF: 3
TOP: 3.4 Motion in Two Dimensions

42. A stone is thrown with an initial speed of 15 m/s at an angle of 53° above the horizontal from the top of a 35 m building. If g = 9.8 m/s^2 and air resistance is negligible, then what is the magnitude of the vertical velocity component of the rock as it hits the ground?

a. 9.0 m/s
b. 18 m/s
c. 26 m/s
d. 29 m/s

ANS: D PTS: 1 DIF: 2
TOP: 3.4 Motion in Two Dimensions

43. A stone is thrown with an initial speed of 15 m/s at an angle of 53° above the horizontal from the top of a 35 m building. If g = 9.8 m/s^2 and air resistance is negligible, then what is the magnitude of the horizontal component of velocity as the rock strikes the ground?

a. 7.5 m/s
b. 9.0 m/s
c. 12 m/s
d. 29 m/s

ANS: B PTS: 1 DIF: 2
TOP: 3.4 Motion in Two Dimensions

44. A stone is thrown with an initial speed of 15 m/s at an angle of 53° above the horizontal from the top of a 35 m building. If g = 9.8 m/s^2 and air resistance is negligible, then what is the speed of the rock as it hits the ground?

a. 15 m/s
b. 21 m/s
c. 30 m/s
d. 36 m/s

ANS: C PTS: 1 DIF: 3
TOP: 3.4 Motion in Two Dimensions

45. A stone is thrown with an initial speed of 15 m/s at an angle of 53° above the horizontal from the top of a 35 m building. If g = 9.8 m/s^2 and air resistance is negligible, what is the magnitude of the horizontal displacement of the rock?

a. 38 m
b. 46 m
c. 66 m
d. 90 m

ANS: A PTS: 1 DIF: 3
TOP: 3.4 Motion in Two Dimensions

46. A bridge that was 5.0 m long has been washed out by the rain several days ago. How fast must a car be going to successfully jump the stream? Although the road is level on both sides of the bridge, the road on the far side is 2.0 m lower than the road on this side.

a. 5.0 m/s
b. 7.8 m/s
c. 13 m/s
d. 25 m/s

ANS: B PTS: 1 DIF: 3
TOP: 3.4 Motion in Two Dimensions

47. A rifle is aimed horizontally toward the center of a target 100 m away. If the bullet strikes 10 cm below the center, what was the velocity of the bullet? (Ignore air friction.)

a. 300 m/s
b. 333 m/s
c. 500 m/s
d. 700 m/s

ANS: D PTS: 1 DIF: 3
TOP: 3.4 Motion in Two Dimensions

48. A quarterback takes the ball from the line of scrimmage, runs backward for 10 yards, then sideways parallel to the line of scrimmage for 15 yards. He then throws a 50-yard forward pass straight downfield perpendicular to the line of scrimmage. The receiver is tackled immediately. How far is the football displaced from its original position?

a. 43 yards
b. 55 yards
c. 63 yards
d. 75 yards

ANS: A PTS: 1 DIF: 2
TOP: 3.4 Motion in Two Dimensions

49. A track star in the broad jump goes into the jump at 12 m/s and launches himself at 20° above the horizontal. How long is he in the air before returning to Earth? (g = 9.8 m/s^2)

a. 0.42 s
b. 0.84 s
c. 1.25 s
d. 1.68 s

ANS: B PTS: 1 DIF: 3
TOP: 3.4 Motion in Two Dimensions

50. Superguy is flying at treetop level near Paris when he sees the Eiffel Tower elevator start to fall (the cable snapped). His x-ray vision tells him Lois LaTour is inside. If Superguy is 1.00 km away from the tower, and the elevator falls from a height of 240 m, how long does Superguy have to save Lois, and what must be his average speed?

a. 3.00 s, 333 m/s
b. 5.00 s, 200 m/s
c. 7.00 s, 143 m/s
d. 9.00 s, 111 m/s

ANS: C PTS: 1 DIF: 2
TOP: 3.4 Motion in Two Dimensions

51. A ball is launched from ground level at 30 m/s at an angle of 35° above the horizontal. How far does it go before it is at ground level again?

a. 14 m
b. 21 m
c. 43 m
d. 86 m

ANS: D PTS: 1 DIF: 3
TOP: 3.4 Motion in Two Dimensions

52. A baseball leaves the bat with a speed of 44.0 m/s and an angle of 30.0° above the horizontal. A 5.0-m-high fence is located at a horizontal distance of 132 m from the point where the ball is struck. Assuming the ball leaves the bat 1.0 m above ground level, by how much does the ball clear the fence?

a. 4.4 m
b. 8.8 m
c. 13.4 m
d. 17.9 m

ANS: C PTS: 1 DIF: 3
TOP: 3.4 Motion in Two Dimensions

53. Wiley Coyote has missed the elusive road runner once again. This time, he leaves the edge of the cliff at 50.0 m/s horizontal velocity. If the canyon is 100 m deep, how far from his starting point at the edge of the cliff does the coyote land?

a. 226 m
b. 247 m
c. 339 m
d. 400 m

ANS: A PTS: 1 DIF: 3
TOP: 3.4 Motion in Two Dimensions

54. A fireman, 50.0 m away from a burning building, directs a stream of water from a fire hose at an angle of 30.0° above the horizontal. If the initial speed of the stream is 40.0 m/s, at what height will the stream of water strike the building?

a. 9.60 m
b. 13.4 m
c. 18.7 m
d. 22.4 m

ANS: C PTS: 1 DIF: 2
TOP: 3.4 Motion in Two Dimensions

55. The highest mountain on Mars is Olympus Mons, rising 22 000 meters above the Martian surface. If we were to throw an object horizontally off the mountain top, how long would it take to reach the surface? (Ignore atmospheric drag forces and use g_{Mars} = 3.72 m/s^2.)

a. 1.8 minutes
b. 2.4 minutes
c. 3.0 minutes
d. 0.79 minute

ANS: A PTS: 1 DIF: 3
TOP: 3.4 Motion in Two Dimensions

56. Two projectiles are launched at 100 m/s, the angle of elevation for the first being 30° and for the second 60°. Which of the following statements is false?

a. Both projectiles have the same acceleration while in flight.
b. The second projectile has the lower speed at maximum altitude.
c. Both projectiles have the same range.
d. All of the above statements are false.

ANS: D PTS: 1 DIF: 3
TOP: 3.4 Motion in Two Dimensions

57. A projectile is thrown horizontally at 10.0 m/s. The projectile hits the ground 0.510 s later. What is the angle of impact the projectile makes with the horizontal ground?

a. –30.0°
b. –26.6°
c. –27.0°
d. –60.0°

ANS: B PTS: 1 DIF: 2
TOP: 3.4 Motion in Two Dimensions

58. A projectile is launched at an angle q above the horizontal. Three seconds later the projectile is moving the same angle q below the horizontal.Which of the following (actual values with units, not just algebraic symbols) can be found from the information given?

a. the initial vertical component of the projectile’s velocity
b. the initial horizontal component of the projectile’s velocity
c. the initial magnitude of the velocity
d. None of the above since at least one of the

above must be given to find the other two values.

ANS: A PTS: 1 DIF: 3
TOP: 3.4 Motion in Two Dimensions

59. A projectile is fired directly upwards at 49.0 m/s. A second projectile is dropped from rest at some higher elevation at the instant the first projectile is fired and passes the first projectile 3.00 s later. From the frame of reference of the first projectile, what is the velocity of the second projectile as it passes by?

a. 27.0 m/s, downward
b. 45.0 m/s, downward
c. 49.0 m/s, downward
d. 58.8 m/s, downward

ANS: C PTS: 1 DIF: 3 TOP: 3.5 Relative Velocity

60. A jet airliner moving at 500 mph due east moves into a region where the wind is blowing at 120 mph in a direction 30.0° north of east. What is the new velocity and direction of the aircraft?

a. 607 mph, 5.67° N of E
b. 620 mph, 5.67° N of E
c. 607 mph, 6.22° N of E
d. 588 mph, 4.87° N of E

ANS: A PTS: 1 DIF: 3 TOP: 3.5 Relative Velocity

61. A boat moves at 10.0 m/s relative to the water. If the boat is in a river where the current is 2.00 m/s, how long does it take the boat to make a complete round trip of 1 000 m upstream followed by a 1 000-m trip downstream?

a. 200 s
b. 203 s
c. 208 s
d. 250 s

ANS: C PTS: 1 DIF: 3 TOP: 3.5 Relative Velocity

62. A river flows due east at 3.0 m/s. A boat crosses the 300-m-wide river by maintaining a constant velocity of 10 m/s due north relative to the water. If no correction is made for the current, how far downstream does the boat move by the time it reaches the far shore?

a. 6 m
b. 30 m
c. 60 m
d. 90 m

ANS: D PTS: 1 DIF: 2 TOP: 3.5 Relative Velocity

63. A boat moves through the water in a river at a speed of 8 m/s relative to the water. The boat makes a trip downstream and then makes a return trip upstream to the original starting place. Which trip takes longer?

a. the downstream trip
b. the upstream trip
c. Both trips take the same amount of time.

d. The answer cannot be figured without knowing the speed of the river flow.

ANS: B PTS: 1 DIF: 2 TOP: 3.5 Relative Velocity

64. A boat travels upstream and after one hour has gone 10 km. The boat next travels downstream and after one hour has gone 14 km. If the boat's speed relative to the water is constant, what is the speed of the current in the river?

a. 1 km/h
b. 2 km/h
c. 3 km/h
d. 4 km/h

ANS: B PTS: 1 DIF: 2 TOP: 3.5 Relative Velocity

65. Plane A is flying at 400 mph in the northeast direction relative to the earth. Plane B is flying at 500 mph in the north direction relative to the earth. What is the speed of Plane B as observed from Plane A?

a. 900 mph
b. 640 mph
c. 357 mph
d. 100 mph

ANS: C PTS: 1 DIF: 3 TOP: 3.5 Relative Velocity

66. Plane A is flying at 400 mph in the northeast direction relative to the earth. Plane B is flying at 500 mph in the north direction relative to the earth. What is the direction of motion of Plane B as observed from Plane A?

a. 52.5° N of E
b. 52.5° N or W
c. 37.5° N of W
d. 36.9° N of W

ANS: C PTS: 1 DIF: 3 TOP: 3.5 Relative Velocity

67. A plane is moving due north, directly towards its destination. Its airspeed is 200 mph. A constant breeze is blowing from west to east at 40 mph. How long will it take for the plane to travel 200 miles north?

a. one hour
b. more than one hour
c. less than one hour
d. more information is needed

ANS: B PTS: 1 DIF: 2 TOP: 3.5 Relative Velocity

68. A plane is moving due north, directly towards its destination. Its airspeed is 200 mph. A constant breeze is blowing from west to east at 20 mph. In which direction is the plane pointed?

a. 5.7° W of N
b. 10° W of N
c. 22° W of N
d. 11° E of N

ANS: A PTS: 1 DIF: 2 TOP: 3.5 Relative Velocity

69. A plane is moving due north, directly towards its destination. Its airspeed is 200 mph. A constant breeze is blowing from west to east at 30 mph. At what rate is the plane moving north?

a. 198 mph
b. 193 mph
c. 188 mph
d. 180 mph

ANS: A PTS: 1 DIF: 2 TOP: 3.5 Relative Velocity

70. Vectors , , and have magnitudes 6, 11, and 20. When these vectors are added, what is the least possible magnitude of their resultant?

a. 25
b. 15
c. 2
d. 3

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Problems

71. Four vectors all have the same magnitude. Vector 1 is at 30°, Vector 2 is at 135°, vector 3 is at 240°, and Vector 4 is at 315°. Which vector has the greatest magnitude x-component and which vector has the greatest magnitude y-component?

a. Vector 1, Vector 2
b. Vector 3, Vector 4
c. Vector 1, Vector 3
d. Vector 3, Vector 2

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

72. Vector 1 is 7 units long and is at 70°. Vector 2 is 5 units long and is at 225°. Vector 3 is 3 units long and is at 150°. Which vector has equal magnitude components?

a. Vector 1
b. Vector 2
c. Vector 3
d. None of the vectors has equal magnitude components.

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Problems

73. A particle moves east at constant velocity for a time interval DT. It then moves north at a constant velocity, with the same speed as before, for another time interval DT. Finally it moves east again with the original velocity. At the instant an additional time interval DT has elapsed, which of the following are true about the average velocity and the average acceleration for the motion described?

a. The average velocity is and the average acceleration is zero.
b. The average velocity is and the average acceleration is not zero.
c. The average velocity is not and the average acceleration is zero.

d. The average velocity is not and the average acceleration is not zero.

ANS: C PTS: 1 DIF: 3 TOP: Conceptual Problems

74. A projectile is fired at an angle of elevation of 60°. Neglecting air resistance, what are possible angles in flight between the acceleration vector and the velocity vector?

a. 160° and 40°
b. 20° and 70°
c. 90° and 60°
d. none of the above

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

Chapter 4—The Laws of Motion

MULTIPLE CHOICE

1. Which of the following is an example of the type of force that acts at a distance?

a.	gravitational
b.	magnetic
c.	electrical
d.	all of the above

ANS: D PTS: 1 DIF: 1
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

2. If we know an object is moving at constant velocity, we may assume:

a.	the net force acting on the object is zero.
b.	there are no forces acting on the object.
c.	the object is accelerating.
d.	the object is losing mass.

ANS: A PTS: 1 DIF: 1
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

3. Which of the following expresses a principle, which was initially stated by Galileo and was later incorporated into Newton's laws of motion?

a.	An object's acceleration is inversely proportional to its mass.
b.	For every action there is an equal but opposite reaction.
c.	The natural condition for a moving object is to remain in motion.
d.	The natural condition for a moving object is to come to rest.

ANS: C PTS: 1 DIF: 1
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

4. What condition must apply to a system's state of motion for it to be regarded as an inertial frame of reference?

a.	in decreasing velocity
b.	in constant velocity
c.	in constant acceleration
d.	in increasing acceleration

ANS: B PTS: 1 DIF: 1
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

5. A 7.0-kg bowling ball experiences a net force of 5.0 N. What will be its acceleration?

a.	35 m/s^2
b.	7.0 m/s^2

c. 5.0 m/s^2
d. 0.71 m/s^2

ANS: D PTS: 1 DIF: 1
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

6. An astronaut applies a force of 500 N to an asteroid, and it accelerates at 7.00 m/s^2. What is the asteroid's mass?

a. 71 kg
b. 135 kg
c. 441 kg
d. 3 500 kg

ANS: A PTS: 1 DIF: 1
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

7. Two ropes are attached to a 40-kg object. The first rope applies a force of 25 N and the second, 40 N. If the two ropes are perpendicular to each other, what is the resultant acceleration of the object?

a. 1.2 m/s^2
b. 3.0 m/s^2
c. 25 m/s^2
d. 47 m/s^2

ANS: A PTS: 1 DIF: 2
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

8. Two forces act on a 6.00-kg object. One of the forces is 10.0 N. If the object accelerates at 2.00 m/s^2, what is the greatest possible magnitude of the other force?

a. 1.0 N
b. 2.0 N
c. 22.0 N
d. 34.0 N

ANS: C PTS: 1 DIF: 2
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

9. The acceleration due to gravity on the Moon's surface is one-sixth that on Earth. An astronaut's life support backpack weighs 300 lb on Earth. What does it weigh on the Moon?

a. 1 800 lb
b. 300 lb
c. 135 lb
d. 50 lb

ANS: D PTS: 1 DIF: 1
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

10. The acceleration due to gravity on the Moon's surface is one-sixth that on Earth. What net force would be required to accelerate a 20-kg object at 6.0 m/s^2 on the moon?

a. 1.3 N
b. 20 N

c. 33 N
d. 120 N

ANS: D PTS: 1 DIF: 2
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

11. If we know that a nonzero net force is acting on an object, which of the following must we assume regarding the object's condition? The object is:

a. at rest.
b. moving with a constant velocity.
c. being accelerated.
d. losing mass.

ANS: C PTS: 1 DIF: 1
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

12. A 2 000-kg sailboat experiences an eastward force of 3 000 N by the ocean tide and a wind force against its sails with magnitude of 6 000 N directed toward the northwest (45° N of W). What is the magnitude of the resultant acceleration?

a. 2.2 m/s^2
b. 2.1 m/s^2
c. 1.5 m/s^2
d. 3.0 m/s^2

ANS: A PTS: 1 DIF: 2
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

13. A 2 000-kg sailboat experiences an eastward force of 3 000 N by the ocean tide and a wind force against its sails with magnitude of 6 000 N directed toward the northwest (45° N of W). What is the direction of the resultant acceleration?

a. 60° N of E
b. 30° N of W
c. 30° N of E
d. 74° N of W

ANS: D PTS: 1 DIF: 2
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

14. A cart of weight 20 N is accelerated across a level surface at 0.15 m/s^2. What net force acts on the wagon? (g = 9.8 m/s^2)

a. 0.92 N
b. 0.31 N
c. 3.0 N
d. 4.5 N

ANS: B PTS: 1 DIF: 2
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

15. A rock is rolled in the sand. It starts at 5.0 m/s, moves in a straight line for a distance of 3.0 m, and then stops. What is the magnitude of the average acceleration?

a.□1.8 m/s^2
b.□4.2 m/s^2
c.□5.4 m/s^2
d.□6.2 m/s^2

ANS: B PTS: 1 DIF: 2
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

16. Rita accelerates a 0.40-kg ball from rest to 9.0 m/s during the 0.15 s in which her foot is in contact with the ball. What average force does she apply to the ball during the kick?

a.□48 N
b.□72 N
c.□24 N
d.□60 N

ANS: C PTS: 1 DIF: 2
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

17. A 70.0-kg man jumps 1.00 m down onto a concrete walkway. His downward motion stops in 0.0200 seconds. If he forgets to bend his knees, what force is transmitted to his leg bones?

a.□15 500 N
b.□7 010 N
c.□4 900 N
d.□3 500 N

ANS: A PTS: 1 DIF: 3
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

18. The accelerating force of the wind on a small 200-kg sailboat is 707 N northeast. If the drag of the keel is 500 N acting west, what is the acceleration of the boat?

a.□1.5 m/s^2 due east
b.□2.5 m/s^2 due north
c.□3.0 m/s^2 northeast
d.□2.0 m/s^2 north by northwest

ANS: B PTS: 1 DIF: 2
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

19. A barefoot field-goal kicker imparts a speed of 30 m/s to a football at rest. If the football has a mass of 0.50 kg and time of contact with the football is 0.025 s, what is the force exerted on the foot?

a.□190 N
b.□380 N
c.□600 N
d.□900 N

ANS: C PTS: 1 DIF: 2
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

20. An automobile of mass 2 000 kg moving at 30 m/s is braked suddenly with a constant braking force of 10 000 N. How far does the car travel before stopping?

a. 45 m
b. 90 m
c. 135 m
d. 180 m

ANS: B PTS: 1 DIF: 2
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

21. A shot-putter moves his arm and the 7.0-kg shot through a distance of 1.0 m, giving the shot a velocity of 10 m/s from rest. Find the average force exerted on the shot during this time.

a. 175 N
b. 350 N
c. 525 N
d. 700 N

ANS: B PTS: 1 DIF: 2
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

22. A baseball batter hits an incoming 40-m/s fastball. The ball leaves the bat at 50 m/s after a ball-on-bat contact time of 0.030 s. What is the force exerted on the 0.15-kg baseball?

a. 450 N
b. 250 N
c. 90 N
d. 50 N

ANS: A PTS: 1 DIF: 2
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

23. In the terminology *a 500-N block*, the *500-N* refers to the block's:

a. mass.
b. force.
c. weight.
d. None of the above.

ANS: C PTS: 1 DIF: 1
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

24. The statement by Newton that "for every action there is an opposite but equal reaction" is regarded as which of his laws of motion?

a. first
b. second
c. third
d. fourth

ANS: C PTS: 1 DIF: 1
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

25. A thrown stone hits a window, but doesn't break it. Instead it reverses direction and ends up on the ground below the window. In this case, we know:

a. the force of the stone on the glass > the force

of the glass on the stone.
b. the force of the stone on the glass = the force of the glass on the stone.
c. the force of the stone on the glass < the force of the glass on the stone.
d. the stone didn't slow down as it broke the glass.

ANS: B PTS: 1 DIF: 2
TOP: 4.1 Forces | 4.2 Newton's First Law | 4.3 Newton's Second Law | 4.4 Newton's Third Law

26. An object of mass is on the surface of the Earth. The distance to the Sun and the Moon are and , and the masses of the Sun and Moon are and . What is the ratio of the gravitational force from the Sun to that of the Moon on the object?

a.
b.
c.
d.

ANS: C PTS: 1 DIF: 2 TOP: 4.4 Newton's Third Law

27. Two blocks, joined by a string, have masses of 6.0 and 9.0 kg. They rest on a frictionless horizontal surface. A 2nd string, attached only to the 9-kg block, has horizontal force = 30 N applied to it. Both blocks accelerate. Find the tension in the string between the blocks.

a. 18 N
b. 28 N
c. 12 N
d. 15 N

ANS: C PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

28. Three forces, 5.0 N, 15.0 N, and 20.0 N, are acting on a 9.81-kg object. Which of the following forces could also be acting on the object if it is moving with constant velocity?

a. 1.0 N
b. 19.0 N
c. 39.0 N
d. any of the above

ANS: D PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

29. An airplane of mass 1.2 ´ 10^4 kg tows a glider of mass 0.6 ´ 10^4 kg. The airplane propellers provide a net forward thrust of 3.6 ´ 10^4 N. What is the glider's acceleration?

a. 2.0 m/s^2
b. 3.0 m/s^2
c. 6.0 m/s^2
d. 9.8 m/s^2

ANS: A PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

30. Two blocks of masses 20 kg and 8 kg are connected together by a light string and rest on a frictionless level surface. Attached to the 8-kg mass is another light string, which a person uses to pull both blocks horizontally. If the two-block system accelerates at 0.5 m/s^2 what is the tension in the connecting string between the blocks?

a. 14 N
b. 6 N
c. 10 N
d. 4.0 N

ANS: C PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

31. Two blocks of masses 20 kg and 8.0 kg are connected together by a light string and rest on a frictionless level surface. Attached to the 8-kg mass is a second light string, which a person uses to pull both blocks horizontally. If the two-block system accelerates at 0.5 m/s^2, what is the tension in the second string attached to the 8-kg mass?

a. 14 N
b. 6.0 N
c. 10 N
d. 4.0 N

ANS: A PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

32. A 10-kg mass and a 2.0-kg mass are connected by a light string over a massless, frictionless pulley. If g = 9.8 m/s^2, what is the acceleration of the system when released?

a. 2.5 m/s^2
b. 6.5 m/s^2
c. 7.8 m/s^2
d. 9.8 m/s^2

ANS: B PTS: 1 DIF: 3
TOP: 4.5 Applications of Newton's Laws

33. A 15-kg block rests on a level frictionless surface and is attached by a light string to a 5.0-kg hanging mass where the string passes over a massless frictionless pulley. If g = 9.8 m/s^2, what is the tension in the connecting string?

a. 65 N
b. 17 N
c. 49 N
d. 37 N

ANS: D PTS: 1 DIF: 3
TOP: 4.5 Applications of Newton's Laws

34. An elevator weighing 20 000 N is supported by a steel cable. What is the tension in the cable when the elevator is being accelerated upward at a rate of 3.00 m/s^2? (g = 9.80 m/s^2)

a. 13 900 N
b. 23 100 N
c. 20 000 N
d. 26 100 N

ANS: D PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

35. As a basketball player starts to jump for a rebound, he begins to move upward faster and faster until he leaves the floor. During this time that he is in contact with the floor, the force of the floor on his shoes is:

a. bigger than his weight.
b. equal in magnitude and opposite in direction to his weight.
c. less than his weight.
d. zero.

ANS: A PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

36. As I slide a box at constant speed up a frictionless slope, pulling parallel to the slope, the tension in the rope will be:

a. greater than the tension would be if the box were stationary.
b. greater than the weight of the box.
c. equal to the weight of the box.
d. less than the weight of the box.

ANS: D PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

37. A boxcar of mass 200 tons at rest becomes uncoupled on a 2.5° grade. If the track is considered to be frictionless, what speed does the boxcar have after 10 seconds?

a. 0.37 m/s
b. 0.59 m/s
c. 1.3 m/s
d. 4.3 m/s

ANS: D PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

38. As a 3.0-kg bucket is being lowered into a 10-m-deep well, starting from the top, the tension in the rope is 9.8 N. The acceleration of the bucket will be:

a. 6.5 m/s^2 downward.
b. 9.8 m/s^2 downward.
c. zero.
d. 3.3 m/s^2 upward.

ANS: A PTS: 1 DIF: 3
TOP: 4.5 Applications of Newton's Laws

39. A 5 000-N weight is held suspended in equilibrium by two cables. Cable 1 applies a horizontal force to the right of the object and has a tension, T_1. Cable 2 applies a force upward and to the left at an angle of 37.0° to the negative *x*-axis and has a tension, T_2. What is the tension, T_1?

a. 4 000 N
b. 6 640 N
c. 8 310 N
d. 3 340 N

ANS: B PTS: 1 DIF: 3
TOP: 4.5 Applications of Newton's Laws

40. A 5 000-N weight is suspended in equilibrium by two cables. Cable 1 applies a horizontal force to the right of the object and has a tension, T_1. Cable 2 applies a force upward and to the left at an angle of 37.0° to the negative *x*-axis and has a tension, T_2. Find T_2.

a. 4 000 N
b. 6 640 N
c. 8 310 N
d. 3 340 N

ANS: C PTS: 1 DIF: 3
TOP: 4.5 Applications of Newton's Laws

41. Three identical 6.0-kg cubes are placed on a horizontal frictionless surface in contact with one another. The cubes are lined up from left to right and a force is applied to the left side of the left cube causing all three cubes to accelerate to the right at 2.0 m/s^2. What is the magnitude of the force exerted on the middle cube by the left cube in this case?

a. 12 N
b. 24 N
c. 36 N
d. none of the above

ANS: B PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

42. Three identical 6.0-kg cubes are placed on a horizontal frictionless surface in contact with one another. The cubes are lined up from left to right and a force is applied to the left side of the left cube causing all three cubes to accelerate to the right at 2.0 m/s^2. What is the magnitude of the force exerted on the right cube by the middle cube in this case?

a. 12 N
b. 24 N
c. 36 N
d. none of the above

ANS: A PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

43. A sled weighs 100 N. It is held in place on a frictionless 20° slope by a rope attached to a stake at the top; the rope is parallel to the slope. Find the tension in the rope.

a. 94 N
b. 47 N

c. □37 N
d. □34 N

ANS: D PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

44. A sled weighs 100 N. It is held in place on a frictionless 20° slope by a rope attached to a stake at the top; the rope is parallel to the slope. What is the normal force of the slope acting on the sled?

a. □94 N
b. □47 N
c. □37 N
d. □34 N

ANS: A PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

45. A 500-N tightrope walker stands at the center of the rope such that each half of the rope makes an angle of 10.0° with the horizontal. What is the tension in the rope?

a. □1 440 N
b. □1 000 N
c. □500 N
d. □2 900 N

ANS: A PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

46. A 500-N tightrope walker stands at the center of the rope. If the rope can withstand a tension of 1 800 N without breaking, what is the minimum angle the rope can make with the horizontal?

a. □4°
b. □8°
c. □10°
d. □15°

ANS: B PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

47. A 20-kg traffic light hangs midway on a cable between two poles 40 meters apart. If the sag in the cable is 0.40 meters, what is the tension in each side of the cable?

a. □12 000 N
b. □9 800 N
c. □4 900 N
d. □980 N

ANS: C PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

48. A girl is using a rope to pull a box that weighs 300 N across a level surface with constant velocity. The rope makes an angle of 30° above the horizontal, and the tension in the rope is 100 N. What is the normal force of the floor on the box?

a. □300 N

b. 86 N
c. 50 N
d. 250 N

ANS: D PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

49. A karate master strikes a board with an initial velocity of 10.0 m/s, decreasing to 1.0 m/s as his hand passes through the board. If the time of contact with the board is 0.002 0 s, and the mass of the coordinated hand and arm is 1.0 kg, what is the force exerted on the board?

a. 1 000 N
b. 1 800 N
c. 2 700 N
d. 4 500 N

ANS: D PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

50. Find the tension in an elevator cable if the 1 000-kg elevator is descending with an acceleration of 1.8 m/s^2, downward.

a. 5 700 N
b. 8 000 N
c. 9 800 N
d. 11 600 N

ANS: B PTS: 1 DIF: 2
TOP: 4.5 Applications of Newton's Laws

51. A block of mass 5.00 kg rests on a horizontal surface where the coefficient of kinetic friction between the two is 0.200. A string attached to the block is pulled horizontally, resulting in a 2.00-m/s^2 acceleration by the block. Find the tension in the string. (g = 9.80 m/s^2)

a. 0.200 N
b. 9.80 N
c. 19.8 N
d. 10.0 N

ANS: C PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

52. A horizontal force of 750 N is needed to overcome the force of static friction between a level floor and a 250-kg crate. If g = 9.8 m/s^2, what is the coefficient of static friction?

a. 3.0
b. 0.15
c. 0.28
d. 0.31

ANS: D PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

53. A horizontal force of 750 N is needed to overcome the force of static friction between a level floor and a 250-kg crate. What is the acceleration of the crate if the 750-N force is maintained after the crate begins to move and the coefficient of kinetic friction is 0.12?

a. 1.8 m/s^2

b. $2.5\ m/s^2$
c. $3.0\ m/s^2$
d. $3.8\ m/s^2$

ANS: A PTS: 1 DIF: 3 TOP: 4.6 Forces of Friction

54. A 100-kg box is placed on a ramp. As one end of the ramp is raised, the box begins to move downward just as the angle of inclination reaches 15°. What is the coefficient of static friction between box and ramp?

a. 0.15
b. 0.27
c. 0.77
d. 0.95

ANS: B PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

55. A 300-kg crate is placed on an adjustable inclined plane. As one end of the incline is raised, the crate begins to move downward. If the crate slides down the plane with an acceleration of $0.70\ m/s^2$ when the incline angle is 25°, what is the coefficient of kinetic friction between ramp and crate? ($g = 9.8\ m/s^2$)

a. 0.47
b. 0.42
c. 0.39
d. 0.12

ANS: C PTS: 1 DIF: 3 TOP: 4.6 Forces of Friction

56. A 250-kg crate is placed on an adjustable inclined plane. If the crate slides down the incline with an acceleration of $0.70\ m/s^2$ when the incline angle is 25°, then what should the incline angle be for the crate to slide down the plane at constant speed? ($g = 9.8\ m/s^2$)

a. 12°
b. 21°
c. 25°
d. 29°

ANS: B PTS: 1 DIF: 3 TOP: 4.6 Forces of Friction

57. Doug hits a hockey puck, giving it an initial velocity of 6.0 m/s. If the coefficient of kinetic friction between ice and puck is 0.050, how far will the puck slide before stopping?

a. 19 m
b. 25 m
c. 37 m
d. 57 m

ANS: C PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

58. It is late and Carlos is sliding down a rope from his third floor window to meet his friend Juan. As he slides down the rope faster and faster, he becomes frightened and grabs harder on the rope, increasing the tension in the rope. As soon as the upward tension in the rope becomes equal to his weight:

a. Carlos will stop.
b. Carlos will slow down.

c. Carlos will continue down at a constant velocity.
d. the rope must break.

ANS: C PTS: 1 DIF: 1 TOP: 4.6 Forces of Friction

59. Three identical 6.0-kg cubes are placed on a horizontal frictionless surface in contact with one another. The cubes are lined up from left to right and a 36-N force is applied to the left side of the left cube causing all three cubes to accelerate to the right. If the cubes are each subject to a frictional force of 6.0 N, what is the magnitude of the force exerted on the middle cube by the left cube in this case?

a. 12 N
b. 24 N
c. 36 N
d. none of the above

ANS: B PTS: 1 DIF: 3 TOP: 4.6 Forces of Friction

60. Three identical 6.0-kg cubes are placed on a horizontal frictionless surface in contact with one another. The cubes are lined up from left to right and a 36-N force is applied to the left side of the left cube causing all three cubes to accelerate to the right. If the cubes are each subject to a frictional force of 6.0 N, what is the magnitude of the force exerted on the right cube by the middle cube in this case?

a. 12 N
b. 24 N
c. 36 N
d. none of the above

ANS: A PTS: 1 DIF: 3 TOP: 4.6 Forces of Friction

61. As a car goes up a hill, there is a force of friction between the road and the tires rolling on the road. The maximum force of friction is equal to:

a. the weight of the car times the coefficient of kinetic friction.
b. the normal force of the road times the coefficient of kinetic friction.
c. the normal force of the road times the coefficient of static friction.
d. zero.

ANS: C PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

62. As a car moves forward on a level road at constant velocity, the net force acting on the tires is:

a. greater than the normal force times the coefficient of static friction.
b. equal to the normal force times the coefficient of static friction.
c. the normal force times the coefficient of kinetic friction.
d. zero.

ANS: D PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

63. As a car skids with its wheels locked trying to stop on a road covered with ice and snow, the force of friction between the icy road and the tires will usually be:

a. greater than the normal force of the road times the coefficient of static friction.
b. equal to the normal force of the road times the coefficient of static friction.
c. less than the normal force of the road times the coefficient of static friction.
d. greater than the normal force of the road times the coefficient of kinetic friction.

ANS: C PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

64. There are six books in a stack, each with a weight of 5.0 N. The coefficient of friction between all the books is 0.20 as is the coefficient between the table and the bottom book. What horizontal push must I just exceed on the next to bottom book to start sliding the top five books off the bottom one?

a. 1.0 N
b. 5.0 N
c. 3.0 N
d. 7.0 N

ANS: B PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

65. Two objects, A and B, are placed on an inclined plane that can be rotated to different angles of elevation. A starts to slide at twice the angle of elevation that B starts sliding. The respective coefficients for static friction for A and B are m_A and m_B. Choose the last answer that is correct.

a. $m_B > m_A$
b. $m_A > m_B$
c. $m_B = 2\ m_A$
d. $m_A = 2\ m_B$

ANS: B PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

66. A 10.0-kg mass is placed on a 25.0° incline and friction keeps it from sliding. The coefficient of static friction in this case is 0.580, and the coefficient of sliding friction is 0.520. What is the frictional force in this situation?

a. 41.4 N
b. 88.8 N
c. 46.2 N
d. 51.5 N

ANS: A PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

67. A 10.0-kg mass is placed on a 25.0° incline and friction keeps it from sliding. The coefficient of static friction in this case is 0.580, and the coefficient of sliding friction is 0.520. The mass is given a shove causing it to slide down the incline. What is the frictional force while the mass is sliding?

a. 41.4 N
b. 88.8 N
c. 46.2 N
d. 51.5 N

ANS: C PTS: 1 DIF: 3 TOP: 4.6 Forces of Friction

68. A 10.0-kg mass is placed on a 25.0° incline and friction keeps it from sliding. The coefficient of static friction in this case is 0.580 and the coefficient of sliding friction is 0.520. The mass is given a shove causing it to slide down the incline. Taking down the incline as positive, what is the acceleration of the mass while it is sliding?

a. 0.477 m/s^2
b. - 0.477 m/s^2
c. 1.99 m/s^2
d. - 1.99 m/s^2

ANS: B PTS: 1 DIF: 3 TOP: 4.6 Forces of Friction

69. A man pulls a sled at a constant velocity across a horizontal snow surface. If a force of 80 N is being applied to the sled rope at an angle of 53° to the ground, what is the force of friction between sled and snow?

a. 80 N
b. 64 N
c. 48 N
d. 40 N

ANS: C PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

70. A trapeze artist, with swing, weighs 800 N; he is momentarily held to one side by his partner so that the swing ropes make an angle of 30.0° with the vertical. In such a condition of static equilibrium, what is the horizontal force being applied by the partner?

a. 924 N
b. 400 N
c. 196 N
d. 462 N

ANS: D PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

71. A trapeze artist, with swing, weighs 800 N; he is being held to one side by his partner so that the swing ropes make an angle of 30.0° with the vertical. In such a condition of static equilibrium, what is the tension in the rope?

a. 924 N
b. 400 N
c. 196 N
d. 461 N

ANS: A PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

72. A 200-N crate rests on an ramp; the maximum angle just before it slips is 25° with the horizontal. What is the coefficient of static friction between crate and ramp surfaces?

a. 0.11
b. 0.21
c. 0.38
d. 0.47

ANS: D PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

73. A 150-N sled is pulled up a 28° slope at a constant speed by a force of 100 N. What is the coefficient of kinetic friction between sled and slope?

a.	0.53
b.	0.22
c.	0.13
d.	0.33

ANS: B PTS: 1 DIF: 3 TOP: 4.6 Forces of Friction

74. Jamal pulls a 150-N sled up a 28.0° slope at constant speed by a force of 100 N. Near the top of the hill he releases the sled. With what acceleration does the sled go down the hill?

a.	1.20 m/s^2
b.	1.67 m/s^2
c.	2.22 m/s^2
d.	2.67 m/s^2

ANS: D PTS: 1 DIF: 3 TOP: 4.6 Forces of Friction

75. Dana uses a rope to pull a box that weighs 300 N across a level surface with constant velocity. The rope makes an angle of 30° above the horizontal and the tension in the rope is 100 N. What is the coefficient of friction?

a.	0.35
b.	0.29
c.	0.17
d.	0.20

ANS: A PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

76. Hector drives a pickup truck horizontally at 15.0 m/s. He is transporting a crate of delicate lead crystal. If the coefficient of static friction between the crate and the truck bed is 0.400, what is the minimum stopping distance for the truck so the crate will not slide?

a.	28.7 m
b.	51.0 m
c.	33.6 m
d.	44.4 m

ANS: A PTS: 1 DIF: 3 TOP: 4.6 Forces of Friction

77. The coefficient of friction between a racecar's wheels and the track is 1.0. The car starts from rest and accelerates at a constant rate for 400 m. Find the maximum speed at the end of the race.

a.	44 m/s
b.	66 m/s
c.	89 m/s
d.	99 m/s

ANS: C PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

78. A worker pulls a 200-N packing crate at constant velocity across a rough floor by exerting a force *F* = 55.0 N at an angle of 35.0° above the horizontal. What is the coefficient of kinetic friction of the floor?

a. 0.133
b. 0.267
c. 0.400
d. 0.200

ANS: B PTS: 1 DIF: 3 TOP: 4.6 Forces of Friction

79. A hockey puck moving at 7.0 m/s coasts to a halt in 75 m on a smooth ice surface. What is the coefficient of friction between the ice and the puck?

a. μ= 0.025
b. μ= 0.033
c. μ= 0.12
d. μ= 0.25

ANS: B PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

80. An Olympic skier moving at 20.0 m/s down a 30.0° slope encounters a region of wet snow, of coefficient of friction μ_k = 0.740. How far down the slope does she go before stopping?

a. 119 m
b. 145 m
c. 170 m
d. 199 m

ANS: B PTS: 1 DIF: 3 TOP: 4.6 Forces of Friction

81. The coefficient of static friction between the tires of a car and the street is μ_s = 0.77. Of the following, what is the steepest inclination angle of a street on which a car can be parked (with wheels locked) without slipping?

a. 22.5°
b. 30°
c. 37°
d. 45°

ANS: C PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

82. A 9.0-kg hanging weight is connected by a string over a pulley to a 5.0-kg block sliding on a flat table. If the coefficient of sliding friction is 0.20, find the tension in the string.

a. 19 N
b. 24 N
c. 32 N
d. 38 N

ANS: D PTS: 1 DIF: 3 TOP: 4.6 Forces of Friction

83. A 100-N block, on a 30° incline, is being held motionless by friction. The coefficient of static friction between the block and the plane is 0.60. The force due to friction is:

a. 0 N.
b. 30 N.
c. 50 N.
d. 52 N.

ANS: C PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

84. A block is launched up an incline plane. After going up the plane, it slides back down to its starting position. The coefficient of friction between the block and the plane is 0.3. The time for the trip up the plane:

a. is the same as the time for the trip down.
b. is more than the time for the trip down.
c. is less than the time for the trip down.
d. cannot be found without knowing the angle of inclination.

ANS: C PTS: 1 DIF: 3 TOP: 4.6 Forces of Friction

85. A block is launched up an incline plane. After going up the plane, it slides back down to its starting position. The coefficient of friction between the block and the plane is 0.3. The speed of the block when it reaches the starting position on the trip down:

a. is the same as the launching speed.
b. is less than the launching speed.
c. is more than the launching speed.
d. cannot be compared to the launch speed with the information given.

ANS: B PTS: 1 DIF: 3 TOP: 4.6 Forces of Friction

86. The maximum possible value for the coefficient of static friction is:

a. 0.50.
b. 1.00.
c. a value up to but not quite 1.00.
d. greater than 1.00.

ANS: D PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

87. A box is to be moved across a level surface. A force of magnitude 200 N may be applied at an angle of 30° below the horizontal to push the box or at an angle of 30° above the horizontal to pull the box, either application sufficient to overcome friction and move the box. Which application will cause the box to have the greater acceleration?

a. the one below the horizontal
b. the one above the horizontal
c. both give equal acceleration
d. more information is needed

ANS: B PTS: 1 DIF: 3 TOP: 4.6 Forces of Friction

88. A crate is in the bed of a pickup truck on a level road. The coefficients of static friction and kinetic friction between the crate and the bed of the truck are and , respectively. When the truck starts from rest, what is the limiting acceleration that it can have before the crate starts sliding along the truck bed?

a.□
b.□
c.□
d.□

ANS: C PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

89. Two boxes are stacked on top of one another on the back of a flat bed truck on a level roadway. The coefficient of static friction between the boxes is , and the coefficient of static friction between the bottom box and the bed of the truck is . What is the limiting acceleration the truck can undergo before one or both of the boxes start sliding if ?

a.□
b.□
c.□
d.□

ANS: C PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

90. Two blocks are at rest on a horizontal frictionless surface with a compressed spring between them. The 10-kg block accelerates when the string holding the system in compression is cut and the 20-kg box accelerates in the opposite direction. What is the magnitude of the force from the expanding spring on the 20-kg box when the 10-kg box is undergoing an acceleration of 8.0 ?

a.□40 N
b.□160 N
c.□(160/3) N
d.□80 N

ANS: D PTS: 1 DIF: 2 TOP: 4.6 Forces of Friction

91. A crate of weight W is being pushed across a horizontal surface by a force directed at an angle of 20° below the horizontal. What is the magnitude of the normal force on the crate?

a.□It is less than W.
b.□It equals W.
c.□It is more than W.
d.□None of the above since the coefficient of kinetic friction is not given.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

92. The net force on an object is in the positive x-direction. Consider the following statements.

(i)□The object can be moving in the negative x-direction.
(ii)□The object can be speeding up.
(iii)□The object can be slowing down.
(iv)□The object can be moving in the positive y-direction.

Which of the statements are true?

a. (i) and (ii)
b. (ii) and (iii)
c. (iii) and (iv)
d. Choose this answer if all the statements are true.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Problems

93. An object weighs 100 N. If the gravitational constant G were half of what it is currently, what would the weight of the object be?

a. 100 N
b. 50 N
c. 25 N
d. 200 N

ANS: B PTS: 1 DIF: 1 TOP: Conceptual Problems

94. Five boxes, each having weight 100 N, are stacked up. The bottom box is the fifth from the top. What is the magnitude of the normal force upward exerted by the fourth box from the top on the third box from the top?

a. 100 N
b. 200 N
c. 300 N
d. 400 N

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

95. A box of mass m is placed on an incline with angle of inclination q. The box does not slide. The magnitude of the frictional force in this case is:

a. ɱ mg sin q.
b. mg cos q.
c. mg sin q.
d. not given.

ANS: C PTS: 1 DIF: 3 TOP: Conceptual Problems

Chapter 5—Energy

MULTIPLE CHOICE

1. The unit of work, joule, is dimensionally the same as:

a. newton/second.
b. newton/kilogram.
c. newton-second.
d. newton-meter.

ANS: D PTS: 1 DIF: 1 TOP: 5.1 Work

2. Rupel pushes a box 5.00 m by applying a 25.0-N horizontal force. What work does she do?

a. 10.0 J
b. 25.0 J
c. 125 J
d. 550 J

ANS: C PTS: 1 DIF: 1 TOP: 5.1 Work

3. A worker pushes a sled with a force of 40 N over a level distance of 6.0 m. If a frictional force of 24 N acts on the wheelbarrow in a direction opposite to that of the worker, what net work is done on the wheelbarrow?

a. 240 J
b. 216 J
c. 144 J
d. 96 J

ANS: D PTS: 1 DIF: 2 TOP: 5.1 Work

4. A horizontal force of 100 N is applied to move a 45-kg cart across a 9.0-m level surface. What work is done by the 100-N force?

a. 405 J
b. 500 J
c. 900 J
d. 4 500 J

ANS: C PTS: 1 DIF: 1 TOP: 5.1 Work

5. I use a rope 2.00 m long to swing a 10.0-kg weight around my head. The tension in the rope is 20.0 N. In half a revolution how much work is done by the rope on the weight?

a. 40.0 J
b. 126 J
c. 251 J
d. 0

ANS: D PTS: 1 DIF: 2 TOP: 5.1 Work

6. The work done by static friction can be:

a. positive.

b. negative.
c. zero.
d. Any of the above.

ANS: D PTS: 1 DIF: 2 TOP: 5.1 Work

7. A satellite is held in orbit by a 2 000-N gravitational force. Each time the satellite completes an orbit of circumference 80 000 km, the work done on it by gravity is:

a. 1.6×10^{8} J.
b. 1.6×10^{11} J.
c. 6.4×10^{11} J.
d. 0.

ANS: D PTS: 1 DIF: 2 TOP: 5.1 Work

8. A student has to work the following problem: A block is being pulled along at constant speed on a horizontal surface a distance d by a rope supplying a force F at an angle of elevation θ. The surface has a frictional force acting during this motion. How much work was done by friction during this motion? The student calculates the value to be $-Fd\sin\theta$. How does this value compare to the correct value?

a. It is the correct value.
b. It is too high.
c. It is too low.
d. The answer cannot be found until it is known whether θ is greater than, less than, or equal to 45°.

ANS: D PTS: 1 DIF: 3 TOP: 5.1 Work

9. Which of the following is an example of a nonconservative force?

a. gravity
b. magnetism
c. friction
d. Both choices A and B are valid.

ANS: C PTS: 1 DIF: 1
TOP: 5.2 Kinetic Energy and the Work-Energy Theorem

10. Which of the following is that form of energy associated with an object's motion?

a. potential
b. thermal
c. bio-chemical
d. kinetic

ANS: D PTS: 1 DIF: 1
TOP: 5.2 Kinetic Energy and the Work-Energy Theorem

11. Which of the following is that form of energy associated with an object's location in a conservative force field?

a. potential
b. thermal

c.	bio-chemical
d.	kinetic

ANS: A PTS: 1 DIF: 1
TOP: 5.2 Kinetic Energy and the Work-Energy Theorem

12. What is the kinetic energy of a 0.135-kg baseball thrown at 40.0 m/s (90.0 mph)?

a.	54.0 J
b.	87.0 J
c.	108 J
d.	216 J

ANS: C PTS: 1 DIF: 1
TOP: 5.2 Kinetic Energy and the Work-Energy Theorem

13. A horizontal force of 200 N is applied to a 55-kg cart across a 10-m level surface. If the cart accelerates at 2.0 m/s^2, then what is the work done by the force of friction as it acts to retard the motion of the cart?

a.	- 1 100 J
b.	- 900 J
c.	- 800 J
d.	- 700 J

ANS: B PTS: 1 DIF: 2
TOP: 5.2 Kinetic Energy and the Work-Energy Theorem

14. A golf ball hits a wall and bounces back at 3/4 the original speed. What part of the original kinetic energy of the ball did it lose in the collision?

a.	1/4
b.	3/8
c.	7/16
d.	9/16

ANS: C PTS: 1 DIF: 2
TOP: 5.2 Kinetic Energy and the Work-Energy Theorem

15. If both mass and velocity of a ball are tripled, the kinetic energy is increased by a factor of:

a.	3.
b.	6.
c.	9.
d.	27.

ANS: D PTS: 1 DIF: 1
TOP: 5.2 Kinetic Energy and the Work-Energy Theorem

16. A 1 200-kg automobile moving at 25 m/s has the brakes applied with a deceleration of 8.0 m/s^2. How far does the car travel before it stops?

a.	39 m
b.	47 m
c.	55 m
d.	63 m

ANS: A PTS: 1 DIF: 2
TOP: 5.2 Kinetic Energy and the Work-Energy Theorem

17. If during a given physical process the only force acting on an object is friction, which of the following must be assumed in regard to the object's kinetic energy?

a. It decreases.
b. It increases.
c. It remains constant.
d. It cannot be determined from the information given.

ANS: D PTS: 1 DIF: 1
TOP: 5.2 Kinetic Energy and the Work-Energy Theorem

18. A 50.0-kg (including the passenger) sled is subject to a net force of 20.0 N pushing in the direction of the sled’s motion as it is moving over a horizontal surface for a distance of 11.0 m after having started from rest. At this point the sled is released as it starts down a 10.0° incline. However, the snow is not very deep, and the sled stops after having moved an additional 35.0 m. What is the work done by friction while the sled is on the incline?

a. –220 J
b. –3200 J
c. –858 J
d. –2980 J

ANS: B PTS: 1 DIF: 3
TOP: 5.1 Work | 5.3 Gravitational Potential Energy

19. A 10.0-kg sled slides down a snowy hill. At position A it is moving at 1.00 m/s. when it reaches position B it is moving at 3.00 m/s. Finally it passes position C moving at 1.00 m/s again. Position C is 3.00 m lower than position A and 1.00 m lower than position B.The coefficient of kinetic friction varies from place to place in the snow. What is the work done by friction on the sled as it moves from A to C?

a.
b.
c.
d. Insufficient information is given to solve this problem.

ANS: A PTS: 1 DIF: 2
TOP: 5.1 Work | 5.3 Gravitational Potential Energy

20. A very light cart holding a 300-N box is moved at constant velocity across a 15-m level surface. What is the net work done in the process?

a. zero
b. 1/20 J
c. 20 J
d. 2 000 J

ANS: A PTS: 1 DIF: 1
TOP: 5.3 Gravitational Potential Energy

21. A 7.00-kg bowling ball falls from a 2.00-m shelf. Just before hitting the floor, what will be its kinetic energy? (g = 9.80 m/s^2 and assume air resistance is negligible)

a.	14.0 J
b.	19.6 J
c.	29.4 J
d.	137 J

ANS: D PTS: 1 DIF: 1
TOP: 5.3 Gravitational Potential Energy

22. A rock is thrown straight up with an initial velocity of 15.0 m/s. Ignore energy lost to air friction. How high will the rock rise?

a.	1.53 m
b.	22.9 m
c.	6.50 m
d.	11.5 m

ANS: D PTS: 1 DIF: 2
TOP: 5.3 Gravitational Potential Energy

23. What is the minimum amount of energy required for an 80-kg climber carrying a 20-kg pack to climb Mt. Everest, 8 850 m high?

a.	8.67 MJ
b.	4.16 MJ
c.	2.47 MJ
d.	1.00 MJ

ANS: A PTS: 1 DIF: 2
TOP: 5.3 Gravitational Potential Energy

24. A professional skier reaches a speed of 56 m/s on a 30° ski slope. Ignoring friction, what was the minimum distance along the slope the skier would have had to travel, starting from rest?

a.	110 m
b.	160 m
c.	320 m
d.	640 m

ANS: C PTS: 1 DIF: 2
TOP: 5.3 Gravitational Potential Energy

25. As an object is lowered into a deep hole in the surface of the earth, which of the following must be assumed in regard to its potential energy?

a.	increase
b.	decrease
c.	remain constant
d.	cannot tell from the information given

ANS: B PTS: 1 DIF: 1
TOP: 5.3 Gravitational Potential Energy

26. When an object is dropped from a tower, what is the effect of the air resistance as it falls?

a.	does positive work
b.	increases the object's kinetic energy
c.	increases the object's potential energy
d.	None of the above choices are valid.

ANS: D PTS: 1 DIF: 1
TOP: 5.3 Gravitational Potential Energy

27. Samantha pushes a 50-N crate up a ramp 25.0 m in length and inclined at 10° with the horizontal. What potential energy change does the crate experience?

a.	13 J
b.	55 J
c.	120 J
d.	220 J

ANS: D PTS: 1 DIF: 1
TOP: 5.3 Gravitational Potential Energy

28. A 15.0-kg crate, initially at rest, slides down a ramp 2.0 m long and inclined at an angle of 20° with the horizontal. If there is no friction between ramp surface and crate, what is the kinetic energy of the crate at the bottom of the ramp? (g = 9.8 m/s^2)

a.	220 J
b.	690 J
c.	10 J
d.	100 J

ANS: D PTS: 1 DIF: 2
TOP: 5.3 Gravitational Potential Energy

29. A 10.0-kg box starts at rest and slides 3.5 m down a ramp inclined at an angle of 10° with the horizontal. If there is no friction between the ramp surface and crate, what is the velocity of the crate at the bottom of the ramp? (g = 9.8 m/s^2)

a.	6.1 m/s
b.	3.5 m/s
c.	10.7 m/s
d.	8.3 m/s

ANS: B PTS: 1 DIF: 2
TOP: 5.3 Gravitational Potential Energy

30. A baseball catcher puts on an exhibition by catching a 0.15-kg ball dropped from a helicopter at a height of 101 m. What is the speed of the ball just before it hits the catcher's glove 1.0 m above the ground? (g = 9.8 m/s^2 and ignore air resistance)

a.	44 m/s
b.	38 m/s
c.	31 m/s
d.	22 m/s

ANS: A PTS: 1 DIF: 2
TOP: 5.3 Gravitational Potential Energy

31. A simple pendulum, 1.00 m in length, is released from rest when the support string is at an angle of 35.0° from the vertical. What is the speed of the suspended mass at the bottom of the swing? (g = 9.80 m/s^2 and ignore air resistance)

a. 0.67 m/s
b. 0.94 m/s
c. 1.33 m/s
d. 1.88 m/s

ANS: D PTS: 1 DIF: 2
TOP: 5.3 Gravitational Potential Energy

32. A simple pendulum, 2.0 m in length, is released with a push when the support string is at an angle of 25° from the vertical. If the initial speed of the suspended mass is 1.2 m/s when at the release point, what is its speed at the bottom of the swing? (g = 9.8 m/s^2)

a. 2.3 m/s
b. 2.6 m/s
c. 2.0 m/s
d. 0.5 m/s

ANS: A PTS: 1 DIF: 3
TOP: 5.3 Gravitational Potential Energy

33. A simple pendulum, 2.0 m in length, is released by a push when the support string is at an angle of 25° from the vertical. If the initial speed of the suspended mass is 1.2 m/s when at the release point, to what maximum angle will it move in the second half of its swing?

a. 37°
b. 30°
c. 27°
d. 21°

ANS: B PTS: 1 DIF: 3
TOP: 5.3 Gravitational Potential Energy

34. A hill is 100 m long and makes an angle of 12° with the horizontal. As a 50-kg jogger runs up the hill, how much work does gravity do on the jogger?

a. 49 000 J
b. 10 000 J
c. - 10 000 J
d. zero

ANS: C PTS: 1 DIF: 1
TOP: 5.3 Gravitational Potential Energy

35. A 2.00-kg ball has zero kinetic and potential energy. Ernie drops the ball into a 10.0-m-deep well. Just before the ball hits the bottom, the sum of its kinetic and potential energy is:

a. zero.
b. 196 J.
c. - 196 J.
d. 392 J.

ANS: A PTS: 1 DIF: 1
TOP: 5.3 Gravitational Potential Energy

36. A 2.00-kg ball has zero potential and kinetic energy. Maria drops the ball into a 10.0-m-deep well. After the ball comes to a stop in the mud, the sum of its potential and kinetic energy is:

a. zero.
b. 196 J.
c. - 196 J.
d. 392 J.

ANS: C PTS: 1 DIF: 2
TOP: 5.3 Gravitational Potential Energy

37. Two blocks are released from the top of a building. One falls straight down while the other slides down a smooth ramp. If all friction is ignored, which one is moving faster when it reaches the bottom?

a. The block that went straight down.
b. The block that went down the ramp.
c. They both will have the same speed.
d. Insufficient information to work the problem.

ANS: C PTS: 1 DIF: 1
TOP: 5.3 Gravitational Potential Energy

38. Old Faithful geyser in Yellowstone Park shoots water hourly to a height of 40 m. With what velocity does the water leave the ground?

a. 7.0 m/s
b. 14 m/s
c. 20 m/s
d. 28 m/s

ANS: D PTS: 1 DIF: 2
TOP: 5.3 Gravitational Potential Energy

39. An 80 000-kg airliner is flying at 900 km/h at a height of 10.0 km. What is its total energy (kinetic + potential) if the total was 0 when the airliner was at rest on the ground?

a. 250 MJ
b. 478 MJ
c. 773 MJ
d. 10 300 MJ

ANS: D PTS: 1 DIF: 2
TOP: 5.3 Gravitational Potential Energy

40. A pole vaulter clears 6.00 m. With what speed does he strike the mat in the landing area?

a. 2.70 m/s
b. 5.40 m/s
c. 10.8 m/s
d. 21.6 m/s

ANS: C PTS: 1 DIF: 2
TOP: 5.3 Gravitational Potential Energy

41. A baseball outfielder throws a baseball of mass 0.15 kg at a speed of 40 m/s and initial angle of 30°. What is the kinetic energy of the baseball at the highest point of the trajectory? Ignore air friction.

a. zero
b. 30 J
c. 90 J
d. 120 J

ANS: C PTS: 1 DIF: 2
TOP: 5.3 Gravitational Potential Energy

42. A bobsled makes a run down an ice track starting at 150 m vertical distance up the hill. If there is no friction, what is the velocity at the bottom of the hill?

a. 27 m/s
b. 36 m/s
c. 45 m/s
d. 54 m/s

ANS: D PTS: 1 DIF: 2
TOP: 5.3 Gravitational Potential Energy

43. A 2 000-kg ore car rolls 50.0 m down a frictionless 10.0° incline. If there is a horizontal spring at the end of the incline, what spring constant is required to stop the ore car in a distance of 1.00 m?

a. 340 kN/m
b. 681 kN/m
c. 980 kN/m
d. 1 960 kN/m

ANS: A PTS: 1 DIF: 2 TOP: 5.4 Spring Potential Energy

44. An amount of work equal to 1.5 J is required to compress the spring in a spring-gun. What is the "launch speed" of a 15-g marble?

a. 14 m/s
b. 15 m/s
c. 18 m/s
d. 21 m/s

ANS: A PTS: 1 DIF: 2 TOP: 5.4 Spring Potential Energy

45. The SI units for *k*, the spring constant, are equivalent to:

a. J.
b. J / N.
c. kg / s^2.
d. None of the above.

ANS: C PTS: 1 DIF: 2 TOP: 5.4 Spring Potential Energy

46. By how much is the energy stored in a Hooke's law spring increased when its stretch is increased from 8.00 cm to 16.0 cm?

a. 100%
b. 200%
c. 300 %
d. The correct answer is not given.

ANS: C PTS: 1 DIF: 2 TOP: 5.4 Spring Potential Energy

47. A Hooke's law spring is compressed 12.0 cm from equilibrium and the potential energy stored is 72.0 J. What is the spring constant in this case?

a. 10 000 N/m
b. 5 000 N/m
c. 1 200 N/m
d. No answer is correct.

ANS: A PTS: 1 DIF: 2 TOP: 5.4 Spring Potential Energy

48. A Hooke's law spring is compressed 12.0 cm from equilibrium, and the potential energy stored is 72.0 J. What compression (as measured from equilibrium) would result in 100 J being stored in this case?

a. 16.7 cm
b. 14.1 cm
c. 13.6 cm
d. No answer is correct.

ANS: B PTS: 1 DIF: 3 TOP: 5.4 Spring Potential Energy

49. A Hooke's law spring is mounted horizontally over a frictionless surface. The spring is then compressed a distance *d* and is used to launch a mass *m* along the frictionless surface. What compression of the spring would result in the mass attaining double the kinetic energy received in the above situation?

a. 1.41 *d*
b. 1.73 *d*
c. 2.00 *d*
d. 4.00 *d*

ANS: A PTS: 1 DIF: 2 TOP: 5.4 Spring Potential Energy

50. A Hooke's law spring is mounted horizontally over a frictionless surface. The spring is then compressed a distance *d* and is used to launch a mass *m* along the frictionless surface. What compression of the spring would result in the mass attaining double the speed received in the above situation?

a. 1.41 *d*
b. 1.73 *d*
c. 2.00 *d*
d. 4.00 *d*

ANS: C PTS: 1 DIF: 3 TOP: 5.4 Spring Potential Energy

51. A 50-N crate is pulled up a 5-m inclined plane by a worker at constant velocity. If the plane is inclined at an angle of 37° to the horizontal and there exists a constant frictional force of 10 N between the crate and the surface, what is the force applied by the worker?

a.□zero
b.□20 N
c.□30 N
d.□40 N

ANS: D PTS: 1 DIF: 2
TOP: 5.5 Systems and Energy Conservation

52. Adisa pulls a 40-N crate up a 5.0-m long inclined plane at a constant velocity. If the plane is inclined at an angle of 37° to the horizontal and there is a constant force of friction of 10 N between the crate and the surface, what is the net change in potential energy of the crate?

a.□120 J
b.□- 120 J
c.□200 J
d.□- 200 J

ANS: A PTS: 1 DIF: 2
TOP: 5.5 Systems and Energy Conservation

53. A 20-N crate starting at rest slides down a rough 5.0-m long ramp, inclined at 25° with the horizontal. 20 J of energy is lost to friction. What will be the speed of the crate at the bottom of the incline?

a.□0.98 m/s
b.□1.9 m/s
c.□3.2 m/s
d.□4.7 m/s

ANS: D PTS: 1 DIF: 2
TOP: 5.5 Systems and Energy Conservation

54. Preston pushes a wheelbarrow weighing 500 N to the top of a 50.0-m ramp, inclined at 20.0° with the horizontal, and leaves it. Tamara accidentally bumps the wheelbarrow. It slides back down the ramp, during which an 80.0-N frictional force acts on it over the 50.0 m. What is the wheelbarrow's kinetic energy at the bottom at of the ramp? ($g = 9.8$ m/s^2)

a.□4 550 J
b.□6 550 J
c.□8 150 J
d.□13 100 J

ANS: A PTS: 1 DIF: 2
TOP: 5.5 Systems and Energy Conservation

55. A pile driver drives a post into the ground. The mass of the pile driver is 2 500 kg and it is dropped through a height of 8.0 m on each stroke. If the resisting force of the ground is 4.0 ´ 10^6 N, how far is the post driven in on each stroke?

a.□4.9 cm
b.□9.8 cm
c.□16 cm
d.□49 cm

ANS: A PTS: 1 DIF: 2
TOP: 5.5 Systems and Energy Conservation

56. A baseball catcher puts on an exhibition by catching a 0.150-kg ball dropped from a helicopter at a height of 100 m above the catcher. If the catcher "gives" with the ball for a distance of 0.750 m while catching it, what average force is exerted on the mitt by the ball? (g = 9.80 m/s^2)

a.	78 N
b.	119 N
c.	197 N
d.	392 N

ANS: C PTS: 1 DIF: 2
TOP: 5.5 Systems and Energy Conservation

57. A girl and her bicycle have a total mass of 40.0 kg. At the top of the hill her speed is 5.0 m/s, and her speed doubles as she rides down the hill. The hill is 10.0 m high and 100 m long. How much kinetic energy and potential energy is lost to friction?

a.	2 420 J
b.	1 500 J
c.	2 000 J
d.	3 920 J

ANS: A PTS: 1 DIF: 2
TOP: 5.5 Systems and Energy Conservation

58. A girl and her bicycle have a total mass of 40 kg. At the top of the hill her speed is 5.0 m/s. The hill is 10 m high and 100 m long. If the force of friction as she rides down the hill is 20 N, what is her speed at the bottom?

a.	5.0 m/s
b.	10 m/s
c.	11 m/s
d.	She stops before she reaches the bottom.

ANS: C PTS: 1 DIF: 2
TOP: 5.5 Systems and Energy Conservation

59. I drop a 60-g golf ball from 2.0 m high. It rebounds to 1.5 m. How much energy is lost?

a.	0.29 J
b.	0.50 J
c.	0.88 J
d.	1.0 J

ANS: A PTS: 1 DIF: 2
TOP: 5.5 Systems and Energy Conservation

60. A parachutist of mass 50.0 kg jumps out of an airplane at a height of 1 000 m. The parachute deploys, and she lands on the ground with a speed of 5.0 m/s. How much energy was lost to air friction during this jump?

a.	49 400 J
b.	98 700 J

c. 198 000 J
d. 489 000 J

ANS: D PTS: 1 DIF: 2
TOP: 5.5 Systems and Energy Conservation

61. A Hooke's law spring is compressed a distance *d* and is used to launch a mass *m* vertically to a height *h* above its starting position. Under the same compression *d*, the spring is now used to launch a mass of 2*m*. How high does this second mass rise?

a. *h*
b. *h*/2
c. *h*/1.41
d. *h*/4

ANS: B PTS: 1 DIF: 2
TOP: 5.5 Systems and Energy Conservation

62. A Hooke's law spring is compressed a distance *d* and is used to launch a mass *m* vertically to a height *h* above its starting position. Under double the compression, the spring is now used to launch the mass. How high does the mass now rise above its starting position?

a. 2 *h*
b. 1.41 *h*
c. 3 *h*
d. 4 *h*

ANS: D PTS: 1 DIF: 2
TOP: 5.5 Systems and Energy Conservation

63. A Hooke's law spring is compressed a distance *d* and is used to launch a particle of mass *m* vertically to a height *h* above its starting position. Under double the compression, the spring is now used to launch a particle of mass 2 *m*. How high does the second mass rise above its starting position?

a. *h*
b. 2 *h*
c. 3 *h*
d. 4 *h*

ANS: B PTS: 1 DIF: 2
TOP: 5.5 Systems and Energy Conservation

64. The quantity of work equal to one joule is also equivalent to which of the following?

a. watt
b. watt /s
c. watt ×s
d. watt /s^2

ANS: C PTS: 1 DIF: 1 TOP: 5.6 Power

65. The rate at which work is done is equivalent to which of the following?

a. increase in potential energy
b. thermal energy

c. potential energy
d. power

ANS: D PTS: 1 DIF: 1 TOP: 5.6 Power

66. The unit of power, watt, is dimensionally the same as:

a. joule-second.
b. joule/second.
c. joule-meter.
d. joule/meter.

ANS: B PTS: 1 DIF: 1 TOP: 5.6 Power

67. A 60-kg woman runs up a flight of stairs having a rise of 4.0 m in a time of 4.2 s. What average power did she supply?

a. 380 W
b. 560 W
c. 620 W
d. 670 W

ANS: B PTS: 1 DIF: 2 TOP: 5.6 Power

68. An automobile delivers 30.0 hp to its wheels when moving at a constant speed of 22.0 m/s. What is the resistance force on the automobile at this speed? (1 hp = 746 watts)

a. 18 600 N
b. 410 000 N
c. 1 020 N
d. 848 N

ANS: C PTS: 1 DIF: 2 TOP: 5.6 Power

69. Yuri, a Russian weightlifter, is able to lift 250 kg 2.00 m in 2.00 s. What is his power output?

a. 500 W
b. 2.45 kW
c. 4.90 kW
d. 9.80 kW

ANS: B PTS: 1 DIF: 2 TOP: 5.6 Power

70. A jet engine develops 1.0×10^5 N of thrust in moving an airplane forward at a speed of 900 km/h. What is the power developed by the engine?

a. 500 kW
b. 10 MW
c. 25 MW
d. 50 MW

ANS: C PTS: 1 DIF: 2 TOP: 5.6 Power

71. A speed boat requires 80 kW to move at a constant speed of 15 m/s. What is the resistive force of the water at this speed?

a. 2 700 N
b. 5 300 N
c. 6 500 N
d. 7 700 N

ANS: B PTS: 1 DIF: 2 TOP: 5.6 Power

72. Water flows over a section of Niagara Falls at a rate of 1.20×10^6 kg/s and falls 50.0 m. What is the power dissipated by the waterfall?

a. 588 MW
b. 294 MW
c. 147 MW
d. 60.0 MW

ANS: A PTS: 1 DIF: 3 TOP: 5.6 Power

73. A 1 000-kg sports car accelerates from zero to 25 m/s in 7.5 s. What is the average power delivered by the automobile engine?

a. 20.8 kW
b. 30.3 kW
c. 41.7 kW
d. 52.4 kW

ANS: C PTS: 1 DIF: 2 TOP: 5.6 Power

74. A force of 5.0 N is applied to a 20-kg mass on a horizontal frictionless surface. As the speed of the mass increases at a constant acceleration, the power delivered to it by the force:

a. remains the same.
b. increases.
c. decreases.
d. doubles every 4.0 seconds.

ANS: B PTS: 1 DIF: 2 TOP: 5.6 Power

75. A 100-W light bulb is left on for 10.0 hours. Over this period of time, how much energy was used by the bulb?

a. 1 000 J
b. 3 600 J
c. 3 600 000 J
d. 1.34 hp

ANS: C PTS: 1 DIF: 2 TOP: 5.6 Power

76. A 200-hp engine can deliver, in SI units, an average power of ____. (1 hp = 746 W)

a. 200 W
b. 74 600 W
c. 149 000 W
d. 298 000 W

ANS: C PTS: 1 DIF: 1 TOP: 5.6 Power

77. The area under the force vs. displacement curve represents:

a.	area.
b.	force.
c.	work.
d.	coefficient of static friction.

ANS: C PTS: 1 DIF: 1
TOP: 5.7 Work Done by a Varying Force

78. A force of 100 N is applied to a 50-kg mass in the direction of motion for a distance of 6.0 m and then the force is increased to 150 N for the next 4.0 m. For the 10 m of travel, how much work is done by the varying force?

a.	1 200 J
b.	1 500 J
c.	2 400 J
d.	- 1 500 J

ANS: A PTS: 1 DIF: 2
TOP: 5.7 Work Done by a Varying Force

79. The net force acting on a 6.0-kg object is given by $F_x = (10 - x)$ N, where F_x is in newtons and x is in meters. How much work is done on the object as it moves from $x = 0$ to $x = 10$ m?

a.	100 J
b.	75 J
c.	50 J
d.	25 J

ANS: C PTS: 1 DIF: 3
TOP: 5.7 Work Done by a Varying Force

80. The net force acting on a 12.6-kg object is given by $F_x = (20 - x)$ N, where F_x is in newtons and x is in meters. How much work is done on the object as it moves from $x = 0$ to $x = 10$ m?

a.	300 J
b.	200 J
c.	150 J
d.	100 J

ANS: C PTS: 1 DIF: 3
TOP: 5.7 Work Done by a Varying Force

81. Is it possible for the total mechanical energy of a moving particle to be negative?

a.	No, because a moving particle has positive kinetic energy.
b.	No, because potential energy cannot have a value more negative than the value of the positive kinetic energy of the particle.
c.	Only if friction is involved.
d.	yes

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Problems

82. Three different mass projectiles are launched from the top of a building each at different angles of elevation. Each particle has the same initial kinetic energy. Which particle has the greatest kinetic energy just as it impacts with the ground?

a. The one launched at the highest angle of elevation.
b. The one with the highest mass.
c. The one with the lowest mass.
d. They all will have the same kinetic energy on impact.

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Problems

83. Three different mass projectiles are launched from the top of a building each at different angles of elevation. Each particle has the same initial kinetic energy. Which particle has the greatest speed just as it impacts with the ground?

a. The one launched at the highest angle of elevation.
b. The one with the highest mass.
c. The one with the lowest mass.
d. They all will have the same speed on impact.

ANS: C PTS: 1 DIF: 3 TOP: Conceptual Problems

84. A block is projected with speed *v* across a horizontal surface and slides to a stop due to friction. The same block is then projected with the same speed *v* up an incline where is slides to a stop due to friction. In which case did the total mechanical energy of the block decrease the least?

a. This problem cannot be solved since it was not indicated whether the horizontal surface and the incline both had the same coefficient of kinetic friction.
b. The case on the horizontal surface had the least decrease in total mechanical energy.
c. The case on the inclined surface had the least decrease in total mechanical energy.
d. In both cases the decrease in mechanical energy was the same.

ANS: C PTS: 1 DIF: 3 TOP: Conceptual Problems

85. In a problem using energy considerations to solve for the speed of a ball thrown from the top of a building when it strikes the ground below, where should the potential energy have its zero value?

a. It should be at the level from where the ball is thrown.
b. It should be at the ground level where the ball hits.
c. It should be slightly below ground level so the potential energy is always positive.

d. It doesn't matter since only differences in potential energy matter in solutions.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Problems

Chapter 6—Momentum and Collisions

MULTIPLE CHOICE

1. A valid unit for momentum is which of the following?

a.	$kg \cdot m/s^2$
b.	kg/m^2
c.	$kg \cdot m/s$
d.	$N \cdot m$

ANS: C PTS: 1 DIF: 1 TOP: 6.1 Momentum and Impulse

2. The dimensional equivalent of the quantity impulse in terms of the fundamental quantities (mass, length, time) is which of the following?

a.	MLT^{-1}
b.	ML^2T^{-2}
c.	MLT
d.	MLT^{-2}

ANS: A PTS: 1 DIF: 1 TOP: 6.1 Momentum and Impulse

3. A 75-kg swimmer dives horizontally off a 500-kg raft. The diver's speed immediately after leaving the raft is 4.0 m/s. A micro-sensor system attached to the edge of the raft measures the time interval during which the diver applies an impulse to the raft just prior to leaving the raft surface. If the time interval is read as 0.20 s, what is the magnitude of the average horizontal force by diver on the raft?

a.	900 N
b.	450 N
c.	525 N
d.	1 500 N

ANS: D PTS: 1 DIF: 2 TOP: 6.1 Momentum and Impulse

4. A 0.12-kg ball is moving at 6 m/s when it is hit by a bat, causing it to reverse direction and have a speed of 14 m/s. What is the change in the magnitude of the momentum of the ball?

a.	$0.39\ kg \cdot m/s$
b.	$0.42\ kg \cdot m/s$
c.	$1.3\ kg \cdot m/s$
d.	$2.4\ kg \cdot m/s$

ANS: D PTS: 1 DIF: 2 TOP: 6.1 Momentum and Impulse

5. The impulse experienced by a body is equivalent to its change in:

a.	velocity.
b.	kinetic energy.
c.	momentum.
d.	None of the above choices are valid.

ANS: C PTS: 1 DIF: 1 TOP: 6.1 Momentum and Impulse

6. The dimensional equivalence of the quantity "momentum" in terms of the fundamental quantities (mass, length, time) is:

a.□MLT^{-1}.
b.□ML^{2}T^{-2}.
c.□MLT.
d.□MLT^{-2}.

ANS: A PTS: 1 DIF: 1 TOP: 6.1 Momentum and Impulse

7. Alex throws a 0.15-kg rubber ball down onto the floor. The ball's speed just before impact is 6.5 m/s, and just after is 3.5 m/s. What is the change in the magnitude of the ball's momentum?

a.□0.09 kg×m/s
b.□1.5 kg×m/s
c.□4.3 kg×m/s
d.□126 kg×m/s

ANS: B PTS: 1 DIF: 2 TOP: 6.1 Momentum and Impulse

8. Alex throws a 0.15-kg rubber ball down onto the floor. The ball's speed just before impact is 6.5 m/s, and just after is 3.5 m/s. If the ball is in contact with the floor for 0.025 s, what is the magnitude of the average force applied by the floor on the ball?

a.□60 N
b.□133 N
c.□3.0 N
d.□3.5 N

ANS: A PTS: 1 DIF: 2 TOP: 6.1 Momentum and Impulse

9. A crane drops a 0.30 kg steel ball onto a steel plate. The ball's speeds just before impact and after are 4.5 m/s and 4.2 m/s, respectively. If the ball is in contact with the plate for 0.030 s, what is the magnitude of the average force that the ball exerts on the plate during impact?

a.□87 N
b.□133 N
c.□3.0 N
d.□3.5 N

ANS: A PTS: 1 DIF: 2 TOP: 6.1 Momentum and Impulse

10. Jerome pitches a baseball of mass 0.20 kg. The ball arrives at home plate with a speed of 40 m/s and is batted straight back to Jerome with a return speed of 60 m/s. What is the magnitude of change in the ball's momentum?

a.□4.0 kg×m/s
b.□8.0 kg×m/s
c.□18 kg×m/s
d.□20 kg×m/s

ANS: D PTS: 1 DIF: 2 TOP: 6.1 Momentum and Impulse

11. Lonnie pitches a baseball of mass 0.20 kg. The ball arrives at home plate with a speed of 40 m/s and is batted straight back to Lonnie with a return speed of 60 m/s. If the bat is in contact with the ball for 0.050 s, what is the impulse experienced by the ball?

a. 360 N×s
b. 20 N×s
c. 400 N×s
d. 9.0 N×s

ANS: B PTS: 1 DIF: 2 TOP: 6.1 Momentum and Impulse

12. A ball with original momentum +4.0 kg×m/s hits a wall and bounces straight back without losing any kinetic energy. The change in momentum of the ball is:

a. 0.
b. - 4.0 kg×m/s.
c. 8.0 kg×m/s.
d. - 8.0 kg×m/s.

ANS: D PTS: 1 DIF: 1 TOP: 6.1 Momentum and Impulse

13. If a glass of water is on a table with a piece of paper under it, it is relatively easy to pull the paper out without disturbing the glass very much if the pull is done very quickly. This is because, with a quick pull:

a. the force on the glass will be less.
b. the momentum of the paper will be greater.
c. the time for the pull will be less.
d. the coefficient of kinetic friction will be less.

ANS: C PTS: 1 DIF: 2 TOP: 6.1 Momentum and Impulse

14. A car wash nozzle directs a steady stream of water at 1.5 kg/s, with a speed of 30 m/s, against a car window. What force does the water exert on the glass? Assume the water does not splash back.

a. 11 N
b. 45 N
c. 110 N
d. 440 N

ANS: B PTS: 1 DIF: 2 TOP: 6.1 Momentum and Impulse

15. The units of impulse are equivalent to:

a. those of energy.
b. N×m.
c. kg×m/s.
d. those of force.

ANS: C PTS: 1 DIF: 1 TOP: 6.1 Momentum and Impulse

16. A 75-kg swimmer dives horizontally off a 500-kg raft. If the diver's speed immediately after leaving the raft is 4 m/s, what is the corresponding raft speed?

a. 0.2 m/s
b. 0.5 m/s
c. 0.6 m/s

d. 4.0 m/s

ANS: C PTS: 1 DIF: 2
TOP: 6.2 Conservation of Momentum

17. A cannon of mass 1 500 kg fires a 10-kg shell with a velocity of 200 m/s at an angle of 45° above the horizontal. Find the recoil velocity of the cannon across the level ground.

a. 1.33 m/s
b. 0.94 m/s
c. 2.41 m/s
d. 1.94 m/s

ANS: B PTS: 1 DIF: 2
TOP: 6.2 Conservation of Momentum

18. The law of conservation of momentum is applicable to systems made up of objects described by which of the following?

a. macroscopic
b. microscopic
c. interacting through friction
d. All the above choices are valid.

ANS: D PTS: 1 DIF: 1
TOP: 6.2 Conservation of Momentum

19. A machine gun is attached to a railroad flatcar that rolls with negligible friction. If the railroad car has a mass of 6.25×10^{4} kg, how many bullets of mass 25 g would have to be fired at 250 m/s off the back to give the railroad car a forward velocity of 0.5 m/s?

a. 400
b. 2 000
c. 3 000
d. 5 000

ANS: D PTS: 1 DIF: 2
TOP: 6.2 Conservation of Momentum

20. Ann the Astronaut weighs 60 kg. She is space walking outside the space shuttle and pushes a 350-kg satellite away from the shuttle at 0.90 m/s. What speed does this give Ann as she moves toward the shuttle?

a. 4.0 m/s
b. 5.3 m/s
c. 8.5 m/s
d. 9.0 m/s

ANS: B PTS: 1 DIF: 2
TOP: 6.2 Conservation of Momentum

21. A miniature spring-loaded, radio-controlled gun is mounted on an air puck. The gun's bullet has a mass of 5.00 g, and the gun and puck have a combined mass of 120 g. With the system initially at rest, the radio controlled trigger releases the bullet causing the puck and empty gun to move with a speed of 0.500 m/s. What is the bullet's speed?

a. 4.80 m/s
b. 11.5 m/s
c. 48.0 m/s
d. 12.0 m/s

ANS: D PTS: 1 DIF: 2
TOP: 6.2 Conservation of Momentum

22. A uranium nucleus (mass 238 units) at rest decays into a helium nucleus (mass 4.0 units) and a thorium nucleus (mass 234 units). If the speed of the helium nucleus is 6.0 ´ 10^5 m/s, what is the speed of the thorium nucleus?

a. 1.0 ´ 10^4 m/s
b. 3.0 ´ 10^4 m/s
c. 3.6 ´ 10^4 m/s
d. 4.1 ´ 10^4 m/s

ANS: A PTS: 1 DIF: 2
TOP: 6.2 Conservation of Momentum

23. If the momentum of an object is tripled, its kinetic energy will change by what factor?

a. zero
b. one-third
c. three
d. nine

ANS: D PTS: 1 DIF: 1
TOP: 6.2 Conservation of Momentum

24. The kinetic energy of an object is quadrupled. Its momentum will change by what factor?

a. zero
b. two
c. eight
d. four

ANS: B PTS: 1 DIF: 1
TOP: 6.2 Conservation of Momentum

25. A moderate force will break an egg. However, an egg dropped on the road usually breaks, while one dropped on the grass usually doesn't break. This is because for the egg dropped on the grass:

a. the change in momentum is greater.
b. the change in momentum is less.
c. the time interval for stopping is greater.
d. the time interval for stopping is less.

ANS: C PTS: 1 DIF: 1
TOP: 6.2 Conservation of Momentum

26. A 70-kg man is standing in a 20-kg boat. The man steps to the right thinking he is stepping out onto the dock. However, the following will actually happen (ignore the friction of the water or air on the boat or the man):

a. The man only moves a short distance to the right while the boat moves a larger distance to the left.
b. The man actually stays still while the boat moves toward the left.
c. The boat doesn't move and the man moves to the right.
d. None of the above.

ANS: A PTS: 1 DIF: 2
TOP: 6.2 Conservation of Momentum

27. A lump of clay is thrown at a wall. A rubber ball of identical mass is thrown with the same speed toward the same wall. Which statement is true?

a. The clay experiences a greater change in momentum than the ball.
b. The ball experiences a greater change in momentum than the clay.
c. The clay and the ball experience the same change in momentum.
d. It is not possible to know which object has the greater change in momentum.

ANS: B PTS: 1 DIF: 2
TOP: 6.2 Conservation of Momentum

28. A high-diver of mass 70 kg jumps off a board 10 m above the water. If, 1.0 s after entering the water his downward motion is stopped, what average upward force did the water exert?

a. 100 N
b. 686 N
c. 980 N
d. No answer is correct.

ANS: D PTS: 1 DIF: 3
TOP: 6.2 Conservation of Momentum

29. Object 1 has twice the mass of Object 2. Both objects have the same kinetic energy. Which of the following statements is true?

a. Both objects can have the same magnitude of momentum.
b. Object 1 has a momentum of greater magnitude than Object 2.
c. The magnitude of the momentum of Object 2 is four times that of Object 1.
d. All the statements are false.

ANS: B PTS: 1 DIF: 3
TOP: 6.2 Conservation of Momentum

30. Object 1 has twice the mass of Object 2. Each of the objects has the same magnitude of momentum. Which of the following statements is true?

a. Both objects can have the same kinetic energy.
b. One object has 0.707 times the kinetic energy of the other.
c. One object has twice the kinetic energy of the other.
d. One object has 4 times the kinetic energy of the other.

ANS: C PTS: 1 DIF: 3
TOP: 6.2 Conservation of Momentum

31. Three satellites are launched into space connected together. Once in deep space, an explosive charge separates the three satellites and they move apart. The satellites each have different masses with $m_1 < m_2 < m_3$. Which of the following statements is always true?

a. The one with mass m_1 receives the greatest impulse.
b. The one with mass m_3 receives the greatest impulse.
c. The all must receive equal impulses.
d. Although one or more of the above statements could be true in special cases, they are not always true.

ANS: D PTS: 1 DIF: 2
TOP: 6.2 Conservation of Momentum

32. A 5.00-g bullet is fired into a 500-g block of wood suspended as a ballistic pendulum. the combined mass swings up to a height of 8.00 cm. What was the magnitude of the momentum of the combined mass immediately after the collision?

a. 6.25×10^{-3} kg·m/s
b. 6.25 kg·m/s
c. 0.632 kg·m/s
d. 0.394 kg·m/s

ANS: C PTS: 1 DIF: 2
TOP: 6.2 Conservation of Momentum

33. A 12.0-g bullet is fired into a 1 100-g block of wood which is suspended as a ballistic pendulum. The combined mass swings up to a height of 8.50 cm. What was the kinetic energy of the combined mass immediately after the collision?

a. 1.44 J
b. 1.86 J
c. 0.632 J
d. 0.926 J

ANS: D PTS: 1 DIF: 2
TOP: 6.2 Conservation of Momentum

34. A 5.00-g bullet is fired into a 900-g block of wood suspended as a ballistic pendulum. The combined mass swings up to a height of 8.00 cm. What was the kinetic energy of the bullet immediately before the collision?

a. 129 J
b. 23.3 kJ
c. 0.709 J
d. 0.355 J

ANS: A PTS: 1 DIF: 2
TOP: 6.2 Conservation of Momentum

35. A man standing on frictionless ice throws a 1.00-kg mass at 20.0 m/s at an angle of elevation of 40.0°. What was the magnitude of the man's momentum immediately after throwing the mass?

a. 16.8 kg·m/s
b. 15.3 kg·m/s
c. 12.9 kg·m/s
d. This cannot be answered because the mass of the man needs to be known.

ANS: B PTS: 1 DIF: 2 TOP: 6.3 Collisions

36. A 20-g bullet moving at 1 000 m/s is fired through a one-kg block of wood emerging at a speed of 100 m/s. If the block had been originally at rest and is free to move, what is its resulting speed?

a. 9 m/s
b. 18 m/s
c. 90 m/s
d. 900 m/s

ANS: B PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

37. A 20-g bullet moving at 1 000 m/s is fired through a one-kg block of wood emerging at a speed of 100 m/s. What is the kinetic energy of the block that results from the collision if the block had not been moving prior to the collision and was free to move?

a. 10 kJ
b. 9.8 kJ
c. 0.16 kJ
d. 0.018 kJ

ANS: C PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

38. A 20-g bullet moving at 1 000 m/s is fired through a one-kg block of wood emerging at a speed of 100 m/s. What is the change in the kinetic energy of the bullet-block system as a result of the collision assuming the block is free to move?

a. 0 J
b. 9.7 kJ
c. - 9.7 kJ
d. - 18 J

ANS: C PTS: 1 DIF: 3
TOP: 6.3 Collisions | 6.4 Glancing Collisions

39. An object of mass *m* moving at speed v_0 strikes an object of mass 2*m* which had been at rest. The first object bounces backward along its initial path at speed v_0. Is this collision elastic, and if not, what is the change in kinetic energy of the system?

a. The collision is elastic.
b. The kinetic energy decreases by mv^2.
c. The kinetic energy decreases by mv^2.
d. The kinetic energy increases by mv^2.

ANS: D PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

40. A billiard ball is moving in the x-direction at 30.0 cm/s and strikes another billiard ball moving in the y-direction at 40.0 cm/s. As a result of the collision, the first ball moves at 50.0 cm/s, and the second ball stops. In what final direction does the first ball move?

a. in the x-direction
b. at an angle of 53.1° ccw from the x-direction
c. at an angle of 45.0° ccw from the x-direction
d. Such a collision cannot happen.

ANS: B PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

41. A billiard ball is moving in the x-direction at 30.0 cm/s and strikes another billiard ball moving in the y-direction at 40.0 cm/s. As a result of the collision, the first ball moves at 50.0 cm/s, and the second ball stops. What is the change in kinetic energy of the system as a result of the collision?

a. 0
b. some positive value
c. some negative value
d. No answer above is correct.

ANS: A PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

42. During a snowball fight two balls with masses of 0.4 and 0.6 kg, respectively, are thrown in such a manner that they meet head-on and combine to form a single mass. The magnitude of initial velocity for each is 15 m/s. What is the speed of the 1.0-kg mass immediately after collision?

a. zero
b. 3 m/s
c. 6 m/s
d. 9 m/s

ANS: B PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

43. A 2 500-kg truck moving at 10.00 m/s strikes a car waiting at a traffic light, hooking bumpers. The two continue to move together at 7.00 m/s. What was the mass of the struck car?

a. 1 730 kg

b.	1 550 kg
c.	1 200 kg
d.	1 070 kg

ANS: D PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

44. A billiard ball collides in an elastic head-on collision with a second stationary identical ball. After the collision which of the following conditions applies to the first ball?

a.	maintains the same velocity as before
b.	has one half its initial velocity
c.	comes to rest
d.	moves in the opposite direction

ANS: C PTS: 1 DIF: 1
TOP: 6.3 Collisions | 6.4 Glancing Collisions

45. A billiard ball collides in an elastic head-on collision with a second identical ball. What is the kinetic energy of the system after the collision compared to that before collision?

a.	the same as
b.	one fourth
c.	twice
d.	four times

ANS: A PTS: 1 DIF: 1
TOP: 6.3 Collisions | 6.4 Glancing Collisions

46. In a two-body collision, if the momentum of the system is conserved, then which of the following best describes the kinetic energy after the collision?

a.	must be less
b.	must also be conserved
c.	may also be conserved
d.	is doubled in value

ANS: C PTS: 1 DIF: 1
TOP: 6.3 Collisions | 6.4 Glancing Collisions

47. In a two-body collision, if the kinetic energy of the system is conserved, then which of the following best describes the momentum after the collision?

a.	must be less
b.	must also be conserved
c.	may also be conserved
d.	is doubled in value

ANS: B PTS: 1 DIF: 1
TOP: 6.3 Collisions | 6.4 Glancing Collisions

48. A railroad freight car, mass 15 000 kg, is allowed to coast along a level track at a speed of 2.0 m/s. It collides and couples with a 50 000-kg loaded second car, initially at rest and with brakes released. What percentage of the initial kinetic energy of the 15 000-kg car is preserved in the two-coupled cars after collision?

a.	14%
b.	23%
c.	86%
d.	100%

ANS: B PTS: 1 DIF: 3
TOP: 6.3 Collisions | 6.4 Glancing Collisions

49. A miniature, spring-loaded, radio-controlled gun is mounted on an air puck. The gun's bullet has a mass of 5.00 g, and the gun and puck have a combined mass of 120 g. With the system initially at rest, the radio-controlled trigger releases the bullet, causing the puck and empty gun to move with a speed of 0.500 m/s. Of the total kinetic energy of the gun-puck-bullet system, what percentage is in the bullet?

a.	4.0%
b.	50%
c.	96%
d.	100%

ANS: C PTS: 1 DIF: 3
TOP: 6.3 Collisions | 6.4 Glancing Collisions

50. A 20-kg object sitting at rest is struck elastically in a head-on collision with a 10-kg object initially moving at +3.0 m/s. Find the final velocity of the 20-kg object after the collision.

a.	- 1.0 m/s
b.	- 2.0 m/s
c.	+1.5 m/s
d.	+2.0 m/s

ANS: D PTS: 1 DIF: 3
TOP: 6.3 Collisions | 6.4 Glancing Collisions

51. A 0.10-kg object moving initially with a velocity of +0.20 m/s makes an elastic head-on collision with a 0.15-kg object initially at rest. What percentage of the original kinetic energy is retained by the 0.10-kg object?

a.	4%
b.	- 4%
c.	50%
d.	96%

ANS: A PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

52. Two billiard balls have velocities of 2.0 m/s and - 1.0 m/s when they meet in an elastic head-on collision. What is the final velocity of the first ball after collision?

a.	- 2.0 m/s
b.	- 1.0 m/s
c.	- 0.5 m/s
d.	+1.0 m/s

ANS: B PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

53. Two objects, one less massive than the other, collide elastically and bounce back after the collision. If the two originally had velocities that were equal in size but opposite in direction, then which one will be moving faster after the collision?

a. The less massive one.
b. The more massive one.
c. The speeds will be the same after the collision.
d. There is no way to be sure without the actual masses.

ANS: A PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

54. In a partially elastic collision between two objects with unequal mass:

a. the velocity of one will increase by the amount that the velocity of the other decreases.
b. the momentum of one will increase by the amount that the momentum of the other decreases.
c. the energy of one increases by the amount that the energy of the other decreases.
d. the total momentum of the system will decrease.

ANS: B PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

55. A 7.0-kg bowling ball strikes a 2.0-kg pin. The pin flies forward with a velocity of 6.0 m/s; the ball continues forward at 4.0 m/s. What was the original velocity of the ball?

a. 4.0 m/s
b. 5.7 m/s
c. 6.6 m/s
d. 3.3 m/s

ANS: B PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

56. A 1.00-kg duck is flying overhead at 1.50 m/s when a hunter fires straight up. The 0.010 0-kg bullet is moving 100 m/s when it hits the duck and stays lodged in the duck's body. What is the speed of the duck and bullet immediately after the hit?

a. 1.49 m/s
b. 2.48 m/s
c. 1.80 m/s
d. 1.78 m/s

ANS: D PTS: 1 DIF: 3
TOP: 6.3 Collisions | 6.4 Glancing Collisions

57. Kaitlin uses a bat to hit a thrown baseball. She knocks the ball back in the direction from which it came in a partially inelastic collision. The bat, which is heavier than the baseball, continues to move in the same direction after the hit as Kaitlin "follows through." Is the ball moving faster before or after it was hit?

a. The ball was moving faster before it was hit.
b. The ball was moving faster after it was hit.
c. The ball was moving at essentially the same speed before and after the hit.
d. There is insufficient information to answer this problem.

ANS: D PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

58. A tennis ball is held above and in contact with a basketball, and then both are simultaneously dropped. The tennis ball bounces off the basketball at a fairly high speed. This is because:

a. the basketball falls farther than the tennis ball.
b. the tennis ball is slightly shielded from the Earth's gravitational pull.
c. the massive basketball transfers momentum to the lighter tennis ball.
d. the tennis ball has a smaller radius.

ANS: C PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

59. Two skaters, both of mass 75 kg, are on skates on a frictionless ice pond. One skater throws a 0.3-kg ball at 5 m/s to his friend, who catches it and throws it back at 5 m/s. When the first skater has caught the returned ball, what is the velocity of each of the two skaters?

a. 0.02 m/s, moving apart
b. 0.04 m/s, moving apart
c. 0.02 m/s, moving towards each other
d. 0.04 m/s, moving towards each other

ANS: B PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

60. A 90-kg halfback running north with a speed of 10 m/s is tackled by a 120-kg opponent running south at 4 m/s. The collision is perfectly inelastic. Compute the velocity of the two players just after the tackle.

a. 3 m/s south
b. 2 m/s south
c. 2 m/s north
d. 3 m/s north

ANS: C PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

61. A neutron in a nuclear reactor makes an elastic head-on collision with a carbon atom initially at rest. (The mass of the carbon atom is 12 times that of the neutron.) What fraction of the neutron's kinetic energy is transferred to the carbon atom?

a. 14.4%
b. 28.4%
c. 41.4%
d. 56.6%

ANS: B PTS: 1 DIF: 3
TOP: 6.3 Collisions | 6.4 Glancing Collisions

62. Popeye, of mass 70 kg, has just downed a can of spinach. He accelerates quickly and stops Bluto, of mass 700 kg (Bluto is very dense), who is charging in at 10 m/s. What was Popeye's speed?

a. 10 m/s
b. 31 m/s
c. 50 m/s
d. 100 m/s

ANS: D PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

63. Mitch throws a 100-g lump of clay at a 500-g target, which is at rest on a horizontal surface. After impact, the target, including the attached clay, slides 2.1 m before stopping. If the coefficient of friction is m= 0.50, find the speed of the clay before impact.

a. 4.5 m/s
b. 12 m/s
c. 27 m/s
d. 36 m/s

ANS: C PTS: 1 DIF: 3
TOP: 6.3 Collisions | 6.4 Glancing Collisions

64. Two identical 7-kg bowling balls roll toward each other. The one on the left is moving at +4 m/s while the one on the right is moving at - 4 m/s. What is the velocity of each ball after they collide elastically?

a. Neither is moving.
b. - 4 m/s, +4 m/s
c. +4 m/s, - 4 m/s
d. - 14 m/s, 14 m/s

ANS: B PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

65. A 5-kg object is moving to the right at 4 m/s and collides with another object moving to the left at 5 m/s. The objects collide and stick together. After the collision, the combined object:

a. is moving to the right.
b. is moving to the left.
c. is at rest.
d. has less kinetic energy than the system had before the collision.

ANS: D PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

66. A 5-kg object is moving to the right at 4 m/s and collides with a 4-kg object moving to the left at 5 m/s. The objects collide and stick together. After the collision, the combined object:

a. has the same kinetic energy that the system had before the collision.
b. has more kinetic energy than the system had before the collision.
c. has no kinetic energy.
d. has less momentum than the system had before the collision.

ANS: C PTS: 1 DIF: 2
TOP: 6.3 Collisions | 6.4 Glancing Collisions

67. If a two-body collision is not head-on, then we may always assume that:

a. momentum is conserved.
b. kinetic energy is conserved.
c. neither momentum nor kinetic energy are conserved.
d. both momentum and kinetic energy are conserved.

ANS: A PTS: 1 DIF: 1
TOP: 6.3 Collisions | 6.4 Glancing Collisions

68. In a system with two moving objects, when a collision occurs between the objects:

a. the total kinetic energy is always conserved.
b. the total momentum is always conserved.
c. the total kinetic energy and total momentum are always conserved.
d. neither the kinetic energy nor the momentum is conserved.

ANS: B PTS: 1 DIF: 1
TOP: 6.3 Collisions | 6.4 Glancing Collisions

69. A billiard ball (Ball #1) moving at 5.00 m/s strikes a stationary ball (Ball #2) of the same mass. After the collision, Ball #1 moves at a speed of 4.35 m/s. Find the speed of Ball #2 after the collision.

a. 1.25 m/s
b. 1.44 m/s
c. 2.16 m/s
d. 2.47 m/s

ANS: D PTS: 1 DIF: 3
TOP: 6.3 Collisions | 6.4 Glancing Collisions

70. A baseball infielder, mass 75.0 kg, jumps up with velocity 3.00 m/s and catches a 0.150-kg baseball moving horizontally at 50.0 m/s. Of the following, which is closest to the final momentum of the system, infielder and baseball?

a. 225 kg×m/s
b. 228 kg×m/s

c. 230 kg·m/s
d. 233 kg·m/s

ANS: A PTS: 1 DIF: 3
TOP: 6.3 Collisions | 6.4 Glancing Collisions

71. When a collision is perfectly inelastic, then:

a. all the kinetic energy is conserved.
b. all the kinetic energy is gone.
c. the participants stick together.
d. the total momentum is zero.

ANS: C PTS: 1 DIF: 1
TOP: 6.3 Collisions | 6.4 Glancing Collisions

72. A model car is propelled by a cylinder of carbon dioxide gas. The cylinder emits gas at a rate of 4.5 g/s with an exit speed of 80.0 m/s. The car has a mass of 400 g, including the CO_2 cylinder. Starting from rest, what is the car's initial acceleration?

a. 0.90 m/s^2
b. 4.5 m/s^2
c. 9.0 m/s^2
d. 36 m/s^2

ANS: A PTS: 1 DIF: 2 TOP: 6.5 Rocket Propulsion

73. A 1 000-kg experimental rocket sled on level frictionless rails is loaded with 50 kg of propellant. It exhausts the propellant in a 20-s "burn." If the rocket, initially at rest, moves at 150 m/s after the burn, what impulse is experienced by the rocket sled?

a. 1.1×10^5 kg·m/s
b. 1.6×10^5 kg·m/s
c. 1.5×10^5 kg·m/s
d. 1.9×10^5 kg·m/s

ANS: C PTS: 1 DIF: 2 TOP: 6.5 Rocket Propulsion

74. A 1 000-kg experimental rocket sled at rest on level frictionless rails is loaded with 50 kg of propellant. It exhausts the propellant in a 20-s "burn." The rocket moves at 150 m/s after the burn. What average force is experienced by the rocket during the burn?

a. 0.95×10^4 N
b. 0.75×10^4 N
c. 0.60×10^4 N
d. 0.35×10^4 N

ANS: B PTS: 1 DIF: 2 TOP: 6.5 Rocket Propulsion

75. A helicopter stays aloft by pushing large quantities of air downward every second. What mass of air must be pushed downward at 40.0 m/s every second to keep a 1 000-kg helicopter aloft?

a. 120 kg
b. 245 kg
c. 360 kg

d. 490 kg

ANS: B PTS: 1 DIF: 2 TOP: 6.5 Rocket Propulsion

76. A model rocket sits on the launch pad until its fuel is ignited, blasting the rocket upward. During the short time of blast-off, as the ignited fuel goes down, the rocket goes up because:

a. the fuel pushes on the ground.
b. air friction pushes on the escaping fuel.
c. the downward force of gravity is less than the downward momentum of the fuel.
d. of none of the above reasons.

ANS: D PTS: 1 DIF: 2 TOP: 6.5 Rocket Propulsion

77. At liftoff, the engines of the Saturn V rocket consumed 13 000 kg/s of fuel and exhausted the combustion products at 2 900 m/s. What was the total upward force (thrust) provided by the engines?

a. 3.77×10^7 N
b. 7.54×10^7 N
c. 1.47×10^8 N
d. 2.95×10^8 N

ANS: A PTS: 1 DIF: 2 TOP: 6.5 Rocket Propulsion

78. Neglecting gravity, doubling the exhaust velocity from a single stage rocket initially at rest changes the final velocity attainable by what factor? Assume all other variables, such as the mass of the rocket and the mass of the fuel, do not change.

a. The final velocity stays the same.
b. The final velocity doubles.
c. The final velocity increases by a factor of 0.693.
d. The final velocity increases by a factor of 0.310.

ANS: B PTS: 1 DIF: 1 TOP: 6.5 Rocket Propulsion

79. Neglecting gravity, doubling the exhaust velocity from a single stage rocket initially at rest changes the final kinetic energy of the burnout stage by what factor? Assume all other variables, such as the mass of the rocket and the mass of the fuel, do not change.

a. It is the same.
b. It doubles.
c. It quadruples.
d. It increases by a factor of 1.693.

ANS: C PTS: 1 DIF: 2 TOP: 6.5 Rocket Propulsion

80. A rocket of total mass M and with burnout mass 0.20 M attains a speed of 3 200 m/s after starting from rest in deep space. What is the exhaust velocity of the rocket?

a. 1 000 m/s
b. 2 000 m/s
c. 3 000 m/s

d. 4 000 m/s

ANS: B PTS: 1 DIF: 2 TOP: 6.5 Rocket Propulsion

81. Two masses collide and stick together. Before the collision one of the masses was at rest. Is there a situation in which the kinetic energy is conserved in such a collision?

a. Yes, if the less massive particle is the one initially at rest.
b. Yes, if the more massive particle is the one initially at rest.
c. Yes, if the two particles have the same mass.
d. No, kinetic energy is always lost is such a collision.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Problems

82. In an automobile collision, how does an airbag lessen the blow to the passenger? Assume as a result of the collision, the passenger stops.

a. The air bag decreases the momentum change of the passenger in the collision.
b. During the collision, the force from the air bag is greater than would be the force from the windshield or dashboard so the passenger cannot hit the hard objects.
c. The stopping impulse is the same for either the hard objects or the airbag. Unlike the windshield or dashboard, the air bag gives some increasing the time for the slowing process and thus decreasing the average force on the passenger.
d. The airbag is there to insure the seatbelt holds.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

83. Two masses m_1 and m_2, with $m_1 = 3\ m_2$, undergo a head-on elastic collision. If the particles were approaching with speed v before the collision, with what speed are they moving apart after collision?

a. $3\ v$
b. $v/3$
c. $3v/4$
d. v

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Problems

84. Two masses m_1 and m_2, with $m_1 < m_2$, have momenta with equal magnitudes. How do their kinetic energies compare?

a. $KE_1 < KE_2$
b. $KE_1 = KE_2$
c. $KE_1 > KE_2$
d. More information is needed.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

85. Two particles collide, one of them initially being at rest. Is it possible for both particles to be at rest after the collision?

a.	If the collision is perfectly inelastic, then this happens.
b.	If the collision is elastic, then this happens.
c.	This can happen sometimes if the more massive particle was at rest.
d.	No.

ANS: D PTS: 1 DIF: 1 TOP: Conceptual Problems

Chapter 7—Rotational Motion and the Law of Gravity

MULTIPLE CHOICE

1. 2 600 rev/min is equivalent to which of the following?

a. 2600 rad/s
b. 43.3 rad/s
c. 273 rad/s
d. 60 rad/s

ANS: C PTS: 1 DIF: 1
TOP: 7.1 Angular Speed and Angular Acceleration

2. A grindstone spinning at the rate of 8.3 rev/s has what approximate angular speed?

a. 3.2 rad/s
b. 26 rad/s
c. 52 rad/s
d. 81 rad/s

ANS: C PTS: 1 DIF: 1
TOP: 7.1 Angular Speed and Angular Acceleration

3. A 0.12-m-radius grinding wheel takes 5.5 s to speed up from 2.0 rad/s to 11.0 rad/s. What is the wheel's average angular acceleration?

a. 9.6 rad/s^2
b. 4.8 rad/s^2
c. 1.6 rad/s^2
d. 0.33 rad/s^2

ANS: C PTS: 1 DIF: 1
TOP: 7.1 Angular Speed and Angular Acceleration

4. What is the angular speed about the rotational axis of the Earth for a person standing on the surface?

a. 7.3×10^{-5} rad/s
b. 3.6×10^{-5} rad/s
c. 6.28×10^{-5} rad/s
d. 3.14×10^{-5} rad/s

ANS: A PTS: 1 DIF: 2
TOP: 7.1 Angular Speed and Angular Acceleration

5. A spool of thread has an average radius of 1.00 cm. If the spool contains 62.8 m of thread, how many turns of thread are on the spool? "Average radius" allows us to not need to treat the layering of threads on lower layers.

a. 100
b. 1 000
c. 3 140
d. 62 800

ANS: B PTS: 1 DIF: 2
TOP: 7.1 Angular Speed and Angular Acceleration

6. A ceiling fan is turned on and reaches an angular speed of 120 rev/min in 20 s. It is then turned off and coasts to a stop in an additional 40 s. The ratio of the average angular acceleration for the first 20 s to that for the last 40 s is which of the following?

a. 2
b. 0.5
c. - 0.5
d. - 2

ANS: D PTS: 1 DIF: 2
TOP: 7.1 Angular Speed and Angular Acceleration

7. A 0.30-m-radius automobile tire rotates how many rad after starting from rest and accelerating at a constant 2.0 rad/s^2 over a 5.0-s interval?

a. 12.5 rad
b. 25 rad
c. 2.0 rad
d. 0.50 rad

ANS: B PTS: 1 DIF: 1
TOP: 7.2 Rotational Motion Under Constant Angular Acceleration

8. A fan blade, initially at rest, rotates with a constant acceleration of 0.025 rad/s^2. What is its angular speed at the instant it goes through an angular displacement of 4.2 rad?

a. 0.025 rad/s
b. 0.11 rad/s
c. 0.46 rad/s
d. 1.2 rad/s

ANS: C PTS: 1 DIF: 2
TOP: 7.2 Rotational Motion Under Constant Angular Acceleration

9. A fan blade, initially at rest, rotates with a constant acceleration of 0.025 rad/s^2. What is the time interval required for it to reach a 4.2-rad displacement after starting from rest?

a. 1.8 s
b. 2.0 s
c. 16 s
d. 18 s

ANS: D PTS: 1 DIF: 2
TOP: 7.2 Rotational Motion Under Constant Angular Acceleration

10. A ceiling fan is turned on and reaches an angular speed of 120 rev/min in 20 s. It is then turned off and coasts to a stop in 40 s. In the one minute of rotation, through how many revolutions did the fan turn?

a. 20
b. 60
c. 0
d. 600

ANS: B PTS: 1 DIF: 2
TOP: 7.2 Rotational Motion Under Constant Angular Acceleration

11. Starting from rest, a wheel undergoes constant angular acceleration for a period of time *T*. At what time after the start of rotation does the wheel reach an angular speed equal to its average angular speed for this interval?

a. 0.25 *T*
b. 0.50 *T*
c. 0.67 *T*
d. 0.71 *T*

ANS: B PTS: 1 DIF: 1
TOP: 7.2 Rotational Motion Under Constant Angular Acceleration

12. Starting from rest, a wheel undergoes constant angular acceleration for a period of time *T*. At which of the following times does the average angular acceleration equal the instantaneous angular acceleration?

a. 0.50 T
b. 0.67 T
c. 0.71 T
d. all of the above

ANS: D PTS: 1 DIF: 1
TOP: 7.2 Rotational Motion Under Constant Angular Acceleration

13. A Ferris wheel starts at rest and builds up to a final angular speed of 0.70 rad/s while rotating through an angular displacement of 4.9 rad. What is its average angular acceleration?

a. 0.10 rad/s^2
b. 0.05 rad/s^2
c. 1.8 rad/s^2
d. 0.60 rad/s^2

ANS: B PTS: 1 DIF: 2
TOP: 7.2 Rotational Motion Under Constant Angular Acceleration

14. A Ferris wheel, rotating initially at an angular speed of 0.50 rad/s, accelerates over a 7.0-s interval at a rate of 0.040 rad/s^2. What is its angular speed after this 7-s interval?

a. 0.20 rad/s
b. 0.30 rad/s
c. 0.46 rad/s
d. 0.78 rad/s

ANS: D PTS: 1 DIF: 2
TOP: 7.2 Rotational Motion Under Constant Angular Acceleration

15. A Ferris wheel, rotating initially at an angular speed of 0.500 rad/s, accelerates over a 7.00-s interval at a rate of 0.040 0 rad/s^2. What angular displacement does the Ferris wheel undergo in this 7-s interval?

a. 4.48 rad
b. 2.50 rad
c. 3.00 rad
d. 0.500 rad

ANS: A PTS: 1 DIF: 2
TOP: 7.2 Rotational Motion Under Constant Angular Acceleration

16. Suppose a wheel is initially rotating at 10.0 rad/s while undergoing constant angular acceleration reaching a speed of 30.0 rad/s after 20.0 seconds have elapsed. How long after the initial time has the wheel undergone half of the angular displacement that it will have gone through during the entire 20.0 second interval?

a. 10.0 s
b. 12.4 s
c. 14.2 s
d. 15.0 s

ANS: B PTS: 1 DIF: 3
TOP: 7.2 Rotational Motion Under Constant Angular Acceleration

17. A ventilation fan has blades 0.25 m in radius rotating at 20 rpm. What is the tangential speed of each blade tip?

a. 0.02 m/s
b. 0.52 m/s
c. 5.0 m/s
d. 20 m/s

ANS: B PTS: 1 DIF: 1
TOP: 7.3 Relations Between Angular and Linear Quantities

18. A 0.30-m-radius automobile tire accelerates from rest at a constant 2.0 rad/s^2 over a 5.0-s interval. What is the tangential component of acceleration for a point on the outer edge of the tire during the 5-s interval?

a. 33 m/s^2
b. 6.7 m/s^2
c. 0.60 m/s^2
d. 0.30 m/s^2

ANS: C PTS: 1 DIF: 1
TOP: 7.3 Relations Between Angular and Linear Quantities

19. A point on the rim of a 0.30-m-radius rotating wheel has a tangential speed of 4.0 m/s. What is the tangential speed of a point 0.20 m from the center of the same wheel?

a. 1.0 m/s
b. 1.3 m/s
c. 2.7 m/s
d. 8.0 m/s

ANS: C PTS: 1 DIF: 2
TOP: 7.3 Relations Between Angular and Linear Quantities

20. A 0.15-m-radius grinding wheel starts at rest and develops an angular speed of 12.0 rad/s in 4.0 s. What is the average tangential acceleration of a point on the wheel's edge?

a. 0.45 m/s^2
b. 6.8 m/s^2
c. 28 m/s^2

d. 14 m/s^2

ANS: A PTS: 1 DIF: 2
TOP: 7.3 Relations Between Angular and Linear Quantities

21. The end of the cutting cord on a gas-powered weed cutter is 0.15 m in length. If the motor rotates at the rate of 20 rev/s, what is the tangential speed of the end of the cord?

a. 628 m/s
b. 25 m/s
c. 19 m/s
d. 63 m/s

ANS: C PTS: 1 DIF: 2
TOP: 7.3 Relations Between Angular and Linear Quantities

22. A bucket in an old well is hoisted upward by a rope which winds up on a cylinder having a radius of 0.050 m. How many rev/s must the cylinder turn if the bucket is raised at a speed of 0.15 m/s?

a. 3.0 rev/s
b. 1.5 rev/s
c. 0.48 rev/s
d. 0.24 rev/s

ANS: C PTS: 1 DIF: 2
TOP: 7.3 Relations Between Angular and Linear Quantities

23. Consider a point on a bicycle wheel as the wheel makes exactly four complete revolutions about a fixed axis. Compare the linear and angular displacement of the point.

a. Both are zero.
b. Only the angular displacement is zero.
c. Only the linear displacement is zero.
d. Neither is zero.

ANS: C PTS: 1 DIF: 2
TOP: 7.3 Relations Between Angular and Linear Quantities

24. Consider a point on a bicycle wheel as the wheel turns about a fixed axis, neither speeding up nor slowing down. Compare the linear and angular velocities of the point.

a. Both are constant.
b. Only the angular velocity is constant.
c. Only the linear velocity is constant.
d. Neither is constant.

ANS: B PTS: 1 DIF: 2
TOP: 7.3 Relations Between Angular and Linear Quantities

25. Consider a point on a bicycle wheel as the wheel turns about a fixed axis, neither speeding up nor slowing down. Compare the linear and angular accelerations of the point.

a. Both are zero.
b. Only the angular acceleration is zero.
c. Only the linear acceleration is zero.

d. Neither is zero.

ANS: B PTS: 1 DIF: 2
TOP: 7.3 Relations Between Angular and Linear Quantities

26. Calculate the linear speed due to the Earth's rotation for a person at the equator of the Earth. The radius of the Earth is 6.40×10^6 m.

a. 74.0 m/s
b. 233 m/s
c. 465 m/s
d. 73.0 m/s

ANS: C PTS: 1 DIF: 2
TOP: 7.3 Relations Between Angular and Linear Quantities

27. Calculate the linear speed due to the Earth's rotation for a person at a point on its surface located at 40° N latitude. The radius of the Earth is 6.40×10^6 m.

a. 299 m/s
b. 357 m/s
c. 390 m/s
d. 465 m/s

ANS: B PTS: 1 DIF: 3
TOP: 7.3 Relations Between Angular and Linear Quantities

28. A ventilation fan has blades 0.25 m long rotating at 20 rpm. What is the centripetal acceleration of a point on the outer tip of a blade?

a. 1.1 m/s^2
b. 0.87 m/s^2
c. 0.55 m/s^2
d. 0.23 m/s^2

ANS: A PTS: 1 DIF: 2 TOP: 7.4 Centripetal Acceleration

29. A 0.30-m-radius automobile tire accelerates from rest at a constant 2.0 rad/s^2. What is the centripetal acceleration of a point on the outer edge of the tire after 5.0 s?

a. 300 m/s^2
b. 33 m/s^2
c. 30 m/s^2
d. 3.0 m/s^2

ANS: C PTS: 1 DIF: 2 TOP: 7.4 Centripetal Acceleration

30. A 0.40-kg mass, attached to the end of a 0.75-m string, is whirled around in a circular horizontal path. If the maximum tension that the string can withstand is 450 N, then what maximum speed can the mass have if the string is not to break?

a. 370 m/s
b. 22 m/s
c. 19 m/s
d. 29 m/s

ANS: D PTS: 1 DIF: 2 TOP: 7.4 Centripetal Acceleration

31. A point on the rim of a 0.25-m-radius fan blade has centripetal acceleration of 0.20 m/s^2. Find the centripetal acceleration of a point 0.05 m from the center of the same wheel.

a. 0.01 m/s^2
b. 0.02 m/s^2
c. 0.04 m/s^2
d. 0.08 m/s^2

ANS: C PTS: 1 DIF: 2 TOP: 7.4 Centripetal Acceleration

32. A point on the rim of a 0.25-m-radius rotating wheel has a centripetal acceleration of 4.0 m/s^2. What is the angular speed of the wheel?

a. 1.0 rad/s
b. 2.0 rad/s
c. 3.2 rad/s
d. 4.0 rad/s

ANS: D PTS: 1 DIF: 2 TOP: 7.4 Centripetal Acceleration

33. A point on the rim of a 0.15-m-radius rotating disk has a centripetal acceleration of 5.0 m/s^2. What is the angular speed of a point 0.075 m from the center of the disk?

a. 0.89 rad/s
b. 1.6 rad/s
c. 3.2 rad/s
d. 5.8 rad/s

ANS: D PTS: 1 DIF: 2 TOP: 7.4 Centripetal Acceleration

34. When a point on the rim of a 0.30-m-radius wheel experiences a centripetal acceleration of 4.0 m/s^2, what tangential acceleration does that point experience?

a. 1.2 m/s^2
b. 2.0 m/s^2
c. 4.0 m/s^2
d. Cannot determine with the information given.

ANS: D PTS: 1 DIF: 2 TOP: 7.4 Centripetal Acceleration

35. A 0.150-m-radius grinding wheel, starting at rest, develops an angular speed of 12.0 rad/s in a time interval of 4.00 s. What is the centripetal acceleration of a point 0.100 m from the center when the wheel is moving at an angular speed of 12.0 rad/s?

a. 0.450 m/s^2
b. 7.20 m/s^2
c. 14.4 m/s^2
d. 28.8 m/s^2

ANS: C PTS: 1 DIF: 2 TOP: 7.4 Centripetal Acceleration

36. The distance from the center of a Ferris wheel to a passenger seat is 12 m. What centripetal acceleration does a passenger experience when the wheel's angular speed is 0.50 rad/s?

a. □16.9 m/s^2
b. □9.0 m/s^2
c. □3.0 m/s^2
d. □6.0 m/s^2

ANS: C PTS: 1 DIF: 2 TOP: 7.4 Centripetal Acceleration

37. What centripetal force does an 80-kg passenger experience when seated 12 m from the center of a Ferris wheel whose angular speed is 0.50 rad/s?

a. □484 N
b. □720 N
c. □914 N
d. □240 N

ANS: D PTS: 1 DIF: 2 TOP: 7.4 Centripetal Acceleration

38. A 0.400-kg object is swung in a circular path and in a vertical plane on a 0.500-m-length string. If the angular speed at the bottom is 8.00 rad/s, what is the tension in the string when the object is at the bottom of the circle?

a. □5.60 N
b. □10.5 N
c. □16.7 N
d. □19.6 N

ANS: C PTS: 1 DIF: 3 TOP: 7.4 Centripetal Acceleration

39. A 0.30-kg rock is swung in a circular path and in a vertical plane on a 0.25-m-length string. At the top of the path, the angular speed is 12.0 rad/s. What is the tension in the string at that point?

a. □7.9 N
b. □16 N
c. □18 N
d. □83 N

ANS: A PTS: 1 DIF: 3 TOP: 7.4 Centripetal Acceleration

40. A 1 500-kg car rounds an unbanked curve with a radius of 52 m at a speed of 12 m/s. What minimum coefficient of friction must exist between the road and tires to prevent the car from slipping? (g = 9.8 m/s^2)

a. □0.18
b. □0.30
c. □0.28
d. □0.37

ANS: C PTS: 1 DIF: 2 TOP: 7.4 Centripetal Acceleration

41. At what angle (relative to the horizontal) should a curve 52 m in radius be banked if no friction is required to prevent the car from slipping when traveling at 12 m/s? (g = 9.8 m/s^2)

a. □28°
b. □32°
c. □16°

d. 10°

ANS: C PTS: 1 DIF: 2 TOP: 7.4 Centripetal Acceleration

42. At what speed will a car round a 52-m-radius curve, banked at a 45° angle, if no friction is required between the road and tires to prevent the car from slipping? (g = 9.8 m/s^2)

a. 27 m/s
b. 17 m/s
c. 23 m/s
d. 35 m/s

ANS: C PTS: 1 DIF: 2 TOP: 7.4 Centripetal Acceleration

43. A roller coaster, loaded with passengers, has a mass of 2 000 kg; the radius of curvature of the track at the bottom point of the dip is 24 m. If the vehicle has a speed of 18 m/s at this point, what force is exerted on the vehicle by the track? (g = 9.8 m/s^2)

a. 2.3×10^4 N
b. 4.7×10^4 N
c. 3.0×10^4 N
d. 1.0×10^4 N

ANS: B PTS: 1 DIF: 3 TOP: 7.4 Centripetal Acceleration

44. Consider a point on a bicycle tire that is momentarily in contact with the ground as the bicycle rolls across the ground with constant speed. The direction for the acceleration for this point at that moment is:

a. upward.
b. down toward the ground.
c. forward.
d. at that moment the acceleration is zero.

ANS: A PTS: 1 DIF: 1 TOP: 7.4 Centripetal Acceleration

45. Consider a child who is swinging. As she reaches the lowest point in her swing:

a. the tension in the rope is equal to her weight.
b. the tension in the rope is equal to her mass times her acceleration.
c. her acceleration is downward at 9.8 m/s^2.
d. none of the above.

ANS: D PTS: 1 DIF: 2 TOP: 7.4 Centripetal Acceleration

46. What angular speed (in revolutions/second) is needed for a centrifuge to produce an acceleration of 1 000 g at a radius arm of 15.0 cm?

a. 40.7 rev/s
b. 75.4 rev/s
c. 81.4 rev/s
d. 151 rev/s

ANS: A PTS: 1 DIF: 2 TOP: 7.4 Centripetal Acceleration

47. An airplane in a wide sweeping "outside" loop can create zero gees inside the aircraft cabin. What must be the radius of curvature of the flight path for an aircraft moving at 150 m/s to create a condition of "weightlessness" inside the aircraft?

a. 1 150 m
b. 1 800 m
c. 2 300 m
d. 3 600 m

ANS: C PTS: 1 DIF: 2 TOP: 7.4 Centripetal Acceleration

48. A cylindrical space colony 8 km in diameter and 30 km long has been proposed as living quarters for future space explorers. Such a habitat would have cities, land and lakes on the inside surface and air and clouds in the center. All this would be held in place by the rotation of the cylinder about the long axis. How fast would such a cylinder have to rotate to produce a 1-*g* gravitational field at the walls of the cylinder?

a. 0.05 rad/s
b. 0.10 rad/s
c. 0.15 rad/s
d. 0.20 rad/s

ANS: A PTS: 1 DIF: 2 TOP: 7.4 Centripetal Acceleration

49. The Earth is 93 million miles (mi) from the Sun and its period of revolution is 1 year = 3.15×10^7 s. What is the acceleration of the Earth in its orbit about the Sun?

a. 18.6 mi/s^2
b. 9.3×10^{-3} mi/s^2
c. 13.6×10^{-6} mi/s^2
d. 3.7×10^{-6} mi/s^2

ANS: D PTS: 1 DIF: 2 TOP: 7.4 Centripetal Acceleration

50. A wheel is rotated about a horizontal axle at a constant angular speed. Next it is rotated in the opposite direction with the same angular speed. The acceleration at a point on the top of the wheel in the second case as compared to the acceleration in the first case:

a. is in the same direction.
b. is in the opposite direction.
c. is upward.
d. is tangential to the wheel.

ANS: A PTS: 1 DIF: 1 TOP: 7.4 Centripetal Acceleration

51. You are facing east looking at the clock on the wall. You see the second hand moving clockwise (of course). In what direction is the angular velocity vector for this second hand?

a. east
b. west
c. north or south, but not east or west
d. For half the rotation it is east, and for the other half of the rotation it is west.

ANS: A PTS: 1 DIF: 1 TOP: 7.4 Centripetal Acceleration

52. An object of mass 0.50 kg is transported to the surface of Planet X where the object's weight is measured to be 20 N. The radius of the planet is 4.0×10^6 m. What is the mass of Planet X? ($G = 6.67 \times 10^{-11}$ N $\times$ m^2/kg^2)

a.	13×10^{19} kg
b.	17×10^{22} kg
c.	9.6×10^{24} kg
d.	21×10^{25} kg

ANS: C PTS: 1 DIF: 3 TOP: 7.5 Newtonian Gravitation

53. An object of mass 0.50 kg is transported to the surface of Planet X where the object's weight is measured to be 20 N. The radius of the planet is 4.0×10^6 m. What free fall acceleration will the 0.50-kg object experience when at the surface of Planet X?

a.	48 m/s^2
b.	20 m/s^2
c.	16 m/s^2
d.	40 m/s^2

ANS: D PTS: 1 DIF: 2 TOP: 7.5 Newtonian Gravitation

54. An object of mass 0.50 kg is transported to the surface of Planet X where the object's weight is measured to be 20 N. The radius of the planet is 4.0×10^6 m. What free fall acceleration will the 0.50-kg object experience when transported to a distance of 2.0×10^6 m from the surface of this planet?

a.	90 m/s^2
b.	20 m/s^2
c.	13 m/s^2
d.	18 m/s^2

ANS: D PTS: 1 DIF: 3 TOP: 7.5 Newtonian Gravitation

55. An Earth satellite is orbiting at a distance from the Earth's surface equal to one Earth radius (4 000 miles). At this location, the acceleration due to gravity is what factor times the value of *g* at the Earth's surface?

a.	There is no acceleration since the satellite is in orbit.
b.	2
c.	1/2
d.	1/4

ANS: D PTS: 1 DIF: 2 TOP: 7.5 Newtonian Gravitation

56. If a planet has 3 times the radius of the Earth, but has the same density as the Earth, what is the gravitational acceleration at the surface of the planet? ($g = 9.8$ m/s^2)

a.	29.4 m/s^2
b.	88.2 m/s^2
c.	265 m/s^2
d.	3.27 m/s^2

ANS: A PTS: 1 DIF: 2 TOP: 7.5 Newtonian Gravitation

57. If a planet has a radius 20% greater than that of the Earth but has the same mass as the Earth, what is the acceleration due to gravity at its surface?

a. 14 m/s^2
b. 12 m/s^2
c. 8.2 m/s^2
d. 6.8 m/s^2

ANS: D PTS: 1 DIF: 2 TOP: 7.5 Newtonian Gravitation

58. The acceleration due to gravity at the surface of Planet X is 10 m/s^2. What is the acceleration due to gravity at an altitude of 3 000 km above the surface of this planet?

a. 10 m/s^2
b. 8.0 m/s^2
c. 4.4 m/s^2
d. More information is needed.

ANS: D PTS: 1 DIF: 2 TOP: 7.5 Newtonian Gravitation

59. An object when orbiting the Earth at a height of three Earth radii from the center of the Earth has a weight of 1.00 N. What is the object's mass? (g at the surface of the Earth is 9.8 m/s^2)

a. 0.102 kg
b. 0.306 kg
c. 0.92 kg
d. 1.0 kg

ANS: C PTS: 1 DIF: 2 TOP: 7.5 Newtonian Gravitation

60. Somewhere between the Earth and the Moon is a point where the gravitational attraction of the Earth is canceled by the gravitational pull of the Moon. The mass of the Moon is 1/81 that of the Earth. How far from the center of the Earth is this point?

a. 8/9 the way to the Moon
b. 9/10 the way to the Moon
c. 3/4 the way to the Moon
d. 80/81 the way to the Moon

ANS: B PTS: 1 DIF: 3 TOP: 7.5 Newtonian Gravitation

61. A satellite is in a circular orbit about the Earth at a distance of one Earth radius above the surface. What is the speed of the satellite? (The radius of the Earth is 6.4×10^6 m, and $G = 6.67 \times 10^{-11}$ N×m^2/kg^2.)

a. 2 800 m/s
b. 4 200 m/s
c. 5 600 m/s
d. 16 800 m/s

ANS: C PTS: 1 DIF: 2 TOP: 7.5 Newtonian Gravitation

62. A careful photographic survey of Jupiter's moon Io by the spacecraft *Voyager 1* showed active volcanoes spewing liquid sulfur to heights of 70 km above the surface of this moon. If the value of g on Io is 2.0 m/s^2, estimate the speed with which the liquid sulfur left the volcano.

a. 260 m/s

b. 530 m/s
c. 790 m/s
d. 970 m/s

ANS: B PTS: 1 DIF: 2 TOP: 7.5 Newtonian Gravitation

63. If the mass of Mars is 0.107 times that of Earth, and its radius is 0.530 that of Earth, estimate the gravitational acceleration *g* at the surface of Mars. (g_{earth} = 9.80 m/s^2)

a. 2.20 m/s^2
b. 3.73 m/s^2
c. 4.20 m/s^2
d. 5.50 m/s^2

ANS: B PTS: 1 DIF: 3 TOP: 7.5 Newtonian Gravitation

64. The escape speed from the surface of the Earth is 11.2 km/s. Estimate the escape speed for a spacecraft from the surface of the Moon. The Moon has a mass 1/81 that of Earth and a radius 0.25 that of Earth.

a. 2.5 km/s
b. 4.0 km/s
c. 5.6 km/s
d. 8.7 km/s

ANS: A PTS: 1 DIF: 3 TOP: 7.5 Newtonian Gravitation

65. Geosynchronous satellites orbit the Earth at a distance of 42 000 km from the Earth's center. Their angular speed at this height is the same as the rotation rate of the Earth, so they appear stationary at certain locations in the sky. What is the force acting on a 1 500-kg satellite at this height?

a. 85 N
b. 333 N
c. 404 N
d. 457 N

ANS: B PTS: 1 DIF: 3 TOP: 7.5 Newtonian Gravitation

66. At an altitude of 4 times the radius of the earth, the acceleration due to gravity is

a. g/2.
b. g/4.
c. g/16.
d. not given.

ANS: D PTS: 1 DIF: 3 TOP: 7.5 Newtonian Gravitation

67. Suppose the gravitational potential energy for a mass at an altitude of one Earth radius is PE_1 and at two Earth radii is PE_2. How do the absolute values of these potential energies compare?

a.
b.
c.
d. but is not equal to

ANS: C PTS: 1 DIF: 2 TOP: 7.5 Newtonian Gravitation

68. An asteroid has a perihelion (the orbit's closest approach to the sun) of 1.5 AU and a period of revolution of 8.0 y. What is its greatest distance from the sun (its aphelion)?

a. 8.0 AU
b. 6.5 AU
c. 4.0 AU
d. 2.5 AU

ANS: B PTS: 1 DIF: 3 TOP: 7.6 Kepler's Laws

69. Two satellites are monitored as they orbit the Earth; satellite X is eight times as far from the Earth's center as is satellite Y. From Kepler's third law one may conclude that the period or revolution of X is what factor times that of Y?

a. 1/2
b. 2.0
c. 4.0
d. 22.6

ANS: D PTS: 1 DIF: 2 TOP: 7.6 Kepler's Laws

70. At what location does an artificial Earth satellite in elliptical orbit have its greatest speed?

a. nearest the Earth
b. farthest from the Earth
c. between Earth and Moon
d. between Earth and Sun

ANS: A PTS: 1 DIF: 1 TOP: 7.6 Kepler's Laws

71. An asteroid in orbit about the sun has a linear speed of 4 km/s when at a distance of closest approach *d* from the sun. What is its linear speed when it is at its greatest distance from the sun, a distance 2 *d*?

a. 1 km/s
b. 2 km/s
c. 8 km/s
d. 16 km/s

ANS: B PTS: 1 DIF: 2 TOP: 7.6 Kepler's Laws

72. An artificial Earth satellite in an elliptical orbit has its greatest centripetal acceleration when it is at what location?

a. nearest the Earth
b. farthest from the Earth
c. between Earth and Moon
d. between Earth and Sun

ANS: A PTS: 1 DIF: 2 TOP: 7.6 Kepler's Laws

73. Which of the following best describes the property of the period of orbital revolution for an Earth satellite?

a. greater when the orbital radius is smaller
b. greater when the orbital radius is larger
c. independent of the orbital radius

d. determined mainly by the satellite's mass

ANS: B PTS: 1 DIF: 1 TOP: 7.6 Kepler's Laws

74. Of the nine known planets in our solar system, the innermost is Mercury. When compared to the other planets in the system, Mercury has the:

a. greatest centripetal acceleration.
b. greatest period of revolution.
c. smallest angular velocity.
d. smallest tangential velocity.

ANS: A PTS: 1 DIF: 1 TOP: 7.6 Kepler's Laws

75. According to Kepler's second law, Halley's Comet circles the Sun in an elliptical path with the Sun at one focus of the ellipse. What is at the other focus of the ellipse?

a. nothing
b. the Earth
c. The comet itself passes through the other focus.
d. The tail of the comet stays at the other ellipse.

ANS: A PTS: 1 DIF: 1 TOP: 7.6 Kepler's Laws

76. For any object orbiting the Sun, Kepler's Law may be written $T^2 = kr^3$. If T is measured in years and r in units of the Earth's distance from the Sun, then $k = 1$. What, therefore, is the time (in years) for Mars to orbit the Sun if its mean radius from the Sun is 1.5 times the Earth's distance from the Sun?

a. 1.8 years
b. 2.8 years
c. 3.4 years
d. 4.2 years

ANS: A PTS: 1 DIF: 2 TOP: 7.6 Kepler's Laws

77. In order for a satellite to be geosynchronous, its orbit must:

a. go over the North and South Poles.
b. be over the equator.
c. be over a single longitude.
d. emit television signals.

ANS: B PTS: 1 DIF: 1 TOP: 7.6 Kepler's Laws

78. An asteroid is in orbit at 4 times the earth's distance from the Sun. What is its period of revolution?

a. one fourth year
b. 4 years
c. 8 years
d. 16 years

ANS: C PTS: 1 DIF: 2 TOP: 7.6 Kepler's Laws

79. Doubling the mean distance from the Sun results in changing the orbital period of revolution by what factor?

a. $2^{1/2}$
b. 2
c. $2^{3/2}$
d. 2^2

ANS: C PTS: 1 DIF: 2 TOP: 7.6 Kepler's Laws

80. The Earth's orbit is closest to the Sun in January and farthest from the Sun in July. When is the Earth moving the fastest in orbit?

a. Neither January nor July since the orbital speed of the Earth is a constant.
b. January
c. July
d. This occurs twice a year, in April and in October.

ANS: B PTS: 1 DIF: 1 TOP: Conceptual Problems

81. Two objects are in circular orbits of different radii around the Sun. Which object has the highest orbital speed?

a. The one closest to the Sun.
b. The one farthest from the Sun.
c. Once in orbit around the Sun, all objects have the same orbital speed regardless of distance from the Sun. It is the greater radius and greater resulting circumference that causes the object farther from the Sun to take longer to complete an orbit.
d. This cannot be found without knowing the relative masses of the objects.

ANS: A PTS: 1 DIF: 2 TOP: Conceptual Problems

82. For a point on a spinning disc in uniform circular motion, which of the following is not constant?

a. Its angular speed.
b. Its angular acceleration.
c. Its centripetal acceleration.
d. The magnitude of its total acceleration.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

83. Two points on a merry-go-round are located at distances from the center r_1 and r_2, where $r_1 < r_2$. While the merry-go-round is in the process of speeding up to operational speed, which of the following equations involving magnitudes of angular speed, angular acceleration, and tangential speed for these points is incorrect?

a. $w_1 = w_2$
b. $a_1 = a_2$
c. $v_{t1} = v_{t2}$

d. All of the equations are correct.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

84. A car is going around a racetrack at constant speed. The curves around the track have different radii. In which turn is the magnitude of the car's acceleration the greatest?

a. It is the greatest in the turn with the greatest radius.
b. It is the greatest in the turn with the smallest radius.
c. The acceleration is zero everywhere because of the constant speed.
d. More information is needed to determine the answer.

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Problems

Chapter 8—Rotational Equilibrium and Rotational Dynamics

MULTIPLE CHOICE

1. A vault is opened by applying a force of 300 N perpendicular to the plane of the door, 0.80 m from the hinges. Find the torque due to this force about an axis through the hinges.

a. 120 N×m
b. 240 N×m
c. 300 N×m
d. 360 N×m

ANS: B PTS: 1 DIF: 1 TOP: 8.1 Torque

2. A 3.0-m rod is pivoted about its left end. A force of 6.0 N is applied perpendicular to the rod at a distance of 1.2 m from the pivot causing a ccw torque, and a force of 5.2 N is applied at the end of the rod 3.0 m from the pivot. The 5.2 N is at an angle of 30° to the rod and causes a cw torque. What is the net torque about the pivot?

a. 15 N×m
b. 0 N×m
c. - 6.3 N×m
d. - 0.6 N×m

ANS: D PTS: 1 DIF: 2 TOP: 8.1 Torque

3. A rod of length L is pivoted about its left end and has a force F applied perpendicular to the other end. The force F is now removed and another force F' is applied at the midpoint of the rod. If F' is at an angle of 30° with respect to the rod, what is its magnitude if the resulting torque is the same as when F was applied?

a. F
b. 2F
c. 3F
d. 4F

ANS: D PTS: 1 DIF: 2 TOP: 8.1 Torque

4. Two children seat themselves on a seesaw. The one on the left has a weight of 400 N while the one on the right weighs 300 N. The fulcrum is at the midpoint of the seesaw. If the child on the left is not at the end but is 1.50 m from the fulcrum and the seesaw is balanced, what is the torque provided by the weight of the child on the right?

a. 600 N×m
b. 450 N×m
c. - 600 N×m
d. - 450 N×m

ANS: C PTS: 1 DIF: 2 TOP: 8.1 Torque

5. A bucket filled with water has a mass of 23 kg and is attached to a rope, which in turn, is wound around a 0.050-m radius cylinder at the top of a well. What torque does the weight of water and bucket produce on the cylinder if the cylinder is not permitted to rotate? (g = 9.8 m/s^2)

a. 34 N×m
b. 17 N×m
c. 11 N×m
d. 23 N×m

ANS: C PTS: 1 DIF: 2 TOP: 8.1 Torque

6. A bucket of water with total mass 23 kg is attached to a rope, which in turn, is wound around a 0.050-m radius cylinder at the top of a well. A crank with a turning radius of 0.25 m is attached to the end of the cylinder. What minimum force directed perpendicular to the crank handle is required to just raise the bucket? (Assume the rope's mass is negligible, that cylinder turns on frictionless bearings, and that $g = 9.8$ m/s^2.)

a. 45 N
b. 68 N
c. 90 N
d. 135 N

ANS: A PTS: 1 DIF: 3 TOP: 8.1 Torque

7. A uniform bridge span weighs 50.0×10^3 N and is 40.0 m long. An automobile weighing 15.0×10^3 N is parked with its center of gravity located 12.0 m from the right pier. What upward support force does the left pier provide?

a. 29.5×10^3 N
b. 35.5×10^3 N
c. 65.0×10^3 N
d. 32.5×10^3 N

ANS: A PTS: 1 DIF: 2
TOP: 8.2 Torque and the Two Conditions for Equilibrium | 8.3 The Center of Gravity | 8.4 Examples of Objects in Equilibrium

8. Masses are distributed in the *x*,*y*-plane as follows: 6.0 kg at (0.0, 0.0) m, 4.0 kg at (2.0, 0.0) m, and 5.0 kg at (2.0, 3.0) m. What is the *x*-coordinate of the center of gravity of this system of masses?

a. 18 m
b. 2.0 m
c. 1.2 m
d. 1.0 m

ANS: C PTS: 1 DIF: 2
TOP: 8.2 Torque and the Two Conditions for Equilibrium | 8.3 The Center of Gravity | 8.4 Examples of Objects in Equilibrium

9. Masses are distributed in the *xy*-plane as follows: 10 kg at (2.0, 6.0) m, 4.0 kg at (2.0, 0.0) m, and 6.0 kg at (0.0, 3.0) m. Where would a 20-kg mass need to be positioned so that the center of gravity of the resulting four mass system would be at the origin?

a. (1.4, 3.9) m
b. (3.9, 1.4) m
c. (- 1.4, - 3.9) m
d. (- 3.9, - 1.4) m

ANS: C PTS: 1 DIF: 2
TOP: 8.2 Torque and the Two Conditions for Equilibrium | 8.3 The Center of Gravity | 8.4 Examples of Objects in Equilibrium

10. A hoop of radius 1.0 m is placed in the first quadrant of an *xy*-coordinate system with its rim touching both the *x*-axis and the *y*-axis. What are the coordinates of its center of gravity?

a.□(1.0, 1.0) m
b.□(0.7, 0.7) m
c.□(0.5, 0.5) m
d.□Since there is nothing at the center of the hoop, it has no center of gravity.

ANS: A PTS: 1 DIF: 1
TOP: 8.2 Torque and the Two Conditions for Equilibrium | 8.3 The Center of Gravity | 8.4 Examples of Objects in Equilibrium

11. Tasha has mass 20 kg and wants to use a 4.0-m board of mass 10 kg as a seesaw. Her friends are busy, so Tasha seesaws by herself by putting the support at the system's center of gravity when she sits on one end of the board. How far is she from the support point?

a.□2.0 m
b.□1.0 m
c.□0.67 m
d.□0.33 m

ANS: C PTS: 1 DIF: 2
TOP: 8.2 Torque and the Two Conditions for Equilibrium | 8.3 The Center of Gravity | 8.4 Examples of Objects in Equilibrium

12. An 80-kg man is one fourth of the way up a 10-m ladder that is resting against a smooth, frictionless wall. If the ladder has a mass of 20 kg and it makes an angle of 60° with the ground, find the force of friction of the ground on the foot of the ladder.

a.□7.8 ´ 10^{2} N
b.□2.0 ´ 10^{2} N
c.□50 N
d.□1.7 ´ 10^{2} N

ANS: D PTS: 1 DIF: 3
TOP: 8.2 Torque and the Two Conditions for Equilibrium | 8.3 The Center of Gravity | 8.4 Examples of Objects in Equilibrium

13. A 100-N uniform ladder, 8.0 m long, rests against a smooth vertical wall. The coefficient of static friction between ladder and floor is 0.40. What minimum angle can the ladder make with the floor before it slips?

a.□22°
b.□51°
c.□18°
d.□42°

ANS: B PTS: 1 DIF: 3
TOP: 8.2 Torque and the Two Conditions for Equilibrium | 8.3 The Center of Gravity | 8.4 Examples of Objects in Equilibrium

14. A meter stick is supported by a knife-edge at the 50-cm mark. Doug hangs masses of 0.40 and 0.60 kg from the 20-cm and 80-cm marks, respectively. Where should Doug hang a third mass of 0.30 kg to keep the stick balanced?

a. 20 cm
b. 70 cm
c. 30 cm
d. 25 cm

ANS: C PTS: 1 DIF: 2
TOP: 8.2 Torque and the Two Conditions for Equilibrium | 8.3 The Center of Gravity | 8.4 Examples of Objects in Equilibrium

15. An 800-N billboard worker stands on a 4.0-m scaffold supported by vertical ropes at each end. If the scaffold weighs 500 N and the worker stands 1.0 m from one end, what is the tension in the rope nearest the worker?

a. 450 N
b. 500 N
c. 800 N
d. 850 N

ANS: D PTS: 1 DIF: 2
TOP: 8.2 Torque and the Two Conditions for Equilibrium | 8.3 The Center of Gravity | 8.4 Examples of Objects in Equilibrium

16. An 800-N billboard worker stands on a 4.0-m scaffold weighing 500 N and supported by vertical ropes at each end. How far would the worker stand from one of the supporting ropes to produce a tension of 550 N in that rope?

a. 1.4 m
b. 2.0 m
c. 2.5 m
d. 2.7 m

ANS: C PTS: 1 DIF: 2
TOP: 8.2 Torque and the Two Conditions for Equilibrium | 8.3 The Center of Gravity | 8.4 Examples of Objects in Equilibrium

17. A woman who weighs 500 N stands on an 8.0-m-long board that weighs 100 N. The board is supported at each end. The support force at the right end is 3 times the support force at the left end. How far from the right end is the woman standing?

a. 4.0 m
b. 2.0 m
c. 2.7 m
d. 1.6 m

ANS: D PTS: 1 DIF: 2
TOP: 8.2 Torque and the Two Conditions for Equilibrium | 8.3 The Center of Gravity | 8.4 Examples of Objects in Equilibrium

18. A uniform, horizontal beam of length 6.0 m and weight 120 N is attached at one end to a wall by a pin connection (so that it may rotate). A cable attached to the wall above the pin supports the opposite end.

The cable makes an angle of 60° with the horizontal. What is the tension in the cable needed to maintain the beam in equilibrium?

a.	35 N
b.	69 N
c.	60 N
d.	120 N

ANS: B PTS: 1 DIF: 3
TOP: 8.2 Torque and the Two Conditions for Equilibrium | 8.3 The Center of Gravity | 8.4 Examples of Objects in Equilibrium

19. A uniform 1.0-N meter stick is suspended horizontally by vertical strings attached at each end. A 2.0-N weight is suspended from the 10-cm position on the stick, another 2.0-N weight is suspended from the 50 cm position, and a 3.0-N weight is suspended from the 60 cm position. What is the tension in the string attached at the 100-cm end of the stick?

a.	1.9 N
b.	3.0 N
c.	3.5 N
d.	4.0 N

ANS: C PTS: 1 DIF: 2
TOP: 8.2 Torque and the Two Conditions for Equilibrium | 8.3 The Center of Gravity | 8.4 Examples of Objects in Equilibrium

20. A 2.00-m by 4.00-m uniform sheet of plywood is in a coordinate system with the origin at its center, the *x*-axis along the longer dimension of the sheet is positive to the right and the *y*-axis along the shorter dimension is positive upwards. The section of the plywood in the 3rd quadrant is sawed off and the resulting piece is then glued squarely over the 4th quadrant portion of the plywood with glue of negligible weight.What are the *x*- and *y*-coordinates of the resulting center of gravity for this arrangement?

a.	(0 m, 1.0 m)
b.	(0.50 m, 0 m)
c.	(1.0 m, –0.50 m)
d.	(1.0 m, 0 m)

ANS: B PTS: 1 DIF: 2 TOP: 8.3 The Center of Gravity

21. A uniform beam of length 3.00 m and weight 100 N is mounted on an axle at one end perpendicular to the length of the beam. A rope is attached to the end of the beam at the other end from the axle, and the beam is lifted by the rope so that the beam makes an angle of 30.0° with the horizontal. If the rope is straight up, what magnitude torque does it supply about the axle?

a.	300 N·m
b.	150 N·m
c.	130 N·m
d.	75.0 N·m

ANS: C PTS: 1 DIF: 2
TOP: 8.1 Torque | 8.2 Torque and the Two conditions for Equilibrium | 8.3 Center of Gravity

22. A uniform beam of length 4.0 m and weight 100 N is mounted on an axle at one end perpendicular to the length of the beam. A rope is attached to the end of the beam at the other end from the axle and the beam

is lifted by the rope so that the beam makes an angle of 30° with the horizontal. What is the tension in the rope if it is straight up?

a.	50 N
b.	87 N
c.	100 N
d.	200 N

ANS: A PTS: 1 DIF: 1
TOP: 8.1 Torque | 8.2 Torque and the Two conditions for Equilibrium | 8.3 Center of Gravity

23. The quantity "moment of inertia" (in terms of the fundamental quantities of mass, length, and time) is equivalent to:

a.	ML^2T^{-2}.
b.	ML.
c.	ML^2.
d.	$ML^{-1}T^{-2}$.

ANS: C PTS: 1 DIF: 1
TOP: 8.5 Relationship Between Torque and Angular Acceleration

24. A 4.2-kg mass is placed at (3.0, 4.0) m. Where can an 8.4-kg mass be placed so that the moment of inertia about the *z*-axis is zero?

a.	(- 3.0, - 4.0) m
b.	(- 6.0, - 8.0) m
c.	(- 1.5, - 2.0) m
d.	There is no position giving this result.

ANS: D PTS: 1 DIF: 2
TOP: 8.5 Relationship Between Torque and Angular Acceleration

25. A 4.0-kg mass is placed at (3.0, 4.0) m, and a 6.0-kg mass is placed at (3.0, - 4.0) m. What is the moment of inertia of this system of masses about the *x*-axis?

a.	160 $kg\times m^2$
b.	90 $kg\times m^2$
c.	250 $kg\times m^2$
d.	32 $kg\times m^2$

ANS: A PTS: 1 DIF: 2
TOP: 8.5 Relationship Between Torque and Angular Acceleration

26. A 4.0-kg mass is placed at (3.0, 4.0) m, and a 6.0-kg mass is placed at (3.0, - 4.0) m. What is the moment of inertia of this system of masses about the *y*-axis?

a.	160 $kg\times m^2$
b.	90 $kg\times m^2$
c.	250 $kg\times m^2$
d.	180 $kg\times m^2$

ANS: B PTS: 1 DIF: 2
TOP: 8.5 Relationship Between Torque and Angular Acceleration

27. A 4.0-kg mass is placed at (3.0, 4.0) m, and a 6.0-kg mass is placed at (3.0, - 4.0) m. What is the moment of inertia of this system of masses about the *z*-axis?

a. 160 kg×m^2
b. 90 kg×m^2
c. 250 kg×m^2
d. 180 kg×m^2

ANS: C PTS: 1 DIF: 2
TOP: 8.5 Relationship Between Torque and Angular Acceleration

28. If a net torque is applied to an object, that object will experience:

a. a constant angular speed.
b. an angular acceleration.
c. a constant moment of inertia.
d. an increasing moment of inertia.

ANS: B PTS: 1 DIF: 1
TOP: 8.5 Relationship Between Torque and Angular Acceleration

29. According to Newton's second law, the angular acceleration experienced by an object is directly proportional to:

a. its moment of inertia.
b. the net applied torque.
c. the object's size.
d. choices a and b above are both valid.

ANS: B PTS: 1 DIF: 1
TOP: 8.5 Relationship Between Torque and Angular Acceleration

30. A ventilation fan with a moment of inertia of 0.034 kg×m^2 has a net torque of 0.11 N×m applied to it. What angular acceleration does it experience?

a. 5.3 rad/s^2
b. 4.0 rad/s^2
c. 3.2 rad/s^2
d. 0.31 rad/s^2

ANS: C PTS: 1 DIF: 1
TOP: 8.5 Relationship Between Torque and Angular Acceleration

31. A disk has a moment of inertia of 3.0×10^{-4} kg×m^2 and rotates with an angular speed of 3.5 rad/sec. What net torque must be applied to bring it to rest within 3 s?

a. 4.5×10^{-3} N×m
b. 7.5×10^{-4} N×m
c. 3.5×10^{-4} N×m
d. 5.0×10^{-4} N×m

ANS: C PTS: 1 DIF: 2
TOP: 8.5 Relationship Between Torque and Angular Acceleration

32. The Earth moves about the Sun in an elliptical orbit. As the Earth moves closer to the Sun, which of the following best describes the Earth-Sun system's moment of inertia?

a.	decreases
b.	increases
c.	remains constant
d.	none of the above choices are valid

ANS: A PTS: 1 DIF: 1
TOP: 8.5 Relationship Between Torque and Angular Acceleration

33. A bowling ball has a mass of 7.0 kg, a moment of inertia of 2.8×10^{-2} kg·m^2 and a radius of 0.10 m. If it rolls down the lane without slipping at a linear speed of 4.0 m/s, what is its angular speed?

a.	0.80 rad/s
b.	10 rad/s
c.	0.050 rad/s
d.	40 rad/s

ANS: D PTS: 1 DIF: 1
TOP: 8.5 Relationship Between Torque and Angular Acceleration

34. A baseball pitcher, loosening up his arm before a game, tosses a 0.15-kg ball using only the rotation of his forearm, 0.32 m in length, to accelerate the ball. If the ball starts at rest and is released with a speed of 12 m/s in a time of 0.40 s, what is the average angular acceleration of the arm and ball?

a.	0.067 rad/s^2
b.	94 rad/s^2
c.	15 rad/s^2
d.	37 rad/s^2

ANS: B PTS: 1 DIF: 2
TOP: 8.5 Relationship Between Torque and Angular Acceleration

35. A baseball pitcher loosens up his pitching arm. He tosses a 0.15-kg ball using only the rotation of his forearm, 0.32 m in length, to accelerate the ball. What is the moment of inertia of the ball alone as it moves in a circular arc with a radius of 0.32 m?

a.	1.5×10^{-2} kg·m^2
b.	16×10^{-2} kg·m^2
c.	4.0×10^{-2} kg·m^2
d.	7.6×10^{-2} kg·m^2

ANS: A PTS: 1 DIF: 2
TOP: 8.5 Relationship Between Torque and Angular Acceleration

36. A baseball pitcher loosens up his pitching arm. He tosses a 0.15-kg ball using only the rotation of his forearm, 0.32 m in length, to accelerate the ball. If the ball starts at rest and is released with a speed of 12 m/s in a time of 0.40 s, what torque is applied to the ball while being held by the pitcher's hand to produce the angular acceleration?

a.	1.1 N·m
b.	11 N·m
c.	7.2 N·m
d.	1.4 N·m

ANS: D PTS: 1 DIF: 2
TOP: 8.5 Relationship Between Torque and Angular Acceleration

37. A bucket of water with total mass 23 kg is attached to a rope, which in turn is wound around a 0.050-m radius cylinder at the top of a well. A crank with a turning radius of 0.25 m is attached to the end of the cylinder and the moment of inertia of cylinder and crank is 0.12 kg×m^2. If the bucket is raised to the top of the well and released, what is the acceleration of the bucket as it falls toward the bottom of the well? (Assume rope's mass is negligible, that cylinder turns on frictionless bearings and that g = 9.8 m/s^2.)

a.	3.2 m/s^2
b.	6.3 m/s^2
c.	7.4 m/s^2
d.	9.8 m/s^2

ANS: A PTS: 1 DIF: 3
TOP: 8.5 Relationship Between Torque and Angular Acceleration

38. A bucket of water with total mass 23 kg is attached to a rope, which in turn is wound around a 0.050-m radius cylinder at the top of a well. The bucket is raised to the top of the well and released. The bucket is moving with a speed of 8.0 m/s upon hitting the water surface in the well. What is the angular speed of the cylinder at this instant?

a.	39 rad/s
b.	79 rad/s
c.	120 rad/s
d.	160 rad/s

ANS: D PTS: 1 DIF: 1
TOP: 8.5 Relationship Between Torque and Angular Acceleration

39. A majorette takes two batons and fastens them together in the middle at right angles to make an "x" shape. Each baton was 0.80 m long and each ball on the end is 0.20 kg. (Ignore the mass of the rods.) What is the moment of inertia if the arrangement is spun around an axis formed by one of the batons?

a.	0.048 kg×m^2
b.	0.064 kg×m^2
c.	0.19 kg×m^2
d.	0.32 kg×m^2

ANS: B PTS: 1 DIF: 2
TOP: 8.5 Relationship Between Torque and Angular Acceleration

40. A majorette takes two batons and fastens them together in the middle at right angles to make an "x" shape. Each baton was 0.80 m long and each ball on the end is 0.20 kg. (Ignore the mass of the rods.) What is the moment of inertia if the arrangement is spun around an axis through the center perpendicular to both rods?

a.	0.064 kg×m^2
b.	0.096 kg×m^2
c.	0.13 kg×m^2
d.	0.32 kg×m^2

ANS: C PTS: 1 DIF: 2
TOP: 8.5 Relationship Between Torque and Angular Acceleration

41. A solid cylinder ($I = MR^2/2$) has a string wrapped around it many times. When I release the cylinder, holding on to the string, the cylinder falls and spins as the string unwinds. What is the downward acceleration of the cylinder as it falls?

a. 0
b. 4.9 m/s^2
c. 6.5 m/s^2
d. 9.8 m/s^2

ANS: C PTS: 1 DIF: 3
TOP: 8.5 Relationship Between Torque and Angular Acceleration

42. A 40-kg boy is standing on the edge of a stationary 30-kg platform that is free to rotate. The boy tries to walk around the platform in a counterclockwise direction. As he does:

a. the platform doesn't rotate.
b. the platform rotates in a clockwise direction just fast enough so that the boy remains stationary relative to the ground.
c. the platform rotates in a clockwise direction while the boy goes around in a counterclockwise direction relative to the ground.
d. both go around with equal angular velocities but in opposite directions.

ANS: C PTS: 1 DIF: 2
TOP: 8.5 Relationship Between Torque and Angular Acceleration

43. A rod of length L is hinged at one end. The moment of inertia as the rod rotates around that hinge is $ML^2/3$. Suppose a 2.00-m rod with a mass of 3.00 kg is hinged at one end and is held in a horizontal position. The rod is released as the free end is allowed to fall. What is the angular acceleration as it is released?

a. 3.70 rad/s^2
b. 7.35 rad/s^2
c. 2.45 rad/s^2
d. 4.90 rad/s^2

ANS: B PTS: 1 DIF: 2
TOP: 8.5 Relationship Between Torque and Angular Acceleration

44. Two hoops or rings ($I = MR^2$) are centered, lying on a turntable. The smaller ring has radius = 0.050 m; the larger has radius = 0.10 m. Both have a mass of 3.0 kg. What is the total moment of inertia as the turntable spins? Ignore the mass of the turntable.

a. 0.030 kg$\times$m^2
b. 0.007 5 kg$\times$m^2
c. 0.038 kg$\times$m^2
d. 0.075 kg$\times$m^2

ANS: C PTS: 1 DIF: 2
TOP: 8.5 Relationship Between Torque and Angular Acceleration

45. An automobile accelerates from zero to 30 m/s in 6.0 s. The wheels have a diameter of 0.40 m. What is the average angular acceleration of each wheel?

a. 5.0 rad/s^2
b. 15 rad/s^2
c. 25 rad/s^2
d. 35 rad/s^2

ANS: C PTS: 1 DIF: 2
TOP: 8.5 Relationship Between Torque and Angular Acceleration

46. An object consists of a rod (of length 3.0 m and negligible moment of inertia) to which four small 2.0-kg masses are attached, one at each end and one at each point on the rod 1.0 m from each end. (The masses are one meter apart.) The moment of inertia of this object about an axis perpendicular to the rod and through one of the inner masses:

a. is 72 kg×m^2.
b. is 12 kg×m^2.
c. is 4 kg×m^2.
d. cannot be uniquely determined until it is stated which inner mass the axis goes through.

ANS: B PTS: 1 DIF: 2
TOP: 8.5 Relationship Between Torque and Angular Acceleration

47. A ventilation fan with a moment of inertia of 0.034 kg×m^2 has a net torque of 0.11 N×m applied to it. If it starts from rest, what kinetic energy will it have 8.0 s later?

a. 31 J
b. 17 J
c. 11 J
d. 6.6 J

ANS: C PTS: 1 DIF: 3
TOP: 8.6 Rotational Kinetic Energy

48. The total kinetic energy of a baseball thrown with a spinning motion is a function of:

a. its linear speed but not rotational speed.
b. its rotational speed but not linear speed.
c. both linear and rotational speeds.
d. neither linear nor rotational speed.

ANS: C PTS: 1 DIF: 1
TOP: 8.6 Rotational Kinetic Energy

49. A bowling ball has a mass of 7.0 kg, a moment of inertia of 2.8×10^{-2} kg×m^2 and a radius of 0.10 m. If it rolls down the lane without slipping at a linear speed of 4.0 m/s, what is its total kinetic energy?

a. 45 J
b. 32 J
c. 11 J

d. 78 J

ANS: D PTS: 1 DIF: 2
TOP: 8.6 Rotational Kinetic Energy

50. A bucket of water with total mass 23 kg is attached to a rope, which in turn is wound around a 0.050-m radius cylinder, with crank, at the top of a well. The moment of inertia of the cylinder and crank is 0.12 kg×m^2. The bucket is raised to the top of the well and released to fall back into the well. What is the kinetic energy of the cylinder and crank at the instant the bucket is moving with a speed of 8.0 m/s?

a. 2.1 ´ 10^3 J
b. 1.5 ´ 10^3 J
c. 0.70 ´ 10^3 J
d. 0.40 ´ 10^3 J

ANS: B PTS: 1 DIF: 2
TOP: 8.6 Rotational Kinetic Energy

51. A solid sphere of mass 4.0 kg and radius 0.12 m is at rest at the top of a ramp inclined 15°. It rolls to the bottom without slipping. The upper end of the ramp is 1.2 m higher than the lower end. Find the sphere's total kinetic energy when it reaches the bottom.

a. 70 J
b. 47 J
c. 18 J
d. 8.8 J

ANS: B PTS: 1 DIF: 2
TOP: 8.6 Rotational Kinetic Energy

52. A solid sphere of mass 4.0 kg and radius 0.12 m starts from rest at the top of a ramp inclined 15°, and rolls to the bottom. The upper end of the ramp is 1.2 m higher than the lower end. What is the linear speed of the sphere when it reaches the bottom of the ramp? (Note: $I = 0.4MR^2$ for a solid sphere and $g = 9.8$ m/s^2)

a. 4.7 m/s
b. 4.1 m/s
c. 3.4 m/s
d. 2.4 m/s

ANS: B PTS: 1 DIF: 3
TOP: 8.6 Rotational Kinetic Energy

53. A solid cylinder of mass 3.0 kg and radius 0.2 m starts from rest at the top of a ramp, inclined 15°, and rolls to the bottom without slipping. (For a cylinder $I = 0.5MR^2$) The upper end of the ramp is 1.2 m higher than the lower end. Find the linear speed of the cylinder when it reaches the bottom of the ramp. (g = 9.8 m/s^2)

a. 4.7 m/s
b. 4.3 m/s
c. 4.0 m/s
d. 2.4 m/s

ANS: C PTS: 1 DIF: 3
TOP: 8.6 Rotational Kinetic Energy

54. A gyroscope has a moment of inertia of 0.14 kg×m^2 and an initial angular speed of 15 rad/s. Friction in the bearings causes its speed to reduce to zero in 30 s. What is the value of the average frictional torque?

a.	3.3×10^{-2} N×m
b.	8.1×10^{-2} N×m
c.	14×10^{-2} N×m
d.	7.0×10^{-2} N×m

ANS: D PTS: 1 DIF: 2
TOP: 8.6 Rotational Kinetic Energy

55. A gyroscope has a moment of inertia of 0.140 kg×m^2 and has an initial angular speed of 15.0 rad/s. If a lubricant is applied to the bearings of the gyroscope so that frictional torque is reduced to 2.00×10^{-2} N×m, then in what time interval will the gyroscope coast from 15.0 rad/s to zero?

a.	150 s
b.	105 s
c.	90.0 s
d.	180 s

ANS: B PTS: 1 DIF: 2
TOP: 8.6 Rotational Kinetic Energy

56. A cylinder with its mass concentrated toward the center has a moment of inertia of 0.1 MR^2. If this cylinder is rolling without slipping along a level surface with a linear speed v, what is the ratio of its rotational kinetic energy to its linear kinetic energy?

a.	1/l0
b.	1/5
c.	1/2
d.	1/1

ANS: A PTS: 1 DIF: 2
TOP: 8.6 Rotational Kinetic Energy

57. A solid sphere with mass, M, and radius, R, rolls along a level surface without slipping with a linear speed, v. What is the ratio of rotational to linear kinetic energy? (For a solid sphere, $I = 0.4\ MR^2$)

a.	1/4
b.	1/2
c.	1/1
d.	2/5

ANS: D PTS: 1 DIF: 2
TOP: 8.6 Rotational Kinetic Energy

58. A rotating flywheel can be used as a method to store energy. If it is required that such a device be able to store up to a maximum of 1.00×10^6 J when rotating at 400 rad/s, what moment of inertia is required?

a.	50 kg×m^2
b.	25 kg×m^2
c.	12.5 kg×m^2

d. 6.3 kg×m^2

ANS: C PTS: 1 DIF: 2
TOP: 8.6 Rotational Kinetic Energy

59. A rotating flywheel can be used as a method to store energy. If it has 1.0×10^6 J of kinetic energy when rotating at 400 rad/s, and if a frictional torque of 4.0 N×m acts on the system, in what interval of time would the flywheel come to rest?

a. 3.5 min
b. 7.0 min
c. 14 min
d. 21 min

ANS: D PTS: 1 DIF: 2
TOP: 8.6 Rotational Kinetic Energy

60. An initially installed flywheel can store 10^6 J of kinetic energy when rotating at 300 rad/s. It is replaced by another flywheel of the same size but made of a lighter and stronger material. If its mass is half that of the original and it is now capable of achieving a rotational speed of 600 rad/s, what maximum energy can be stored?

a. 40×10^5 J
b. 20×10^5 J
c. 10×10^5 J
d. 5.0×10^5 J

ANS: B PTS: 1 DIF: 2
TOP: 8.6 Rotational Kinetic Energy

61. A cylinder ($I = MR^2/2$) is rolling along the ground at 7.0 m/s. It comes to a hill and starts going up. Assuming no losses to friction, how high does it get before it stops?

a. 1.2 m
b. 3.7 m
c. 4.2 m
d. 5.9 m

ANS: B PTS: 1 DIF: 2
TOP: 8.6 Rotational Kinetic Energy

62. A meter stick is hinged at its lower end and allowed to fall from a vertical position. If its moment of inertia is $ML^2/3$, with what angular speed does it hit the table?

a. 5.42 rad/s
b. 2.71 rad/s
c. 1.22 rad/s
d. 7.67 rad/s

ANS: A PTS: 1 DIF: 3
TOP: 8.6 Rotational Kinetic Energy

63. A bus is designed to draw its power from a rotating flywheel that is brought up to its maximum speed (3 000 rpm) by an electric motor. The flywheel is a solid cylinder of mass 500 kg and radius 0.500 m ($I_{cylinder} = MR^2/2$). If the bus requires an average power of 10.0 kW, how long will the flywheel rotate?

a. 154 s
b. 308 s
c. 463 s
d. 617 s

ANS: B PTS: 1 DIF: 2
TOP: 8.6 Rotational Kinetic Energy

64. An object of radius R and moment of inertia I rolls down an incline of height H after starting from rest. Its total kinetic energy at the bottom of the incline:

a. is gR/I.
b. is I/gH.
c. is 0.5 Ig/H.
d. cannot be found from the given information alone.

ANS: D PTS: 1 DIF: 2
TOP: 8.6 Rotational Kinetic Energy

65. A uniform solid sphere rolls down an incline of height 3 m after starting from rest. In order to calculate its speed at the bottom of the incline, one needs to know:

a. the mass of the sphere.
b. the radius of the sphere.
c. the mass and the radius of the sphere.
d. no more than is given in the problem.

ANS: D PTS: 1 DIF: 2
TOP: 8.6 Rotational Kinetic Energy

66. Consider the use of the terms "rotation" and "revolution". In physics:

a. the words are used interchangeably.
b. the words are used interchangeably but "rotation" is the preferred word.
c. the words have different meaning.
d. "rotation" is the correct word and "revolution" should not be used.

ANS: C PTS: 1 DIF: 2
TOP: 8.6 Rotational Kinetic Energy

67. A solid disk of radius R rolls down an incline in time T. The center of the disk is removed up to a radius of R/2. The remaining portion of the disk with its center gone is again rolled down the same incline. The time it takes is:

a. T.
b. more than T.
c. less than T.
d. requires more information than given in the

problem to figure out.

ANS: B PTS: 1 DIF: 3
TOP: 8.6 Rotational Kinetic Energy

68. The quantity "angular momentum" (in terms of the fundamental quantities of mass, length, and time) is equivalent to:

a. MLT^{-2}.
b. ML^2T^{-1}.
c. ML^2T^{-3}.
d. ML^3T.

ANS: B PTS: 1 DIF: 1 TOP: 8.7 Angular Momentum

69. A ventilation fan with a moment of inertia of 0.034 kg×m^2 has a net torque of 0.11 N×m applied to it. If it starts from rest, what angular momentum will it have 8.0 s later?

a. 0.88 kg×m^2/s
b. 0.97 kg×m^2/s
c. 2.0 kg×m^2/s
d. 3.25 kg×m^2/s

ANS: A PTS: 1 DIF: 2 TOP: 8.7 Angular Momentum

70. A figure skater with arms initially extended starts spinning on the ice at 3 rad/s. She then pulls her arms in close to her body. Which of the following results?

a. a smaller rotational rate
b. a greater rotational rate
c. a greater angular momentum
d. a smaller angular momentum

ANS: B PTS: 1 DIF: 1 TOP: 8.7 Angular Momentum

71. An ice skater spins at 2.5 rev/s when his arms are extended. He draws his arms in and spins at 6.0 rev/s. By what factor does his moment of inertia change in the process?

a. 2.4
b. 1.0
c. 0.42
d. 0.12

ANS: C PTS: 1 DIF: 1 TOP: 8.7 Angular Momentum

72. A figure skater on ice with arms extended, spins at a rate of 2.5 rev/s. After he draws his arms in, he spins at 6.0 rev/s. By what factor does the skater's kinetic energy change when he draws his arms in?

a. 2.4
b. 1.0
c. 0.42
d. 0.12

ANS: A PTS: 1 DIF: 2 TOP: 8.7 Angular Momentum

73. A turntable has a moment of inertia of 3.00×10^{-2} kg·m^2 and spins freely on a frictionless bearing at 25.0 rev/min. A 0.300-kg ball of putty is dropped vertically onto the turntable and sticks at a point 0.100 m from the center. What is the new rate of rotation of the system?

a. 40.8 rev/min
b. 22.7 rev/min
c. 33.3 rev/min
d. 27.2 rev/min

ANS: B PTS: 1 DIF: 2 TOP: 8.7 Angular Momentum

74. A turntable has a moment of inertia of 3.00×10^{-2} kg·m^2 and spins freely on a frictionless bearing at 25.0 rev/min. A 0.300-kg ball of putty is dropped vertically on the turntable and sticks at a point 0.100 m from the center. By what factor does the angular momentum of the system change after the putty is dropped onto the turntable?

a. 1.22
b. 1.00 (no change)
c. 0.820
d. 1.50

ANS: B PTS: 1 DIF: 2 TOP: 8.7 Angular Momentum

75. A turntable has a moment of inertia of 3.0×10^{-2} kg·m^2 and spins freely on a frictionless bearing at 25 rev/min. A 0.30-kg ball of putty is dropped vertically on the turntable and sticks at a point 0.10 m from the center. By what factor does the kinetic energy of the system change after the putty is dropped onto the turntable?

a. 0.91
b. 1.0
c. 0.82
d. 1.5

ANS: A PTS: 1 DIF: 3 TOP: 8.7 Angular Momentum

76. The Earth's gravity exerts no torque on a satellite orbiting the Earth in an elliptical orbit. Compare the motion of the satellite at the point nearest the Earth (perigee) to the motion at the point farthest from the Earth (apogee). At these two points:

a. the tangential velocities are the same.
b. the angular velocities are the same.
c. the angular momenta are the same.
d. the kinetic energies are the same.

ANS: C PTS: 1 DIF: 2 TOP: 8.7 Angular Momentum

77. The Earth's gravity exerts no torque on a satellite orbiting the Earth in an elliptical orbit. Compare the motion at the point nearest the Earth (perigee) to the motion at the point farthest from the Earth (apogee). At the point closest to the Earth:

a. the angular speed will be greatest although the linear speed will be the same.
b. the speed will be greatest although the angular speed will be the same.
c. the kinetic energy and angular momentum

will both be greater.
d. None of the above.

ANS: D PTS: 1 DIF: 2 TOP: 8.7 Angular Momentum

78. A tetherball is attached to a pole with a 2.0-m rope. It is circling at 0.20 rev/s. As the rope wraps around the pole it shortens. How long is the rope when the ball is moving at 5.0 m/s?

a. 1.8 m
b. 1.5 m
c. 1.2 m
d. 1.0 m

ANS: D PTS: 1 DIF: 2 TOP: 8.7 Angular Momentum

79. An astronaut is on a 100-m lifeline outside a spaceship, circling the ship with an angular speed of 0.100 rad/s. How far inward can she be pulled before the centripetal acceleration reaches $5g = 49 \text{ m/s}^2$?

a. 10.1 m
b. 50.0 m
c. 72.7 m
d. 89.9 m

ANS: C PTS: 1 DIF: 3 TOP: 8.7 Angular Momentum

80. An object with mass m and moment of inertia I is spinning with an angular momentum L. Its kinetic energy is:

a. $0.5\ I^2/L$.
b. $0.5\ L^2/I$.
c. $0.5\ L^2/m$.
d. $0.5\ I^2/m$.

ANS: B PTS: 1 DIF: 1 TOP: 8.7 Angular Momentum

81. An object of mass m and moment of inertia I has rotational kinetic energy K_R. Its angular momentum is:

a. $0.5\ I/m$.
b. $(2\ IK_R)^{1/2}$.
c. $(2\ mK_R)^{1/2}$.
d. not given above.

ANS: B PTS: 1 DIF: 2 TOP: 8.7 Angular Momentum

82. Two spheres, one with the center core up to $r = R/2$ hollow and the other solid, have the same mass M and same outer radius R. If they are both rolling at the same linear speed, which one has the greater kinetic energy?

a. The both have the same kinetic energy.
b. The hollow one has the greater kinetic energy.
c. The solid one has the greater kinetic energy.
d. More information is needed to choose an answer.

ANS: B PTS: 1 DIF: 1 TOP: Conceptual Problems

83. A box slides down a frictionless incline, and a hoop rolls down another incline. Both inclines have the same height, and both the box and the hoop have the same mass. If both objects start from rest, upon reaching the bottom of the incline which one will have the greater kinetic energy and which one will have the greater speed?

a. The box will have both the greater kinetic energy and the greater speed.
b. The hoop will have both the greater kinetic energy and the greater speed.
c. Both will have the same kinetic energy but the hoop will have the greater speed.
d. Both will have the same kinetic energy but the box will have the greater speed.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Problems

84. The torque caused by a force *F* applied at a distance *r* from the axis of rotation, is given by , where q is the angle between and . If the magnitudes *r* and *F* remain the same, what other angle q¢will produce the same torque as was produced at angle q if q was less than 90°?

a.
b.
c.
d. None of the above.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

85. Two equal magnitude forces are in opposite directions and their lines of action are separated by distance *d*. These two forces are applied to a solid disk, which is mounted on a frictionless axle. If *d* is half the radius *r* of the disk, which of the following positions for the forces would give the most torque.

a. One force on a line touching the circumference of the disk, the other on a line halfway to the center.
b. One force on a line at a distance *d* from the center and the other on a line through the center of the disk.
c. One force on a line at a distance *d*/2 from the center of the disk, and the other on a line at a distance *d*/2 on the opposite side of the center of the disk.
d. Since all the above orientations give the same torque, choose this answer.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Problems

86. A uniform meter stick balances on a fulcrum placed at the 40 cm mark when a weight W is placed at the 30 cm mark. What is the weight of the meter stick?

a. W
b. 2W
c. W/2
d. 0.4 W

ANS: A PTS: 1 DIF: 2 TOP: Conceptual Problems

Chapter 9—Solids and Fluids

MULTIPLE CHOICE

1. Which state of matter is associated with the very highest of temperatures?

a.	liquid
b.	plasma
c.	gas
d.	solid

ANS: B PTS: 1 DIF: 1
TOP: 9.1 States of Matter | 9.3 The Deformation of Solids

2. A copper wire of length 2.0 m, cross sectional area 7.1×10^{-6} m^2 and Young's modulus 11×10^{10} N/m^2 has a 200-kg load hung on it. What is its increase in length? (g = 9.8 m/s^2)

a.	0.50 mm
b.	1.0 mm
c.	2.5 mm
d.	5.0 mm

ANS: D PTS: 1 DIF: 2
TOP: 9.1 States of Matter | 9.3 The Deformation of Solids

3. In an elastic solid there is a direct proportionality between strain and:

a.	elastic modulus.
b.	temperature.
c.	cross-sectional area.
d.	stress.

ANS: D PTS: 1 DIF: 1
TOP: 9.1 States of Matter | 9.3 The Deformation of Solids

4. The quantity "stress" expressed in terms of the fundamental quantities (mass, length, time) is equivalent to:

a.	MLT^{-1}.
b.	$ML^{-1}T^{-2}$.
c.	$M^2L^{-1}T^{-3}$.
d.	a dimensionless quantity.

ANS: B PTS: 1 DIF: 1
TOP: 9.1 States of Matter | 9.3 The Deformation of Solids

5. The quantity "strain" expressed in terms of the fundamental quantities (mass, length, time) is equivalent to:

a.	MLT^{-1}.
b.	$ML^{-1}T^{-2}$.
c.	$M^2L^{-1}T^{-3}$.
d.	a dimensionless quantity.

ANS: D PTS: 1 DIF: 1
TOP: 9.1 States of Matter | 9.3 The Deformation of Solids

6. The bulk modulus of a material, as a meaningful physical property, is applicable to which of the following?

a.□only solids
b.□only liquids
c.□only gases
d.□solids, liquids and gases

ANS: D PTS: 1 DIF: 1
TOP: 9.1 States of Matter | 9.3 The Deformation of Solids

7. A uniform pressure of 7.0 ´ 10^5 N/m^2 is applied to all six sides of a copper cube. What is the percentage change in volume of the cube? (for copper, B = 14 ´ 10^{10} N/m^2)

a.□2.4 ´ 10^{-2} %
b.□0.4 ´ 10^{-2} %
c.□8.4 ´ 10^{-2} %
d.□0.5 ´ 10^{-3} %

ANS: D PTS: 1 DIF: 2
TOP: 9.1 States of Matter | 9.3 The Deformation of Solids

8. Bar One has a Young's modulus that is bigger than that of Bar Two. This indicates Bar One:

a.□is longer than Bar Two.
b.□has a greater cross-sectional area than Bar Two.
c.□has a greater elastic limit than Bar Two.
d.□is made of material that is different from Bar Two.

ANS: D PTS: 1 DIF: 1
TOP: 9.1 States of Matter | 9.3 The Deformation of Solids

9. Consider two steel rods, A and B. B has three times the area and twice the length of A, so Young's modulus for B will be what factor times Young's modulus for A?

a.□3.0
b.□0.5
c.□1.5
d.□1.0

ANS: D PTS: 1 DIF: 2
TOP: 9.1 States of Matter | 9.3 The Deformation of Solids

10. A tire stops a car by use of friction. What modulus should we use to calculate the stress and strain on the tire?

a.□Young's modulus
b.□compression modulus
c.□shear modulus
d.□bulk modulus

ANS: C PTS: 1 DIF: 2
TOP: 9.1 States of Matter | 9.3 The Deformation of Solids

11. How large a force is necessary to stretch a 2.0-mm-diameter steel wire ($Y = 2.0 \times 10^{11}$ N/m^2) by 1.0%?

a.	3.1×10^3 N
b.	6.3×10^3 N
c.	9.4×10^3 N
d.	1.3×10^4 N

ANS: B PTS: 1 DIF: 2
TOP: 9.1 States of Matter | 9.3 The Deformation of Solids

12. The standard kilogram is a platinum-iridium cylinder 39.0 mm in height and 39.0 mm in diameter. What is the density of the material?

a.	21.5 g/cm^3
b.	19.3 g/cm^3
c.	13.6 g/cm^3
d.	10.7 g/cm^3

ANS: A PTS: 1 DIF: 2 TOP: 9.2 Density and Pressure

13. The quantity "pressure" expressed in terms of the fundamental quantities (mass, length, time) is equivalent to:

a.	MLT^{-1}.
b.	$ML^{-1}T^{-2}$.
c.	$M^2L^{-1}T^{-3}$.
d.	a dimensionless quantity.

ANS: B PTS: 1 DIF: 1 TOP: 9.2 Density and Pressure

14. The pressure inside a commercial airliner is maintained at 1.00 atm (10^5 Pa). What is the net outward force exerted on a 1.0 m $\times$ 2.0 m cabin door if the outside pressure is 0.30 atm?

a.	140 N
b.	1 400 N
c.	14 000 N
d.	140 000 N

ANS: D PTS: 1 DIF: 2 TOP: 9.2 Density and Pressure

15. A stonecutter's chisel has an edge area of 0.50 cm^2. If the chisel is struck with a force of 45 N, what is the pressure exerted on the stone?

a.	9 000 Pa
b.	90 000 Pa
c.	450 000 Pa
d.	900 000 Pa

ANS: D PTS: 1 DIF: 2 TOP: 9.2 Density and Pressure

16. When water freezes, it expands about nine percent. What would be the pressure increase inside your automobile engine block if the water in there froze? (The bulk modulus of ice is 2.0×10^9 Pa, and 1 atm = 1.0×10^5 Pa.)

a. 18 atm
b. 270 atm
c. 1 080 atm
d. 1 800 atm

ANS: D PTS: 1 DIF: 3 TOP: 9.2 Density and Pressure

17. The Greenland ice sheet can be one km thick. Estimate the pressure underneath the ice. (The density of ice is 918 kg/m^3.)

a. 9.0×10^5 Pa (9 atm)
b. 2.5×10^6 Pa (25 atm)
c. 4.5×10^6 Pa (45 atm)
d. 9.0×10^6 Pa (90 atm)

ANS: D PTS: 1 DIF: 2 TOP: 9.2 Density and Pressure

18. What is the total mass of the Earth's atmosphere? (The radius of the Earth is 6.4×10^6 m, and atmospheric pressure at the surface is 10^5 N/m^2.)

a. 5×10^{16} kg
b. 1×10^{18} kg
c. 5×10^{18} kg
d. 1×10^{20} kg

ANS: C PTS: 1 DIF: 2 TOP: 9.2 Density and Pressure

19. A solid object is made of two materials, one material having density of 2 000 kg/m^3 and the other having density of 6 000 kg/m^3. If the object contains equal volumes of the materials, what is its average density?

a. 3 000 kg/m^3
b. 4 000 kg/m^3
c. 5 300 kg/m^3
d. more information is needed

ANS: B PTS: 1 DIF: 1 TOP: 9.2 Density and Pressure

20. A solid object is made of two materials, one material having density of 2 000 kg/m^3 and the other having density of 6 000 kg/m^3. If the object contains equal masses of the materials, what is its average density?

a. 3 000 kg/m^3
b. 4 000 kg/m^3
c. 5 300 kg/m^3
d. more information is needed

ANS: A PTS: 1 DIF: 2 TOP: 9.2 Density and Pressure

21. The maximum pressure that a certain type of drainpipe can safely withstand from the water inside is 10 atmospheres above the outside pressure. The pipe is to run from the roof to a storm drain connection in the basement of the building along a corner of an inside wall. Leakage is not an option. If this drainpipe is to be used with a tall building, what is the maximum height, of those given below, for this drainpipe if it

may be subject to clogging at the bottom? Assume that the pipe is in an environment that surrounds it with 1.0 atmosphere pressure.where 1 atm = Pa.

a.□
b.□
c.□
d.□

ANS: A PTS: 1 DIF: 2 TOP: 9.2 Density and Pressure

22. A very tall building has a drainpipe that runs from the roof to a storm sewer under the basement of the building. Unfortunately, over time the drainpipe becomes clogged when it passes though the basement. How high above the clog does the water have to be for the water near the clog to have its volume compressed by one tenth of one percent? The bulk modulus of water is .

a.□
b.□
c.□
d.□

ANS: A PTS: 1 DIF: 3
TOP: 9.3 The Deformation of Solids

23. The bulk modulus of aluminum is Pa and that of copper is Pa.When identical size cubes of aluminum and copper are subjected to high pressure, what is the ratio of the change in volume of the aluminum cube to that of the copper cube?

a.□0.50
b.□2.0
c.□
d.□

ANS: B PTS: 1 DIF: 2
TOP: 9.3 The Deformation of Solids

24. What is the total force on the bottom of a 2.0-m-diameter by 1.0-m-deep round wading pool due to the weight of the air and the weight of the water? (Note the pressure contribution from the atmosphere is 1.0 ´ 10^5 N/m^2, the density of water is 1 000 kg/m^3, and g = 9.8 m/s^2.)

a.□3.4 ´ 10^5 N
b.□2.4 ´ 10^6 N
c.□3.2 ´ 10^6 N
d.□6.0 ´ 10^6 N

ANS: A PTS: 1 DIF: 2
TOP: 9.4 Variation of Pressure with Depth | 9.5 Pressure Measurements

25. In a large tank of liquid, the hydrostatic pressure at a given depth is a function of:

a.□depth.
b.□surface area.
c.□liquid density.
d.□Choices a and c are both valid.

ANS: D PTS: 1 DIF: 1
TOP: 9.4 Variation of Pressure with Depth | 9.5 Pressure Measurements

26. A 15 000-N car on a hydraulic lift rests on a cylinder with a piston of radius 0.20 m. If a connecting cylinder with a piston of 0.040-m radius is driven by compressed air, what force must be applied to this smaller piston in order to lift the car?

a.□600 N
b.□1 500 N
c.□3 000 N
d.□15 000 N

ANS: A PTS: 1 DIF: 2
TOP: 9.4 Variation of Pressure with Depth | 9.5 Pressure Measurements

27. By what factor is the total pressure greater at a depth of 850 m in water than at the surface where pressure is one atmosphere? (water density = 1.0 ´ 10^3 kg/m^3, 1 atmosphere pressure = 1.01 ´ 10^5 N/m^2, and g = 9.8 m/s^2)

a.□100
b.□83
c.□74
d.□19

ANS: B PTS: 1 DIF: 2
TOP: 9.4 Variation of Pressure with Depth | 9.5 Pressure Measurements

28. If the column of mercury in a barometer stands at 72.6 cm, what is the atmospheric pressure? (The density of mercury is 13.6 ´ 10^3 kg/m^3 and g = 9.80 m/s^2)

a.□0.968 ´ 10^5 N/m^2
b.□1.03 ´ 10^5 N/m^2
c.□0.925 ´ 10^5 N/m^2
d.□1.07 ´ 10^5 N/m^2

ANS: A PTS: 1 DIF: 2
TOP: 9.4 Variation of Pressure with Depth | 9.5 Pressure Measurements

29. Dams at two different locations are needed to form a lake. When the lake is filled, the water level will be at the top of both dams. The Dam #2 is twice as high and twice as wide as Dam #1. How much greater is the force of the water on Dam #2 than the force on Dam #1? (Ignore atmospheric pressure; it is pushing on both sides of the dams.)

a.□2
b.□4
c.□8
d.□16

ANS: C PTS: 1 DIF: 2
TOP: 9.4 Variation of Pressure with Depth | 9.5 Pressure Measurements

30. Atmospheric pressure is 1.0 ´ 10^5 N/m^2, and the density of air is 1.29 kg/m^3. If the density of air is constant as you get higher and higher, calculate the height of the atmosphere needed to produce this pressure.

a.□7 900 m
b.□77 000 m
c.□1 260 m
d.□10 300 m

ANS: A PTS: 1 DIF: 2
TOP: 9.4 Variation of Pressure with Depth | 9.5 Pressure Measurements

31. The water behind Grand Coulee Dam is 1 200 m wide and 150 m deep. Find the hydrostatic force on the back of the dam. (Hint: the total force = average pressure ´ area)

a.□5.2 ´ 10^{9} N
b.□8.8 ´ 10^{10} N
c.□13.2 ´ 10^{10} N
d.□18.0 ´ 10^{10} N

ANS: C PTS: 1 DIF: 2
TOP: 9.4 Variation of Pressure with Depth | 9.5 Pressure Measurements

32. How deep under the surface of a lake would the pressure be double that at the surface? (1 atm = 1.01 ´ 10^{5} Pa)

a.□1.00 m
b.□9.80 m
c.□10.3 m
d.□32.2 m

ANS: C PTS: 1 DIF: 2
TOP: 9.4 Variation of Pressure with Depth | 9.5 Pressure Measurements

33. A piece of aluminum has density 2.70 g/cm^{3} and mass 775 g. The aluminum is submerged in a container of oil (oil's density = 0.650 g/cm^{3}). How much oil does the metal displace?

a.□287 cm^{3}
b.□309 cm^{3}
c.□232 cm^{3}
d.□1 125 cm^{3}

ANS: A PTS: 1 DIF: 1
TOP: 9.6 Buoyant Forces and Archimedes's Principle

34. A piece of aluminum has density 2.70 g/cm^{3} and mass 775 g. The aluminum is submerged in a container of oil of density 0.650 g/cm^{3}. A spring balance is attached with string to the piece of aluminum. What reading will the balance register in grams (g) for the submerged metal?

a.□960 g
b.□775 g
c.□588 g
d.□190 g

ANS: C PTS: 1 DIF: 3
TOP: 9.6 Buoyant Forces and Archimedes's Principle

35. A block of wood has density 0.50 g/cm^3 and mass 1 500 g. It floats in a container of oil (the oil's density is 0.75 g/cm^3). What volume of oil does the wood displace?

a. 3 000 cm^3
b. 2 000 cm^3
c. 1 500 cm^3
d. 1 000 cm^3

ANS: B PTS: 1 DIF: 2
TOP: 9.6 Buoyant Forces and Archimedes's Principle

36. What volume of water is displaced by a submerged 2.0-kg cylinder made of solid aluminum? (aluminum density = 2.7×10^3 kg/m^3 and water density = 1.0×10^3 kg/m^3)

a. 7.4×10^{-4} m^3
b. 1.4×10^3 m^3
c. 9.9×10^3 m^3
d. 6.0×10^2 m^3

ANS: A PTS: 1 DIF: 1
TOP: 9.6 Buoyant Forces and Archimedes's Principle

37. A ping-pong ball has an average density of 0.0840 g/cm^3 and a diameter of 3.80 cm. What force would be required to keep the ball completely submerged under water?

a. 1.000 N
b. 0.788 N
c. 0.516 N
d. 0.258 N

ANS: D PTS: 1 DIF: 2
TOP: 9.6 Buoyant Forces and Archimedes's Principle

38. A cube of wood of density 0.78 g/cm^3 is 10 cm on a side. When placed in water, what height of the block will float above the surface? (water density = 1.00 g/cm^3)

a. 7.8 cm
b. 5.0 cm
c. 2.2 cm
d. 6.4 cm

ANS: C PTS: 1 DIF: 2
TOP: 9.6 Buoyant Forces and Archimedes's Principle

39. The bottom of a flat-bottomed aluminum boat has an area of 4.0 m^2 and the boat's mass is 60 kg. When set afloat in water, how far below the water surface is the boat bottom? (water density = 1.0×10^3 kg/m^3)

a. 0.060 m
b. 0.015 m
c. 0.030 m
d. 0.075 m

ANS: B PTS: 1 DIF: 2
TOP: 9.6 Buoyant Forces and Archimedes's Principle

40. The bottom of a flat-bottomed aluminum boat has area = 4.0 m^2 and mass = 60 kg. If two fishermen and their fishing gear with total mass of 300 kg are placed in the boat, how much lower will the boat ride in the water? (H_2O density = 1.0×10^3 kg/m^3)

a.	0.15 m
b.	0.090 m
c.	0.075 m
d.	0.060 m

ANS: C PTS: 1 DIF: 2
TOP: 9.6 Buoyant Forces and Archimedes's Principle

41. Legend says that Archimedes, in determining whether or not the king's crown was made of pure gold, measured its volume by the water displacement method. If the density of gold is 19.3 g/cm^3, and the crown's mass is 600 g, what volume would be necessary to prove that it is pure gold?

a.	31.1 cm^3
b.	114×10^3 cm^3
c.	22.8×10^3 cm^3
d.	1.81×10^{-2} cm^3

ANS: A PTS: 1 DIF: 2
TOP: 9.6 Buoyant Forces and Archimedes's Principle

42. A solid rock, suspended in air by a spring scale, has a measured mass of 9.00 kg. When the rock is submerged in water, the scale reads 3.30 kg. What is the density of the rock? (water density = 1 000 kg/m^3)

a.	4.55×10^3 kg/m^3
b.	3.50×10^3 kg/m^3
c.	1.20×10^3 kg/m^3
d.	1.58×10^3 kg/m^3

ANS: D PTS: 1 DIF: 2
TOP: 9.6 Buoyant Forces and Archimedes's Principle

43. As ice floats in water, about 10% of the ice floats above the surface of the water. If we float some ice in a glass of water, what will happen to the water level as the ice melts?

a.	The water level will rise 10% of the volume of the ice that melts.
b.	The water level will rise, but not as much as the 10% indicated in answer a.
c.	The water level will remain unchanged.
d.	The water level will become lower.

ANS: C PTS: 1 DIF: 2
TOP: 9.6 Buoyant Forces and Archimedes's Principle

44. A large stone is resting on the bottom of the swimming pool. The normal force of the bottom of the pool on the stone is equal to the:

a.	weight of the stone.
b.	weight of the water displaced.
c.	sum of the weight of the stone and the

weight of the displaced water.
d. difference between the weight of the stone and the weight of the displaced water.

ANS: D PTS: 1 DIF: 2
TOP: 9.6 Buoyant Forces and Archimedes's Principle

45. A blimp is filled with 400 m^3 of helium. How big a payload can the balloon lift? (The density of air is 1.29 kg/m^3; the density of helium is 0.18 kg/m^3.)

a. 111 kg
b. 129 kg
c. 215 kg
d. 444 kg

ANS: D PTS: 1 DIF: 2
TOP: 9.6 Buoyant Forces and Archimedes's Principle

46. A heavily loaded boat is floating in a pond. The boat sinks because of a leak. What happens to the surface level of the pond?

a. It stays the same.
b. It goes up.
c. It goes down.
d. More information is needed to reach a conclusion.

ANS: C PTS: 1 DIF: 2
TOP: 9.6 Buoyant Forces and Archimedes's Principle

47. A heavily loaded boat is floating in a pond. The boat starts to sink because of a leak but quick action plugging the leak stops the boat from going under although it is now deeper in the water. What happens to the surface level of the pond?

a. It stays the same.
b. It goes up.
c. It goes down.
d. More information is needed to reach a conclusion.

ANS: A PTS: 1 DIF: 2
TOP: 9.6 Buoyant Forces and Archimedes's Principle

48. A block of wood has specific gravity 0.80. When placed in water, what percent of the volume of the wood is above the surface?

a. 0, the block sinks.
b. 20%
c. 25%
d. 80%

ANS: B PTS: 1 DIF: 2
TOP: 9.6 Buoyant Forces and Archimedes's Principle

49. An ideal fluid flows through a pipe made of two sections with diameters of 1.0 and 3.0 inches, respectively. The speed of the fluid flow through the 3.0-inch section will be what factor times that through the 1.0-inch section?

a. □6.0
b. □9.0
c. □1/3
d. □1/9

ANS: D PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

50. The flow rate of a liquid through a 2.0-cm-radius pipe is 0.008 0 m^3/s. The average fluid speed in the pipe is:

a. □0.64 m/s.
b. □2.0 m/s.
c. □0.040 m/s.
d. □6.4 m/s.

ANS: D PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

51. Think of Bernoulli's equation as it pertains to an ideal fluid flowing through a horizontal pipe. Imagine that you take measurements along the pipe in the direction of fluid flow. What happens to the sum of the pressure and energy per unit volume?

a. □It increases as the pipe diameter increases.
b. □It decreases as the pipe diameter increases.
c. □It remains constant as the pipe diameter increases.
d. □No choices above are valid.

ANS: C PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

52. An ideal fluid, of density 0.85 ´ 10^3 kg/m^3, flows at 0.25 kg/s through a pipe of radius 0.010 m. What is the fluid speed?

a. □0.85 m/s
b. □1.3 m/s
c. □3.0 m/s
d. □0.94 m/s

ANS: D PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

53. An ideal fluid, of density 0.90 ´ 10^3 kg/m^3, flows at 6.0 m/s through a level pipe with radius of 0.50 cm. The pressure in the fluid is 1.3 ´ 10^5 N/m^2. This pipe connects to a second level pipe, with radius of 1.5 cm. Find the speed of flow in the second pipe.

a. □54 m/s
b. □18 m/s
c. □0.67 m/s
d. □0.33 m/s

ANS: C PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

54. The flow rate of blood through the average human aorta, of radius 1.0 cm, is about 90 cm^3/s. What is the speed of the blood flow through the aorta?

a. 14 cm/s
b. 32 cm/s
c. 37 cm/s
d. 29 cm/s

ANS: D PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

55. Water (density = 1×10^3 kg/m^3) flows at 15 m/s through a pipe with radius 0.040 m. The pipe goes up to the second floor of the building, 3.0 m higher, and the pressure remains unchanged. What is the speed of the water flow in the pipe on the second floor?

a. 13 m/s
b. 14 m/s
c. 15 m/s
d. 16 m/s

ANS: A PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

56. Water (density = 1×10^3 kg/m^3) flows at 10 m/s through a pipe with radius 0.030 m. The pipe goes up to the second floor of the building, 2.0 m higher, and the pressure remains unchanged. What is the radius of the pipe on the second floor?

a. 0.046 m
b. 0.034 m
c. 0.015 m
d. 0.012 m

ANS: B PTS: 1 DIF: 3
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

57. Air pressure is 1.0×10^5 N/m^2, air density is 1.3 kg/m^3, and the density of soft drinks is 1.0×10^3 kg/m^3. If one blows carefully across the top of a straw sticking up 0.100 m from the liquid in a soft drink can, it is possible to make the soft drink rise half way up the straw and stay there. How fast must the air be blown across the top of the straw?

a. 76 m/s
b. 27 m/s
c. 19 m/s
d. 0.99 m/s

ANS: B PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

58. A hole is poked through the metal side of a drum holding water. The hole is 18 cm below the water surface. What is the initial speed of outflow?

a. 1.9 m/s

b. 2.96 m/s
c. 3.2 m/s
d. 3.5 m/s

ANS: A PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

59. Water comes down the spillway of a dam from an initial vertical height of 170 m. What is the highest possible speed of the water at the end of the spillway?

a. 15 m/s
b. 25 m/s
c. 58 m/s
d. 1 370 m/s

ANS: C PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

60. Water pressurized to 3×10^5 Pa is flowing at 5.0 m/s in a pipe which contracts to 1/3 of its former area. What are the pressure and speed of the water after the contraction? (Density of water = 1×10^3 kg/m^3.)

a. 2×10^5 Pa, 15 m/s
b. 3×10^5 Pa, 10 m/s
c. 3×10^5 Pa, 15 m/s
d. 4×10^5 Pa, 1.5 m/s

ANS: A PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

61. A fountain sends water to a height of 100 m. What must be the pressurization (above atmospheric) of the underground water system? (1 atm = 10^5 N/m^2)

a. 1 atm
b. 4.2 atm
c. 7.2 atm
d. 9.8 atm

ANS: D PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

62. The Garfield Thomas water tunnel at Pennsylvania State University has a circular cross-section that constricts from a diameter of 3.6 m to the test section, which is 1.2 m in diameter. If the speed of flow is 3.0 m/s in the large-diameter pipe, determine the speed of flow in the test section.

a. 9.0 m/s
b. 18 m/s
c. 27 m/s
d. 1.0 m/s

ANS: C PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

63. A Boeing-737 airliner has a mass of 20 000 kg. The total area of the wings is 100 m^2. What must be the pressure difference between the top and bottom of the wings to keep the airplane up?

a. 1 960 Pa
b. 3 920 Pa
c. 7 840 Pa
d. 15 700 Pa

ANS: A PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

64. How much air must be pushed downward at 40.0 m/s to keep an 800-kg helicopter aloft?

a. 98.0 kg/s
b. 196 kg/s
c. 294 kg/s
d. 392 kg/s

ANS: B PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

65. A jet of water flowing from a hose at 15 m/s is directed against a wall. If the mass flow in the fluid stream is 2.0 kg/s, what force is the water applying to the wall if backsplash is negligible?

a. 30 N
b. 40 N
c. 65 N
d. 127 N

ANS: A PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

66. A Venturi tube may be used as the inlet to an automobile carburetor. If the inlet pipe of 2.0 cm diameter narrows to 1.0 cm diameter, what is the pressure drop in the constricted section for airflow of 3.0 m/s in the 2-cm section? (Assume air density is 1.25 kg/m^3.)

a. 70 Pa
b. 84 Pa
c. 100 Pa
d. 115 Pa

ANS: B PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

67. Water is sent from a fire hose at 30 m/s at an angle of 30° above the horizontal. What is the maximum height reached by the water?

a. 7.5 m
b. 11 m
c. 15 m
d. 19 m

ANS: B PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

68. How much power is theoretically available from a mass flow of 1 000 kg/s of water that falls a vertical distance of 100 m?

a. 980 kW
b. 98 kW
c. 4 900 W
d. 980 W

ANS: A PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

69. A fluid is drawn up through a tube as shown below. The atmospheric pressure is the same at both ends. Use Bernoulli's equation to determine the speed of fluid flow out of the tank. If the height difference from the top of the tank to the bottom of the siphon is 1.0 m, then the speed of outflow is:

a. 1.1 m/s
b. 2.2 m/s
c. 4.4 m/s
d. 8.8 m/s

ANS: C PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

70. It takes 2.0 minutes to fill a gas tank with 40 liters of gasoline. If the pump nozzle is 1.0 cm in radius, what is the average speed of the gasoline as it leaves the nozzle? (1 000 liters = one cubic meter)

a. 0.27 m/s
b. 1.1 m/s
c. 11 m/s
d. 64 m/s

ANS: B PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

71. Water is being sprayed from a nozzle at the end of a garden hose of diameter 2.0 cm. If the nozzle has an opening of diameter 0.50 cm, and if the water leaves the nozzle at a speed of 10 m/s, what is the speed of the water inside the hose?

a. 0.63 m/s
b. 0.80 m/s
c. 2.5 m/s
d. also 10 m/s

ANS: A PTS: 1 DIF: 2
TOP: 9.7 Fluids in Motion | 9.8 Other Applications of Fluid Dynamics

72. A unit for viscosity, the centipoise, is equal to which of the following?

a. 10^{-3} N·s/m^2
b. 10^{-2} N·s/m^2
c. 10^{-1} N·s/m^2
d. 10^{2} N·s/m^2

ANS: A PTS: 1 DIF: 1
TOP: 9.9 Surface Tension, Capillary Action, and Viscous Fluid Flow

73. The condition for onset of turbulent flow is that the Reynolds Number reaches what value?

a. 1 000
b. 2 000
c. 3 000
d. 4 000

ANS: C PTS: 1 DIF: 1
TOP: 9.9 Surface Tension, Capillary Action, and Viscous Fluid Flow

74. A fluid has a density of 1 040 kg/m^3. If it rises to a height of 1.8 cm in a 1.0-mm diameter capillary tube, what is the surface tension of the liquid? Assume a contact angle of zero.

a. 0.046 N/m
b. 0.056 N/m
c. 0.092 N/m
d. 0.11 N/m

ANS: A PTS: 1 DIF: 2
TOP: 9.9 Surface Tension, Capillary Action, and Viscous Fluid Flow

75. A pipe carrying water has a radius of 1.0 cm. If the flow velocity is 9.0 cm/s, which of the following characterizes the flow? Take the viscosity of water to be 1.0×10^{-3} N×s/m.

a. streamlined
b. unstable
c. turbulent
d. stagnant

ANS: A PTS: 1 DIF: 2
TOP: 9.9 Surface Tension, Capillary Action, and Viscous Fluid Flow

76. In order to overcome a surface tension of a fluid, a force of 1.32×10^{-2} N is required to lift a wire ring of circumference 12.0 cm. What is the surface tension of the fluid?

a. 0.055 N/m
b. 0.11 N/m
c. 0.035 N/m
d. 0.018 N/m

ANS: A PTS: 1 DIF: 2
TOP: 9.9 Surface Tension, Capillary Action, and Viscous Fluid Flow

77. A pipe of diameter three cm is replaced by one of the same length but of diameter six cm. If the pressure difference between the ends of the pipe remains the same, by what factor is the rate of flow of a viscous liquid through it changed?

a. 2
b. 4
c. 8
d. 16

ANS: D PTS: 1 DIF: 2
TOP: 9.9 Surface Tension, Capillary Action, and Viscous Fluid Flow

78. Spherical particles of density 2.0 g/cm^3 are shaken in a container of water (viscosity = 1.0×10^{-3} N×s/m^3). The water is 8.0 cm deep and is allowed to stand for 30 minutes. What is the greatest terminal velocity of the particles still in suspension at that time?

a.	0.55×10^{-5} m/s
b.	1.1×10^{-5} m/s
c.	2.2×10^{-5} m/s
d.	4.4×10^{-5} m/s

ANS: D PTS: 1 DIF: 2 TOP: 9.10 Transport Phenomena

79. Spherical particles of density 2.0 g/cm^3 are shaken in a container of water (viscosity = 1.0×10^{-3} N×s/m^3). The water is 8.0 cm deep and is allowed to stand for 30 minutes. What is the radius of the largest particles still in suspension at that time?

a.	4.5×10^{-6} m
b.	9.0×10^{-6} m
c.	2.3×10^{-6} m
d.	5.6×10^{-6} m

ANS: A PTS: 1 DIF: 3 TOP: 9.10 Transport Phenomena

80. A centrifuge rotates at 100 rev/s (i.e., 628 rad/s). If the test tube places the suspension at 8.0 cm from the axis of rotation, by what factor are the terminal speeds of the settling particles increased as compared to sedimentation cause by gravity?

a.	3.2×10^2
b.	64
c.	800
d.	3.9×10^5

ANS: A PTS: 1 DIF: 2 TOP: 9.10 Transport Phenomena

81. Which of the following characterizes the net force on a particle falling through a fluid at its terminal speed?

a.	It is at a maximum.
b.	It is upwards.
c.	It is downwards.
d.	It is zero.

ANS: D PTS: 1 DIF: 1 TOP: 9.10 Transport Phenomena

82. A container is filled with water and the pressure at the container bottom is *P*. If the container is instead filled with oil having specific gravity 0.80, what new bottom pressure results?

a.	a pressure < *P*
b.	the same pressure *P*
c.	a pressure > *P*
d.	This is unable to be determined with the information given.

ANS: A PTS: 1 DIF: 1 TOP: Conceptual Problems

83. A container is filled with water and the pressure at the bottom of the container is *P*. Then the container is emptied halfway and topped off with oil of density 0.80×10^3 kg/m^3, which floats on top of the water. What is the pressure at the bottom of the container now?

a.	a pressure < *P*
b.	the same pressure *P*
c.	a pressure > *P*
d.	This is unable to be determined with the information given.

ANS: A PTS: 1 DIF: 1 TOP: Conceptual Problems

84. At a pressure of 1 atmosphere a column of mercury in a barometer is supported to the height $h = 0.76$ m. The density of mercury is 13.6×10^3 kg/m^3. A barometer of similar design filled with water would support a column of water how high at a pressure of 1 atmosphere?

a.	more than ten times *h*
b.	about 1.36 *h*
c.	less than one tenth *h*
d.	the same height *h*

ANS: A PTS: 1 DIF: 2 TOP: Conceptual Problems

85. When an artery gets a constricted region due to plaque, how does the pressure in this region compare to the pressure in an unconstricted region adjacent?

a.	Since this is a closed system, the pressure is the same in both regions.
b.	In the constricted region the blood moves at a higher speed than in the unconstricted region resulting in an increased pressure.
c.	In the constricted region the blood moves at a higher speed than in the unconstricted region resulting in a decreased pressure.
d.	In the constricted region the blood moves at a lower speed than in the unconstricted region resulting in an increased pressure.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

86. An ice cube with a small solid steel sphere frozen inside floats in a glass of water filled to the brim. What happens to the level of water in the glass as a result of the ice melting?

a.	It goes up, overflowing.
b.	It stays the same.
c.	It goes down.
d.	It depends on air pressure, thus the answer is indeterminate.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

Chapter 10—Thermal Physics

MULTIPLE CHOICE

1. Which best describes the relationship between two systems in thermal equilibrium?

a.	no net energy is exchanged
b.	volumes are equal
c.	masses are equal
d.	zero velocity

ANS: A PTS: 1 DIF: 1
TOP: 10.1 Temperature and the Zeroth Law of Thermodynamics | 10.2 Thermometers and Temperature Scales

2. The zeroth law of thermodynamics pertains to what relational condition that may exist between two systems?

a.	zero net forces
b.	zero velocities
c.	zero temperature
d.	thermal equilibrium

ANS: D PTS: 1 DIF: 1
TOP: 10.1 Temperature and the Zeroth Law of Thermodynamics | 10.2 Thermometers and Temperature Scales

3. If it is given that 546 K equals 273°C, then it follows that 400 K equals:

a.	127°C.
b.	150°C.
c.	473°C.
d.	1 200°C.

ANS: A PTS: 1 DIF: 2
TOP: 10.1 Temperature and the Zeroth Law of Thermodynamics | 10.2 Thermometers and Temperature Scales

4. What is the temperature of a system in thermal equilibrium with another system made up of water and steam at one atmosphere of pressure?

a.	0°F
b.	273 K
c.	0 K
d.	100°C

ANS: D PTS: 1 DIF: 1
TOP: 10.1 Temperature and the Zeroth Law of Thermodynamics | 10.2 Thermometers and Temperature Scales

5. What is the temperature of a system in thermal equilibrium with another system made up of ice and water at one atmosphere of pressure?

a.	0°F

b. 273 K
c. 0 K
d. 100°C

ANS: B PTS: 1 DIF: 1
TOP: 10.1 Temperature and the Zeroth Law of Thermodynamics | 10.2 Thermometers and Temperature Scales

6. Which best describes a system made up of ice, water and steam existing together?

a. absolute zero
b. triple point
c. ice point
d. steam point

ANS: B PTS: 1 DIF: 1
TOP: 10.1 Temperature and the Zeroth Law of Thermodynamics | 10.2 Thermometers and Temperature Scales

7. A temperature change from 15°C to 35°C corresponds to what incremental change in °F?

a. 20
b. 40
c. 36
d. 313

ANS: C PTS: 1 DIF: 2
TOP: 10.1 Temperature and the Zeroth Law of Thermodynamics | 10.2 Thermometers and Temperature Scales

8. A substance is heated from 15°C to 35°C. What would the same incremental change be when registered in kelvins?

a. 20
b. 40
c. 36
d. 313

ANS: A PTS: 1 DIF: 1
TOP: 10.1 Temperature and the Zeroth Law of Thermodynamics | 10.2 Thermometers and Temperature Scales

9. 88°F is how many degrees Celsius?

a. 31
b. 49
c. 56
d. 158

ANS: A PTS: 1 DIF: 1
TOP: 10.1 Temperature and the Zeroth Law of Thermodynamics | 10.2 Thermometers and Temperature Scales

10. At what temperature is the same numerical value obtained in Celsius and Fahrenheit?

a.	- 40°
b.	0°
c.	40°
d.	- 72°

ANS: A PTS: 1 DIF: 2
TOP: 10.1 Temperature and the Zeroth Law of Thermodynamics | 10.2 Thermometers and Temperature Scales

11. Normal body temperature for humans is 37°C. What is this temperature in kelvins?

a.	296
b.	310
c.	393
d.	273

ANS: B PTS: 1 DIF: 2
TOP: 10.1 Temperature and the Zeroth Law of Thermodynamics | 10.2 Thermometers and Temperature Scales

12. Carbon dioxide forms into a solid (dry ice) at approximately - 157°F. What temperature in degrees Celsius does this correspond to?

a.	- 157°C
b.	- 93°C
c.	- 121°C
d.	- 105°C

ANS: D PTS: 1 DIF: 2
TOP: 10.1 Temperature and the Zeroth Law of Thermodynamics | 10.2 Thermometers and Temperature Scales

13. An interval of one Celsius degree is equivalent to an interval of:

a.	one Fahrenheit degree.
b.	one kelvin.
c.	5/9 Fahrenheit degree.
d.	5/9 kelvin.

ANS: B PTS: 1 DIF: 1
TOP: 10.1 Temperature and the Zeroth Law of Thermodynamics | 10.2 Thermometers and Temperature Scales

14. A temperature of 233 K equals which of the following?

a.	506°C
b.	40°C
c.	- 40°F
d.	40°F

ANS: C PTS: 1 DIF: 2
TOP: 10.1 Temperature and the Zeroth Law of Thermodynamics | 10.2 Thermometers and Temperature Scales

15. Which of the following properties can be used to measure temperature?

a. the color of a glowing object
b. the length of a solid
c. the volume of gas held at constant pressure
d. all of the above

ANS: D PTS: 1 DIF: 2
TOP: 10.1 Temperature and the Zeroth Law of Thermodynamics | 10.2 Thermometers and Temperature Scales

16. The pressure in a constant-volume gas thermometer extrapolates to zero at what temperature?

a. 0°C
b. 0 K
c. 0°F
d. 0 Pa

ANS: B PTS: 1 DIF: 1
TOP: 10.1 Temperature and the Zeroth Law of Thermodynamics | 10.2 Thermometers and Temperature Scales

17. A steel wire, 150 m long at 10°C, has a coefficient of linear expansion of 11×10^{-6}/C°. Give its change in length as the temperature changes from 10°C to 45°C.

a. 0.65 cm
b. 1.8 cm
c. 5.8 cm
d. 12 cm

ANS: C PTS: 1 DIF: 2
TOP: 10.3 Thermal Expansion of Solids and Liquids

18. A rectangular steel plate with dimensions of 30 cm × 25 cm is heated from 20°C to 220°C. What is its change in area? (Coefficient of linear expansion for steel is 11×10^{-6}/C°.)

a. 0.82 cm^2
b. 1.65 cm^2
c. 3.3 cm^2
d. 6.6 cm^2

ANS: C PTS: 1 DIF: 2
TOP: 10.3 Thermal Expansion of Solids and Liquids

19. What happens to a given mass of water as it is cooled from 4°C to zero?

a. expands
b. contracts
c. vaporizes
d. Neither expands, contracts, nor vaporizes.

ANS: A PTS: 1 DIF: 2
TOP: 10.3 Thermal Expansion of Solids and Liquids

20. The observation that materials expand in size with an increase in temperature can be applied to what proportion of existing substances?

a. 100%
b. most
c. few
d. none

ANS: B PTS: 1 DIF: 1
TOP: 10.3 Thermal Expansion of Solids and Liquids

21. Which best expresses the value for the coefficient of volume expansion, b, for given material as a function of its corresponding coefficient of linear expansion, a?

a. $b = a^{3}$
b. $b = 3a$
c. $b = a^{2}$
d. $b = 2a$

ANS: B PTS: 1 DIF: 2
TOP: 10.3 Thermal Expansion of Solids and Liquids

22. A steel plate has a hole drilled through it. The plate is put into a furnace and heated. What happens to the size of the inside diameter of a hole as its temperature increases?

a. increases
b. decreases
c. remains constant
d. becomes elliptical

ANS: A PTS: 1 DIF: 1
TOP: 10.3 Thermal Expansion of Solids and Liquids

23. A brass cube, 10 cm on a side, is raised in temperature by 200°C. The coefficient of volume expansion of brass is 57 ´ 10^{-6}/C°. By what percentage does volume increase?

a. 12%
b. 2.8%
c. 1.1%
d. 0.86%

ANS: C PTS: 1 DIF: 2
TOP: 10.3 Thermal Expansion of Solids and Liquids

24. A brass cube, 10 cm on a side, is raised in temperature by 200°C. The coefficient of volume expansion of brass is 57 ´ 10^{-6}/C°. By what percentage is any one of the 10-cm edges increased in length?

a. 4%
b. 2.8%
c. 0.38%
d. 0.29%

ANS: C PTS: 1 DIF: 2
TOP: 10.3 Thermal Expansion of Solids and Liquids

25. An automobile gas tank is filled to its capacity of 15.00 gallons with the gasoline at an initial temperature of 10°C. The automobile is parked in the sun causing the gasoline's temperature to rise to 60°C. If the coefficient of volume expansion for gasoline is 9.6×10^{-4}/C°, what volume runs out the overflow tube? Assume the change in volume of the tank is negligible.

a. 1.74 gallons
b. 1.18 gallons
c. 0.72 gallons
d. 0.30 gallons

ANS: C PTS: 1 DIF: 2
TOP: 10.3 Thermal Expansion of Solids and Liquids

26. What happens to a given volume of water when heated from 0°C to 4°C?

a. density increases
b. density decreases
c. density remains constant
d. vaporizes

ANS: A PTS: 1 DIF: 1
TOP: 10.3 Thermal Expansion of Solids and Liquids

27. What happens to a volume of water when its temperature is reduced from 8°C to 4°C?

a. density increases
b. density decreases
c. density remains constant
d. vaporizes

ANS: A PTS: 1 DIF: 1
TOP: 10.3 Thermal Expansion of Solids and Liquids

28. The thermal expansion of a solid is caused by:

a. the breaking of bonds between atoms.
b. increasing the amplitude of the atoms vibration.
c. increasing the distance between equilibrium positions for the vibrating atoms.
d. all of the above.

ANS: C PTS: 1 DIF: 1
TOP: 10.3 Thermal Expansion of Solids and Liquids

29. A steel sphere sits on top of an aluminum ring. The steel sphere ($\alpha = 1.10 \times 10^{-5}$/C°) has a diameter of 4.000 0 cm at 0°C. The aluminum ring ($\alpha = 2.40 \times 10^{-5}$/C°) has an inside diameter of 3.994 0 cm at 0°C. Closest to which temperature given will the sphere just fall through the ring?

a. 462°C
b. 208°C
c. 116°C
d. 57.7°C

ANS: C PTS: 1 DIF: 3
TOP: 10.3 Thermal Expansion of Solids and Liquids

30. Between 0° and 4°C, the volume coefficient of expansion for water:

a. is positive.
b. is zero.
c. is becoming less dense.
d. is negative.

ANS: D PTS: 1 DIF: 1
TOP: 10.3 Thermal Expansion of Solids and Liquids

31. A long steel beam has a length of twenty-five meters on a cold day when the temperature is 0°C. What is the length of the beam on a hot day when T = 40°C? ($\alpha_{steel} = 1.1 \times 10^{-5}$/C°)

a. 25.000 44 m
b. 25.004 4 m
c. 25.011 m
d. 25.044 m

ANS: C PTS: 1 DIF: 2
TOP: 10.3 Thermal Expansion of Solids and Liquids

32. Suppose the ends of a 20-m-long steel beam are rigidly clamped at 0°C to prevent expansion. The rail has a cross-sectional area of 30 cm^2. What force does the beam exert when it is heated to 40°C? ($\alpha_{steel} = 1.1 \times 10^{-5}$/C°, $Y_{steel} = 2.0 \times 10^{11}$ N/m^2).

a. 2.6×10^5 N
b. 5.6×10^4 N
c. 1.3×10^3 N
d. 6.5×10^2 N

ANS: A PTS: 1 DIF: 3
TOP: 10.3 Thermal Expansion of Solids and Liquids

33. At 20°C an aluminum ring has an inner diameter of 5.000 cm, and a brass rod has a diameter of 5.050 cm. Keeping the brass rod at 20°C, which of the following temperatures of the ring will allow the ring to just slip over the brass rod? ($\alpha_{Al} = 2.4 \times 10^{-5}$ /C°, $\alpha_{brass} = 1.9 \times 10^{-5}$/C°)

a. 111°C
b. 236°C
c. 384°C
d. 437°C

ANS: D PTS: 1 DIF: 2
TOP: 10.3 Thermal Expansion of Solids and Liquids

34. As a copper wire is heated, its length increases by 0.100%. What is the change of the temperature of the wire? ($\alpha_{Cu} = 16.6 \times 10^{-6}$/C°)

a. 120.4°C
b. 60.2°C
c. 30.1°C

d. 6.0°C

ANS: B PTS: 1 DIF: 2
TOP: 10.3 Thermal Expansion of Solids and Liquids

35. The coefficient of area expansion is:

a. half the coefficient of volume expansion.
b. three halves the coefficient of volume expansion.
c. double the coefficient of linear expansion.
d. triple the coefficient of linear expansion.

ANS: C PTS: 1 DIF: 1
TOP: 10.3 Thermal Expansion of Solids and Liquids

36. At room temperature, the coefficient of linear expansion for Pyrex glass is ____ that for ordinary glass.

a. the same as
b. more than
c. less than
d. stronger than

ANS: C PTS: 1 DIF: 1
TOP: 10.3 Thermal Expansion of Solids and Liquids

37. A pipe of length 10.0 m increases in length by 1.5 cm when its temperature is increased by 90°F. What is its coefficient of linear expansion?

a. 30×10^{-6}/°C
b. 17×10^{-6}/°C
c. 13×10^{-6}/°C
d. 23×10^{-6}/°C

ANS: A PTS: 1 DIF: 2
TOP: 10.3 Thermal Expansion of Solids and Liquids

38. A material has a coefficient of volume expansion of 60×10^{-6}/°C. What is its area coefficient of expansion?

a. 120×10^{-6}/°C
b. 40×10^{-6}/°C
c. 20×10^{-6}/°C
d. 180×10^{-6}/°C

ANS: B PTS: 1 DIF: 2
TOP: 10.3 Thermal Expansion of Solids and Liquids

39. What happens to its moment of inertia when a steel disk is heated?

a. It increases.
b. It decreases.
c. It stays the same.
d. It increases for half the temperature increase and then decreases for the rest of the tempera-

ture increase.

ANS: A PTS: 1 DIF: 2
TOP: 10.3 Thermal Expansion of Solids and Liquids

40. An ideal gas is confined to a container with adjustable volume. The pressure and mole number are constant. By what factor will volume change if absolute temperature triples?

a. 1/9
b. 1/3
c. 3.0
d. 9.0

ANS: C PTS: 1 DIF: 1
TOP: 10.4 Macroscopic Description of an Ideal Gas

41. An ideal gas is confined to a container with constant volume. The number of moles is constant. By what factor will the pressure change if the absolute temperature triples?

a. 1/9
b. 1/3
c. 3.0
d. 9.0

ANS: C PTS: 1 DIF: 1
TOP: 10.4 Macroscopic Description of an Ideal Gas

42. An ideal gas is confined to a container with adjustable volume. The number of moles and temperature are constant. By what factor will the volume change if pressure triples?

a. 1/9
b. 1/3
c. 3.0
d. 9.0

ANS: B PTS: 1 DIF: 1
TOP: 10.4 Macroscopic Description of an Ideal Gas

43. A 2.00-L container holds half a mole of an ideal gas at a pressure of 12.5 atm. What is the gas temperature? (R = 0.082 1 L×atm/mol×K)

a. 1 980 K
b. 1 190 K
c. 965 K
d. 609 K

ANS: D PTS: 1 DIF: 2
TOP: 10.4 Macroscopic Description of an Ideal Gas

44. With volume and molar quantity held constant, by what factor does the absolute temperature change for an ideal gas when the pressure is five times bigger?

a. 0.2
b. 1.0
c. 5.0

d. 25.0

ANS: C PTS: 1 DIF: 1
TOP: 10.4 Macroscopic Description of an Ideal Gas

45. With molar quantity and temperature held constant, by what factor does the pressure of an ideal gas change when the volume is five times bigger?

a. 0.2
b. 1.0
c. 5.0
d. 25.0

ANS: A PTS: 1 DIF: 1
TOP: 10.4 Macroscopic Description of an Ideal Gas

46. Two moles of nitrogen gas are contained in an enclosed cylinder with a movable piston. If the molecular mass of nitrogen is 28, how many grams of nitrogen are present?

a. 0.14
b. 56
c. 42
d. 112

ANS: B PTS: 1 DIF: 1
TOP: 10.4 Macroscopic Description of an Ideal Gas

47. Two moles of nitrogen gas are contained in an enclosed cylinder with a movable piston. If the gas temperature is 298 K, and the pressure is 1.01×10^{6} N/m^2, what is the volume? (R = 8.31 J/mol×K)

a. 9.80×10^{-3} m^3
b. 4.90×10^{-3} m^3
c. 17.3×10^{-3} m^3
d. 8.31×10^{-3} m^3

ANS: B PTS: 1 DIF: 2
TOP: 10.4 Macroscopic Description of an Ideal Gas

48. Boltzmann's constant, k_B, may be derived as a function of R, the universal gas constant, and N_A, Avogadro's number. Which expresses the value of k_B?

a. $N_A R^2$
b. $N_A R$
c. R/N_A
d. N_A/R

ANS: C PTS: 1 DIF: 2
TOP: 10.4 Macroscopic Description of an Ideal Gas

49. How many atoms are present in a sample of pure iron with a mass of 300 g? (The atomic mass of iron = 56 and $N_A = 6.02 \times 10^{23}$)

a. 1.8×10^{19}
b. 6.7×10^{22}
c. 1.6×10^{28}

d. 3.2×10^{24}

ANS: D PTS: 1 DIF: 2
TOP: 10.4 Macroscopic Description of an Ideal Gas

50. Two moles of an ideal gas at 3.0 atm and 10°C are heated up to 150 °C. If the volume is held constant during this heating, what is the final pressure?

a. 4.5 atm
b. 1.8 atm
c. 0.14 atm
d. 1.0 atm

ANS: A PTS: 1 DIF: 2
TOP: 10.4 Macroscopic Description of an Ideal Gas

51. One way to heat a gas is to compress it. A gas at 1.00 atm at 25.0°C is compressed to one tenth of its original volume, and it reaches 40.0 atm pressure. What is its new temperature?

a. 1 500 K
b. 1 500°C
c. 1 192°C
d. 919°C

ANS: D PTS: 1 DIF: 3
TOP: 10.4 Macroscopic Description of an Ideal Gas

52. A pressure of 1.0×10^{-7} mm of Hg is achieved in a vacuum system. How many gas molecules are present per liter volume if the temperature is 293 K? (760 mm of Hg = 1 atm, R = 0.082 1 L×atm/mol×K, and N_A = 6.02×10^{23})

a. 16×10^{18}
b. 4.7×10^{16}
c. 3.3×10^{12}
d. 3.4×10^{9}

ANS: C PTS: 1 DIF: 3
TOP: 10.4 Macroscopic Description of an Ideal Gas

53. A helium-filled weather balloon has a 0.90 m radius at liftoff where air pressure is 1.0 atm and the temperature is 298 K. When airborne, the temperature is 210 K, and its radius expands to 3.0 m. What is the pressure at the airborne location?

a. 0.50 atm
b. 0.013 atm
c. 0.019 atm
d. 0.38 atm

ANS: C PTS: 1 DIF: 2
TOP: 10.4 Macroscopic Description of an Ideal Gas

54. One mole of an ideal gas at 1.00 atm and 0.00°C occupies 22.4 L. How many molecules of an ideal gas are in one cm^3 under these conditions?

a. 28.9

b. □22 400
c. □2.69 ´ 10^{19}
d. □6.02 ´ 10^{23}

ANS: C PTS: 1 DIF: 2
TOP: 10.4 Macroscopic Description of an Ideal Gas

55. How many moles of air must escape from a 10-m ´ 8.0-m ´ 5.0-m room when the temperature is raised from 0°C to 20°C? Assume the pressure remains unchanged at one atmosphere while the room is heated.

a. □1.3 ´ 10^{3} moles
b. □1.2 ´ 10^{3} moles
c. □7.5 ´ 10^{2} moles
d. □3.7 ´ 10^{2} moles

ANS: B PTS: 1 DIF: 3
TOP: 10.4 Macroscopic Description of an Ideal Gas

56. Estimate the volume of a helium-filled balloon at STP if it is to lift a payload of 500 kg. The density of air is 1.29 kg/m^3 and helium has a density of 0.178 kg/m^3.

a. □4 410 m^3
b. □932 m^3
c. □450 m^3
d. □225 m^3

ANS: C PTS: 1 DIF: 3
TOP: 10.4 Macroscopic Description of an Ideal Gas

57. Tricia puts 44 g of dry ice (solid CO_2) into a 2.0-L container and seals the top. The dry ice turns to gas at room temperature (20°C). Find the pressure increase in the 2.0-L container. (One mole of CO_2 has a mass of 44 g, R = 0.082 1 L×atm/mol×K. Ignore the initial volume of the dry ice.)

a. □6.0 atm
b. □12 atm
c. □18 atm
d. □2.0 atm

ANS: B PTS: 1 DIF: 2
TOP: 10.4 Macroscopic Description of an Ideal Gas

58. The mass of a hot-air balloon and its cargo (not including the air inside) is 200 kg. The air outside is at a temperature of 10°C and a pressure of 1 atm = 10^5 N/m^2. The volume of the balloon is 400 m^3. Which temperature below of the air in the balloon will allow the balloon to just lift off? (Air density at 10°C is 1.25 kg/m^3.)

a. □37°C
b. □69°C
c. □99°C
d. □200°C

ANS: D PTS: 1 DIF: 3
TOP: 10.4 Macroscopic Description of an Ideal Gas

59. 9.0 g of water in a 2.0-L pressure vessel is heated to 500°C. What is the pressure inside the container? (*R* = 0.082 L×atm/mol×K, one mole of water has a mass of 18 grams)

a.	7.9 atm
b.	16 atm
c.	24 atm
d.	32 atm

ANS: B PTS: 1 DIF: 2
TOP: 10.4 Macroscopic Description of an Ideal Gas

60. A spherical air bubble originating from a scuba diver at a depth of 18.0 m has a diameter of 1.0 cm. What will the bubble's diameter be when it reaches the surface? (Assume constant temperature.)

a.	0.7 cm
b.	1.0 cm
c.	1.4 cm
d.	1.7 cm

ANS: C PTS: 1 DIF: 3
TOP: 10.4 Macroscopic Description of an Ideal Gas

61. A tank with a volume of 0.150 m^3 contains 27.0°C helium gas at a pressure of 100 atm. How many balloons can be blown up if each filled balloon is a sphere 30.0 cm in diameter at 27.0°C and absolute pressure of 1.20 atm? Assume all the helium is transferred to the balloons.

a.	963 balloons
b.	884 balloons
c.	776 balloons
d.	598 balloons

ANS: B PTS: 1 DIF: 3
TOP: 10.4 Macroscopic Description of an Ideal Gas

62. The ideal gas law treats gas as consisting of:

a.	atoms.
b.	molecules.
c.	chemicals.
d.	bubbles.

ANS: B PTS: 1 DIF: 1
TOP: 10.4 Macroscopic Description of an Ideal Gas

63. The sulfur hexafluoride molecule consists of one sulfur atom and six fluorine atoms. The atomic masses of sulfur and fluorine are 32.0 u and 19.0 u respectively. One mole of this very heavy gas has what mass?

a.	32 g
b.	51 g
c.	146 g
d.	608 g

ANS: C PTS: 1 DIF: 2
TOP: 10.4 Macroscopic Description of an Ideal Gas

64. A room has a volume of 60 m^3 and is filled with air of an average molecular mass of 29 u. What is the mass of the air in the room at a pressure of 1.0 atm and temperature of 22°C? R = 0.082 L×atm/mol×K

a. 2.4 kg
b. 2 400 kg
c. 72 kg
d. 700 kg

ANS: C PTS: 1 DIF: 2
TOP: 10.4 Macroscopic Description of an Ideal Gas

65. Different units can be used for length: m and cm, and of these two, m is the larger by a factor of 100. Different units can also be used for R: (1) J/mol×K, (2) L×atm/mol×K, and (3) (N/m^2)×m^3/mol×K. Which of these units for R is the largest? Hint: When expressing R in each of these units, which expression has the lowest numerical factor? (1L = 10^{-3} m^3, 1 atm = 1.01 ´ 10^5 Pa)

a. 1
b. 2
c. 3
d. They are all equal.

ANS: B PTS: 1 DIF: 2
TOP: 10.4 Macroscopic Description of an Ideal Gas

66. Two one-liter containers each contain 10 moles of a gas. The temperature is the same in both containers. Container A holds helium (molecular mass = 4 u), and Container B holds oxygen (molecular mass = 16 u). Which container has the higher pressure and by what factor?

a. Container A has 4 times the pressure of Container B.
b. Container A has 2 times the pressure of Container B.
c. Both containers have the same pressure.
d. More information is needed to answer this question.

ANS: C PTS: 1 DIF: 2
TOP: 10.4 Macroscopic Description of an Ideal Gas

67. Two ideal gases, X and Y, are thoroughly mixed and at thermal equilibrium in a single container. The molecular mass of X is 9 times that of Y. What is the ratio of root-mean-square velocities of the two gases, $v_{X, rms}/v_{Y, rms}$?

a. 9/1
b. 3/1
c. 1/3
d. 1/9

ANS: C PTS: 1 DIF: 2
TOP: 10.5 The Kinetic Theory of Gases

68. The absolute temperature of an ideal gas is directly proportional to which of the following properties, when taken as an average, of the molecules of that gas?

a. speed

b. momentum
c. mass
d. kinetic energy

ANS: D PTS: 1 DIF: 1
TOP: 10.5 The Kinetic Theory of Gases

69. What is the root-mean-square speed of chlorine gas molecules at a temperature of 320 K? (R = 8.31 J/mol·K, $N_A = 6.02 \times 10^{23}$, and the molecular mass of Cl_2 = 71)

a. 1.7×10^{2} m/s
b. 3.4×10^{2} m/s
c. 0.8×10^{4} m/s
d. 1.1×10^{5} m/s

ANS: B PTS: 1 DIF: 2
TOP: 10.5 The Kinetic Theory of Gases

70. If the temperature of an ideal gas contained in a box is increased:

a. the average velocity of the molecules in the box will be increased.
b. the average speed of the molecules in the box will be increased.
c. the distance between molecules in the box will be increased.
d. all of the above.

ANS: B PTS: 1 DIF: 2
TOP: 10.5 The Kinetic Theory of Gases

71. For an ideal gas of a given mass, if the pressure remains the same and the volume increases:

a. the average kinetic energy of the molecules decreases.
b. the average kinetic energy of the molecules stays the same.
c. the average kinetic energy of the molecules increases.
d. Nothing can be determined about the molecular kinetic energy.

ANS: C PTS: 1 DIF: 2
TOP: 10.5 The Kinetic Theory of Gases

72. John rapidly pulls a plunger out of a cylinder. As the plunger moves away, the gas molecules bouncing elastically off the plunger are:

a. rebounding at a higher speed than they would have if the plunger weren't removed.
b. rebounding at a lower speed than they would have if the plunger weren't removed.
c. rebounding at the same speed as they would have if the plunger weren't removed.

d. Whether they speed up or slow down depends on how fast the plunger is removed.

ANS: B PTS: 1 DIF: 2
TOP: 10.5 The Kinetic Theory of Gases

73. Consider two containers with the same volume and temperature. Container One holds "dry" air--a mixture of nitrogen and oxygen. Container Two holds "moist" air. The "moist" air has the same ratio of nitrogen to oxygen molecules, but also contains water vapor. According to the ideal gas law, if the pressures are equal, the weight of the gas in Container One will be:

a. lighter than the gas inside the second container.
b. equal to the weight of the gas in the second container.
c. heavier than the gas inside the second container.
d. all the above are incorrect because the pressures cannot be equal.

ANS: C PTS: 1 DIF: 3
TOP: 10.5 The Kinetic Theory of Gases

74. Evaporation cools the liquid that is left behind because the molecules that leave the liquid during evaporation:

a. have kinetic energy.
b. have greater than average speed.
c. have broken the bonds that held them in the liquid.
d. create vapor pressure.

ANS: B PTS: 1 DIF: 1
TOP: 10.5 The Kinetic Theory of Gases

75. What is the internal energy of 50 moles of Neon gas (molecular mass = 20 u) at 27°C? (R = 8.31 J/mol×K)

a. 1.9 ´ 10^5 J
b. 1.6 ´ 10^5 J
c. 3.8 ´ 10^3 J
d. It depends on the container size, which is not given.

ANS: A PTS: 1 DIF: 2
TOP: 10.5 The Kinetic Theory of Gases

76. A quantity of a monatomic ideal gas expands to twice the volume while maintaining the same pressure. If the internal energy of the gas were U_0 before the expansion, what is it after the expansion?

a. U_0
b. 2 U_0
c. 4 U_0
d. The change in temperature must also be known to answer this question.

ANS: B PTS: 1 DIF: 2
TOP: 10.5 The Kinetic Theory of Gases

77. The internal energy of a monatomic ideal gas is equal to which of the following?

a.	(3/2)*PV*
b.	(3/2)*nT*/*V*
c.	3 *T*/*P*
d.	none of the above

ANS: A PTS: 1 DIF: 2
TOP: 10.5 The Kinetic Theory of Gases

78. In a physics experiment a pulsed electron beam is fired at a target. Each pulse lasts 60.0 ns, and there are electrons in each pulse. Each electron in a pulse travels with a speed of m/s. What is the impulse delivered to the target during one pulse if all the electrons are reflected elastically by the target?

a.	N·s
b.	N·s
c.	N·s
d.	The impulse is more than double the largest value given in the other answers.

ANS: B PTS: 1 DIF: 2
TOP: 10.5 Kinetic Theory of Gases

79. A pulsed proton beam is fired at a target. Each pulse lasts 45.0 ns, and there are protons in each pulse, each proton having a speed of m/s. All the protons hit a circular area of , called the beam spot. What is the average pressure on the beam spot during a pulse if all the protons are absorbed by the target?

a.	250 Pa
b.	98.4 Pa
c.	197 Pa
d.	49.2Pa

ANS: B PTS: 1 DIF: 3
TOP: 10.5 Kinetic Theory of Gases

80. A single pulse of monoenergetic protons is fired at a small target, and all the protons are absorbed. The speed of each of the protons . The average pressure on the target during this pulse is . The experiment is repeated, but this time the kinetic energy of the protons is doubled, the area of the target is doubled, and the duration of the pulse is doubled although the pulse contains the same number of protons as in the first procedure. What is the average pressure on the target during the second pulse?

a.	
b.	
c.	
d.	

ANS: C PTS: 1 DIF: 2
TOP: 10.5 Kinetic Theory of Gases

81. Metal lids on glass jars can often be loosened by running them under hot water. Why is this?

a.	The hot water is a lubricant.

b. The metal and glass expand due to the heating, and the glass being of smaller radius expands less than the metal.
c. The metal has a higher coefficient of thermal expansion than glass so the metal expands more than the glass thus loosening the connection.
d. This is just folklore.

ANS: C PTS: 1 DIF: 1 TOP: Conceptual Problems

82. Why do vapor bubbles get larger in boiling water as they approach the surface?

a. They only appear to get larger, this being a magnification effect due to looking through the water.
b. The bubbles' pressure increases as they rise.
c. The pressure in the water decreases as the bubble moves toward the surface.
d. Bubbles always get bigger after they form.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

83. Suppose the pressure of 20 g of an ideal monatomic gas is tripled while its volume is halved. What happens to the internal energy of the gas?

a. It stays the same, as the described changes do not involve internal energy.
b. It increases.
c. It decreases.
d. This depends on the molecular weight of the gas involved, thus this is indeterminate.

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Problems

84. The temperature of a quantity of ideal gas in a sealed container is increased from 0°C to 273°C. What happens to the rms speed of the molecules of the gas as a result of this temperature increase?

a. It does not change since rms speed is independent of temperature.
b. It increases but it less than doubles.
c. It doubles.
d. It quadruples.

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Problems

85. The noble gases, listed by increasing molecular weight, are He, Ne, Ar, Kr, Xe, and Rn. If samples of 1 mole each of these gases are placed in separate containers and heated to 300 K, which gas has the greatest internal energy and the molecules of which gas have the highest rms speed?

a. The He has the greatest internal energy, and the Rn has the greatest rms speed.
b. The Rn has the greatest internal energy, and the He has the greatest rms speed.
c. All the gases have the same internal energy,

and the Rn has the greatest rms speed.
d. All the gases have the same internal energy, and the He has the greatest rms speed.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Problems

Chapter 11—Energy in Thermal Processes

MULTIPLE CHOICE

1. Arrange from smallest to largest: the BTU, the joule, and the calorie.

a. BTU, J, cal
b. J, cal, BTU
c. cal, BTU, J
d. J, BTU, cal

ANS: B PTS: 1 DIF: 1
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

2. Of the following systems, which contains the most heat?

a. 100 kg of water at 80°C
b. 250 kg of water at 40°C
c. 600 kg of ice at 0°C
d. Systems do not contain heat.

ANS: D PTS: 1 DIF: 1
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

3. Heat flow occurs between two bodies in thermal contact when they differ in what property?

a. mass
b. specific heat
c. density
d. temperature

ANS: D PTS: 1 DIF: 1
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

4. Calories of the food type are equal to which of the following?

a. 4.186 J
b. 4 186 J
c. 1 BTU
d. 1054 J

ANS: B PTS: 1 DIF: 1
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

5. Who demonstrated that when heat is gained or lost by a system during some process, the gain or loss can be accounted for by an equivalent quantity of mechanical work done on the system?

a. Joule
b. Boltzmann
c. Thompson, Count Rumford
d. Kelvin

ANS: A PTS: 1 DIF: 1
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

6. The first experiment, which systematically demonstrated the equivalence of mechanical energy and heat, was performed by:

a.□Joule.
b.□Boltzmann.
c.□Thompson, Count Rumford.
d.□Kelvin.

ANS: A PTS: 1 DIF: 1
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

7. If heat is flowing from a table to a block of ice moving across the table, which of the following <u>must</u> be true?

a.□The table is rough and there is friction between the table and ice.
b.□The ice is cooler than the table.
c.□The ice is changing phase.
d.□All three are possible, but none is absolutely necessary.

ANS: B PTS: 1 DIF: 1
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

8. How many calories are equal to one BTU? (One calorie = 4.186 J, one BTU = 1 054 J.)

a.□0.252
b.□3.97
c.□252
d.□397

ANS: C PTS: 1 DIF: 2
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

9. Which of the following statements is true?

a.□A hot object contains a lot of heat.
b.□A cold object contains only a little heat.
c.□Objects do not contain heat.
d.□Statements a and b are true.

ANS: C PTS: 1 DIF: 2
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

10. A 10-kg piece of aluminum (which has a specific heat of 900 J/kg×°C) is warmed so that its temperature increases by 5.0 C°. How much heat was transferred into it?

a.□4.5 ´ 10^4 J
b.□9.0 ´ 10^4 J
c.□1.4 ´ 10^5 J
d.□2.0 ´ 10^5 J

ANS: A PTS: 1 DIF: 2
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

11. Sea breezes that occur near the shore are attributed to a difference between land and water with respect to what property?

a. mass density
b. coefficient of volume expansion
c. specific heat
d. emissivity

ANS: C PTS: 1 DIF: 1
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

12. On a sunny day at the beach, the reason the sand gets so hot and the water stays relatively cool is attributed to the difference in which property between water and sand?

a. mass density
b. specific heat
c. temperature
d. thermal conductivity

ANS: B PTS: 1 DIF: 1
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

13. Marc attaches a falling 500-kg object with a rope through a pulley to a paddle wheel shaft. He places the system in a well-insulated tank holding 25 kg of water. When the object falls, it causes the paddle wheel to rotate and churn the water. If the object falls a vertical distance of 100 m at constant speed, what is the temperature change of the water? (1 kcal = 4 186 J, the specific heat of water is 4 186 J/kg⋅°C, and $g = 9.8$ m/s^2)

a. 19 600 C°
b. 4 700 C°
c. 4.7 C°
d. 0.8 C°

ANS: C PTS: 1 DIF: 2
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

14. An inventor develops a stationary cycling device by which an individual, while pedaling, can convert all of the energy expended into heat for warming water. How much mechanical energy is required to increase the temperature of 300 g of water (enough for 1 cup of coffee) from 20°C to 95°C? (1 cal = 4.186 J, the specific heat of water is 4 186 J/kg⋅°C)

a. 94 000 J
b. 22 000 J
c. 5 400 J
d. 14 J

ANS: A PTS: 1 DIF: 2
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

15. An inventor develops a stationary cycling device by which an individual, while pedaling, can convert all of the energy expended into heat for warming water. What minimum power must be generated if 300 g water (enough for 1 cup of coffee) is to be heated in 10 min from 20°C to 95°C? (1 cal = 4.186 J, the specific heat of water is 4 186 J/kg⋅°C)

a. 9 400 W

b.	590 W
c.	160 W
d.	31 W

ANS: C PTS: 1 DIF: 2
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

16. A 3.00-g lead bullet is traveling at a speed of 240 m/s when it embeds in a wood post. If we assume that half of the resultant heat energy generated remains with the bullet, what is the increase in temperature of the embedded bullet? (specific heat of lead = 0.030 5 kcal/kg×°C, 1 kcal = 4 186 J)

a.	113°C
b.	137°C
c.	226°C
d.	259°C

ANS: A PTS: 1 DIF: 3
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

17. A swimming pool heater has to be able to raise the temperature of the 40 000 gallons of water in the pool by 10.0 C°. How many kilowatt-hours of energy are required? (One gallon of water has a mass of approximately 3.8 kg and the specific heat of water is 4 186 J/kg×°C.)

a.	1 960 kWh
b.	1 770 kWh
c.	330 kWh
d.	216 kWh

ANS: B PTS: 1 DIF: 2
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

18. A solar heated house loses about 5.4×10^7 cal through its outer surfaces on a typical 24-h winter day. What mass of storage rock is needed to provide this amount of heat if it is brought up to initial temperature of 62°C by the solar collectors and the house is maintained at 20°C? (Specific heat of rock is 0.21 cal/g×°C.)

a.	163 kg
b.	1 230 kg
c.	6 100 kg
d.	12 700 kg

ANS: C PTS: 1 DIF: 2
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

19. A 0.2-kg aluminum plate, initially at 20°C, slides down a 15-m-long surface, inclined at a 30° angle to the horizontal. The force of kinetic friction exactly balances the component of gravity down the plane so that the plate, once started, glides down at constant velocity. If 90% of the mechanical energy of the system is absorbed by the aluminum, what is its temperature increase at the bottom of the incline? (Specific heat for aluminum is 900 J/kg×°C.)

a.	0.16 C°
b.	0.07 C°
c.	0.04 C°

d. 0.03 C°

ANS: B PTS: 1 DIF: 3
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

20. A waterfall is 145 m high. What is the increase in water temperature at the bottom of the falls if all the initial potential energy goes into heating the water? (g = 9.8 m/s^2, c_w = 4 186 J/kg⋅°C)

a. 0.16°C
b. 0.34°C
c. 0.69°C
d. 1.04°C

ANS: B PTS: 1 DIF: 2
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

21. What is the temperature increase of 4.0 kg of water when heated by an 800-W immersion heater for 10 min? (c_w = 4 186 J/kg⋅°C)

a. 56°C
b. 51°C
c. 29°C
d. 14°C

ANS: C PTS: 1 DIF: 2
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

22. A solar heating system has a 25.0% conversion efficiency; the solar radiation incident on the panels is 1 000 W/m^2. What is the increase in temperature of 30.0 kg of water in a 1.00-h period by a 4.00-m^2-area collector? (c_w = 4 186 J/kg⋅°C)

a. 14.3°C
b. 22.4°C
c. 28.7°C
d. 44.3°C

ANS: C PTS: 1 DIF: 2
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

23. A machine gear consists of 0.10 kg of iron and 0.16 kg of copper. How much total heat is generated in the part if its temperature increases by 35 C°? (Specific heats of iron and copper are 450 and 390 J/kg⋅°C, respectively.)

a. 910 J
b. 3 800 J
c. 4 000 J
d. 4 400 J

ANS: B PTS: 1 DIF: 2
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

24. As I use sandpaper on some rusty metal, the sandpaper gets hot because:

a. heat is flowing from the sandpaper into the metal.

b. heat is flowing from the metal into the sandpaper.
c. frictional processes increase the internal energy of the sandpaper.
d. heat is flowing from my hand into the sandpaper.

ANS: C PTS: 1 DIF: 1
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

25. If a 1000-kg car was moving at 30 m/s, what would be its kinetic energy expressed in the unusual (for kinetic energy) units of calories? (1 cal = 4.186 J)

a. 3.0×10^4
b. 9.0×10^5
c. 3.8×10^6
d. 1.1×10^5

ANS: D PTS: 1 DIF: 2
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

26. A 2.00-kg copper rod is 50.00 cm long at 23°C. If 40 000 J are transferred to the rod by heat, what is its change in length? c_{copper} = 387 J/kg⋅°C and $\alpha_{copper} = 17 \times 10^{-6}$/°C.

a. 0.022 cm
b. 0.044 cm
c. 0.059 cm
d. More information is needed.

ANS: B PTS: 1 DIF: 3
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

27. A piece of copper of mass 100 g is being drilled through with a $^1/_2$" electric drill. The drill operates at 40.0 W and takes 30.0 s to bore through the copper. If all the energy from the drill heats the copper, find the copper's increase in temperature. c_{copper} = 387 J/kg⋅°C.

a. 40.6 C°
b. 34.7 C°
c. 31.0 C°
d. 27.3 C°

ANS: C PTS: 1 DIF: 2
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

28. A slice of bread contains about 100 kcal. If specific heat of a person were 1.00 kcal/kg⋅°C, by how many °C would the temperature of a 70.0-kg person increase if all the energy in the bread were converted to heat?

a. 2.25°C
b. 1.86°C
c. 1.43°C
d. 1.00°C

ANS: C PTS: 1 DIF: 2
TOP: 11.1 Heat and Internal Energy | 11.2 Specific Heat

29. A hot (70°C) lump of metal has a mass of 250 g and a specific heat of 0.25 cal/g·°C. John drops the metal into a 500-g calorimeter containing 75 g of water at 20°C. The calorimeter is constructed of a material that has a specific heat of 0.10 cal/ g·°C. When equilibrium is reached, what will be the final temperature? c_{water} = 1.00 cal/g·°C.

a.	114°C
b.	72°C
c.	64°C
d.	37°C

ANS: D PTS: 1 DIF: 3 TOP: 11.3 Calorimetry

30. An 80.0-g piece of copper, initially at 295°C, is dropped into 250 g of water contained in a 300-g aluminum calorimeter; the water and calorimeter are initially at 10.0°C. What is the final temperature of the system? (Specific heats of copper and aluminum are 0.092 0 and 0.215 cal/g·°C, respectively. c_w = 1.00 cal/g·°C)

a.	12.8°C
b.	16.5°C
c.	28.4°C
d.	32.1°C

ANS: B PTS: 1 DIF: 3 TOP: 11.3 Calorimetry

31. A 120-g block of copper is taken from a kiln and quickly placed into a beaker of negligible heat capacity containing 300 g of water. The water temperature rises from 15°C to 35°C. Given c_{Cu} = 0.10 cal/g·°C, and c_{water} = 1.00 cal/g·°C, what was the temperature of the kiln?

a.	500°C
b.	360°C
c.	720°C
d.	535°C

ANS: D PTS: 1 DIF: 2 TOP: 11.3 Calorimetry

32. Find the final equilibrium temperature when 10.0 g of milk at 10.0°C is added to 160 g of coffee at 90.0°C. (Assume the specific heats of coffee and milk are the same as water and neglect the heat capacity of the container.) c_{water} = 1.00 cal/g·°C = 4186 J/kg·°C

a.	85.3°C
b.	77.7°C
c.	71.4°C
d.	66.7°C

ANS: A PTS: 1 DIF: 2 TOP: 11.3 Calorimetry

33. Twenty grams of a solid at 70°C is place in 100 grams of a fluid at 20°C. Thermal equilibrium is reached at 30°C. The specific heat of the solid:

a.	is equal to that of the fluid.

b. is less than that of the fluid.
c. is more than that of the fluid.
d. cannot be compared to that of a material in a different phase.

ANS: C PTS: 1 DIF: 2 TOP: 11.3 Calorimetry

34. Which of the following best describes a substance in which the temperature remains constant while at the same time it is experiencing an inward heat flow?

a. gas
b. liquid
c. solid
d. substance undergoing a change of state

ANS: D PTS: 1 DIF: 1
TOP: 11.4 Latent Heat and Phase Change

35. A 0.003 0-kg lead bullet is traveling at a speed of 240 m/s when it embeds in a block of ice at 0°C. If all the heat generated goes into melting ice, what quantity of ice is melted? (L_f = 80 kcal/kg, the specific heat of lead = 0.03 kcal/kg×°C, and 1 kcal = 4 186 J)

a. 1.47×10^{-2} kg
b. 5.8×10^{-4} kg
c. 3.2×10^{-3} kg
d. 2.6×10^{-4} kg

ANS: D PTS: 1 DIF: 2
TOP: 11.4 Latent Heat and Phase Change

36. A puddle holds 150 g of water. If 0.50 g of water evaporates from the surface, what is the approximate temperature change of the remaining water? (L_v = 540 cal/g)

a. +1.8 C°
b. - 1.8 C°
c. +0.18 C°
d. - 0.18 C°

ANS: B PTS: 1 DIF: 2
TOP: 11.4 Latent Heat and Phase Change

37. Iced tea is made by adding ice to 1.8 kg of hot tea, initially at 80°C. How many kg of ice, initially at 0°C, are required to bring the mixture to 10°C? ($L_f = 3.33 \times 10^5$ J/kg, c_w = 4 186 J/kg×°C)

a. 1.8 kg
b. 1.6 kg
c. 1.4 kg
d. 1.2 kg

ANS: C PTS: 1 DIF: 2
TOP: 11.4 Latent Heat and Phase Change

38. A 50-g cube of ice, initially at 0.0°C, is dropped into 200 g of water in an 80-g aluminum container, both initially at 30°C. What is the final equilibrium temperature? (Specific heat for aluminum is 900 J/kg·°C, the specific heat of water is 4 186 J/kg·°C, and $L_f = 3.33 \times 10^5$ J/kg.)

a. 17.9°C
b. 9.5°C
c. 12.1°C
d. 20.6°C

ANS: B PTS: 1 DIF: 3
TOP: 11.4 Latent Heat and Phase Change

39. 125 g of dry ice (solid CO_2) is dropped into a beaker containing 500 g of 66°C water. The dry ice converts directly to gas, leaving the solution. When the dry ice is gone, the final temperature of the water is 29°C. What is the heat of vaporization of solid CO_2? (c_{water} = 1.00 cal/g·°C)

a. 37 cal/g
b. 74 cal/g
c. 111 cal/g
d. 148 cal/g

ANS: D PTS: 1 DIF: 2
TOP: 11.4 Latent Heat and Phase Change

40. In cloud formation, water vapor turns into water droplets which get bigger and bigger until it rains. This will cause the temperature of the air in the clouds to:

a. get warmer.
b. get cooler.
c. will not affect the temperature of the air in the clouds.
d. There is no air in clouds.

ANS: A PTS: 1 DIF: 2
TOP: 11.4 Latent Heat and Phase Change

41. I take 1.0 kg of ice and dump it into 1.0 kg of water and, when equilibrium is reached, I have 2.0 kg of ice at 0°C. The water was originally at 0°C. The specific heat of water = 1.00 kcal/kg·°C, the specific heat of ice = 0.50 kcal/kg·°C, and the latent heat of fusion of water is 80 kcal/kg. The original temperature of the ice was:

a. one or two degrees below 0°C.
b. - 80°C.
c. - 160°C.
d. The whole experiment is impossible.

ANS: C PTS: 1 DIF: 2
TOP: 11.4 Latent Heat and Phase Change

42. How much heat energy is required to vaporize a 1.0-g ice cube at 0°C? The heat of fusion of ice is 80 cal/g. The heat of vaporization of water is 540 cal/g, and c_{water} = 1.00 cal/g·°C.

a. 620 cal
b. 720 cal

c.	820 cal
d.	1 kcal

ANS: B PTS: 1 DIF: 2
TOP: 11.4 Latent Heat and Phase Change

43. How much heat energy must be removed from 100 g of oxygen at 22°C to liquefy it at - 183°C? (The specific heat of oxygen gas is 0.218 cal/g×C, and its heat of vaporization is 50.9 cal/g.)

a.	13 700 cal
b.	9 560 cal
c.	4 320 cal
d.	2 160 cal

ANS: B PTS: 1 DIF: 2
TOP: 11.4 Latent Heat and Phase Change

44. 100 g of liquid nitrogen at its boiling point of 77 K is stirred into a beaker containing 500 g of 15°C water. If the nitrogen leaves the solution as soon as it turns to gas, how much water freezes? The heat of vaporization of nitrogen is 48 cal/g and that of water is 80 cal/g.

a.	none
b.	29 g
c.	68 g
d.	109 g

ANS: A PTS: 1 DIF: 2
TOP: 11.4 Latent Heat and Phase Change

45. A 5-g lead bullet traveling in 20°C air at 300 m/s strikes a flat steel plate and stops. What is the final temperature of the lead bullet? (Assume the bullet retains all heat.) The melting point of lead is 327°C. The specific heat of lead is 0.128 J/g×C. The heat of fusion of lead is 24.5 J/g.

a.	227°C
b.	260°C
c.	293°C
d.	327°C

ANS: D PTS: 1 DIF: 3
TOP: 11.4 Latent Heat and Phase Change

46. Which of the following involves the greatest heat transfer?

a.	One gram of steam at 100°C changing to water at 100°C.
b.	One gram of ice at 0°C changing to water at 0°C.
c.	One gram of water cooling from 100°C to 0°C.
d.	One gram of ice heating from - 100°C to 0°C.

ANS: A PTS: 1 DIF: 2
TOP: 11.4 Latent Heat and Phase Change

47. Carly places one end of a steel bar in a Bunsen flame and the other end in an ice cube. By what factor is the rate of heat flow changed when the bar's cross-sectional area is doubled?

a. 2
b. 1/2
c. 4.0
d. 1/4

ANS: A PTS: 1 DIF: 1 TOP: 11.5 Energy Transfer

48. Dmitri places one end of a copper rod in a heat reservoir and the other end in a heat sink. By what factor is the rate of heat flow changed when the temperature difference between the reservoir and sink is tripled?

a. 0.33
b. 1/9
c. 3.0
d. 9.0

ANS: C PTS: 1 DIF: 1 TOP: 11.5 Energy Transfer

49. If one's hands are being warmed by holding them to one side of a flame, the predominant form of heat transfer is what process?

a. conduction
b. radiation
c. convection
d. vaporization

ANS: B PTS: 1 DIF: 1 TOP: 11.5 Energy Transfer

50. When a wool blanket is used to keep warm, what is the primary insulating material?

a. wool
b. air
c. the trim around the edge of the blanket
d. a thin layer of aluminum foil (usually not apparent) inside the blanket

ANS: B PTS: 1 DIF: 1 TOP: 11.5 Energy Transfer

51. The surfaces of a Dewar flask are silvered for the purpose of minimizing heat transfer by what process?

a. conduction
b. radiation
c. convection
d. vaporization

ANS: B PTS: 1 DIF: 1 TOP: 11.5 Energy Transfer

52. The use of fiberglass insulation in the outer walls of a building is intended to minimize heat transfer through the wall by what process?

a. conduction
b. radiation
c. convection

d. vaporization

ANS: A PTS: 1 DIF: 1 TOP: 11.5 Energy Transfer

53. How does the heat energy from the sun reach us through the vacuum of space?

a. conduction
b. radiation
c. convection
d. none of the above choices are valid

ANS: B PTS: 1 DIF: 1 TOP: 11.5 Energy Transfer

54. Which one of the following processes of heat transfer requires the presence of a fluid?

a. conduction
b. radiation
c. convection
d. none of the above choices are valid

ANS: C PTS: 1 DIF: 1 TOP: 11.5 Energy Transfer

55. If cooking is done using an aluminum pan over an electric burner, which of the following will not promote the rate of heat flow from burner to food?

a. increase pan bottom thickness
b. increase pan bottom area
c. increase burner temperature
d. decrease height of pan sides

ANS: A PTS: 1 DIF: 2 TOP: 11.5 Energy Transfer

56. A windowpane is half a centimeter thick and has an area of 1.0 m^2. The temperature difference between the inside and outside surfaces of the pane is 15 °C. What is the rate of heat flow through this window? (Thermal conductivity for glass is 0.84 J/s×m×°C.)

a. 50 000 J/s
b. 2 500 J/s
c. 1 300 J/s
d. 630 J/s

ANS: B PTS: 1 DIF: 2 TOP: 11.5 Energy Transfer

57. A 2.0-m^2 Thermopane window is constructed, using two layers of glass 4.0 mm thick, separated by an air space of 5.0 mm. If the temperature difference is 20 °C from the inside of the house to the outside air, what is the rate of heat flow through this window? (Thermal conductivity for glass is 0.84 J/s×m×°C and for air 0.023 4 J/s×m×°C.)

a. 7 700 W
b. 1 900 W
c. 547 W
d. 180 W

ANS: D PTS: 1 DIF: 3 TOP: 11.5 Energy Transfer

58. The filament temperature of a light bulb is 2 000 K when the bulb delivers 40 W of power. If its emissivity remains constant, what power is delivered when the filament temperature is 2 500 K?

a. 105 W
b. 62 W
c. 98 W
d. 50 W

ANS: C PTS: 1 DIF: 2 TOP: 11.5 Energy Transfer

59. The emissivity of an ideal reflector has which of the following values?

a. 0
b. 1
c. 100
d. infinity

ANS: A PTS: 1 DIF: 1 TOP: 11.5 Energy Transfer

60. The thermal conductivity of aluminum is 238 J/s×m×°C and of copper is 397 J/s×m×°C. A rod of each material is used as a heat conductor. If the rods have the same geometry and are used between the same temperature differences for the same time interval, what is the ratio of the heat transferred by the aluminum to the heat transferred by the copper?

a. 0.599
b. 1.67
c. 0.359
d. 2.78

ANS: A PTS: 1 DIF: 2 TOP: 11.5 Energy Transfer

61. I place a 500-g ice cube (initially at 0°C) in a Styrofoam box with wall thickness 1.0 cm and total surface area 600 cm^2. If the air surrounding the box is at 20°C and after 4 hours the ice is completely melted, what is the conductivity of the Styrofoam material? (L_f = 80 cal/g)

a. 9.6×10^{-5} cal/s×cm×°C
b. 2.8×10^{-6} cal/s×cm×°C
c. 1.15×10^{-2} cal/s×cm×°C
d. 2.3×10^{-4} cal/s×cm×°C

ANS: D PTS: 1 DIF: 3 TOP: 11.5 Energy Transfer

62. Consider two different rods. The greatest thermal conductivity will be in the rod with:

a. electrons that are freer to move from atom to atom.
b. the greater specific heat.
c. the greater cross-sectional area.
d. the greater length.

ANS: A PTS: 1 DIF: 1 TOP: 11.5 Energy Transfer

63. Which type of heating causes sunburn?

a. conduction
b. convection

c. radiation
d. all of the above

ANS: C PTS: 1 DIF: 1 TOP: 11.5 Energy Transfer

64. In winter, light-colored clothes will keep you warmer than dark-colored clothes if:

a. you are warmer than your surroundings.
b. you are at the same temperature as your surroundings.
c. you are cooler than your surroundings.
d. you are standing in sunlight.

ANS: A PTS: 1 DIF: 2 TOP: 11.5 Energy Transfer

65. A silver bar of length 30 cm and cross-sectional area 1.0 cm^2 is used to transfer heat from a 100°C reservoir to a 0°C block of ice. How much ice is melted per second? (For silver, k = 427 J/s×m×°C. For ice, L_f = 334 000 J/kg.)

a. 4.2 g/s
b. 2.1 g/s
c. 0.80 g/s
d. 0.043 g/s

ANS: D PTS: 1 DIF: 3 TOP: 11.5 Energy Transfer

66. At high noon, the sun delivers 1 000 W to each square meter of a blacktop road. What is the equilibrium temperature of the hot asphalt, assuming its emissivity e = 1? ($\sigma = 5.67 \times 10^{-8}$ $W/m^2 \times K^4$) .

a. 75°C
b. 84°C
c. 91°C
d. 99°C

ANS: C PTS: 1 DIF: 2 TOP: 11.5 Energy Transfer

67. The surface of the Sun has a temperature of about 5 800 K. If the radius of the Sun is 7×10^8 m, determine the power output of the sun. (Take e = 1, and $\sigma = 5.67 \times 10^{-8}$ $W/m^2 \times K^4$).

a. 3.95×10^{26} W
b. 5.17×10^{27} W
c. 9.62×10^{28} W
d. 6.96×10^{30} W

ANS: A PTS: 1 DIF: 2 TOP: 11.5 Energy Transfer

68. The tungsten filament of a light bulb has an operating temperature of about 2 100 K. If the emitting area of the filament is 1.0 cm^2, and its emissivity is 0.68, what is the power output of the light bulb? ($\sigma = 5.67 \times 10^{-8}$ $W/m^2 \times K^4$)

a. 100 W
b. 75 W
c. 60 W
d. 40 W

ANS: B PTS: 1 DIF: 2 TOP: 11.5 Energy Transfer

69. An object at 27°C has its temperature increased to 37°C. The power then radiated by this object increases by how many percent?

a.	3.3
b.	14
c.	37
d.	253

ANS: B PTS: 1 DIF: 2 TOP: 11.5 Energy Transfer

70. What temperature increase is necessary to increase the power radiated from an object by a factor of 8?

a.	8 K
b.	2 K
c.	100%
d.	about 68%

ANS: D PTS: 1 DIF: 2 TOP: 11.5 Energy Transfer

71. A metal bar is used to conduct heat. When the temperature at one end is 100°C and at the other is 20°C, heat is transferred at a rate of 16 J/s. If the temperature of the hotter end is reduced to 80°C, what will be the rate of heat transfer?

a.	4 J/s
b.	8 J/s
c.	9 J/s
d.	12 J/s

ANS: D PTS: 1 DIF: 2 TOP: 11.5 Energy Transfer

72. A metal bar is used to conduct heat. When the temperature at one end is 100°C and at the other is 20°C, heat is transferred at a rate of 16 J/s. The bar is then stretched uniformly to twice its original length. If again it has ends at 100°C and 20°C, at what rate will heat be transferred between it ends?

a.	4 J/s
b.	8 J/s
c.	16 J/s
d.	32 J/s

ANS: A PTS: 1 DIF: 2 TOP: 11.5 Energy Transfer

73. A storage area, which is maintained at 22°C, has an outside wall of area . On a day when the outside temperature is 8.0°C, the rate of energy transfer through the wall is 220 W. What is the R-value of the wall?

a.	
b.	
c.	
d.	

ANS: C PTS: 1 DIF: 2 TOP: 11.5 Energy Transfer

74. In order to conserve energy, it is decided to increase the R-value of an outside wall from by adding an inexpensive layer of sheathing on the inside of the wall which has an R-value of . When the temperature difference between the inside and outside is 20°C, by what percentage is the rate of energy transfer through the wall reduced by this added insulation?

a. 37%
b. 58%
c. 63%
d. This cannot be found without also knowing the area of the wall.

ANS: C PTS: 1 DIF: 3 TOP: 11.5 Energy Transfer

75. A person has a thermal conductivity of 0.18 W/m·K between his inner core and his skin with an effective shell thickness of 1.8 cm between his core and skin. If his inner core is at the normal 98.6°F, and his skin has a surface area of 1.64 , what will be his rate of loss of thermal energy due to conduction through his skin if his skin temperature is 31.0°?

a. 65 W
b. 52 W
c. 89 W
d. 98 W

ANS: D PTS: 1 DIF: 2 TOP: 11.5 Energy Transfer

76. A person is losing thermal energy through the skin at a rate of 120 W when his skin temperature is 30°C. He puts on a sweater, and his skin temperature rises to 33°C. The effective thermal conductivity between his core and the environment changes from 0.22 W/m·K to 0.18 W/m·K. At what rate is he now losing thermal energy?

a. 98 W
b. 69 W
c. 63 W
d. 56 W

ANS: D PTS: 1 DIF: 2 TOP: 11.5 Thermal Transfer

77. In a greenhouse, electromagnetic energy in the form of visible light enters the glass panes and is absorbed and then reradiated. What happens to this reradiated electromagnetic radiation from within the greenhouse?

a. 100% returns to the atmosphere.
b. It's partially blocked by glass.
c. It's transformed into ultraviolet upon striking the glass.
d. It's reflected as visible light upon striking the glass.

ANS: B PTS: 1 DIF: 1
TOP: 11.6 Global Warming and Greenhouse Gases

78. Of the planets with atmospheres, which is the warmest?

a. Venus
b. Earth

c. Mars
d. Jupiter

ANS: A PTS: 1 DIF: 1
TOP: 11.6 Global Warming and Greenhouse Gases

79. Which of the following produces greenhouse gases?

a. burning fossil fuel
b. digestive processes in cows
c. automobile pollution
d. all of the above

ANS: D PTS: 1 DIF: 1
TOP: 11.6 Global Warming and Greenhouse Gases

80. Carbon dioxide and water molecules in the atmosphere will absorb:

a. infrared light.
b. visible light.
c. ultraviolet light.
d. radio waves.

ANS: A PTS: 1 DIF: 1
TOP: 11.6 Global Warming and Greenhouse Gases

81. Pennies used to be made of copper, but now they are made of copper-coated zinc. If one were to do a precise calorimetry experiment to determine the specific heat of the new pennies, what would the result be?

a. It would be that of copper since copper is on the outside.
b. It would be that of zinc since zinc is in the center.
c. It would be the sum of the copper and zinc specific heats.
d. It would be between that of copper and that of zinc, depending on coating thickness.

ANS: D PTS: 1 DIF: 1 TOP: Conceptual Problems

82. Inside a house, stepping on a tile floor barefooted may feel almost cold, but stepping on carpet in an adjacent room feels comfortably warm. Why is this?

a. It's because the tile is below room temperature while the carpet is at room temperature.
b. It's because the tile is at room temperature while carpet is normally warmer.
c. It's because the thermal conductivity of tile is less than that of carpet.
d. It's because the thermal conductivity of carpet is less than that of tile.

ANS: D PTS: 1 DIF: 1 TOP: Conceptual Problems

83. Two stars, A and B, have the same emissivity, but the radii and surface temperatures are different with $R_A = 0.5\ R_B$, and $T_A = 2\ T_B$. Assuming the temperature of space to be negligible, which star radiates the most energy per unit time?

a.	Star A
b.	Star B
c.	Both radiate the same amount of energy per unit time.
d.	More information is needed in order to make a determination.

ANS: A PTS: 1 DIF: 2 TOP: Conceptual Problems

84. The inside of a house is at 20°C on an early morning when the temperature outside is 15°C. The next morning the inside temperature is the same but the outside temperature is now 10°C. How much does the energy per unit time lost by conduction through the walls, windows, doors, etc., change for the house from the first morning to the second one?

a.	Since the inside temperature stays the same, the loss is the same both days.
b.	The loss doubles.
c.	The loss halves.
d.	The loss increases by 5/288 since we need to use the Kelvin scale for this calculation.

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Problems

85. A plot of the temperature versus the energy per kg added to a piece of ice as it goes from below freezing at - 10°C to becoming steam at 110°C consists of straight lines, some horizontal and some with an upward slope. What do the upward slopes represent?

a.	specific heats
b.	reciprocals of specific heats
c.	latent heats
d.	reciprocals of latent heats

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Problems

Chapter 12—The Laws of Thermodynamics

MULTIPLE CHOICE

1. The volume of an ideal gas changes from 0.40 to 0.55 m^3 although its pressure remains constant at 50 000 Pa. What work is done on the system by its environment?

a.	- 7 500 J
b.	- 200 000 J
c.	7 500 J
d.	200 000 J

ANS: A PTS: 1 DIF: 2
TOP: 12.1 Work in Thermodynamic Processes

2. During an isobaric process which one of the following does not change?

a.	volume
b.	temperature
c.	internal energy
d.	pressure

ANS: D PTS: 1 DIF: 1
TOP: 12.1 Work in Thermodynamic Processes

3. Area on a P-V diagram has units associated with:

a.	energy.
b.	momentum.
c.	temperature.
d.	change in temperature.

ANS: A PTS: 1 DIF: 1
TOP: 12.1 Work in Thermodynamic Processes

4. What is the work done on the gas as it expands from pressure P_1 and volume V_1 to pressure P_2 and volume V_2 along the indicated straight line?

a.	$(P_1 + P_2)(V_1 - V_2)/2$
b.	$(P_1 + P_2)(V_1 - V_2)$
c.	$(P_1 + P_2)(V_1 - V_2)/2$
d.	$(P_1 - P_2)(V_1 + V_2)$

ANS: A PTS: 1 DIF: 2
TOP: 12.1 Work in Thermodynamic Processes

5. On a P-V diagram, an _____ process is represented by a horizontal line.

a.	isobaric
b.	isothermal
c.	isovolumetric

d. adiabatic

ANS: A PTS: 1 DIF: 1
TOP: 12.1 Work in Thermodynamic Processes

6. In an isobaric process 4.5 ´ 10^4 J of work is done on a quantity of gas while its volume changes from 2.6 m^3 to 1.1 m^3. What is the pressure during this process?

a. 1.2 ´ 10^4 Pa
b. 2.4 ´ 10^4 Pa
c. 3.0 ´ 10^4 Pa
d. 4.1 ´ 10^4 Pa

ANS: C PTS: 1 DIF: 2
TOP: 12.1 Work in Thermodynamic Processes

7. In the first law of thermodynamics, , *W* is positive when

a. the work is being done on the environment by the system.
b. the work is being done on the system by the environment.
c. the work is being done on the environment by the system, and the temperature of the system goes up.
d. the work is being done on the system by the environment, and the temperature of the system goes up.

ANS: B PTS: 1 DIF: 1
TOP: 12.2 The First Law of Thermodynamics

8. A system is acted on by its surroundings in such a way that it receives 50 J of heat while simultaneously doing 20 J of work. What is its net change in internal energy?

a. 70 J
b. 30 J
c. zero
d. - 30 J

ANS: B PTS: 1 DIF: 2
TOP: 12.2 The First Law of Thermodynamics \| 12.3 Thermal Processes

9. In an isothermal process for an ideal gas system (where the internal energy doesn't change), which of the following choices best corresponds to the value of the work done on the system?

a. its heat intake
b. twice its heat intake
c. the negative of its heat intake
d. twice the negative of its heat intake

ANS: C PTS: 1 DIF: 2
TOP: 12.2 The First Law of Thermodynamics \| 12.3 Thermal Processes

10. According to the first law of thermodynamics, the sum of the heat gained by a system and the work done on that same system is equivalent to which of the following?

a. entropy change
b. internal energy change
c. temperature change
d. specific heat

ANS: B PTS: 1 DIF: 1
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

11. If an ideal gas does positive work on its surroundings, we may assume, with regard to the gas:

a. temperature increases.
b. volume increases.
c. pressure increases.
d. internal energy decreases.

ANS: B PTS: 1 DIF: 2
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

12. In an isovolumetric process by an ideal gas, the system's heat gain is equivalent to a change in:

a. temperature.
b. volume.
c. pressure.
d. internal energy.

ANS: D PTS: 1 DIF: 2
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

13. A 2.0-mol ideal gas system is maintained at a constant volume of 4.0 L. If 100 J of heat is added, what is the work done on the system?

a. zero
b. 5.0 J
c. - 6.7 J
d. 20 J

ANS: A PTS: 1 DIF: 1
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

14. A closed 2.0-L container holds 3.0 mol of an ideal gas. If 200 J of heat is added, what is the change in internal energy of the system?

a. zero
b. 100 J
c. 150 J
d. 200 J

ANS: D PTS: 1 DIF: 1
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

15. The adiabatic index of a gas is given by which of the following?

a. C_P/C_V

b. C_V / C_P
c. $C_P - C_V$
d. $C_P + C_V$

ANS: A PTS: 1 DIF: 1
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

16. An adiabatic expansion refers to the fact that:

a. no heat is transferred between a system and its surroundings.
b. the pressure remains constant.
c. the temperature remains constant.
d. the volume remains constant.

ANS: A PTS: 1 DIF: 1
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

17. A 4-mol ideal gas system undergoes an adiabatic process where it expands and does 20 J of work on its environment. What is its change in internal energy?

a. - 20 J
b. - 5 J
c. zero
d. +20 J

ANS: A PTS: 1 DIF: 2
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

18. A 4-mol ideal gas system undergoes an adiabatic process where it expands and does 20 J of work on its environment. How much heat is received by the system?

a. - 20 J
b. zero
c. +5 J
d. +20 J

ANS: B PTS: 1 DIF: 1
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

19. A quantity of monatomic ideal gas expands adiabatically from a volume of 2.0 liters to 6.0 liters. If the initial pressure is P_0, what is the final pressure?

a. 9.0 P_0
b. 6.2 P_0
c. 3.0 P_0
d. 0.16 P_0

ANS: D PTS: 1 DIF: 2
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

20. A 5-mol ideal gas system undergoes an adiabatic free expansion (a rapid expansion into a vacuum), going from an initial volume of 10 L to a final volume of 20 L. How much work is done on the system during this adiabatic free expansion?

a. - 50 J
b. - 10 J
c. zero
d. +50 J

ANS: C PTS: 1 DIF: 2
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

21. Which of the following increases the internal energy of a solid metal rod?

a. raising it to a greater height
b. throwing it through the air
c. having the rod conduct heat
d. having the rod absorb heat

ANS: D PTS: 1 DIF: 1
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

22. As the ideal gas expands from pressure P_1 and volume V_1 to pressure P_2 and volume V_2 along the indicated straight line, it is possible that:

a. the temperature stays constant.
b. the internal energy decreases.
c. the gas is changing state.
d. all of the above are impossible for this particular graph.

ANS: D PTS: 1 DIF: 2
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

23. Heat is applied to an ice-water mixture to melt some of the ice. In this process:

a. work is done by the ice-water mixture.
b. the temperature increases.
c. the internal energy increases.
d. all of the above are correct.

ANS: C PTS: 1 DIF: 2
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

24. An ideal gas at pressure, volume, and temperature, P_0, V_0, and T_0, respectively, is heated to point A, allowed to expand to point B also at A's temperature $2T_0$, and then returned to the original condition. The internal energy increases by $3P_0V_0/2$ going from point T_0 to point A. How much heat entered the gas from point T_0 to point A?

a. 0
b. $P_0V_0/2$
c. 3 $P_0V_0/2$

d. 5 $P_0V_0/2$

ANS: C PTS: 1 DIF: 3
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

25. An ideal gas at pressure, volume, and temperature, P_0, V_0, and T_0, respectively, is heated to point A, allowed to expand to point B also at A's temperature $2T_0$, and then returned to the original condition. The internal energy decreases by $3P_0V_0/2$ going from point B to point T_0. How much heat left the gas from point B to point T_0?

a. 0
b. $P_0V_0/2$
c. $3P_0V_0/2$
d. $5P_0V_0/2$

ANS: D PTS: 1 DIF: 3
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

26. An ideal gas at pressure, volume, and temperature, P_0, V_0, and T_0, respectively, is heated to point A, allowed to expand to point B also at A's temperature $2T_0$, and then returned to the original condition. The internal energy decreases by $3P_0V_0/2$ going from point B to point T_0. In going around this cycle once, which quantity equals zero?

a. the net change in internal energy of the gas
b. the net work done by the gas
c. the net heat added to the gas
d. All three are zero.

ANS: A PTS: 1 DIF: 2
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

27. A cylinder containing an ideal gas has a volume of 2.0 m^3 and a pressure of 1.0×10^5 Pa at a temperature of 300 K. The cylinder is placed against a metal block that is maintained at 900 K and the gas expands as the pressure remains constant until the temperature of the gas reaches 900 K. The change in internal energy of the gas is $+6.0 \times 10^5$ J. How much heat did the gas absorb?

a. 0
b. 4.0×10^5 J
c. 6.0×10^5 J
d. 10×10^5 J

ANS: D PTS: 1 DIF: 3
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

28. A thermodynamic process that happens very quickly tends to be:

a. isobaric.
b. isothermal.

c. isovolumetric.
d. adiabatic.

ANS: D PTS: 1 DIF: 1
TOP: 12.2 The First Law of Thermodynamics | 12.3 Thermal Processes

29. System 1 is 4.30 moles of a monatomic ideal gas held at a constant volume as it undergoes a temperature increase. System 2 is 4.30 moles of a diatomic ideal gas held at constant volume as it also undergoes a temperature increase. The thermal energy absorbed by System 1 is , and the thermal energy absorbed by System 2 is as both systems undergo a temperature increase of 75.0 K. What is the ratio ?

a. 1.00
b. 0.600
c. 1.67
d. The volumes of the systems need to be known before the ratio can be found.

ANS: B PTS: 1 DIF: 3 TOP: 12.3 Thermal Processes

30. System 1 is 3.5 moles of a monatomic ideal gas held at a constant volume of 2.22 L as it undergoes a temperature increase. System 2 is 3.5 moles of a diatomic ideal gas held at a constant volume of 2.22 L as it undergoes a temperature increase equal to the temperature increase of System 1. The pressure increase for system 1 is and for System 2 is during the temperature increases. What is the ratio of ?

a. 1.00
b. 0.600
c. 1.67
d. 2.50

ANS: A PTS: 1 DIF: 2 TOP: 12.3 Thermal Processes

31. How much thermal energy must be added to 7.30 moles of a diatomic ideal gas to raise its temperature 22.5 K?

a. 467 J
b. 1 460 J
c. 2 050 J
d. 3 410 J

ANS: D PTS: 1 DIF: 2 TOP: 12.3 Thermal Processes

32. A heat engine exhausts 3 000 J of heat while performing 1 500 J of useful work. What is the efficiency of the engine?

a. 15%
b. 33%
c. 50%
d. 60%

ANS: B PTS: 1 DIF: 2
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

33. A heat engine operating between a pair of hot and cold reservoirs with respective temperatures of 500 K and 200 K will have what maximum efficiency?

a. 60%

b.	50%
c.	40%
d.	30%

ANS: A PTS: 1 DIF: 2
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

34. An electrical power plant manages to send 88% of the heat produced in the burning of fossil fuel into the water-to-steam conversion. Of the heat carried by the steam, 40% is converted to the mechanical energy of the spinning turbine. Which of the following choices best describes the overall efficiency of the heat-to-work conversion in the plant (as a percentage)?

a.	greater than 88%
b.	64%
c.	less than 40%
d.	40%

ANS: C PTS: 1 DIF: 2
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

35. According to the second law of thermodynamics, which of the following applies to the heat received from a high temperature reservoir by a heat engine operating in a complete cycle?

a.	must be completely converted to work
b.	equals the entropy increase
c.	converted completely into internal energy
d.	cannot be completely converted to work

ANS: D PTS: 1 DIF: 1
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

36. The maximum theoretical thermodynamic efficiency of a heat engine operating between hot and cold reservoirs is a function of which of the following?

a.	hot reservoir temperature only
b.	cold reservoir temperature only
c.	both hot and cold reservoir temperatures
d.	None of the above choices are valid.

ANS: C PTS: 1 DIF: 1
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

37. A heat engine receives 6 000 J of heat from its combustion process and loses 4 000 J through the exhaust and friction. What is its efficiency?

a.	33%
b.	40%
c.	67%
d.	73%

ANS: A PTS: 1 DIF: 2
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

38. If a heat engine has an efficiency of 30% and its power output is 600 W, what is the rate of heat input from the combustion phase?

a.	1 800 W
b.	2 400 W
c.	2 000 W
d.	3 000 W

ANS: C PTS: 1 DIF: 2
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

39. A turbine takes in 1 000-K steam and exhausts the steam at a temperature of 500 K. What is the maximum theoretical efficiency of this system?

a.	24%
b.	33%
c.	50%
d.	67%

ANS: C PTS: 1 DIF: 2
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

40. An electrical generating plant operates at a boiler temperature of 220°C and exhausts the unused heat into a nearby river at 18°C. What is the maximum theoretical efficiency of the plant? (0°C = 273 K)

a.	61%
b.	32%
c.	21%
d.	41%

ANS: D PTS: 1 DIF: 2
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

41. An electrical generating plant operates at a boiler temperature of 220°C and exhausts the unused heat into a nearby river at 19°C. If the generating plant has a power output of 800 megawatts (MW) and if the actual efficiency is 3/4 the theoretical efficiency, how much heat per second must be delivered to the boiler? (0°C = 273 K)

a.	5 200 MW
b.	1 810 MW
c.	3 620 MW
d.	2 620 MW

ANS: D PTS: 1 DIF: 2
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

42. During each cycle of operation a refrigerator absorbs 55 cal from the freezer compartment and expels 85 cal to the room. If one cycle occurs every 10 s, how many minutes will it take to freeze 500 g of water, initially at 0°C? (L_v = 80 cal/g)

a.	800 min
b.	4 400 min
c.	120 min
d.	60 min

ANS: C PTS: 1 DIF: 3
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

43. In which system is heat usually transferred from the cooler part to the warmer part?

a.□a stove as it heats up water
b.□a refrigerator that is running
c.□an electric fan that is running
d.□none of the above, because it is impossible to transfer heat in this manner

ANS: B PTS: 1 DIF: 1
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

44. When gasoline is burned, it gives off 46 000 J/g of heat energy. If an automobile uses 13.0 kg of gasoline per hour with an efficiency of 21%, what is the average horsepower output of the engine? (1 hp = 746 W)

a.□47 hp
b.□110 hp
c.□67 hp
d.□34 hp

ANS: A PTS: 1 DIF: 3
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

45. Suppose a power plant uses a Carnot engine to generate electricity, using the atmosphere at 300 K as the low-temperature reservoir. Suppose the power plant produces 1 ´ 10^6 J of electricity with the hot reservoir at 500 K during Day One and then produces 1 ´ 10^6 J of electricity with the hot reservoir at 600 K during Day Two. The thermal pollution was:

a.□greatest on Day One.
b.□greatest on Day Two.
c.□the same on both days.
d.□zero on both days.

ANS: A PTS: 1 DIF: 3
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

46. The efficiency of a Carnot engine operating between 100°C and 0°C is most nearly:

a.□7%.
b.□15%.
c.□27%.
d.□51%.

ANS: C PTS: 1 DIF: 2
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

47. An 800-MW electric power plant has an efficiency of 30%. It loses its waste heat in large cooling towers. Approximately how much waste heat (in MJ) is discharged to the atmosphere per second?

a.□1 200 MJ
b.□1 900 MJ
c.□800 MJ
d.□560 MJ

ANS: B PTS: 1 DIF: 2
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

48. A gasoline engine with an efficiency of 30.0% operates between a high temperature T_1 and a low temperature T_2 = 320 K. If this engine operates with Carnot efficiency, what is the high-side temperature T_1?

a.	1 070 K
b.	868 K
c.	614 K
d.	457 K

ANS: D PTS: 1 DIF: 2
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

49. The Carnot cycle consists of a combination of ____ and ____ processes.

a.	isobaric, isovolumetric
b.	isovolumetric, adiabatic
c.	isobaric, isothermal
d.	adiabatic, isothermal

ANS: D PTS: 1 DIF: 2
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

50. Of the following heat engines, which has the highest efficiency?

a.	Hero's engine
b.	a Carnot engine
c.	a car's gasoline engine
d.	a truck's diesel engine

ANS: B PTS: 1 DIF: 1
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

51. A Carnot engine runs between a hot reservoir at T_h and a cold reservoir at T_c. If one of the temperatures is either increased or decreased by 3.5 K, which of the following changes would increase the efficiency by the greatest amount?

a.	increasing T_h
b.	increasing T_c
c.	decreasing T_c
d.	cannot be determined from information given

ANS: C PTS: 1 DIF: 3
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

52. On a P-V diagram, if a process involves a closed curve, the area inside the curve represents:

a.	internal energy.
b.	heat.
c.	work.
d.	zero.

ANS: C PTS: 1 DIF: 1
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

53. The P-V diagram of a cyclic process shows a curve that encloses an area. The work done by the heat engine, represented by the enclosed area, is positive when the path around the area proceeds in which of the following fashions?

a. clockwise
b. counterclockwise
c. It is always positive.
d. It is always negative.

ANS: A PTS: 1 DIF: 2
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

54. A refrigerator has a coefficient of performance of 4.0. When removing 2.4 ´ 10^4 J from inside the refrigerator, how much energy is sent into the environment?

a. 9.6 ´ 10^4 J
b. 3.0 ´ 10^4 J
c. 1.8 ´ 10^4 J
d. 0.60 ´ 10^4 J

ANS: B PTS: 1 DIF: 2
TOP: 12.4 Heat Engines and the Second Law of Thermodynamics

55. Which of the following choices best corresponds to what is required by the second law of thermodynamics for any process taking place in an isolated system?

a. entropy decreases
b. entropy remains constant
c. entropy increases
d. entropy equals work done on the system

ANS: C PTS: 1 DIF: 1 TOP: 12.5 Entropy

56. Which of the following choices is an appropriate unit for measuring entropy changes?

a. J×K
b. N×K
c. J/s
d. J/K

ANS: D PTS: 1 DIF: 1 TOP: 12.5 Entropy

57. If one could observe the individual atoms making up a piece of matter and note that during a process of change their motion somehow became more orderly, then one may assume which of the following in regard to the system?

a. increases in entropy
b. decreases in entropy
c. gains in thermal energy
d. positive work done on

ANS: B PTS: 1 DIF: 1 TOP: 12.5 Entropy

58. A 1.0-kg chunk of ice at 0°C melts, absorbing 80 000 cal of heat in the process. Which of the following best describes what happens to this system?

a. increased entropy
b. lost entropy
c. entropy maintained constant
d. work converted to energy

ANS: A PTS: 1 DIF: 1 TOP: 12.5 Entropy

59. According to the first law of thermodynamics, for any process that may occur within an isolated system, which of the following choices applies?

a. entropy remains constant
b. entropy increases
c. entropy decreases
d. None of the above choices apply.

ANS: D PTS: 1 DIF: 1 TOP: 12.5 Entropy

60. A 2.00-kg block of ice is at STP (0°C, 1 atm) while it melts completely to water. What is its change in entropy? (For ice, $L_f = 3.34 \times 10^5$ J/kg)

a. zero
b. 584 J/K
c. 1 220 J/K
d. 2 450 J/K

ANS: D PTS: 1 DIF: 2 TOP: 12.5 Entropy

61. One kilogram of water at 1.00 atm at the boiling point of 100°C is heated until all the water vaporizes. What is its change in entropy? (For water, $L_v = 2.26 \times 10^6$ J/kg)

a. 12 100 J/K
b. 6 060 J/K
c. 3 030 J/K
d. 1 220 J/K

ANS: B PTS: 1 DIF: 2 TOP: 12.5 Entropy

62. What is the change in entropy (ΔS) when one mole of silver (108 g) is completely melted at 961°C? (The heat of fusion of silver is 8.82×10^4 J/kg.)

a. 5.53 J/K
b. 7.72 J/K
c. 9.91 J/K
d. 12.10 J/K

ANS: B PTS: 1 DIF: 2 TOP: 12.5 Entropy

63. An avalanche of ice and snow of mass 1 800 kg slides a vertical distance of 160 m down a mountainside. If the temperature of the ice, snow, mountain and surrounding air are all at 0°C, what is the change in entropy of the universe?

a. 31 000 J/K

b. 10 000 J/K
c. 3 200 J/K
d. 1 100 J/K

ANS: B PTS: 1 DIF: 2 TOP: 12.5 Entropy

64. A cylinder containing an ideal gas has a volume of 2.0 m^3 and a pressure of 1.0×10^5 Pa at a temperature of 300 K. The cylinder is placed against a metal block that is maintained at 900 K and the gas expands as the pressure remains constant until the temperature of the gas reaches 900 K. The change in internal energy of the gas is 6.0×10^5 J. Find the change in entropy of the block associated with the heat transfer to the gas.

a. 0
b. +670 J/K
c. - 440 J/K
d. - 1 100 J/K

ANS: D PTS: 1 DIF: 3 TOP: 12.5 Entropy

65. The surface of the Sun is at approximately 5 700 K and the temperature of the Earth's surface is about 290 K. What total entropy change occurs when 1 000 J of heat energy is transferred from the Sun to the Earth?

a. 2.89 J/K
b. 3.27 J/K
c. 3.62 J/K
d. 3.97 J/K

ANS: B PTS: 1 DIF: 3 TOP: 12.5 Entropy

66. Entropy is a measure of the _____ of a system.

a. disorder
b. temperature
c. heat
d. internal energy

ANS: A PTS: 1 DIF: 1 TOP: 12.5 Entropy

67. When considering human metabolism in terms of the 1st Law of Thermodynamics, which of the following represents the metabolic rate?

a. $\Delta U / \Delta t$
b. $\Delta Q / \Delta t$
c. $W / \Delta t$
d. $\Delta W / \Delta t$

ANS: A PTS: 1 DIF: 1 TOP: 12.6 Human Metabolism

68. On an average diet, the consumption of 10 liters of oxygen releases how much energy? (4.8 kcal are released per liter of oxygen consumed.)

a. 48 kJ
b. 200 kJ
c. 4.2 kJ
d. 4 200 kJ

ANS: B PTS: 1 DIF: 2 TOP: 12.6 Human Metabolism

69. A person consumes 2 500 kcal/day while expending 3 500 kcal/day. In a month's time, about how much weight would this person lose if the loss were essentially all from body fat? (Body fat has an energy content of about 4 100 kcal per pound.)

a. 1 pound
b. 2 pounds
c. 7 pounds
d. 15 pounds

ANS: C PTS: 1 DIF: 2 TOP: 12.6 Human Metabolism

70. A pound of body fat has an energy content of about 4 100 kcal. If a 1 400-kg automobile had an equivalent amount of translational kinetic energy, how fast would it be moving? (0.447 m/s = 1 mph, 1 kcal = 4 186 J)

a. 3.1 mph
b. 14 mph
c. 75 mph
d. 350 mph

ANS: D PTS: 1 DIF: 3 TOP: 12.6 Human Metabolism

71. On a *PV* diagram, 2 curves are plotted, both starting at the same point (P_1, V_1) and both ending at the same increased volume (V_2). One curve is for an isothermal process; the other is for an adiabatic process. Except for the common starting point, which curve is the upper one?

a. The isothermal process curve will always be the upper one.
b. The adiabatic process curve will always be the upper one.
c. Since they start at the same point and end at the same volume, they will coincide.
d. The isothermal one will start out higher, but the adiabatic one will eventually cross it.

ANS: A PTS: 1 DIF: 1 TOP: Conceptual Problems

72. At the dice factory, sets of novelty dice are created where a side with 7 dots replaces the single dot side. The sides then range from 2 to 7 instead of the usually 1 to 6. Using such dice for a game of craps, what will be the most probable roll?

a. 7, this change in dots results in the same most probable value.
b. 7.5
c. 8
d. 9

ANS: D PTS: 1 DIF: 3 TOP: Conceptual Problems

73. On a *PV* diagram, 2 curves are plotted, both starting at the same point and both ending at the same final increased volume. One curve is for an isothermal process; the other is for an adiabatic process. What does the area between these two curves represent?

a. Q absorbed by the isothermal process.
b. W done by the adiabatic process.
c. DU for the isothermal process.
d. Neither Q, W, nor DU for either of the processes is represented.

ANS: A PTS: 1 DIF: 3 TOP: Conceptual Problems

74. Three Carnot engines operate between temperature reservoirs as follows: Engine A: T_h = 1 300 K, T_c = 1 000 K; Engine B: T_h = 1 000 K, T_c = 700 K; Engine C: T_h = 650 K, T_c = 500 K. Which two engines have the same thermal efficiency?

a. A and B
b. B and C
c. A and C
d. No two have the same thermal efficiency.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

75. In an isovolumetric process where the pressure increases, are the heat absorbed, work done by the system, and the change in internal energy of the system positive, negative, or zero?

a. Q is +, W is +, and DU is +.
b. Q is +, W is - , and DU is 0.
c. Q is +, W is 0, and DU is +.
d. Q is - , W is 0, and DU is - .

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

Chapter 13—Vibrations and Waves

MULTIPLE CHOICE

1. The SI base units for spring constant are which of the following?

a. $kg \times s^2$
b. kg/m^2
c. kg/s^2
d. $kg \times m^2$

ANS: C PTS: 1 DIF: 1 TOP: 13.1 Hooke's Law

2. A large spring requires a force of 150 N to compress it only 0.010 m. What is the spring constant of the spring?

a. 125 000 N/m
b. 15 000 N/m
c. 15 N/m
d. 1.5 N/m

ANS: B PTS: 1 DIF: 1 TOP: 13.1 Hooke's Law

3. A 0.20-kg object is attached to a spring with spring constant k = 10 N/m and moves with simple harmonic motion over a horizontal frictionless surface. At the instant that it is displaced from equilibrium by - 0.050 m, what is its acceleration?

a. 1 000 m/s^2
b. - 40 m/s^2
c. 0.1 m/s^2
d. 2.5 m/s^2

ANS: D PTS: 1 DIF: 2 TOP: 13.1 Hooke's Law

4. Tripling the weight suspended vertically from a coil spring will result in a change in the displacement of the spring's lower end by what factor?

a. 0.33
b. 1.0
c. 3.0
d. 9.0

ANS: C PTS: 1 DIF: 1 TOP: 13.1 Hooke's Law

5. Tripling the displacement from equilibrium of an object in simple harmonic motion will bring about a change in the magnitude of the object's acceleration by what factor?

a. 0.33
b. 1.0
c. 3.0
d. 9.0

ANS: C PTS: 1 DIF: 1 TOP: 13.1 Hooke's Law

6. A tiny spring, with a spring constant of 1.20 N/m, will be stretched to what displacement by a 0.005 0-N force?

a.	4.2 mm
b.	6.0 mm
c.	7.2 mm
d.	9.4 mm

ANS: A PTS: 1 DIF: 1 TOP: 13.1 Hooke's Law

7. A mass of 0.40 kg, attached to a spring with a spring constant of 80 N/m, is set into simple harmonic motion. What is the magnitude of the acceleration of the mass when at its maximum displacement of 0.10 m from the equilibrium position?

a.	zero
b.	5 m/s^2
c.	10 m/s^2
d.	20 m/s^2

ANS: D PTS: 1 DIF: 2 TOP: 13.1 Hooke's Law

8. A mass of 4.0 kg, resting on a horizontal frictionless surface, is attached on the right to a horizontal spring with spring constant 20 N/m and on the left to a horizontal spring with spring constant 50 N/m. If this system is moved from equilibrium, what is the effective spring constant?

a.	30 N/m
b.	- 30 N/m
c.	70 N/m
d.	14 N/m

ANS: C PTS: 1 DIF: 3 TOP: 13.1 Hooke's Law

9. Suppose there is an object for which $F = +kx$. What will happen if the object is moved away from equilibrium ($x = 0$) and released?

a.	It will return to the equilibrium position.
b.	It will move further away with constant velocity.
c.	It will move further away with constant acceleration.
d.	It will move further away with increasing acceleration.

ANS: D PTS: 1 DIF: 2 TOP: 13.1 Hooke's Law

10. Which is not an example of approximate simple harmonic motion?

a.	A ball bouncing on the floor.
b.	A child swinging on a swing.
c.	A piano string that has been struck.
d.	A car's radio antenna as it waves back and forth.

ANS: A PTS: 1 DIF: 1 TOP: 13.1 Hooke's Law

11. If it takes 4.0 N to stretch a spring 6.0 cm and if the spring is then cut in half, what force does it take to stretch one of the halves 3.0 cm?

a. 2.0 N
b. 4.0 N
c. 8.0 N
d. 16 N

ANS: B PTS: 1 DIF: 2 TOP: 13.1 Hooke's Law

12. Three identical springs each have the same spring constant *k*. If these three springs are attached end to end forming a spring three times the length of one of the original springs, what will be the spring constant of the combination?

a. k
b. $3\ k$
c. $k/3$
d. $1.73\ k$

ANS: C PTS: 1 DIF: 2 TOP: 13.1 Hooke's Law

13. Two springs, each with spring constant 20 N/m, are connected in parallel, and the combination is hung vertically from one end. A 10-N weight is then suspended from the other end of the combined spring. How far does the combined spring stretch as it comes to equilibrium?

a. 0.50 m
b. 1.0 m
c. 2.0 m
d. 0.25 m

ANS: D PTS: 1 DIF: 2 TOP: 13.1 Hooke's Law

14. Two springs, each with spring constant *k*, are attached end to end in a series fashion. A second pair of identical springs are also attached in series fashion. Then the pair of series attached springs are attached in parallel to each other. What is the effective spring constant of the resulting combination of springs?

a. $k/2$
b. $2k$
c. either $k/4$ or $4k$
d. k

ANS: D PTS: 1 DIF: 3 TOP: 13.1 Hooke's Law

15. Spring #1 has spring constant 60 N/m. Spring #2 has an unknown spring constant, but when connected in series with Spring #1, the connected springs have an effective force constant of 20 N/m. What is the spring constant for Spring #2?

a. 40 N/m
b. 90 N/m
c. 50 N/m
d. 30 N/m

ANS: D PTS: 1 DIF: 2 TOP: 13.1 Hooke's Law

16. A 0.20-kg object is oscillating on a spring with a spring constant of $k = 15$ N/m. What is the potential energy of the system when the object displacement is 0.040 m, exactly half the maximum amplitude?

a.□zero
b.□0.006 0 J
c.□0.012 J
d.□2.5 J

ANS: C PTS: 1 DIF: 2 TOP: 13.2 Elastic Potential Energy

17. A 0.20 kg object, attached to a spring with spring constant k = 10 N/m, is moving on a horizontal frictionless surface in simple harmonic motion of amplitude of 0.080 m. What is its speed at the instant when its displacement is 0.040 m? (Hint: Use conservation of energy.)

a.□9.8 m/s
b.□4.9 m/s
c.□49 cm/s
d.□24.5 cm/s

ANS: C PTS: 1 DIF: 2 TOP: 13.2 Elastic Potential Energy

18. A mass of 0.40 kg, hanging from a spring with a spring constant of 80 N/m, is set into an up-and-down simple harmonic motion. What is the speed of the mass when moving through the equilibrium point? The starting displacement from equilibrium is 0.10 m.

a.□zero
b.□1.4 m/s
c.□2.0 m/s
d.□3.4 m/s

ANS: B PTS: 1 DIF: 2 TOP: 13.2 Elastic Potential Energy

19. A mass of 0.40 kg, hanging from a spring with a spring constant of 80 N/m, is set into an up-and-down simple harmonic motion. What is the speed of the mass when moving through a point at 0.05 m displacement? The starting displacement of the mass is 0.10 m from its equilibrium position.

a.□zero
b.□1.4 m/s
c.□1.7 m/s
d.□1.2 m/s

ANS: D PTS: 1 DIF: 2 TOP: 13.2 Elastic Potential Energy

20. A runaway railroad car, with mass 30 ´ 10^4 kg, coasts across a level track at 2.0 m/s when it collides with a spring-loaded bumper at the end of the track. If the spring constant of the bumper is 2.0 ´ 10^6 N/m, what is the maximum compression of the spring during the collision? (Assume the collision is elastic.)

a.□0.77 m
b.□0.58 m
c.□0.34 m
d.□1.07 m

ANS: A PTS: 1 DIF: 2 TOP: 13.2 Elastic Potential Energy

21. A 0.20-kg mass is oscillating on a spring over a horizontal frictionless surface. When it is at a displacement of 2.6 cm for equilibrium it has a kinetic energy of 1.4 J and a spring potential energy of 2.2 J. What is the maximum speed of the mass during its oscillation?

a.□3.7 m/s
b.□4.7 m/s
c.□6.0 m/s
d.□6.3 m/s

ANS: C PTS: 1 DIF: 2 TOP: 13.2 Elastic Potential Energy

22. A 0.20-kg block rests on a frictionless level surface and is attached to a horizontally aligned spring with a spring constant of 40 N/m. The block is initially displaced 4.0 cm from the equilibrium point and then released to set up a simple harmonic motion. What is the speed of the block when it passes through the equilibrium point?

a.□2.1 m/s
b.□1.6 m/s
c.□1.1 m/s
d.□0.57 m/s

ANS: D PTS: 1 DIF: 2 TOP: 13.2 Elastic Potential Energy

23. A 0.20-kg block rests on a frictionless level surface and is attached to a horizontally aligned spring with a spring constant of 40 N/m. The block is initially displaced 4.0 cm from the equilibrium point and then released to set up a simple harmonic motion. A frictional force of 0.3 N exists between the block and surface. What is the speed of the block when it passes through the equilibrium point after being released from the 4.0-cm displacement point?

a.□0.45 m/s
b.□0.63 m/s
c.□0.80 m/s
d.□1.2 m/s

ANS: A PTS: 1 DIF: 3 TOP: 13.2 Elastic Potential Energy

24. The oxygen molecule (O_2) may be regarded as two masses connected by a spring. In vibrational motion, each oxygen atom alternately approaches, then moves away from the center of mass of the system. If each oxygen atom of mass $m = 2.67 \times 10^{-26}$ kg has a vibrational energy of 1.6×10^{-21} J and the effective spring constant is 50 N/m, then what is the amplitude of oscillation of each oxygen atom?

a.□3.2×10^{-11} m
b.□1.6×10^{-11} m
c.□1.1×10^{-11} m
d.□8.0×10^{-12} m

ANS: D PTS: 1 DIF: 2 TOP: 13.2 Elastic Potential Energy

25. Suppose a 0.3-kg mass on a spring that has been compressed 0.10 m has elastic potential energy of 1 J. What is the spring constant?

a.□10 N/m
b.□20 N/m
c.□200 N/m
d.□300 N/m

ANS: C PTS: 1 DIF: 2 TOP: 13.2 Elastic Potential Energy

26. Suppose a 0.3-kg mass on a spring that has been compressed 0.10 m has elastic potential energy of 1.0 J. How much further must the spring be compressed to triple the elastic potential energy?

a. 0.30 m
b. 0.20 m
c. 0.17 m
d. 0.07 m

ANS: D PTS: 1 DIF: 2 TOP: 13.2 Elastic Potential Energy

27. Suppose a 0.30-kg mass on a spring-loaded gun that has been compressed 0.10 m has elastic potential energy of 1.0 J. How high above the spring's equilibrium point can the gun fire the mass if the gun is fired straight up?

a. 0.10 m
b. 0.34 m
c. 0.24 m
d. 10 m

ANS: C PTS: 1 DIF: 2 TOP: 13.2 Elastic Potential Energy

28. An ore car of mass 4 000 kg rolls downhill on tracks from a mine. At the end of the tracks, 10.0 m lower in elevation, is a spring with k = 400 000 N/m. How much is the spring compressed in stopping the ore car? Ignore friction.

a. 0.14 m
b. 0.56 m
c. 1.40 m
d. 1.96 m

ANS: C PTS: 1 DIF: 2 TOP: 13.2 Elastic Potential Energy

29. An object is attached to a spring and its frequency of oscillation is measured. Then another object is connected to the first object, and the resulting mass is four times the original value. By what factor is the frequency of oscillation changed?

a. 1/4
b. 1/2
c. 1/16
d. 4

ANS: B PTS: 1 DIF: 2
TOP: 13.3 Comparing Simple Harmonic Motion with Uniform Circular Motion

30. By what factor must one change the weight suspended vertically from a spring coil in order to triple its period of simple harmonic motion?

a. 1/9
b. 0.33
c. 3.0
d. 9.0

ANS: D PTS: 1 DIF: 2
TOP: 13.3 Comparing Simple Harmonic Motion with Uniform Circular Motion

31. Which one of the following quantities is at a maximum when an object in simple harmonic motion is at its maximum displacement?

a.	speed
b.	acceleration
c.	kinetic energy
d.	frequency

ANS: B PTS: 1 DIF: 1
TOP: 13.3 Comparing Simple Harmonic Motion with Uniform Circular Motion

32. I attach a 2.0-kg block to a spring that obeys Hooke's Law and supply 16 J of energy to stretch the spring. I release the block; it oscillates with period 0.30 s. The amplitude is:

a.	38 cm.
b.	19 cm.
c.	9.5 cm.
d.	4.3 cm.

ANS: B PTS: 1 DIF: 3
TOP: 13.3 Comparing Simple Harmonic Motion with Uniform Circular Motion

33. A mass on a spring vibrates in simple harmonic motion at a frequency of 4.0 Hz and an amplitude of 8.0 cm. If the mass of the object is 0.20 kg, what is the spring constant?

a.	40 N/m
b.	87 N/m
c.	126 N/m
d.	160 N/m

ANS: C PTS: 1 DIF: 2
TOP: 13.3 Comparing Simple Harmonic Motion with Uniform Circular Motion

34. For a mass suspended on a spring in the vertical direction, the time for one complete oscillation will depend on:

a.	the value for *g* (the acceleration due to gravity).
b.	the distance the mass was originally pulled down.
c.	the maximum speed of the oscillating mass.
d.	the time doesn't depend on any of the above.

ANS: D PTS: 1 DIF: 1
TOP: 13.3 Comparing Simple Harmonic Motion with Uniform Circular Motion

35. A car with bad shocks bounces up and down with a period of 1.50 s after hitting a bump. The car has a mass of 1 500 kg and is supported by four springs of force constant *k*. What is *k* for each spring?

a.	6 580 N/m
b.	5 850 N/m
c.	4 440 N/m
d.	3 630 N/m

ANS: A PTS: 1 DIF: 2
TOP: 13.3 Comparing Simple Harmonic Motion with Uniform Circular Motion

36. A mass on a spring vibrates in simple harmonic motion at a frequency of 4.0 Hz and an amplitude of 4.0 cm. If a timer is started when its displacement is a maximum (hence x = 4 cm when t = 0), what is the speed of the mass when t = 3 s?

a.	zero
b.	0.006 5 m/s
c.	0.015 m/s
d.	0.024 m/s

ANS: A PTS: 1 DIF: 2
TOP: 13.4 Position, Velocity, and Acceleration as a Function of Time

37. A mass on a spring vibrates in simple harmonic motion at a frequency of 4.0 Hz and an amplitude of 4.0 cm. If a timer is started when its displacement is a maximum (hence x = 4 cm when t = 0), what is the acceleration magnitude when t = 3 s?

a.	zero
b.	8.13 m/s^2
c.	14.3 m/s^2
d.	25.3 m/s^2

ANS: D PTS: 1 DIF: 2
TOP: 13.4 Position, Velocity, and Acceleration as a Function of Time

38. A mass on a spring vibrates in simple harmonic motion at a frequency of 4.0 Hz and an amplitude of 8.0 cm. If a timer is started when its displacement is a maximum (hence x = 8 cm when t = 0), what is the displacement of the mass when t = 3.7 s?

a.	zero
b.	0.025 m
c.	0.036 m
d.	0.080 m

ANS: B PTS: 1 DIF: 3
TOP: 13.4 Position, Velocity, and Acceleration as a Function of Time

39. An object moving in simple harmonic motion has an amplitude of 0.020 m and a maximum acceleration of 40 m/s^2. What is the frequency of the system?

a.	0.60 Hz
b.	51 Hz
c.	7.1 Hz
d.	16 Hz

ANS: C PTS: 1 DIF: 2
TOP: 13.4 Position, Velocity, and Acceleration as a Function of Time

40. Consider the curve $x = A \sin(kt)$, with $A > 0$. At which point on the graph is it possible that $t = 0$?

a.	Point t_1
b.	Point t_2

c. Point t_3
d. Point t_4

ANS: C PTS: 1 DIF: 1
TOP: 13.4 Position, Velocity, and Acceleration as a Function of Time

41. The motion of a piston in an automobile engine is nearly simple harmonic. If the 1-kg piston travels back and forth over a total distance of 10.0 cm, what is its maximum speed when the engine is running at 3 000 rpm?

a. 31.4 m/s
b. 15.7 m/s
c. 7.85 m/s
d. 3.93 m/s

ANS: B PTS: 1 DIF: 3
TOP: 13.4 Position, Velocity, and Acceleration as a Function of Time

42. The position of a 0.64-kg mass undergoing simple harmonic motion is given by x = (0.160 m) cos (pt/16). What is its period of oscillation?

a. 100 s
b. 32 s
c. 16 s
d. 8.0 s

ANS: B PTS: 1 DIF: 2
TOP: 13.4 Position, Velocity, and Acceleration as a Function of Time

43. The position of a 0.64-kg mass undergoing simple harmonic motion is given by x = (0.160 m) cos (pt/16). What is the maximum net force on the mass as it oscillates?

a. 3.9 ´ 10^{-3} N
b. 9.9 ´ 10^{-3} N
c. 1.3 ´ 10^{-3} N
d. 6.3 N

ANS: A PTS: 1 DIF: 3
TOP: 13.4 Position, Velocity, and Acceleration as a Function of Time

44. The position of a 0.64-kg mass undergoing simple harmonic motion is given by x = (0.160 m) cos (pt/16). What is its position at t = 5.0 s?

a. 0.160 m
b. 0.159 m
c. 0.113 m
d. 0.089 m

ANS: D PTS: 1 DIF: 2
TOP: 13.4 Position, Velocity, and Acceleration as a Function of Time

45. The kinetic energy of the bob on a simple pendulum swinging in simple harmonic motion has its maximum value when the displacement from equilibrium is at what point in its swing?

a. zero displacement

b. 1/4 the amplitude
c. 1/2 the amplitude
d. equal the amplitude

ANS: A PTS: 1 DIF: 1 TOP: 13.5 Motion of a Pendulum

46. If one could transport a simple pendulum of constant length from the Earth's surface to the Moon's, where the acceleration due to gravity is one-sixth (1/6) that on the Earth, by what factor would the pendulum frequency be changed?

a. about 6.0
b. about 2.5
c. about 0.41
d. about 0.17

ANS: C PTS: 1 DIF: 2 TOP: 13.5 Motion of a Pendulum

47. Tripling the mass of the bob on a simple pendulum will cause a change in the frequency of the pendulum swing by what factor?

a. 0.33
b. 1.0
c. 3.0
d. 9.0

ANS: B PTS: 1 DIF: 1 TOP: 13.5 Motion of a Pendulum

48. By what factor should the length of a simple pendulum be changed if the period of vibration were to be tripled?

a. 1/9
b. 0.33
c. 3.0
d. 9.0

ANS: D PTS: 1 DIF: 2 TOP: 13.5 Motion of a Pendulum

49. A simple pendulum has a period of 2.0 s. What is the pendulum length? ($g = 9.8$ m/s^2)

a. 0.36 m
b. 0.78 m
c. 0.99 m
d. 2.4 m

ANS: C PTS: 1 DIF: 2 TOP: 13.5 Motion of a Pendulum

50. A simple pendulum of length 1.00 m has a mass of 100 g attached. It is drawn back 30.0° and then released. What is the maximum speed of the mass?

a. 1.14 m/s
b. 3.13 m/s
c. 2.21 m/s
d. 1.62 m/s

ANS: D PTS: 1 DIF: 2 TOP: 13.5 Motion of a Pendulum

51. A simple pendulum has a mass of 0.25 kg and a length of 1.0 m. It is displaced through an angle of 30° and then released. After a time, the maximum angle of swing is only 10°. How much energy has been lost to friction?

a. 0.29 J
b. 0.65 J
c. 0.80 J
d. 1.0 J

ANS: A PTS: 1 DIF: 3 TOP: 13.5 Motion of a Pendulum

52. When car shock absorbers wear out and lose their damping ability, what is the resulting oscillating behavior?

a. underdamped
b. critically damped
c. overdamped
d. hyperdamped

ANS: A PTS: 1 DIF: 1
TOP: 13.6 Damped Oscillations | 13.7 Waves | 13.8 Frequency, Amplitude, and Wavelength

53. For a wave on the ocean, the amplitude is:

a. the distance between crests.
b. the height difference between a crest and a trough.
c. one half the height difference between a crest and a trough.
d. how far the wave goes up on the beach.

ANS: C PTS: 1 DIF: 1
TOP: 13.6 Damped Oscillations | 13.7 Waves | 13.8 Frequency, Amplitude, and Wavelength

54. As a gust of wind blows across a field of grain, a wave can be seen to move across the field as the tops of the plants sway back and forth. This wave is a:

a. transverse wave.
b. longitudinal wave.
c. polarized wave.
d. interference of waves.

ANS: B PTS: 1 DIF: 1
TOP: 13.8 Frequency, Amplitude, and Wavelength

55. Which of the following is an example of a longitudinal wave?

a. sound wave in air
b. wave traveling in a string
c. both a and b
d. neither a nor b

ANS: A PTS: 1 DIF: 1
TOP: 13.6 Damped Oscillations | 13.7 Waves | 13.8 Frequency, Amplitude, and Wavelength

56. If the frequency of a traveling wave train is increased by a factor of three in a medium where the speed is constant, which of the following is the result?

a. amplitude is one third as big
b. amplitude is tripled
c. wavelength is one third as big
d. wavelength is tripled

ANS: C PTS: 1 DIF: 2
TOP: 13.6 Damped Oscillations | 13.7 Waves | 13.8 Frequency, Amplitude, and Wavelength

57. The wavelength of a traveling wave can be calculated if one knows the:

a. frequency.
b. speed and amplitude.
c. amplitude and frequency.
d. frequency and speed.

ANS: D PTS: 1 DIF: 1
TOP: 13.6 Damped Oscillations | 13.7 Waves | 13.8 Frequency, Amplitude, and Wavelength

58. A traveling wave train has wavelength 0.50 m, speed 20 m/s. Find the wave frequency.

a. 0.025 Hz
b. 20 Hz
c. 40 Hz
d. 10 Hz

ANS: C PTS: 1 DIF: 1
TOP: 13.6 Damped Oscillations | 13.7 Waves | 13.8 Frequency, Amplitude, and Wavelength

59. A musical tone, sounded on a piano, has a frequency of 410 Hz and a wavelength in air of 0.800 m. What is the wave speed?

a. 170 m/s
b. 235 m/s
c. 328 m/s
d. 587 m/s

ANS: C PTS: 1 DIF: 1
TOP: 13.6 Damped Oscillations | 13.7 Waves | 13.8 Frequency, Amplitude, and Wavelength

60. If a radio wave has speed 3.00×10^8 m/s and frequency 94.7 MHz, what is its wavelength?

a. 8.78 m
b. 1.20 m
c. 2.50 m
d. 3.17 m

ANS: D PTS: 1 DIF: 1
TOP: 13.6 Damped Oscillations | 13.7 Waves | 13.8 Frequency, Amplitude, and Wavelength

61. Consider the curve $f(x) = A\cos(2\pi x/\lambda)$. The wavelength of the wave will be:

a. the distance *0* to *A*.
b. twice the distance *0* to *A*.
c. the distance x_2 to x_3.
d. twice the distance x_2 to x_3.

ANS: D PTS: 1 DIF: 2
TOP: 13.6 Damped Oscillations | 13.7 Waves | 13.8 Frequency, Amplitude, and Wavelength

62. Bats can detect small objects such as insects that are of a size approximately that of one wavelength. If bats emit a chirp at a frequency of 60 kHz, and the speed of sound waves in air is 330 m/s, what is the smallest size insect they can detect?

a. 1.5 mm
b. 3.5 mm
c. 5.5 mm
d. 7.5 mm

ANS: C PTS: 1 DIF: 2
TOP: 13.6 Damped Oscillations | 13.7 Waves | 13.8 Frequency, Amplitude, and Wavelength

63. Waves propagate at 8.0 m/s along a stretched string. The end of the string is vibrated up and down once every 1.5 s. What is the wavelength of the waves that travel along the string?

a. 3.0 m
b. 12 m
c. 6.0 m
d. 5.3 m

ANS: B PTS: 1 DIF: 2
TOP: 13.6 Damped Oscillations | 13.7 Waves | 13.8 Frequency, Amplitude, and Wavelength

64. An earthquake emits both P-waves and S-waves that travel at different speeds through the Earth. A P-wave travels at 8 000 m/s and an S-wave at 4 000 m/s. If P-waves are received at a seismic station 30.0 s before an S-wave arrives, how far is the station from the earthquake center?

a. 2 420 km
b. 1 210 km
c. 240 km
d. 120 km

ANS: C PTS: 1 DIF: 2
TOP: 13.6 Damped Oscillations | 13.7 Waves | 13.8 Frequency, Amplitude, and Wavelength

65. A long string is pulled so that the tension in it increases by a factor of three. If the change in length is negligible, by what factor does the wave speed change?

a. 3.0
b. 1.7
c. 0.58
d. 0.33

ANS: B PTS: 1 DIF: 2
TOP: 13.9 The Speed of Waves on Strings

66. What is the phase difference when two waves, traveling in the same medium, undergo constructive interference?

a. 270°
b. 180°
c. 90°
d. 0°

ANS: D PTS: 1 DIF: 1
TOP: 13.9 The Speed of Waves on Strings

67. Tripling both the tension in a guitar string and its mass per unit length will result in changing the wave speed in the string by what factor?

a. 0.58
b. 1.00 (i.e., no change)
c. 1.73
d. 3.00

ANS: B PTS: 1 DIF: 2
TOP: 13.9 The Speed of Waves on Strings

68. Tripling the mass per unit length of a guitar string will result in changing the wave speed in the string by what factor?

a. 0.58
b. 1.00 (i.e., no change)
c. 1.73
d. 3.00

ANS: A PTS: 1 DIF: 2
TOP: 13.9 The Speed of Waves on Strings

69. A 2.0-m long piano string of mass 10 g is under a tension of 338 N. Find the speed with which a wave travels on this string.

a. 130 m/s
b. 260 m/s
c. 520 m/s
d. 1 040 m/s

ANS: B PTS: 1 DIF: 2
TOP: 13.9 The Speed of Waves on Strings

70. Transverse waves travel with a speed of 200 m/s along a taut copper wire that has a diameter of 1.50 mm. What is the tension in the wire? (The density of copper is 8.93 g/cm^3.)

a. 1 890 N
b. 1 260 N
c. 631 N
d. 315 N

ANS: C PTS: 1 DIF: 3
TOP: 13.9 The Speed of Waves on Strings

71. For a wave traveling in a string, by what factor would the tension need to be increased to double the wave speed?

a.	1.4
b.	2.0
c.	4.0
d.	16

ANS: C PTS: 1 DIF: 2
TOP: 13.9 The Speed of Waves on Strings

72. A wave is traveling in a string at 60 m/s. When the tension is then increased 20%, what will be the resulting wave speed?

a.	also 60 m/s
b.	66 m/s
c.	72 m/s
d.	55 m/s

ANS: B PTS: 1 DIF: 3
TOP: 13.9 The Speed of Waves on Strings

73. A wave travels in a string at 60 m/s. A second string of 20% greater linear density has the same tension applied as in the first string. What will be the resulting wave speed in the second string?

a.	also 60 m/s
b.	66 m/s
c.	72 m/s
d.	55 m/s

ANS: D PTS: 1 DIF: 3
TOP: 13.9 The Speed of Waves on Strings

74. A string is strung horizontally with a fixed tension. A wave of frequency 100 Hz is sent along the string, and it has a wave speed of 50.0 m/s. Then a second wave, one of frequency 200 Hz, is sent along the string. What is the wave speed of the second wave?

a.	25.0 m/s
b.	50.0 m/s
c.	70.7 m/s
d.	100 m/s

ANS: B PTS: 1 DIF: 2
TOP: 13.9 The Speed of Waves on Strings

75. The superposition principle has to do with which of the following?

a.	effects of waves at great distances
b.	the ability of some waves to move very far
c.	how displacements of interacting waves add together
d.	relativistic wave behavior

ANS: C PTS: 1 DIF: 1
TOP: 13.10 Interference of Waves | 13.11 Reflection of Waves

76. Equal wavelength waves of amplitude 0.25 m and 0.15 m interfere with one another. What is the resulting minimum amplitude that can result?

a. 0.15 m
b. 0.10 m
c. 0 m
d. - 0.40 m

ANS: B PTS: 1 DIF: 2
TOP: 13.10 Interference of Waves | 13.11 Reflection of Waves

77. If a wave pulse is reflected from a free boundary, which of the following choices best describes what happens to the reflected pulse?

a. becomes inverted
b. remains upright
c. halved in amplitude
d. doubled in amplitude

ANS: B PTS: 1 DIF: 1
TOP: 13.10 Interference of Waves | 13.11 Reflection of Waves

78. Consider two identical and symmetrical wave pulses on a string. Suppose the first pulse reaches the fixed end of the string and is reflected back and then meets the second pulse. When the two pulses overlap exactly, the superposition principle predicts that the amplitude of the resultant pulses, at that moment, will be what factor times the amplitude of one of the original pulses?

a. 0
b. 1
c. 2
d. 4

ANS: A PTS: 1 DIF: 2
TOP: 13.10 Interference of Waves | 13.11 Reflection of Waves

79. Two water waves meet at the same point, one having a displacement above equilibrium of 60 cm and the other having a displacement above equilibrium of 80 cm. At this moment, what is the resulting displacement above equilibrium?

a. 140 cm
b. 100 cm
c. 70 cm
d. Information about the amplitudes needs to be given to find an answer.

ANS: A PTS: 1 DIF: 2
TOP: 13.10 Interference of Waves | 13.11 Reflection of Waves

80. A mass-spring system on a horizontal frictionless surface is set in simple harmonic motion with amplitude A. The mass is then doubled and the system is again set into simple harmonic motion with the same amplitude. Which of the following is true about the total mechanical energy of the system due to doubling the mass?

a.	It has doubled.
b.	It has quadrupled.
c.	It has halved.
d.	It has not changed.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Problems

81. If a long spring with spring constant *k* is cut into 4 equal lengths, what is the spring constant of each of the 4 shorter springs?

a.	It is still *k*.
b.	It is *k*/4.
c.	It is 4 *k*.
d.	It is *k*/16.

ANS: C PTS: 1 DIF: 1 TOP: Conceptual Problems

82. When an object is moving in simple harmonic motion, which of the following is at a minimum when the displacement from equilibrium is zero?

a.	the magnitude of the velocity
b.	the magnitude of the acceleration
c.	the kinetic energy
d.	the total mechanical energy

ANS: B PTS: 1 DIF: 1 TOP: Conceptual Problems

83. A pendulum on the Earth has a period *T*. The acceleration of due to gravity on Mars is less than that on the Earth, and the acceleration due to gravity on the Moon is even less. Where would the period of an identical pendulum be the least?

a.	on the Earth
b.	on the Moon
c.	on Mars
d.	The period of a pendulum would be the same on the Earth, Moon, and Mars since the period depends on the pendulum's length which is the same for identical pendula.

ANS: A PTS: 1 DIF: 2 TOP: Conceptual Problems

84. Two identical springs, each with spring constant *k*, are attached in parallel to a mass, which is then set into simple harmonic motion. What would be the spring constant of a single spring which would result in the same frequency of oscillation as the parallel springs?

a.	*k*
b.	2*k*
c.	*k*/2
d.	

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Problems

Chapter 14—Sound

MULTIPLE CHOICE

1. When a sine wave is used to represent a sound wave, the crest corresponds to:

a. rarefaction.
b. condensation.
c. point where molecules vibrate at a right angle to the direction of wave travel.
d. region of low elasticity.

ANS: B PTS: 1 DIF: 1
TOP: 14.1 Producing a Sound Wave

2. A sound wave coming from a tuba has a wavelength of 1.50 m and travels to your ears at a speed of 345 m/s. What is the frequency of the sound you hear?

a. 517 Hz
b. 1/517 Hz
c. 230 Hz
d. 1/230 Hz

ANS: C PTS: 1 DIF: 1
TOP: 14.1 Producing a Sound Wave

3. A series of ocean waves, 5.0 m between crests, move past at 2.0 waves/s. Find their speed.

a. 2.5 m/s
b. 5.0 m/s
c. 8.0 m/s
d. 10 m/s

ANS: D PTS: 1 DIF: 1
TOP: 14.1 Producing a Sound Wave

4. Consider a vibrating string that makes a sound wave that moves through the air. As the guitar string moves up and down, the air molecules that are a certain horizontal distance from the string will move:

a. up and down.
b. toward and away from the guitar string.
c. back and forth along the direction of the length of the string.
d. in circles around the guitar string.

ANS: B PTS: 1 DIF: 1
TOP: 14.1 Producing a Sound Wave

5. When a sound wave moves through a medium such as air, the motion of the molecules of the medium is in what direction (with respect to the motion of the sound wave)?

a. perpendicular
b. parallel
c. anti-parallel (in opposite direction)

d. Both choices b and c are valid.

ANS: D PTS: 1 DIF: 1
TOP: 14.2 Characteristics of Sound Waves

6. Which of the following ranges corresponds to the longest wavelengths?

a. infrasonic
b. audible
c. ultrasonic
d. all have the same wavelengths

ANS: A PTS: 1 DIF: 1
TOP: 14.2 Characteristics of Sound Waves

7. The frequency separating audible waves and ultrasonic waves is considered to be 20 kHz. What wavelength in air at room temperature is associated with this frequency? (Assume the speed of sound to be 340 m/s.)

a. 1.7 cm
b. 5.2 cm
c. 34 cm
d. 55 cm

ANS: A PTS: 1 DIF: 2
TOP: 14.2 Characteristics of Sound Waves

8. Assuming that the wave speed varies little when sound waves are traveling though a material that suddenly changes density by 10%, what percentage of the incident wave intensity is reflected?

a. < 1%
b. 5%
c. 10%
d. 20%

ANS: A PTS: 1 DIF: 2
TOP: 14.2 Characteristics of Sound Waves

9. A relatively new medical device that uses ultrasonics is referred to by the acronym CUSA. What does the letter A stand for?

a. aspirator
b. accumulator
c. array
d. audible

ANS: A PTS: 1 DIF: 1
TOP: 14.2 Characteristics of Sound Waves

10. A sound wave is traveling toward a boundary where the density of the medium decreases by 10%. What percent of the wave intensity is transmitted through the boundary?

a. 22
b. 47
c. 53

d. 78

ANS: D PTS: 1 DIF: 2
TOP: 14.2 Characteristics of Sound Waves

11. The speed of sound in air is a function of which one of the following?

a. wavelength
b. frequency
c. temperature
d. amplitude

ANS: C PTS: 1 DIF: 1 TOP: 14.3 The Speed of Sound

12. The speed of sound at 0°C is 331 m/s. What is the speed of sound at 25°C? (0°C = 273 K)

a. 346 m/s
b. 356 m/s
c. 343 m/s
d. 350 m/s

ANS: A PTS: 1 DIF: 2 TOP: 14.3 The Speed of Sound

13. The density of a certain metal solid is 7.2×10^3 kg/m^3, and its Young's modulus is 10×10^{10} N/m^2. What is the speed of sound in this metal?

a. 1.4×10^7 m/s
b. 5 900 m/s
c. 3 700 m/s
d. 3 000 m/s

ANS: C PTS: 1 DIF: 2 TOP: 14.3 The Speed of Sound

14. How far away is a lightning strike if you hear the thunderclap 3.00 s after you see the lightning bolt strike? (v_{sound} = 340 m/s, $v_{light} = 3 \times 10^8$ m/s)

a. 113 m
b. 340 m
c. 680 m
d. 1 020 m

ANS: D PTS: 1 DIF: 2 TOP: 14.3 The Speed of Sound

15. A sound wave in air has a frequency of 500 Hz and a wavelength of 0.68 m. What is the air temperature?

a. - 18°C
b. 0°C
c. 15°C
d. 27°C

ANS: C PTS: 1 DIF: 2 TOP: 14.3 The Speed of Sound

16. Comparing the speed of sound in liquids, gases, and solids, the speed of sound is usually lowest in ____ and highest in ____.

a. solids, liquids

b.	gases, liquids
c.	liquids, solids
d.	gases, solids

ANS: D PTS: 1 DIF: 1 TOP: 14.3 The Speed of Sound

17. Tripling the power output from a speaker emitting a single frequency will result in what increase in loudness?

a.	0.33 dB
b.	3.0 dB
c.	4.8 dB
d.	9.0 dB

ANS: C PTS: 1 DIF: 2
TOP: 14.4 Energy and Intensity of Sound Waves

18. What is the intensity level of a sound with intensity of 5.0×10^{-10} W/m^2? ($I_0 = 10^{-12}$ W/m^2)

a.	74 dB
b.	54 dB
c.	2.7 dB
d.	27 dB

ANS: D PTS: 1 DIF: 2
TOP: 14.4 Energy and Intensity of Sound Waves

19. What is the intensity of a sound with a measured intensity level of 84 dB? ($I_0 = 10^{-12}$ W/m^2)

a.	8.4×10^{-3} W/m^2
b.	2.5×10^{-4} W/m^2
c.	1.2×10^{-5} W/m^2
d.	7.4×10^{-4} W/m^2

ANS: B PTS: 1 DIF: 2
TOP: 14.4 Energy and Intensity of Sound Waves

20. If one-third of the members of a symphony orchestra are absent because of head colds, thus reducing the overall intensity of sound by 33%, what will be the reduction in the decibel level?

a.	30 dB
b.	3 dB
c.	48 dB
d.	1.7 dB

ANS: D PTS: 1 DIF: 2
TOP: 14.4 Energy and Intensity of Sound Waves

21. If $I_0 = 10^{-12}$ W/m^2 is the threshold of hearing, a sound with intensity $I_1 = 10^{-11}$ W/m^2 will give a certain decibel level. Suppose a new sound has an intensity $I_2 = I_1^2/I_0$. What is the new decibel level?

a.	2.0
b.	20
c.	100
d.	it will square the decibel level

ANS: B PTS: 1 DIF: 2
TOP: 14.4 Energy and Intensity of Sound Waves

22. If the intensity of a sound is increased by a factor of 100, how is the decibel level changed? The new decibel level will be:

a.	two units greater.
b.	double the old one.
c.	ten times greater.
d.	twenty units greater.

ANS: D PTS: 1 DIF: 2
TOP: 14.4 Energy and Intensity of Sound Waves

23. What is the intensity of sound from a band with a sound level of 120 dB? ($I_0 = 10^{-12}$ W/m^2)

a.	1 W/m^2
b.	1.2 W/m^2
c.	10 W/m^2
d.	12 W/m^2

ANS: A PTS: 1 DIF: 2
TOP: 14.4 Energy and Intensity of Sound Waves

24. In the afternoon, the decibel level of a busy freeway is 80 dB with 100 cars passing a given point every minute. Late at night, the traffic flow is only 5 cars per minute. What is the late-night decibel level?

a.	77 dB
b.	74 dB
c.	70 dB
d.	68 dB

ANS: D PTS: 1 DIF: 3
TOP: 14.4 Energy and Intensity of Sound Waves

25. What sound level change corresponds to a factor of two change in intensity?

a.	0.5 dB
b.	2 dB
c.	3 dB
d.	5 dB

ANS: C PTS: 1 DIF: 2
TOP: 14.4 Energy and Intensity of Sound Waves

26. Tripling the distance between sound source and a listener will change the intensity, as detected by the listener, by what factor?

a.	1/9
b.	0.33
c.	3.0
d.	9.0

ANS: A PTS: 1 DIF: 1
TOP: 14.5 Spherical and Plane Waves

27. If the distance between a point sound source and a dB detector is increased by a factor of 4, what will be the reduction in intensity level?

a.	16 dB
b.	12 dB
c.	4 dB
d.	0.5 dB

ANS: B PTS: 1 DIF: 2
TOP: 14.5 Spherical and Plane Waves

28. The intensity level of sound 20 m from a jet airliner is 120 dB. At what distance from the airplane will the sound intensity level be a tolerable 100 dB? (Assume spherical spreading of sound.)

a.	90 m
b.	120 m
c.	150 m
d.	200 m

ANS: D PTS: 1 DIF: 2
TOP: 14.5 Spherical and Plane Waves

29. A very loud train whistle has an acoustic power output of 100 W. If the sound energy spreads out spherically, what is the intensity level in dB at a distance of 100 meters from the train? ($I_0 = 10^{-12}$ W/m^2)

a.	78.3 dB
b.	81.6 dB
c.	89.0 dB
d.	95.0 dB

ANS: C PTS: 1 DIF: 3
TOP: 14.5 Spherical and Plane Waves

30. By what amount does the sound intensity decrease when the distance to the source doubles?

a.	1.4 dB
b.	2.0 dB
c.	4.0 dB
d.	6.0 dB

ANS: D PTS: 1 DIF: 2
TOP: 14.5 Spherical and Plane Waves

31. A train station bell gives off a fundamental tone of 500 Hz as the train approaches the station at a speed of 20 m/s. If the speed of sound in air is 335 m/s, what will be the apparent frequency of the bell to an observer riding the train?

a.	532 Hz
b.	530 Hz
c.	470 Hz
d.	472 Hz

ANS: B PTS: 1 DIF: 2 TOP: 14.6 The Doppler Effect

32. You stand by the railroad tracks as a train passes by. You hear a 1 000-Hz frequency when the train approaches, which changes to 800 Hz as it goes away. How fast is the train moving? The speed of sound in air is 340 m/s.

a.	15.7 m/s
b.	21.2 m/s
c.	28.0 m/s
d.	37.8 m/s

ANS: D PTS: 1 DIF: 3 TOP: 14.6 The Doppler Effect

33. A sound source of frequency 1 000 Hz moves at 50.0 m/s toward a listener who is at rest. What is the apparent frequency heard by the listener? (speed of sound = 340 m/s)

a.	853 Hz
b.	872 Hz
c.	1 150 Hz
d.	1 170 Hz

ANS: D PTS: 1 DIF: 2 TOP: 14.6 The Doppler Effect

34. A 500-Hz whistle is moved toward a listener at a speed of 10.0 m/s. At the same time, the listener moves at a speed of 20.0 m/s in a direction away from the whistle. What is the apparent frequency heard by the listener? (The speed of sound is 340 m/s.)

a.	473 Hz
b.	485 Hz
c.	533 Hz
d.	547 Hz

ANS: B PTS: 1 DIF: 3 TOP: 14.6 The Doppler Effect

35. As a train starts from rest and then accelerates down the track, coming toward me faster and faster, the speed of the sound waves coming toward me will be:

a.	slower than the normal speed of sound in air.
b.	equal to the normal speed of sound in air.
c.	some constant speed faster than the normal speed of sound in air.
d.	faster and faster.

ANS: B PTS: 1 DIF: 1 TOP: 14.6 The Doppler Effect

36. An airplane flying with a constant speed flies from a warm air mass into a cold air mass. The Mach number will:

a.	increase.
b.	decrease.
c.	stay the same.
d.	become unstable.

ANS: A PTS: 1 DIF: 2 TOP: 14.6 The Doppler Effect

37. While standing at a crosswalk, you hear a frequency of 560 Hz from an approaching police car. After the police car passes, its frequency is 480 Hz. What is the speed of the police car? (speed of sound = 340 m/s)

a.□13.1 m/s
b.□17.4 m/s
c.□21.1 m/s
d.□26.2 m/s

ANS: D PTS: 1 DIF: 3 TOP: 14.6 The Doppler Effect

38. A bat, flying at 5.00 m/s toward a wall, emits a chirp at 50.0 kHz. If the wall reflects this sound pulse, what is the frequency of the echo received by the bat? (v_{sound} = 340 m/s)

a.□51.5 kHz
b.□51.2 kHz
c.□40.8 kHz
d.□50.5 kHz

ANS: A PTS: 1 DIF: 3 TOP: 14.6 The Doppler Effect

39. The Doppler shift of ultrasonic waves can measure the speed of blood in an artery. If the frequency of the stationary source is 100 kHz and the reflected sound has a Doppler shift of 200 Hz, what is the blood flow speed? (The speed of sound inside the body is 1 500 m/s.)

a.□1.0 m/s
b.□1.5 m/s
c.□2.2 m/s
d.□3.3 m/s

ANS: B PTS: 1 DIF: 3 TOP: 14.6 The Doppler Effect

40. Two cars, one in front of the other, are traveling down the highway at 25 m/s. The car behind sounds its horn, which has a frequency of 500 Hz. What is the frequency heard by the driver of the lead car? (v_{sound} = 340 m/s)

a.□463 Hz
b.□540 Hz
c.□579 Hz
d.□500 Hz

ANS: D PTS: 1 DIF: 2 TOP: 14.6 The Doppler Effect

41. A plane is traveling at Mach 0.950 through air at a temperature of 0°C. What is the plane's speed? (Speed of sound at 0°C is 331 m/s.)

a.□314 m/s
b.□331 m/s
c.□348 m/s
d.□Mach number is undefined at 0°C.

ANS: A PTS: 1 DIF: 1 TOP: 14.6 The Doppler Effect

42. A phase difference of 270° corresponds to what wavelength difference?

a.□3l
b.□3l /2
c.□3l /4
d.□4l /3

ANS: C PTS: 1 DIF: 2
TOP: 14.7 Interference of Sound Waves

43. When two sound waves are out of phase by ____, destructive interference will occur.

a.	90°
b.	270°
c.	540°
d.	720°

ANS: C PTS: 1 DIF: 2
TOP: 14.7 Interference of Sound Waves

44. Two loudspeakers are placed next to each other and driven by the same source at 500 Hz. A listener is positioned in front of the two speakers and on the line separating them, thus creating a constructive interference at the listener's ear. What minimum distance would one of the speakers be moved back away from the listener to produce destructive interference at the listener's ear? (The speed of sound = 340 m/s.)

a.	1.36 m
b.	0.68 m
c.	0.34 m
d.	0.17 m

ANS: C PTS: 1 DIF: 2
TOP: 14.7 Interference of Sound Waves

45. Two loudspeakers are placed side by side and driven by the same source at 500 Hz. A listener is positioned in front of the two speakers and on the line separating them, thus creating a constructive interference at the listener's ear. If one of the speakers is gradually pushed toward the listener, how far must it be moved to repeat the condition of constructive interference at the listener's ear? (The speed of sound = 340 m/s.)

a.	1.02 m
b.	0.68 m
c.	0.34 m
d.	0.17 m

ANS: B PTS: 1 DIF: 2
TOP: 14.7 Interference of Sound Waves

46. When I stand halfway between two speakers, with one on my left and one on my right, a musical note from the speakers gives me constructive interference. How far to my left should I move to obtain destructive interference?

a.	one-fourth of a wavelength
b.	half a wavelength
c.	one wavelength
d.	one and a half wavelengths

ANS: A PTS: 1 DIF: 2
TOP: 14.7 Interference of Sound Waves

47. If the tension on a guitar string is increased by a factor of 3, the fundamental frequency at which it vibrates is changed by what factor?

a. 9
b. 3
c.
d.

ANS: C PTS: 1 DIF: 2 TOP: 14.8 Standing Waves

48. Doubling the tension in a guitar string will change its natural frequency by what factor?

a. 0.71
b. 1.0
c. 1.4
d. 2.0

ANS: C PTS: 1 DIF: 2 TOP: 14.8 Standing Waves

49. If I triple the mass per unit length of guitar string, its natural frequency changes by what factor?

a. 0.58
b. 1.0
c. 1.7
d. 3.0

ANS: A PTS: 1 DIF: 2 TOP: 14.8 Standing Waves

50. The lower A on a piano has a frequency of 27.5 Hz. If the tension in the 2.0-m-long string is 304 N and one-half wavelength occupies the string, what is the mass of the string?

a. 100 g
b. 25 g
c. 37 g
d. 50 g

ANS: D PTS: 1 DIF: 3 TOP: 14.8 Standing Waves

51. If a guitar string has a fundamental frequency of 500 Hz, what is the frequency of its second overtone?

a. 250 Hz
b. 750 Hz
c. 1 000 Hz
d. 1 500 Hz

ANS: D PTS: 1 DIF: 2 TOP: 14.8 Standing Waves

52. A 100-m-long high-voltage cable is suspended between two towers. The mass of the 100-m cable is 150 kg. If the tension in the cable is 30 000 N, what is the lowest frequency at which this cable can oscillate?

a. 0.71 Hz
b. 1.0 Hz
c. 1.4 Hz
d. 2.0 Hz

ANS: A PTS: 1 DIF: 2 TOP: 14.8 Standing Waves

53. A standing wave is set up in a 200-cm string fixed at both ends. The string vibrates in 5 distinct segments when driven by a 120-Hz source. What is the wavelength?

a. 10 cm
b. 20 cm
c. 40 cm
d. 80 cm

ANS: D PTS: 1 DIF: 2 TOP: 14.8 Standing Waves

54. A 1.5-m string is held fixed at both ends. When driven by a 180-Hz source, the string vibrates in 4 distinct segments. What is the natural fundamental frequency of the string?

a. 45 Hz
b. 90 Hz
c. 240 Hz
d. 600 Hz

ANS: A PTS: 1 DIF: 2 TOP: 14.8 Standing Waves

55. A standing wave is set up in a 2.0-m string fixed at both ends. The string vibrates in 5 distinct segments when driven by a 120-Hz source. In how many distinct standing wave segments will the string vibrate if the tension is increased by a factor of 4?

a. 3
b. 10
c. 20
d. No standing wave pattern occurs.

ANS: D PTS: 1 DIF: 3 TOP: 14.8 Standing Waves

56. For a standing wave on a string the wavelength must equal:

a. the distance between adjacent nodes.
b. the distance between adjacent antinodes.
c. twice the distance between adjacent nodes.
d. the distance between supports.

ANS: C PTS: 1 DIF: 2 TOP: 14.8 Standing Waves

57. I stretch a rubber band and "plunk" it to make it vibrate in its fundamental frequency. I then stretch it to twice its length and make it vibrate in the fundamental frequency once again. The rubber band is made so that doubling its length doubles the tension and reduces the mass per unit length by a factor of 2. The new frequency will be related to the old by a factor of:

a. 1.0.
b. 1.4.
c. 2.0.
d. 4.0.

ANS: A PTS: 1 DIF: 3 TOP: 14.8 Standing Waves

58. A C note (f = 256 Hz) is sounded on a piano. If the length of the piano wire is 1.00 m and its mass density is 2.50 g/m, what is the tension in the wire?

a. 84 N
b. 168 N
c. 655 N

d. 1 280 N

ANS: C PTS: 1 DIF: 2 TOP: 14.8 Standing Waves

59. A child sits on a swing supported by ropes of length 3.0 m. With what frequency will she need to apply the driving force to maintain swinging?

a. 0.29 Hz
b. 0.48 Hz
c. 2.1 Hz
d. 3.5 Hz

ANS: A PTS: 1 DIF: 2
TOP: 14.9 Forced Vibrations and Resonance

60. A 2.50-m-long organ pipe is open at one end and closed at the other. Its fundamental tone has wavelength:

a. 1.25 m.
b. 5.00 m.
c. 10.0 m.
d. 16.25 m.

ANS: C PTS: 1 DIF: 2
TOP: 14.10 Standing Waves in Air Columns

61. What is the lowest frequency that will resonate in an organ pipe 2.00 m in length, closed at one end? The speed of sound in air is 340 m/s.

a. 42.5 Hz
b. 85.0 Hz
c. 170 Hz
d. 680 Hz

ANS: A PTS: 1 DIF: 2
TOP: 14.10 Standing Waves in Air Columns

62. When the standing wave pattern in a pipe is NANA, the pipe has which of the following set of properties? (N stands for node, A for antinode.)

a. It is open at both ends.
b. It is closed at both ends.
c. It is open at one end and closed at the other end.
d. Any of the above could be true.

ANS: C PTS: 1 DIF: 2
TOP: 14.10 Standing Waves in Air Columns

63. What is the first overtone frequency for an organ pipe 2.00 m in length, closed at one end? The speed of sound in air is 340 m/s.

a. 42.5 Hz
b. 85.0 Hz
c. 128 Hz

d. 680 Hz

ANS: C PTS: 1 DIF: 2
TOP: 14.10 Standing Waves in Air Columns

64. A tuning fork is sounded above a resonating tube (one end closed), which resonates at a length of 0.200 m and again at 0.600 m. What is the frequency of the fork when the speed of sound is taken to be 340 m/s?

a. 567 Hz
b. 425 Hz
c. 1 700 Hz
d. 950 Hz

ANS: B PTS: 1 DIF: 3
TOP: 14.10 Standing Waves in Air Columns

65. A tuning fork is sounded above a resonating tube (one end closed), which resonates at a length of 0.20 m and again at 0.60 m. If the tube length were extended further, at what point will the tuning fork again create a resonance condition?

a. 0.8 m
b. 1.0 m
c. 1.2 m
d. 1.6 m

ANS: B PTS: 1 DIF: 2
TOP: 14.10 Standing Waves in Air Columns

66. For a standing wave in an air column in a pipe that is open at both ends, there must be at least:

a. one node and one antinode.
b. two nodes and one antinode.
c. two antinodes and one node.
d. two nodes and two antinodes.

ANS: C PTS: 1 DIF: 2
TOP: 14.10 Standing Waves in Air Columns

67. If two adjacent frequencies of an organ pipe closed at one end are 550 Hz and 650 Hz, what is the length of the organ pipe? (v_{sound} = 340 m/s)

a. 0.85 m
b. 1.25 m
c. 1.50 m
d. 1.70 m

ANS: D PTS: 1 DIF: 2
TOP: 14.10 Standing Waves in Air Columns

68. A flute behaves like a tube open at both ends. If its length is 65.3 cm, and the speed of sound is 340 m/s, what is its fundamental frequency in Hz?

a. 130 Hz
b. 159 Hz
c. 212 Hz

d. 260 Hz

ANS: D PTS: 1 DIF: 2
TOP: 14.10 Standing Waves in Air Columns

69. The air in a tube open at both ends is sent into its fundamental resonance. One end of the tube is then closed and the air column is again set into its fundamental resonance. The resonant frequency ____ after the end is closed.

a. halves
b. stays the same
c. doubles
d. increases by a factor of 1.4

ANS: A PTS: 1 DIF: 2
TOP: 14.10 Standing Waves in Air Columns

70. What phenomenon is created by two tuning forks, side by side, emitting frequencies, which differ by only a small amount?

a. resonance
b. interference
c. the Doppler effect
d. beats

ANS: D PTS: 1 DIF: 1 TOP: 14.11 Beats

71. Two vibrating tuning forks, held side by side, will create a beat frequency of what value if the individual frequencies of the two forks are 342 Hz and 345 Hz, respectively?

a. 687 Hz
b. 343.5 Hz
c. 339 Hz
d. 3 Hz

ANS: D PTS: 1 DIF: 1 TOP: 14.11 Beats

72. A vibrating guitar string emits a tone simultaneously with one from a 500-Hz tuning fork. If a beat frequency of 5 Hz results, what is the frequency of vibration of the string?

a. 2 500 Hz
b. 505 Hz
c. 495 Hz
d. Either choice b or c is valid.

ANS: D PTS: 1 DIF: 1 TOP: 14.11 Beats

73. Two tuning forks sounding together result in a beat frequency of 3 Hz. If the frequency of one of the forks is 256 Hz, what is the frequency of the other?

a. 262 Hz or 250 Hz
b. 105 Hz
c. 259 Hz or 253 Hz
d. 85 Hz

ANS: C PTS: 1 DIF: 1 TOP: 14.11 Beats

74. The number of overtones, and their relative intensities, is associated with what property of the tone generated by a musical instrument?

a. quality
b. interference pattern
c. range
d. attack pattern

ANS: A PTS: 1 DIF: 1 TOP: 14.12 Quality of Sound

75. The term "timbre" refers to which of the following?

a. Any musical instrument made primarily of wood.
b. The quality of sound from instruments due to the mixture of harmonics.
c. Instruments that have valves.
d. An instrument made in France.

ANS: B PTS: 1 DIF: 1 TOP: 14.12 Quality of Sound

76. Of the frequencies listed below, to which one is the human ear most sensitive?

a. 33 Hz
b. 330 Hz
c. 3 300 Hz
d. 33 000 Hz

ANS: C PTS: 1 DIF: 1 TOP: 14.13 The Ear

77. In which part of the ear is the cochlea?

a. outer ear
b. middle ear
c. inner ear
d. ear canal

ANS: C PTS: 1 DIF: 1 TOP: 14.13 The Ear

78. Which of the following best describes a sound level of intensity 1 W/m^2?

a. extremely loud
b. about that of a power mower
c. normal conversation
d. like a whisper

ANS: A PTS: 1 DIF: 1 TOP: Conceptual Problems

79. How far away is a lightning bolt if it takes 10 s for the sound of the associated thunder to reach the observer?

a. 1 mile
b. 2 miles
c. 5 miles
d. 10 miles

ANS: B PTS: 1 DIF: 1 TOP: Conceptual Problems

80. If the air temperature decreases, how does the resonant frequency in a pipe closed at one end change?

a.	It increases.
b.	It decreases.
c.	It doesn't change since one end of the pipe is closed.
d.	It doesn't change because resonance is pressure phenomenon.

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Problems

81. A buzzer with frequency f_0 is thrown straight upwards. On the buzzer's trip down, what is the frequency behavior heard by an observer below?

a.	The frequency heard is still f_0.
b.	The frequency is a constant one greater than f_0.
c.	The frequency is an increasing one greater than f_0.
d.	The frequency is a decreasing one less than f_0.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Problems

82. The air in a pipe resonates at 150 Hz and 750 Hz, one of these resonances being the fundamental. If the pipe is open at both ends, how many resonances are between the two given ones, and if the pipe is closed at one end, how many resonances are between the two given ones?

a.	open: 3; closed: 1
b.	open: 1; closed: 3
c.	open: 2; closed: 0
d.	open: 0; closed: 2

ANS: A PTS: 1 DIF: 2 TOP: Conceptual Problems

CHAPTER 15—Electric Forces and Electric Fields

MULTIPLE CHOICE

1. Doug rubs a piece of fur on a hard rubber rod, giving the rod a negative charge. What happens?
   a. Protons are removed from the rod.
   b. Electrons are added to the rod.
   c. The fur is also charged negatively.
   d. The fur is left neutral.

   ANS: B PTS: 1 DIF: 1
   TOP: 15.1 Properties of Electric Charges

2. A repelling force must occur between two charged objects under which conditions?
   a. Charges are of unlike signs.
   b. Charges are of like signs.
   c. Charges are of equal magnitude.
   d. Charges are of unequal magnitude.

   ANS: B PTS: 1 DIF: 1
   TOP: 15.1 Properties of Electric Charges

3. When a glass rod is rubbed with silk, which of the following statements best describes what happens?
   a. Electrons are removed from the rod.
   b. Protons are removed from the silk.
   c. The silk is charged positively.
   d. The silk remains neutral.

   ANS: A PTS: 1 DIF: 1
   TOP: 15.1 Properties of Electric Charges

4. A metallic object holds a charge of -3.8×10^{-6} C. What total number of electrons does this represent? ($e = 1.6 \times 10^{-19}$ C is the magnitude of the electronic charge.)
   a. 4.2×10^{14}
   b. 6.1×10^{13}
   c. 2.4×10^{13}
   d. 1.6×10^{14}

   ANS: C PTS: 1 DIF: 2
   TOP: 15.1 Properties of Electric Charges

5. When charging two objects by rubbing them together:
   a. Neither may be a conductor.
   b. They must be made of different material.
   c. They will sometimes end up with both being positively charged.
   d. The heat produced by friction is a necessary part of this process.

   ANS: B PTS: 1 DIF: 1
   TOP: 15.1 Properties of Electric Charges

6. About how many electrons are in 30 grams of water (H_2O)?
   a. 10^{25}
   b. 10^{23}
   c. 10^{21}

d. 10^{19}

ANS: A PTS: 1 DIF: 3
TOP: 15.1 Properties of Electric Charges

7. Who was the first to determine the electron's charge?
   a. Franklin
   b. Coulomb
   c. Millikan
   d. Faraday

ANS: C PTS: 1 DIF: 1
TOP: 15.1 Properties of Electric Charges

8. An uncharged conductor is supported by an insulating stand. I pass a positively charged rod near the left end of the conductor, but do not touch it. The right end of the conductor will be:
   a. negative.
   b. positive.
   c. neutral.
   d. attracted.

ANS: B PTS: 1 DIF: 1
TOP: 15.2 Insulators and Conductors

9. Of the following substances, which one contains the highest density of free electrons?
   a. hard rubber
   b. iron
   c. amber
   d. glass

ANS: B PTS: 1 DIF: 1
TOP: 15.2 Insulators and Conductors

10. Which of the following best characterizes electrical conductors?
    a. low mass density
    b. high tensile strength
    c. electric charges move freely
    d. poor heat conductors

ANS: C PTS: 1 DIF: 1
TOP: 15.2 Insulators and Conductors

11. Which of the following best characterizes electrical insulators?
    a. charges on the surface don't move
    b. high tensile strength
    c. electric charges move freely
    d. good heat conductors

ANS: A PTS: 1 DIF: 1
TOP: 15.2 Insulators and Conductors

12. If body M, with a positive charge, is used to charge body N by induction, what will be the nature of the charge left on the latter?
    a. must be equal in magnitude to that on M
    b. must be negative
    c. must be positive

d. must be greater in magnitude than that on M

ANS: B PTS: 1 DIF: 2
TOP: 15.2 Insulators and Conductors

13. If body P, with a positive charge, is placed in contact with body Q (initially uncharged), what will be the nature of the charge left on Q?
    a. must be equal in magnitude to that on P
    b. must be negative
    c. must be positive
    d. must be greater in magnitude than that on P

ANS: C PTS: 1 DIF: 1
TOP: 15.2 Insulators and Conductors

14. I wish to use a positively charged rod to charge a ball by induction. Which statement is correct?
    a. The charge on the ball will be positive.
    b. The ball must be a conductor.
    c. The ball must be an insulator that is connected temporarily to the ground.
    d. The ball is charged as the area of contact between the two increases.

ANS: B PTS: 1 DIF: 1
TOP: 15.2 Insulators and Conductors

15. How can a charged object attract an uncharged object made of non-conducting material?
    a. The uncharged object must somehow gain a like charge.
    b. The uncharged object must somehow gain an unlike charge.
    c. The charges in the uncharged object can become polarized.
    d. Attraction of an insulator is not possible.

ANS: C PTS: 1 DIF: 1
TOP: 15.2 Insulators and Conductors

16. Two point charges are 4 cm apart. They are moved to a new separation of 2 cm. By what factor does the resulting mutual force between them change?
    a. 1/2
    b. 2
    c. 1/4
    d. 4

ANS: D PTS: 1 DIF: 1 TOP: 15.3 Coulomb’s Law

17. If the distance between two point charges is tripled, the mutual force between them will be changed by what factor?
    a. 9.0
    b. 3.0
    c. 0.33
    d. 1/9

ANS: D PTS: 1 DIF: 1 TOP: 15.3 Coulomb’s Law

18. If the size of the charge value is tripled for both of two point charges maintained at a constant separation, the mutual force between them will be changed by what factor?
    a. 9.0
    b. 3.0
    c. 0.33

d. 1/9

ANS: A PTS: 1 DIF: 1 TOP: 15.3 Coulomb's Law

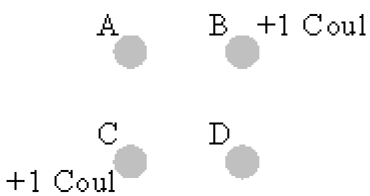
19. The constant k_e, which appears in Coulomb's law formula, is equivalent dimensionally to which of the following?
a. $N \cdot m/C$
b. N/C
c. $N \cdot m^2/C^2$
d. N/C^2

ANS: C PTS: 1 DIF: 1 TOP: 15.3 Coulomb's Law

20. Two point charges, separated by 1.5 cm, have charge values of +2.0 and - 4.0 μC, respectively. What is the value of the mutual force between them? ($k_e = 8.99 \times 10^9$ $N \cdot m^2/C^2$)
a. 320 N
b. 3.6×10^{-8} N
c. 8.0×10^{-12} N
d. 3.1×10^{-3} N

ANS: A PTS: 1 DIF: 2 TOP: 15.3 Coulomb's Law

21. Four charges are at the corners of a square, with B and C on opposite



corners. Charges A and D, on the other two corners, have equal charge, while both B and C have a charge of +1.0 C. What is the charge on A so that the force on B is zero?
a. - 1.0 C
b. - 0.50 C
c. - 0.35 C
d. - 0.71 C

ANS: C PTS: 1 DIF: 3 TOP: 15.3 Coulomb's Law

22. Charge A and charge B are 3.00 m apart, and charge A is +2.00 C and charge B is +3.00 C. Charge C is located between them at a certain point and the force on charge C is zero. How far from charge A is charge C?
a. 0.555 m
b. 0.667 m
c. 1.35 m
d. 1.50 m

ANS: C PTS: 1 DIF: 3 TOP: 15.3 Coulomb's Law

23. The beam of electrons that hits the screen of an oscilloscope is moved up and down by:
a. gravity.
b. a phosphorescent coating.
c. varying the electron's charge.
d. electrical charges on deflecting plates.

ANS: D PTS: 1 DIF: 1 TOP: 15.3 Coulomb's Law

24. In a thundercloud there may be an electric charge of +40 C near the top of the cloud and - 40 C near the bottom of the cloud. These charges are separated by about 2.0 km. What is the electric force between these two sets of charges? ($k_e = 8.99 \times 10^{9}$ N·m^2/C^2)
a. 3.6×10^{4} N
b. 3.6×10^{5} N
c. 3.6×10^{6} N
d. 3.6×10^{7} N

ANS: C PTS: 1 DIF: 2 TOP: 15.3 Coulomb's Law

25. An electron is sent at high speed toward a gold nucleus (charge +79*e*). What is the electrical force acting on the electron when it is 3.0×10^{-14} m away from the gold nucleus? ($e = 1.6 \times 10^{-19}$ C, $k_e = 8.99 \times 10^{9}$ N·m^2/C^2)
a. 20 N
b. 0.25 N
c. 2.0×10^{-4} N
d. 2.1×10^{-6} N

ANS: A PTS: 1 DIF: 2 TOP: 15.3 Coulomb's Law

26. Two electrons are separated by one cm. What is the ratio of the electric force to the gravitational force between them? ($m_e = 9.11 \times 10^{-31}$ kg, $k_e = 8.99 \times 10^{9}$ N·m^2/C^2, G = 6.67×10^{-11} N·m^2/kg^2, and $e = 1.6 \times 10^{-19}$ C)
a. 2.3×10^{2}
b. 1.3×10^{20}
c. 3.1×10^{22}
d. 4.2×10^{42}

ANS: D PTS: 1 DIF: 2 TOP: 15.3 Coulomb's Law

27. Two equal charges, each Q, are separated by some distance. What third charge would need to be placed half way between the two charges so that the net force on each charge would be zero?
a. - Q
b. - Q/2
c. - Q/4
d. - Q/8

ANS: C PTS: 1 DIF: 2 TOP: 15.3 Coulomb's Law

28. A 6.0 μC charge is placed at the origin and a second charge is placed on the x-axis at x = 0.30 m. If the resulting force on the second charge is 5.4 N in the positive x-direction, what is the value of its charge?
a. 9.0 μC
b. 9.0 nC
c. –9.0 μC
d. –9.0 nC

ANS: A PTS: 1 DIF: 2 TOP: 15.3 Coulomb's Law

29. A 6.00 μC charge is placed at the origin and a second charge is placed on the x-axis at x = 0.300 m. If the resulting force on the second charge is 6.40 N in the positive x-direction, what is the force on the charge at the origin?
a. 6.40 N in the positive x-direction
b. 6.40 N in the negative x-direction

c. 0 N
d. not able to be determined until the second charge is known

ANS: B PTS: 1 DIF: 2 TOP: 15.3 Coulomb's Law

30. Two point charges each have a value of 30.0 mC and are separated by a distance of 4.00 cm. What is the electric field midway between the two charges? ($k_e = 8.99 \times 10^9$ N·m^2/C^2)
a. 40.5×10^7 N/C
b. 20.3×10^7 N/C
c. 10.1×10^7 N/C
d. zero

ANS: D PTS: 1 DIF: 2 TOP: 15.4 The Electric Field

31. Two point charges are separated by 10.0 cm and have charges of +2.00 μC and - 2.00 μC, respectively. What is the electric field at a point midway between the two charges? ($k_e = 8.99 \times 10^9$ N·m^2/C^2)
a. 28.8×10^6 N/C
b. 14.4×10^6 N/C
c. 7.19×10^6 N/C
d. zero

ANS: B PTS: 1 DIF: 2 TOP: 15.4 The Electric Field

32. Electric field is dimensionally equivalent to which of the following?
a. N·m/C
b. N/C
c. N·m^2/C^2
d. N/C^2

ANS: B PTS: 1 DIF: 1 TOP: 15.4 The Electric Field

33. An electron with a charge value of 1.6×10^{-19} C is moving in the presence of an electric field of 400 N/C. What force does the electron experience?
a. 2.3×10^{-22} N
b. 1.9×10^{-21} N
c. 6.4×10^{-17} N
d. 4.9×10^{-17} N

ANS: C PTS: 1 DIF: 2 TOP: 15.4 The Electric Field

34. Charges of 4.0 μC and - 6.0 μC are placed at two corners of an equilateral triangle with sides of 0.10 m. At the third corner, what is the electric field magnitude created by these two charges? ($k_e = 8.99 \times 10^9$ N·m^2/C^2)
a. 4.5×10^6 N/C
b. 3.1×10^6 N/C
c. 1.6×10^6 N/C
d. 4.8×10^6 N/C

ANS: D PTS: 1 DIF: 3 TOP: 15.4 The Electric Field

35. The average distance of the electron from the proton in the hydrogen atom is 0.51×10^{-10} m. What is the electric field from the proton's charge at the location of the electron? ($k_e = 8.99 \times 10^9$ N·m^2/C^2, $e = 1.6 \times 10^{-19}$ C)
a. 5.5×10^{11} N/C

b. 1.0 ´ 10^6 N/C
c. 3.2 ´ 10^2 N/C
d. 8.8 ´ 10^{-8} N/C

ANS: A PTS: 1 DIF: 2 TOP: 15.4 The Electric Field

36. Two point charges are placed along a horizontal axis with the following values and positions: +3.0 μC at x = 0 cm and - 7.0 μC at x = 20 cm. At what point along the x axis is the electric field zero?
a. 8.0 cm
b. - 44 cm
c. - 69 cm
d. - 38 cm

ANS: D PTS: 1 DIF: 3 TOP: 15.4 The Electric Field

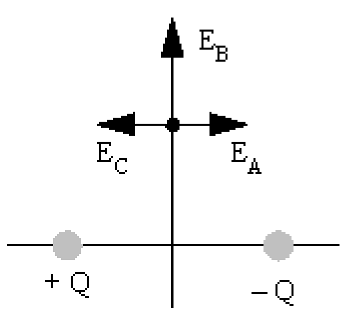
37. A proton initially moves left to right long the x axis at a speed of 2.00 ´ 10^3 m/s. It moves into an electric field, which points in the negative x direction, and travels a distance of 0.200 m before coming to rest. What acceleration magnitude does the proton experience?
a. 6.67 ´ 10^3 m/s^2
b. 1.00 ´ 10^7 m/s^2
c. 9.33 ´ 10^9 m/s^2
d. 2.67 ´ 10^{11}m/s^2

ANS: B PTS: 1 DIF: 2 TOP: 15.4 The Electric Field

38. A proton initially moves left to right long the x axis at a speed of 2.00 ´ 10^3 m/s. It moves into an electric field, which points in the negative x direction, and travels a distance of 0.200 m before coming to rest. If the proton's mass and charge are 1.67 ´ 10^{-27} kg and 1.60 ´ 10^{-19} C respectively, what is the magnitude of the electric field?
a. 28.3 N/C
b. 13.9 N/C
c. 0.104 N/C
d. 0.038 N/C

ANS: C PTS: 1 DIF: 2 TOP: 15.4 The Electric Field

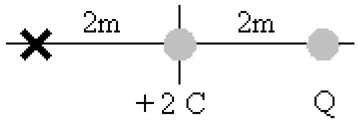
39. Two charges, +Q and - Q, are located two meters apart and there is a point along the line that is equidistant from the two charges as indicated. Which vector best represents the direction of the electric field at that point?



a. Vector E_A
b. Vector E_B
c. Vector E_C
d. The electric field at that point is zero.

ANS: A PTS: 1 DIF: 2 TOP: 15.4 The Electric Field

40. A charge of +2 C is at the origin. When charge Q is placed at 2 m along the positive x axis, the electric field at 2 m along the negative x axis becomes zero. What is the value of Q?



a. -3 C
b. -6 C
c. -7 C
d. -8 C

ANS: D PTS: 1 DIF: 2 TOP: 15.4 The Electric Field

41. An electron with a speed of 2.0×10^{6} m/s moves into a uniform electric field of 500 N/C that is parallel to the electron's motion. How long does it take to bring the electron to rest? ($m_e = 9.11 \times 10^{-31}$ kg, $e = 1.6 \times 10^{-19}$ C)
a. 2.3×10^{-8} s
b. 3.5×10^{-8} s
c. 1.2×10^{-7} s
d. 2.3×10^{-6} s

ANS: A PTS: 1 DIF: 2 TOP: 15.4 The Electric Field

42. In x-ray machines, electrons are subjected to electric fields as great as 6.0×10^{5} N/C. Find an electron's acceleration in this field. ($m_e = 9.11 \times 10^{-31}$ kg, $e = 1.6 \times 10^{-19}$ C)
a. 1.1×10^{17} m/s^2
b. 5.4×10^{13} m/s^2
c. 4.6×10^{10} m/s^2
d. 3.6×10^{8} m/s^2

ANS: A PTS: 1 DIF: 2 TOP: 15.4 The Electric Field

43. A proton moving at 3.0×10^{4} m/s is projected at an angle of 30° above a horizontal plane. If an electric field of 400 N/C is acting down, how long does it take the proton to return to the horizontal plane? (Hint: Ignore gravity. $m_{\text{proton}} = 1.67 \times 10^{-27}$ kg, $q_{\text{proton}} = 1.6 \times 10^{-19}$ C)
a. 7.8×10^{-7} s
b. 1.7×10^{-6} s
c. 3.9×10^{-6} s
d. 7.8×10^{-6} s

ANS: A PTS: 1 DIF: 3 TOP: 15.4 The Electric Field

44. An airplane is flying through a thundercloud at a height of 2 000 m. (This is a very dangerous thing to do because of updrafts, turbulence, and the possibility of electric discharge.) If there is a charge concentration of +40 C at height 3 000 m within the cloud and -40 C at height 1 000 m, what is the magnitude of the electric field E at the aircraft? ($k_e = 8.99 \times 10^{9}$ N·m^2/C^2)
a. 90 000 N/C
b. 180 000 N/C
c. 360 000 N/C
d. 720 000 N/C

ANS: D PTS: 1 DIF: 2 TOP: 15.4 The Electric Field

45. Electrons in a particle beam each have a kinetic energy of 3.2×10^{-17} J. What is the magnitude of the electric field that will stop these electrons in a distance of 0.1 m? ($e = 1.6 \times 10^{-19}$ C)
a. 200 N/C
b. 1 000 N/C
c. 2 000 N/C
d. 4 000 N/C

ANS: C PTS: 1 DIF: 2 TOP: 15.4 The Electric Field

46. The electric field in a cathode ray tube is supposed to accelerate electrons from 0 to 1.60×10^{7} m/s in a distance of 2.00 cm. What electric field is required? ($m_e = 9.11 \times 10^{-31}$ kg and $e = 1.60 \times 10^{-19}$ C)
a. 9 110 N/C
b. 18 200 N/C
c. 36 400 N/C
d. 72 800 N/C

ANS: C PTS: 1 DIF: 2 TOP: 15.4 The Electric Field

47. The electric field of a point charge has an inverse ________ behavior.
a. $r^{1/2}$
b. r
c. r^2
d. r^3

ANS: C PTS: 1 DIF: 1 TOP: 15.4 The Electric Field

48. The number of electric field lines passing through a unit cross sectional area is indicative of:
a. field direction.
b. charge density.
c. field strength.
d. charge motion.

ANS: C PTS: 1 DIF: 1 TOP: 15.5 Electric Field Lines

49. Two point charges, separated by 1.5 cm, have charge values of +2.0 and - 4.0 μC, respectively. Suppose we determine that 10 field lines radiate out from the +2.0-μC charge. If so, what might be inferred about the - 4.0-μC charge with respect to field lines?
a. 20 radiate out
b. 5 radiate out
c. 20 radiate in
d. 10 radiate in

ANS: C PTS: 1 DIF: 2 TOP: 15.5 Electric Field Lines

50. Charge A has 10 electric field lines coming out, Charge B has 20 lines coming out, and Charge C has 30 lines coming in. Which pair of these charges will have the largest force between them if placed one cm apart?
a. A and B
b. B and C
c. C and A
d. More information is needed.

ANS: B PTS: 1 DIF: 2 TOP: 15.5 Electric Field Lines

51. Q_1 has 50 electric field lines radiating outward and Q_2 has 100 field lines converging inward. What is the ratio Q_1/Q_2?
a. 2
b. - 2
c. 1/2
d. - 1/2

ANS: D PTS: 1 DIF: 2 TOP: 15.5 Electric Field Lines

52. Relative distribution of charge density on the surface of a conducting solid depends on:
a. the shape of the conductor.
b. mass density of the conductor.
c. type of metal of which the conductor is made.
d. strength of the earth's gravitational field.

ANS: A PTS: 1 DIF: 1
TOP: 15.6 Conductors in Electrostatic Equilibrium

53. The electric field at the surface of a positively charged conductor has a direction characterized by which of the following?
a. tangent to the surface
b. perpendicular inward toward the charge
c. at a 45° angle to the surface
d. perpendicular outward and away from the charge

ANS: D PTS: 1 DIF: 1
TOP: 15.6 Conductors in Electrostatic Equilibrium

54. The electric field associated with a uniformly charged hollow metallic sphere is the greatest at:
a. the center of the sphere.
b. the sphere’s inner surface.
c. infinity.
d. the sphere’s outer surface.

ANS: D PTS: 1 DIF: 1
TOP: 15.6 Conductors in Electrostatic Equilibrium

55. At what point is the charge per unit area greatest on the surface of an irregularly shaped conducting solid?
a. where surface curves inward
b. where surface is flat
c. where curvature is least
d. where curvature is greatest

ANS: D PTS: 1 DIF: 1
TOP: 15.6 Conductors in Electrostatic Equilibrium

56. An initially uncharged hollow metallic sphere with radius of 5 cm has a small object with a charge of +10 μC carefully placed at the center of the sphere through a hole in the latter’s surface. With the charge in place, what charge is now present on the outside surface of the sphere?
a. zero
b. - 10 μC
c. +4 000 μC
d. +10 μC

ANS: D PTS: 1 DIF: 2
TOP: 15.6 Conductors in Electrostatic Equilibrium

57. An initially uncharged hollow metallic sphere with radius of 5 cm has a small object with a charge of +10 μC carefully placed at the center of the sphere through a hole in the latter's surface. What charge resides inner surface of the sphere?
a. - 4 000 μC
b. - 10 μC
c. +10 μC
d. zero

ANS: B PTS: 1 DIF: 2
TOP: 15.6 Conductors in Electrostatic Equilibrium

58. We have an initially uncharged hollow metallic sphere with radius of 5.0 cm. I place a small object with a charge of +10 μC at the center of the sphere through a hole in the surface. Find the electric field present at a point 10 cm from the sphere's center. ($k_e = 8.99 \times 10^9$ N·m^2/C^2)
a. 1.1×10^6 N/C
b. 2.3×10^6 N/C
c. 9.0×10^6 N/C
d. 36×10^6 N/C

ANS: C PTS: 1 DIF: 2
TOP: 15.6 Conductors in Electrostatic Equilibrium

59. We have a hollow metallic sphere with charge - 5.0 μC and radius 5.0 cm. We insert a +10-μC charge at the center of the sphere through a hole in the surface. What charge now rests on the outer surface of the sphere?
a. +5 μC
b. +10 μC
c. +15 μC
d. - 5 μC

ANS: A PTS: 1 DIF: 3
TOP: 15.6 Conductors in Electrostatic Equilibrium

60. Two identical spheres each carry a charge of - 40.0 μC. The spheres are separated by a distance of 1.00 m. What is the electric force between the spheres? ($k_e = 8.99 \times 10^9$ N·m^2/C^2)
a. 28.8 N (repulsive)
b. 14.4 N (repulsive)
c. 7.19 N (attractive)
d. 43.2 N (attractive)

ANS: B PTS: 1 DIF: 2
TOP: 15.6 Conductors in Electrostatic Equilibrium

61. A ping-pong ball covered with a conducting graphite coating has a mass of 5.0×10^{-3} kg and a charge of 4.0 μC. What electric field directed upward will exactly balance the weight of the ball? (g = 9.8 m/s^2)
a. 8.2×10^2 N/C
b. 1.2×10^4 N/C
c. 2.0×10^{-7} N/C
d. 5.1×10^6 N/C

ANS: B PTS: 1 DIF: 2
TOP: 15.6 Conductors in Electrostatic Equilibrium

62. Two identical iron spheres have equal positive charges and the force between them when they are 1 m apart is 1 N. What percentage of the electrons has been removed from each sphere if each sphere has 1 mole (6×10^{23}) of iron atoms? ($k_e = 8.99 \times 10^9$ N·m^2/C^2, the atomic number of iron is 26, and the electron charge is -1.6×10^{-19} C)
a. 0.001%
b. 0.000 002%
c. 1×10^{-8} %
d. 4×10^{-10} %

ANS: D PTS: 1 DIF: 3
TOP: 15.6 Conductors in Electrostatic Equilibrium

63. Two identical balls have the same amount of charge, but the charge on ball A is positive and the charge on ball B is negative. The balls are placed on a smooth, level, frictionless table whose top is an insulator. Which of the following is true?
a. Since the force on A is equal but opposite to the force on B, they will not move.
b. They will move together with constant acceleration.
c. Since the force on both balls is negative, they will move in the negative direction.
d. None of the above is correct.

ANS: D PTS: 1 DIF: 2
TOP: 15.6 Conductors in Electrostatic Equilibrium

64. If a conductor is in electrostatic equilibrium near an electrical charge:
a. the total charge on the conductor must be zero.
b. the electric field inside the conductor must be zero.
c. any charges on the conductor must be uniformly distributed.
d. the sum of all forces between the conductor and the charge must be zero.

ANS: B PTS: 1 DIF: 1
TOP: 15.6 Conductors in Electrostatic Equilibrium

65. If a charge $+Q$ is placed inside a hollow isolated conductor that is originally neutral and the charge does not touch that conductor at any time:
a. the inside surface of the conductor will become positively charged.
b. the outside surface of the conductor will become positively charged.
c. both the inner and outer surfaces will remain neutral.
d. both the inner and outer surfaces will become negative.

ANS: B PTS: 1 DIF: 2
TOP: 15.6 Conductors in Electrostatic Equilibrium

66. A thin uncharged conducting spherical shell has a charge q carefully placed at its center through a small hole in the shell. The charge q does not touch the shell. What is the charge on the shell?
a. q
b. - q
c. 2q
d. 0

ANS: D PTS: 1 DIF: 1
TOP: 15.6 Conductors in Electrostatic Equilibrium

67. The combination of two separated point charges of opposite sign but equal magnitude is called an electric:
   a. monopole.
   b. dipole.
   c. quadrapole.
   d. magnapole.

   ANS: B PTS: 1 DIF: 1
   TOP: 15.6 Conductors in Electrostatic Equilibrium

68. The Millikan oil-drop experiment demonstrated that:
   a. small oil drops fall slowly through the air.
   b. light beams can be used to illuminate small oil droplets.
   c. the electronic charge is quantized.
   d. falling oil droplets reach terminal speed.

   ANS: C PTS: 1 DIF: 1
   TOP: 15.7 The Millikan Oil-Drop Experiment

69. In the Millikan oil-drop experiment it was found that oil droplets:
   a. could only have positive net charge.
   b. could only have negative net charge.
   c. could only have negative or zero net charge.
   d. could have positive, negative, or zero net charge.

   ANS: D PTS: 1 DIF: 1
   TOP: 15.7 The Millikan Oil-Drop Experiment

70. In Millikan's oil drop experiment, if the electric field between the plates was of just the right magnitude, it would exactly balance the weight of the drop. Suppose a tiny spherical oil droplet of radius 1.6×10^{-4} cm carries a charge equivalent to one electron. What electric field is required to balance the weight? (The density of oil is 0.85 g/cm^3, $e = 1.6 \times 10^{-19}$ C.)
   a. 1.1×10^5 N/C
   b. 2.2×10^5 N/C
   c. 4.5×10^5 N/C
   d. 8.9×10^5 N/C

   ANS: D PTS: 1 DIF: 2
   TOP: 15.7 The Millikan Oil-Drop Experiment

71. A charge Q accumulates on the hollow metallic dome, of radius R, of a Van de Graaff generator. A probe measures the electric field strength at various points outside the sphere surface. If the probe is initially at a distance $3R$ from the sphere's center and then is moved to $4R$, by what factor will the electric field reading change?
   a. $(4/3)^2$
   b. 4/3
   c. 3/4
   d. $(3/4)^2$

   ANS: D PTS: 1 DIF: 2
   TOP: 15.8 The Van de Graaff Generator

72. A charge Q accumulates on the hollow metallic dome, of radius R, of a Van de Graaff generator. A probe measures the electric field strength at various points outside the sphere surface. By what factor will the electric field value at the $2R$ distance be changed if the charge value were increased to $(4/3)Q$?

a. $(4/3)^2$
b. 4/3
c. 3/4
d. $(3/4)^2$

ANS: B PTS: 1 DIF: 2
TOP: 15.8 The Van de Graaff Generator

73. A Van de Graaff generator has a spherical dome of radius 20 cm. Operating in dry air, where "atmospheric breakdown" is at $E_{max} = 3.0 \times 10^6$ N/C, what is the maximum charge that can be held on the dome? ($k_e = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$)
a. 2.7×10^{-5} C
b. 1.3×10^{-5} C
c. 2.6×10^{-6} C
d. 1.2×10^{-6} C

ANS: B PTS: 1 DIF: 3
TOP: 15.8 The Van de Graaff Generator

74. A charge, +*Q*, is placed inside a balloon and the balloon is inflated. As the radius of the balloon *r* increases the number of field lines going through the surface of the balloon:
a. increases proportional to r^2.
b. increases proportional to *r*.
c. stays the same.
d. decreases as 1/*r*.

ANS: C PTS: 1 DIF: 1
TOP: 15.9 Electric Flux and Gauss's Law

75. A spherical volume of space has an electric field of intensity 100 N/C directed radially outward from it surface of radius 0.600 m. What is the net charge enclosed within this surface?
a. 6.8 nC
b. 4.0 nC
c. –6.8 nC
d. –4.0 nC

ANS: B PTS: 1 DIF: 1
TOP: 15.9 Electric Flux and Gauss's Law

76. A closed surface contains the following point charges: 6 C, 4 C, –2 C, –4 C. The electric flux coming out of the surface is:
a. 16 C/ϵ_o.
b. –16 C/ϵ_o.
c. 4 C/ϵ_o.
d. –4 C/ϵ_o.

ANS: C PTS: 1 DIF: 2
TOP: 15.9 Electric Flux and Gauss's Law

77. Object A has a charge *q* on it, object B has a charge *q* on it, and object C has a charge 2*q* on it. These charges are arranged, one each, at the vertices of an equilateral triangle. Which charge has the greatest magnitude electric force on it?
a. A
b. B
c. C

d. All have equal magnitude forces on them.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Questions

78. Three equal positive charges are placed on the x-axis, one at the origin, one at $x = 2$ m, and the third at $x = 4$ m. Of the following points, which has the greatest magnitude electric field?
a. $x = 1$ m
b. $x = 3$ m
c. $x = 5$ m
d. The electric field has the same magnitude at all three positions.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Questions

79. Charges q, q, and $-q$ are placed on the x-axis at $x = 0$, $x = 2$ m, and $x = 4$ m, respectively. At which of the following points does the electric field have the greatest magnitude?
a. $x = 1$ m
b. $x = 3$ m
c. $x = 5$ m
d. The electric field has the same magnitude at all three positions.

ANS: B PTS: 1 DIF: 3 TOP: Conceptual Questions

80. Two small objects are suspended from threads. When the objects are moved close together, they attract one another. Which of the following could produce this result?
a. One object is positively charged and the other is negatively charge.
b. One object is positively charged and the other is uncharged.
c. One object is negatively charged and the other is uncharged.
d. All of the above could result in such attraction.

ANS: D PTS: 1 DIF: 1 TOP: Conceptual Questions

81. A spherical surface surrounds a point charge it its center. If the charge is doubled and if the radius of the surface is also doubled, what happens to the electric flux F_E out of the surface and the magnitude E of the electric field at the surface as a result of these doublings?
a. F_E and E do not change.
b. F_E increases and E remains the same.
c. F_E increases and E decreases.
d. F_E increases and E increases.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Questions

CHAPTER 16—Electrical Energy and Capacitance

MULTIPLE CHOICE

1. An electron (charge -1.6×10^{-19} C) moves on a path perpendicular to the direction of a uniform electric field of strength 3.0 N/C. How much work is done on the electron as it moves 15 cm?
   a. 4.8×10^{-20} J
   b. -4.8×10^{-20} J
   c. 1.6×10^{-20} J
   d. zero

   ANS: D PTS: 1 DIF: 2
   TOP: 16.1 Potential Difference and Electric Potential

2. A proton ($+1.6 \times 10^{-19}$ C) moves 10 cm on a path in the direction of a uniform electric field of strength 3.0 N/C. How much work is done on the proton by the electrical field?
   a. 4.8×10^{-20} J
   b. -4.8×10^{-20} J
   c. 1.6×10^{-20} J
   d. zero

   ANS: A PTS: 1 DIF: 2
   TOP: 16.1 Potential Difference and Electric Potential

3. A proton ($+1.6 \times 10^{-19}$ C) moves 10 cm along the direction of an electric field of strength 3.0 N/C. The electrical potential difference between the proton's initial and ending points is:
   a. 4.8×10^{-19} V.
   b. 0.30 V.
   c. 0.033 V.
   d. 30 V.

   ANS: B PTS: 1 DIF: 2
   TOP: 16.1 Potential Difference and Electric Potential

4. A 9.0-V battery is connected between two parallel metal plates 4.0 mm apart. What is the magnitude of the electric field between the plates?
   a. 2.3×10^{3} N/C
   b. 9.0 N/C
   c. 2.3 N/C
   d. 0.75×10^{-6} N/C

   ANS: A PTS: 1 DIF: 1
   TOP: 16.1 Potential Difference and Electric Potential

5. If an electron is accelerated from rest through a potential difference of 1 200 V, find its approximate velocity at the end of this process. ($e = 1.6 \times 10^{-19}$ C; $m_e = 9.1 \times 10^{-31}$ kg)
   a. 1.0×10^{7} m/s
   b. 1.4×10^{7} m/s
   c. 2.1×10^{7} m/s
   d. 2.5×10^{7} m/s

   ANS: C PTS: 1 DIF: 2
   TOP: 16.1 Potential Difference and Electric Potential

6. The unit of electrical potential, the volt, is dimensionally equivalent to:
   a. J×C.
   b. J/C.
   c. C/J.
   d. F×C.

   ANS: B PTS: 1 DIF: 1
   TOP: 16.1 Potential Difference and Electric Potential

7. The quantity of electrical potential, the volt, is dimensionally equivalent to:
   a. force/charge.
   b. force $\times$ charge.
   c. electric field $\times$ distance.
   d. electric field/distance.

   ANS: C PTS: 1 DIF: 1
   TOP: 16.1 Potential Difference and Electric Potential

8. A free electron is in an electric field. With respect to the field, it experiences a force acting:
   a. parallel.
   b. anti-parallel (opposite in direction).
   c. perpendicular.
   d. along a constant potential line.

   ANS: B PTS: 1 DIF: 1
   TOP: 16.1 Potential Difference and Electric Potential

9. A uniform electric field, with a magnitude of 600 N/C, is directed parallel to the positive *x-axis*. If the potential at x = 3.0 m is 1 000 V, what is the potential at x = 1.0 m?
   a. 400 V
   b. 1 600 V
   c. 2 200 V
   d. 2 500 V

   ANS: C PTS: 1 DIF: 2
   TOP: 16.1 Potential Difference and Electric Potential

10. A uniform electric field, with a magnitude of 600 N/C, is directed parallel to the positive *x-axis*. If the potential at x = 3.0 m is 1 000 V, what is the change in potential energy of a proton as it moves from x = 3.0 m to x = 1.0 m? ($q_p = 1.6 \times 10^{-19}$ C)
    a. 8.0×10^{-17} J
    b. 1.9×10^{-16} J
    c. 0.80×10^{-21} J
    d. 500 J

    ANS: B PTS: 1 DIF: 2
    TOP: 16.1 Potential Difference and Electric Potential

11. An electron in a cathode ray tube is accelerated through a potential difference of 5.0 kV. What kinetic energy does the electron gain in the process? ($e = 1.6 \times 10^{-19}$ C)
    a. 1.6×10^{-16} J
    b. 8.0×10^{-16} J
    c. 1.6×10^{-22} J
    d. 8.0×10^{22} J

ANS: B PTS: 1 DIF: 2
TOP: 16.1 Potential Difference and Electric Potential

12. In which case does an electric field do positive work on a charged particle?
   a. A negative charge moves opposite to the direction of the electric field.
   b. A positive charge is moved to a point of higher potential energy.
   c. A positive charge completes one circular path around a stationary positive charge.
   d. A positive charge completes one elliptical path around a stationary positive charge.

ANS: A PTS: 1 DIF: 1
TOP: 16.1 Potential Difference and Electric Potential

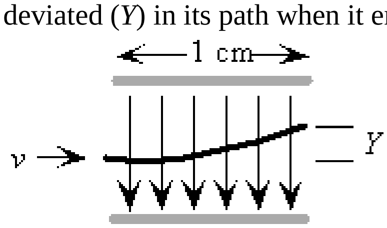
13. If the distance between two isolated parallel plates that are oppositely charged is doubled, the electric field between the plates is essentially unchanged. However, the:
   a. potential difference between the plates will double.
   b. charge on each plate will double.
   c. force on a charged particle halfway between the plates will get twice as small.
   d. force on a charged particle halfway between the plates will get four times as small.

ANS: A PTS: 1 DIF: 2
TOP: 16.1 Potential Difference and Electric Potential

14. An electron is released from rest at the negative plate of a parallel-plate capacitor. If the distance across the plate is 5.0 mm and the potential difference across the plate is 5.0 V, with what velocity does the electron hit the positive plate? (m_e = 9.1 ´ 10^{-31} kg, e = 1.6 ´ 10^{-19} C)
   a. 2.6 ´ 10^5 m/s
   b. 5.3 ´ 10^6 m/s
   c. 1.0 ´ 10^6 m/s
   d. 1.3 ´ 10^6 m/s

ANS: D PTS: 1 DIF: 2
TOP: 16.1 Potential Difference and Electric Potential

15. An electron with velocity v = 1.0 ´ 10^6 m/s is sent between the plates of a capacitor where the electric field is E = 500 V/m. If the distance the electron travels through the field is 1.0 cm, how far is it deviated (Y) in its path when it emerges from the electric field? (m_e = 9.1 ´ 10^{-31} kg, e = 1.6 ´ 10^{-19} C)



   a. 2.2 mm
   b. 4.4 mm
   c. 2.2 cm
   d. 4.4 cm

ANS: B PTS: 1 DIF: 3
TOP: 16.1 Potential Difference and Electric Potential

16. An ion is released from rest and moves due to the force from an electric field from a position in the field having a potential of 14 V to a position having a potential of 8 V. The ion:
   a. must have a positive charge.
   b. must have a negative charge.

c. can have either a positive or a negative charge.
d. must be neutral.

ANS: A PTS: 1 DIF: 2
TOP: 16.1 Potential Difference and Electric Potential

17. A 9.0-V battery moves 20 mC of charge through a circuit running from its positive terminal to its negative terminal. How much energy was delivered to the circuit?
a. 2.2 mJ
b. 0.020 J
c. 0.18 J
d. 4.5×10^3 J

ANS: C PTS: 1 DIF: 2
TOP: 16.1 Potential Difference and Electric Potential

18. If the distance between two negative point charges is increased by a factor of three, the resultant potential energy is what factor times the initial potential energy?
a. 3.0
b. 9.0
c. 1/3
d. 1/9

ANS: C PTS: 1 DIF: 1
TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

19. Four point charges are on the rim of a circle of radius 10 cm. The charges are (in μC) +0.50, +1.5, - 1.0, - 0.50. If the electrical potential at the circle's center due to the +0.5 charge alone is 4.5×10^4 V, what is the total potential at the center due to the four charges combined?
a. 18×10^4 V
b. 4.5×10^4 V
c. zero
d. -4.5×10^4 V

ANS: B PTS: 1 DIF: 2
TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

20. Which of the following characteristics are held in common by both gravitational and electrostatic forces when dealing with either point masses or charges?
a. inverse square distance law applies
b. forces are conservative
c. potential energy is a function of distance of separation
d. all of the above choices are valid

ANS: D PTS: 1 DIF: 1
TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

21. Find the electrical potential at 0.15 m from a point charge of 6.0 μC. ($k_e = 8.99 \times 10^9$ N$\cdot$m^2/C^2)
a. 5.4×10^4 V
b. 3.6×10^5 V
c. 2.4×10^6 V
d. 1.2×10^7 V

ANS: B PTS: 1 DIF: 2
TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

22. Two point charges of values +3.4 and +6.6 μC, respectively, are separated by 0.20 m. What is the potential energy of this 2-charge system? ($k_e = 8.99 \times 10^9$ N·m^2/C^2)
a. +0.34 J
b. - 0.75 J
c. +1.0 J
d. - 3.4 J

ANS: C PTS: 1 DIF: 2
TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

23. Two point charges of values +3.4 and +6.6 μC are separated by 0.10 m. What is the electrical potential at the point midway between the two point charges? ($k_e = 8.99 \times 10^9$ N·m^2/C^2)
a. $+1.8 \times 10^6$ V
b. -0.90×10^6 V
c. $+0.90 \times 10^6$ V
d. $+3.6 \times 10^6$ V

ANS: C PTS: 1 DIF: 2
TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

24. At what distance from a point charge of 8.0 μC would the electrical potential be 4.2×10^4 V? ($k_e = 8.99 \times 10^9$ N·m^2/C^2)
a. 0.58 m
b. 0.76 m
c. 1.7 m
d. 2.9 m

ANS: C PTS: 1 DIF: 2
TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

25. A point charge of +3.0 μC is located at the origin of a coordinate system and a second point charge of - 6.0 μC is at x = 1.00 m. What is the electric potential at the x = 0.50 m point? ($k_e = 8.99 \times 10^9$ N·m^2/C^2)
a. 16×10^4 V
b. 11×10^4 V
c. -11×10^4 V
d. -5.4×10^4 V

ANS: D PTS: 1 DIF: 2
TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

26. A point charge of +3.0 μC is located at the origin of a coordinate system and a second point charge of - 6.0 μC is at x = 1.0 m. At what point on the x axis is the electrical potential zero?
a. - 0.25 m
b. +0.25 m

c. +0.33 m
d. +0.75 m

ANS: C PTS: 1 DIF: 2
TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

27. Consider two charged spheres, one with charge +2 C and the other with - 2 C. A proton (a positively charged particle) is at the point halfway between the spheres. What is not zero?
a. the potential energy of the proton
b. the work to move the proton from infinity to that point
c. the force on the proton
d. all of the three above are zero

ANS: C PTS: 1 DIF: 1
TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

28. Two protons, each of charge 1.60 ´ 10^{-19} C, are 2.00 ´ 10^{-5} m apart. What is the change in potential energy if they are brought 1.00 ´ 10^{-5} m closer together? (k_e = 8.99 ´ 10^{9} $N \cdot m^2/C^2$)
a. 1.15 ´ 10^{-23} J
b. 3.20 ´ 10^{-19} J
c. 3.20 ´ 10^{-16} J
d. 1.60 ´ 10^{-14} J

ANS: A PTS: 1 DIF: 2
TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

29. When charge Q_1 is placed at point P_1, the resulting potential at point P is V_1. When Q_2 is placed at point P_2 after Q_1 is in position at P_1, the resulting potential at P becomes V_2. What is the potential at point P if charge Q_1 is then removed?
a. $V_1 + V_2$
b. $V_1 - V_2$
c. $V_2 - V_1$
d. $(V_1 + V_2)/2$

ANS: C PTS: 1 DIF: 2
TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

30. When charges q_a, q_b, and q_c are placed respectively at the corners a, b, and c of a right triangle, the potential at the midpoint of the hypotenuse is 20 V. When the charge q_a is removed, the potential at the midpoint becomes 15 V. When, instead, the charge q_b is removed (q_a and q_c both in place), the potential at the midpoint becomes 12 V. What is the potential at the midpoint if only the charge q_c is removed from the array of charges?
a. 8 V
b. 5 V
c. 7 V
d. 13 V

ANS: D PTS: 1 DIF: 3
TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

31. When charges q_a, q_b, and q_c are placed respectively at the corners a, b, and c of a right triangle, the potential at the midpoint of the hypotenuse is 20 V. When the charge q_a is removed, the potential at the midpoint becomes 15 V. When, instead, the charge q_b is removed (q_a and q_c both in place), the potential at the midpoint becomes 12 V. What is the potential at the midpoint if both charges q_a and q_c are removed?
a. 8 V
b. 5 V
c. 7 V
d. 13 V

ANS: A PTS: 1 DIF: 3
TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

32. A solid conducting sphere of 10 cm radius has a net charge of 20 nC. If the potential at infinity is taken as zero, what is the potential at the center of the sphere?
a. 36 mV
b. 360 mV
c. 1.8 ´ 10^{3} V
d. >1.8 ´ 10^{4} V

ANS: C PTS: 1 DIF: 3
TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

33. If a doubly-ionized oxygen atom (O^{-2}) is accelerated from rest by going through a potential difference of 20 V, what will be the change in its kinetic energy?
a. 10 eV
b. 20 eV
c. 40 eV
d. none of the above

ANS: C PTS: 1 DIF: 2
TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

34. An electron in a TV picture tube is accelerated through a potential difference of 10 kV before it hits the screen. What is the kinetic energy of the electron in electron volts? (1 eV = 1.6 ´ 10^{-19} J)
a. 1.0 ´ 10^{4} eV
b. 1.6 ´ 10^{-15} eV
c. 1.6 ´ 10^{-22} eV
d. 6.25 ´ 10^{22} eV

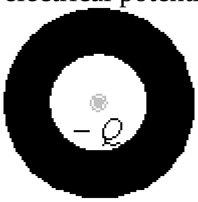
ANS: A PTS: 1 DIF: 1
TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

35. Electrons in an x-ray machine are accelerated from rest through a potential difference of 50 000 V. What is the kinetic energy of each of these electrons in eV?
a. 50 eV
b. 80 eV
c. 330 eV
d. 50 keV

ANS: D PTS: 1 DIF: 1

TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

36. There is a hollow, conducting, uncharged sphere with a negative charge inside the sphere. Consider the electrical potential at the inner and outer surfaces of the sphere. Which of the following is true?



a. The potential on the inner surface is greater.
b. The potential on the outer surface is greater.
c. The potentials on both surfaces are zero.
d. The potentials on both surfaces are equal but not zero.

ANS: D PTS: 1 DIF: 2
TOP: 16.2 Electric Potential and Potential Energy Due to Point Charges | 16.3 Potentials and Charged Conductors | 16.4 Equipotential Surfaces

37. At which location will the electric field between the two parallel plates of a charged capacitor be the strongest in magnitude?
a. near the positive plate
b. near the negative plate
c. midway between the two plates at their ends
d. midway between the two plates nearest their center

ANS: D PTS: 1 DIF: 1 TOP: 16.6 Capacitance

38. The unit of capacitance, the farad, is dimensionally equivalent to which of the following?
a. V/C
b. V×C
c. J/V
d. C/V

ANS: D PTS: 1 DIF: 1 TOP: 16.6 Capacitance

39. Increasing the voltage across the two plates of a capacitor will produce what effect on the capacitor?
a. increase charge
b. decrease charge
c. increase capacitance
d. decrease capacitance

ANS: A PTS: 1 DIF: 1 TOP: 16.6 Capacitance

40. A 0.25-μF capacitor is connected to a 400-V battery. Find the charge on the capacitor.
a. 1.2×10^{-12} C
b. 1.0×10^{-4} C
c. 0.040 C
d. 0.020 C

ANS: B PTS: 1 DIF: 1 TOP: 16.6 Capacitance

41. A parallel-plate capacitor has a capacitance of 20 μF. What potential difference across the plates is required to store 7.2×10^{-4} C on this capacitor?

a. 36 V
b. 2.2×10^{-2} V
c. 1.4×10^{-8} V
d. 68 V

ANS: A PTS: 1 DIF: 2 TOP: 16.6 Capacitance

42. If two parallel, conducting plates have equal positive charge, the electric field lines will:
a. leave one plate and go straight to the other plate.
b. leave both plates and go to infinity.
c. enter both plates from infinity.
d. none of the above.

ANS: B PTS: 1 DIF: 1 TOP: 16.6 Capacitance

43. A 20-μF capacitor is attached across a 1000-V power supply. What is the net charge on the capacitor?
a. 10 mC
b. 20 mC
c. 40 mC
d. none of the above

ANS: D PTS: 1 DIF: 1 TOP: 16.6 Capacitance

44. Doubling the voltage across a parallel plate capacitor does not double which of the following?
a. the charge
b. the electric field between the plates
c. the energy stored
d. both a and b

ANS: C PTS: 1 DIF: 2 TOP: 16.6 Capacitance

45. Increasing the separation of the two charged parallel plates of a capacitor, which are disconnected from a battery, will produce what effect on the capacitor?
a. increase charge
b. decrease charge
c. increase capacitance
d. decrease capacitance

ANS: D PTS: 1 DIF: 1
TOP: 16.7 The Parallel-Plate Capacitor | 16.8 Combinations of Capacitors

46. Three capacitors of 1.0, 1.5, and 2.0 μF are connected in series. Find the combined capacitance.
a. 4.5 μF
b. 4.0 μF
c. 2.2 μF
d. 0.46 μF

ANS: D PTS: 1 DIF: 2
TOP: 16.7 The Parallel-Plate Capacitor | 16.8 Combinations of Capacitors

47. If three 4.0-μF capacitors are connected in parallel, what is the combined capacitance?
a. 12 μF
b. 0.75 μF
c. 8.0 μF
d. 0.46 μF

ANS: A PTS: 1 DIF: 1
TOP: 16.7 The Parallel-Plate Capacitor | 16.8 Combinations of Capacitors

48. Two capacitors with capacitances of 1.5 and 0.25 μF, respectively, are connected in parallel. The system is connected to a 50-V battery. What charge accumulates on the 1.5-μF capacitor?
a. 100 μC
b. 75 μC
c. 50 μC
d. 33 μC

ANS: B PTS: 1 DIF: 2
TOP: 16.7 The Parallel-Plate Capacitor | 16.8 Combinations of Capacitors

49. Two capacitors with capacitances of 1.0 and 0.50 μF, respectively, are connected in series. The system is connected to a 100-V battery. What charge accumulates on the 1.0-μF capacitor?
a. 150 μC
b. 100 μC
c. 50 μC
d. 33 μC

ANS: D PTS: 1 DIF: 2
TOP: 16.7 The Parallel-Plate Capacitor | 16.8 Combinations of Capacitors

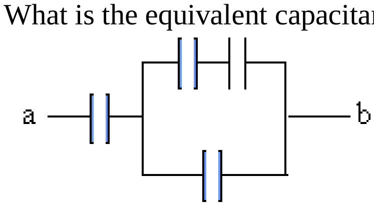
50. Two capacitors with C_A greater than C_B and are connected in series with a battery. Which of the following is true?
a. There is more charge stored on C_A.
b. There is more charge stored on C_B.
c. There is the same charge stored on each capacitor.
d. There is the same potential difference across both capacitors.

ANS: C PTS: 1 DIF: 2
TOP: 16.7 The Parallel-Plate Capacitor | 16.8 Combinations of Capacitors

51. Two capacitors with C_A greater than C_B are connected in parallel with a battery. Which of the following is true?
a. There is more potential difference across C_A.
b. There is more potential difference across C_B.
c. There is the same charge stored on each capacitor.
d. There is the same potential difference across both capacitors.

ANS: D PTS: 1 DIF: 2
TOP: 16.7 The Parallel-Plate Capacitor | 16.8 Combinations of Capacitors

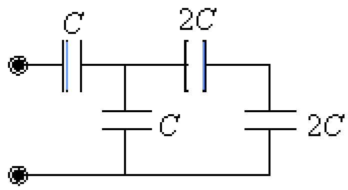
52. What is the equivalent capacitance between points a and b? All capacitors are 1.0 μF.



a. 4.0 μF
b. 1 7 μF
c. 0.60 μF
d. 0.25 μF

ANS: C PTS: 1 DIF: 2
TOP: 16.7 The Parallel-Plate Capacitor | 16.8 Combinations of Capacitors

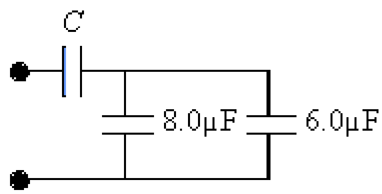
53. If C = 36 μF, determine the equivalent capacitance for the combination shown.



a. 36 μF
b. 32 μF
c. 28 μF
d. 24 μF

ANS: D PTS: 1 DIF: 2
TOP: 16.7 The Parallel-Plate Capacitor | 16.8 Combinations of Capacitors

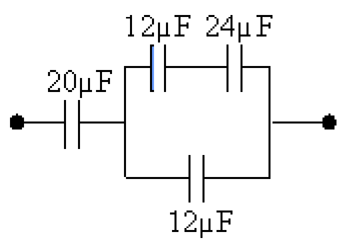
54. If C = 10 μF, what is the equivalent capacitance for the combination shown?



a. 7.5 μF
b. 6.5 μF
c. 7.0 μF
d. 5.8 μF

ANS: D PTS: 1 DIF: 2
TOP: 16.7 The Parallel-Plate Capacitor | 16.8 Combinations of Capacitors

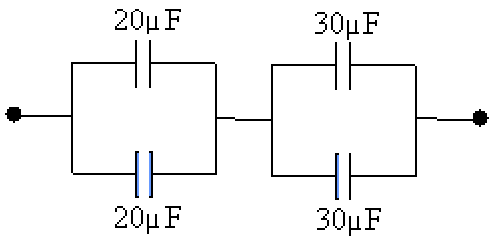
55. What is the equivalent capacitance of the combination shown?



a. 29 μF
b. 10 μF
c. 40 μF
d. 25 μF

ANS: B PTS: 1 DIF: 2
TOP: 16.7 The Parallel-Plate Capacitor | 16.8 Combinations of Capacitors

56. What is the equivalent capacitance of the combination shown?



a. 24 μF
b. 100 μF
c. 12 μF
d. 4.6 μF

ANS: A PTS: 1 DIF: 2
TOP: 16.7 The Parallel-Plate Capacitor | 16.8 Combinations of Capacitors

57. Four identical 1 mF capacitors are connected together electrically. What is the least possible capacitance of the combination?
a. 4 mF
b. 1 mF
c. 1/4 mF
d. 1/8 mF

ANS: C PTS: 1 DIF: 2
TOP: 16.7 The Parallel-Plate Capacitor | 16.8 Combinations of Capacitors

58. Four identical 1-mF capacitors are connected together electrically. What is the greatest possible capacitance of the combination?
a. 8 mF
b. 4 mF
c. 1 mF
d. 1/4 mF

ANS: B PTS: 1 DIF: 2
TOP: 16.7 The Parallel-Plate Capacitor | 16.8 Combinations of Capacitors

59. Using a 1-mF capacitor, a 2-mF capacitor, and a 3-mF capacitor, which of the following capacitances cannot be made by a combination that uses all three? (Hint: At most only 2 combinations must be considered to determine the correct answer).
a. 6 mF
b. 6/11 mF
c. 11/3 mF
d. 5/11 mF

ANS: D PTS: 1 DIF: 3
TOP: 16.7 The Parallel-Plate Capacitor | 16.8 Combinations of Capacitors

60. A 10.0-*m*F capacitor is attached to a 20-V power supply. How much energy is stored in the capacitor?
a. 2.0×10^{-3} J
b. 1.2×10^{-3} J
c. 2.0×10^{-4} J
d. 5.2×10^{-4} J

ANS: A PTS: 1 DIF: 2
TOP: 16.9 Energy Stored in a Charged Capacitor

61. A 0.25-μF capacitor is connected to a 400-V battery. What potential energy is stored in the capacitor?
a. 1.2×10^{-12} J
b. 1.0×10^{-4} J
c. 0.040 J
d. 0.020 J

ANS: D PTS: 1 DIF: 2
TOP: 16.9 Energy Stored in a Charged Capacitor

62. Two capacitors with capacitances of 1.5 μF and 0.25 μF, respectively, are connected in parallel. The system is connected to a 50-V battery. What electrical potential energy is stored in the 1.5-μF capacitor?
a. 0.50×10^{-3} J
b. 1.2×10^{-3} J
c. 1.9×10^{-3} J
d. 10.0×10^{-3} J

ANS: C PTS: 1 DIF: 2
TOP: 16.9 Energy Stored in a Charged Capacitor

63. Two capacitors with capacitances of 1.0 μF and 0.50 μF, respectively, are connected in series. The system is connected to a 100-V battery. What electrical potential energy is stored in the 1.0-μF capacitor?
a. 0.065×10^{-3} J
b. 4.3×10^{-3} J
c. 0.80×10^{-3} J
d. 5.6×10^{-4} J

ANS: D PTS: 1 DIF: 3
TOP: 16.9 Energy Stored in a Charged Capacitor

64. If $C_1 = 25\ \mu$F, $C_2 = 20\ \mu$F, $C_3 = 10\ \mu$F, and $\Delta V_0 = 21$ V, determine the energy stored by C_2.
a. 0.72 mJ
b. 0.32 mJ
c. 0.40 mJ
d. 0.91 mJ

ANS: D PTS: 1 DIF: 3
TOP: 16.9 Energy Stored in a Charged Capacitor

65. A parallel-plate capacitor with plate area *A* and plate separation *d* has a capacitance of 3.0 with the gap between the plates unfilled. The gap is then filled with two dielectric materials, one with dielectric constant 2.0 and the other one with dielectric constant 4.0. Each slab of dielectric has area *A* and thickness *d*/2, the layering of the dielectrics resulting in the gap being completely filled. Which of the following combinations of capacitors will have the same capacitance as the newly filled parallel-plate one?
a. a 6.0- capacitor and a 12- capacitor in parallel
b. a 6.0- capacitor and a 12- capacitor in series
c. a 24- capacitor and a 12- capacitor in parallel
d. a 24- capacitor and a 12- capacitor in series

ANS: D PTS: 1 DIF: 3
TOP: 16.8 Combinations of Capacitors | 16.10 Capacitors with Dielectrics

66. A parallel-plate capacitor with plate area *A* and plate separation *d* has a capacitance of 3.0 with the gap between the plates unfilled. The gap is then filled with two dielectric materials, one with dielectric constant 2.0 and the other one with dielectric constant 4.0. Each slab of dielectric has area *A*/2 and thickness *d*, the placing side-by-side of the dielectics resulting in the gap being completely filled. Which of the following combinations of capacitors will have the same capacitance as the newly filled parallel-plate one?

a. a 3.0- capacitor and a 6.0- capacitor in parallel
b. a 3.0- capacitor and a 6.0- capacitor in series
c. a 6.0- capacitor and a 12- capacitor in parallel
d. a 6.0- capacitor and a 12- capacitor in series

ANS: A PTS: 1 DIF: 3
TOP: 16.8 Combinations of Capacitors | 16.10 Capacitors with Dielectrics

67. Inserting a dielectric material between two charged parallel conducting plates, originally separated by air and disconnected from a battery, will produce what effect on the capacitor?
a. increase charge
b. increase voltage
c. increase capacitance
d. decrease capacitance

ANS: C PTS: 1 DIF: 1
TOP: 16.10 Capacitors with Dielectrics

68. A “sandwich” is constructed of two flat pieces of metal (2.00 cm on a side) with a 2.00-mm-thick piece of a dielectric called Rutile (κ = 100) in between them. What is the capacitance? (ϵ_0 = 8.85 ´ 10^{-12} $C^2/N×m^2$)
a. 177 pF
b. 885 nF
c. 8.85 μF
d. 100 μF

ANS: A PTS: 1 DIF: 2
TOP: 16.10 Capacitors with Dielectrics

69. The dielectric strength of Rutile is 6.0 ´ 10^{6} V/m, which corresponds to the maximum electric field that the dielectric can sustain before breakdown. What is the maximum charge that a 10^{-10}-F capacitor with a 1.0-mm thickness of Rutile can hold?
a. 1.7 nC
b. 0.60 μC
c. 0.30 mC
d. 6.0 C

ANS: B PTS: 1 DIF: 3
TOP: 16.10 Capacitors with Dielectrics

70. A parallel-plate capacitor has dimensions 4.0 cm ´ 5.0 cm. The plates are separated by a 1.0-mm thickness of paper (dielectric constant κ = 3.7). What is the charge that can be stored on this capacitor, when connected to a 1.5-V battery? (ϵ_0 = 8.85 ´ 10^{-12} $C^2/N×m^2$)
a. 20 ´ 10^{-12} C
b. 4.8 ´ 10^{-12} C
c. 4.8 ´ 10^{-11} C
d. 9.8 ´ 10^{-11} C

ANS: D PTS: 1 DIF: 3
TOP: 16.10 Capacitors with Dielectrics

71. How much charge can be placed on a capacitor of plate area 10 cm^2 with air between the plates before it reaches "atmospheric breakdown" where $E = 3.0 \times 10^6$ V/m? ($\epsilon_0 = 8.85 \times 10^{-12}$ $C^2/N \cdot m^2$)
a. 2.7×10^{-8} C
b. 4.0×10^{-7} C
c. 5.3×10^{-6} C
d. 6.6×10^{-5} C

ANS: A PTS: 1 DIF: 3
TOP: 16.10 Capacitors with Dielectrics

72. Very large capacitors have been considered as a means for storing electrical energy. If we constructed a very large parallel-plate capacitor of plate area 1.0 m^2 using paper ($\kappa = 3.7$) of thickness 1.0 mm as a dielectric, how much electrical energy would it store at a plate voltage of 5 000 V? ($\epsilon_0 = 8.85 \times 10^{-12}$ $C^2/N \cdot m^2$)
a. 0.41 J
b. 90 J
c. 9 000 J
d. 45 000 J

ANS: A PTS: 1 DIF: 2
TOP: 16.10 Capacitors with Dielectrics

73. A pair of parallel plates, forming a capacitor, are charged. The plates are pulled apart to double the original separation, the charges on the plates remaining the same. What is the ratio of the final energy stored to the original energy stored?
a. 4
b. 2
c. 1
d. 1/2

ANS: B PTS: 1 DIF: 2
TOP: 16.10 Capacitors with Dielectrics

74. A pair of parallel plates, forming a capacitor, are connected to a battery. While the capacitor is still connected to the battery maintaining a constant voltage, the plates are pulled apart to double their original distance. What is the ratio of the final energy stored to the original energy stored?
a. 2
b. 1
c. 1/2
d. 1/4

ANS: C PTS: 1 DIF: 2
TOP: 16.10 Capacitors with Dielectrics

75. Two parallel-plate capacitors have the same plate area, and the gap between the plates is filled with a dielectric with a dielectric constant equal to 4. The gap in capacitor A is one half that in Capacitor B. What is the ratio of the capacitance of A to B?
a. 2
b. 1
c. 1/2
d. The ratio is not given.

ANS: A PTS: 1 DIF: 2
TOP: 16.10 Capacitors with Dielectrics

76. A capacitor is made by taking two sheets of aluminum foil, each 0.022 mm thick and placing between them a sheet of paper which comes from a ream of 500 sheets, the ream being 5.5 cm thick with sheets measuring 216 mm by 279 mm (the usual 8 1/2 by 11). What is the capacitance of the capacitor made this way if the dielectric constant of the paper is 3.7? ($\epsilon_0 = 8.85 \times 10^{-12}$ $C^2/N \times m^2$)
a. 24 nF
b. 48 nF
c. 18 nF
d. 1.3 nF

ANS: C PTS: 1 DIF: 2
TOP: 16.10 Capacitors with Dielectrics

77. A parallel plate capacitor with plate separation *d* has capacitance *C*. The gap between its plates is then filled half way with a dielectric with dielectric constant k having thickness $d/2$ resulting in a capacitor with capacitance *C*'. What is the ratio of *C*' to *C*?
a.
b.
c.
d.

ANS: C PTS: 1 DIF: 2
TOP: 16.10 Capacitors with Dielectrics

78. A parallel plate capacitor with plate separation *d* has capacitance . The gap between its plates is then partially filled with a dielectric with dielectric constant and having a thickness $d/3$. What is the resulting capacitance?
a.
b.
c.
d.

ANS: B PTS: 1 DIF: 3
TOP: 16.10 Capacitors with Dielectrics

79. Two equal positive charges are separated by *d*. Then one of the charges is replaced by a negative charge of the same magnitude. Take the potential at infinity to be zero. In which situation is the potential higher midway between the charges; is this value of potential zero?
a. the first situation; yes
b. the first situation; no
c. the second situation; yes
d. the second situation; no

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Questions

80. Case 1: An electron is released from rest in a uniform electric field. Case 2: A proton is released from rest in a uniform electric field of the same magnitude as in case 1. How does the electric potential energy of the charge-field system behave in these cases?
a. In both cases, the potential energy increases.
b. In both cases, the potential energy decreases.
c. In case 1 the potential energy increases, but in case 2 it decreases.
d. In case 1 the potential energy decreases, but in case 2 it increases.

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Questions

81. An electron and a proton are each released from rest in the same uniform electric field. The electron moves a distance d_{electron} and the proton moves a distance d_{proton} as each particle's kinetic energy increases by 1.6 eV. How do d_{electron} and d_{proton} compare?
a. $d_{\text{electron}} < d_{\text{proton}}$
b. $d_{\text{electron}} > d_{\text{proton}}$
c. $d_{\text{electron}} = d_{\text{proton}}$
d. The answer depends on the direction of the electric field.

ANS: C PTS: 1 DIF: 3 TOP: Conceptual Questions

82. Three capacitors have capacitances $C_1 < C_2 < C_3$. If these capacitors are connected in series, which of the following is true for the resulting equivalent capacitance?
a. $C_{eq} < C_1$
b. $C_{eq} > C_3$
c. $C_{eq} = (C_1 + C_2 + C_3)/3$
d. None of the above is always correct.

ANS: A PTS: 1 DIF: 1 TOP: Conceptual Questions

83. A capacitor is attached across a battery and charged. Then the battery is removed leaving the capacitor charged. The positive lead of the capacitor is then connected to one lead of a previously uncharged identical capacitor, and then the other lead of the charged capacitor is connected to the other lead of the second capacitor. How does the energy E_o stored in the originally charged capacitor compare to the energy E_f stored in the connected capacitors?
a. $E_o < E_f$
b. $E_o = E_f$
c. $E_o = 2E_f$
d. $E_o = 4E_f$

ANS: C PTS: 1 DIF: 3 TOP: Conceptual Questions

CHAPTER 17—Current and Resistance

MULTIPLE CHOICE

1. The current in an electron beam in a cathode-ray tube is measured to be 70 μA. How many electrons hit the screen in 5.0 s? ($e = 1.6 \times 10^{-19}$ C)
   a. 2.2×10^{11} electrons
   b. 8.8×10^{13} electrons
   c. 2.2×10^{15} electrons
   d. 8.8×10^{18} electrons

   ANS: C PTS: 1 DIF: 1 TOP: 17.1 Electric Current

2. A wire carries a steady current of 0.1 A over a period of 20 s. What total charge passes through the wire in this time interval?
   a. 200 C
   b. 20 C
   c. 2 C
   d. 0.005 C

   ANS: C PTS: 1 DIF: 1 TOP: 17.1 Electric Current

3. In a certain material there is a current of 16 A flowing through a surface to the right, and there is an equal amount of positive and negative charge passing through the surface producing the current. How much negative charge passes through the surface?
   a. 8 C/s toward the right
   b. 8 C/s toward the left
   c. 16 C/s toward the right
   d. 16 C/s toward the left

   ANS: B PTS: 1 DIF: 2 TOP: 17.1 Electric Current

4. The charge flowing through a light bulb attached to a 12.0-V battery in 14.0 s is 30.0 C. On the average, how many electrons pass a point in the filament of the bulb per second?
   a.
   b.
   c.
   d.

   ANS: A PTS: 1 DIF: 2 TOP: 17.1 Electric Current

5. The charge flowing through a light bulb attached to a 12.0-V battery in 14.0 s is 30.0 C. What is the total energy delivered to the filament during this process?
   a. 12.0 J
   b. 360 J
   c. 5040 J
   d. 168 J

   ANS: B PTS: 1 DIF: 2 TOP: 17.1 Electric Current

6. The charge flowing through a light bulb attached to a 12.0-V battery in 14.0 s is 30.0 C.What is the average power supplied by the battery during this process?
   a. 360 W
   b. 12.0 W

c. 25.7 W
d. 5.63 W

ANS: C PTS: 1 DIF: 2 TOP: 17.1 Electric Current

7. If the current in a wire is tripled, what effect does this have on the electron drift velocity in the wire?
a. It stays the same.
b. It triples.
c. It decreases by a factor of three.
d. It increases by a factor of nine.

ANS: B PTS: 1 DIF: 1
TOP: 17.2 A Microscopic View: Current and Drift Speed

8. Wire A and Wire B are each carrying the same current. If the diameter of Wire A is twice that of Wire B, how does the drift velocity v_{dA} in Wire A compare to that in in Wire B?
a. $v_{dA} = v_{dB}$
b. $v_{dA} = 2\ v_{dB}$
c. $v_{dA} = v_{dB}\ /2$
d. $v_{dA} = v_{dB}\ /4$

ANS: D PTS: 1 DIF: 2
TOP: 17.2 A Microscopic View: Current and Drift Speed

9. The number density of conduction electrons in a metal can be found from the density r of the metal, the mass per mole M of the metal, the number of conduction electrons per metal atom, and Avogadro's number N_A. If we assume one conduction electron per atom, which of the following gives the number density of conduction electrons for a given metal?
a. $N_A\ r\ M$
b. $N_A\ r\ /M$
c. $N_A\ M/r$
d. $N_A\ /r\ M$

ANS: B PTS: 1 DIF: 2
TOP: 17.2 A Microscopic View: Current and Drift Speed

10. If a metallic wire of cross sectional area 3.0 ´ 10^{-6} m^2 carries a current of 6.0 A and has a mobile charge density of 4.24 ´ 10^{28} carriers/m^3, what is the average drift velocity of the mobile charge carriers? (charge value = 1.6 ´ 10^{-19} C)
a. 3.4 ´ 10^3 m/s
b. 1.7 ´ 10^3 m/s
c. 1.5 ´ 10^{-4} m/s
d. 2.9 ´ 10^{-4} m/s

ANS: D PTS: 1 DIF: 2
TOP: 17.2 A Microscopic View: Current and Drift Speed

11. The size of the electric current in a electrical conductor is a function of which of the following?
a. velocity of charge carriers
b. conductor cross sectional area
c. density of charge carriers
d. All of the above choices are valid.

ANS: D PTS: 1 DIF: 1
TOP: 17.2 A Microscopic View: Current and Drift Speed

12. When an electric current exists within a conducting wire, which of the following statements describes the condition of any accompanying electric field?
    a. must be zero
    b. must be parallel to current flow
    c. must be anti-parallel (opposite direction) to current flow
    d. must be perpendicular to current flow

    ANS: B PTS: 1 DIF: 1
    TOP: 17.2 A Microscopic View: Current and Drift Speed

13. When you flip a switch to turn on a light, the delay before the light turns on is determined by:
    a. the number of electron collisions per second in the wire.
    b. the drift speed of the electrons in the wire.
    c. the speed of the electric field moving in the wire.
    d. none of these, since the light comes on instantly.

    ANS: C PTS: 1 DIF: 2
    TOP: 17.2 A Microscopic View: Current and Drift Speed

14. A high voltage transmission line of diameter 2 cm and length 200 km carries a steady current of 1 000 A. If the conductor is copper with a free charge density of 8×10^{28} electrons/m^3, how long does it take one electron to travel the full length of the cable? ($e = 1.6 \times 10^{-19}$ C)
    a. 8×10^{2} s
    b. 8×10^{4} s
    c. 8×10^{6} s
    d. 8×10^{8} s

    ANS: D PTS: 1 DIF: 3
    TOP: 17.2 A Microscopic View: Current and Drift Speed

15. Materials having resistance changes as voltage or current varies are called:
    a. ohmic.
    b. inohmic.
    c. nonohmic.
    d. deohmic.

    ANS: C PTS: 1 DIF: 1
    TOP: 17.4 Resistance, Resistivity, and Ohm's Law

16. You measure a 25.0-V potential difference across a 5.00-Ω resistor. What is the current flowing through it?
    a. 125 A
    b. 5.00 A
    c. 4.00 A
    d. 1.00 A

    ANS: B PTS: 1 DIF: 1
    TOP: 17.4 Resistance, Resistivity, and Ohm's Law

17. The unit of electric current, the ampere, is equivalent to which of the following?
    a. V·Ω
    b. V/Ω
    c. Ω·m
    d. V/s

ANS: B PTS: 1 DIF: 1
TOP: 17.4 Resistance, Resistivity, and Ohm’s Law

18. The unit of electric resistance, the ohm, is equivalent to which of the following?
a. V/A
b. V×m
c. A/s
d. A/m

ANS: A PTS: 1 DIF: 1
TOP: 17.4 Resistance, Resistivity, and Ohm’s Law

19. A flashlight bulb operating at a voltage of 4.5 V has a resistance of 8.0 W. How many electrons pass through the bulb filament per second (e = 1.6 ´ 10^{-19} C)?
a. 3.7 ´ 10^{16}
b. 1.8 ´ 10^{21}
c. 9.4 ´ 10^{17}
d. 3.5 ´ 10^{18}

ANS: D PTS: 1 DIF: 2
TOP: 17.4 Resistance, Resistivity, and Ohm’s Law

20. If a certain resistor obeys Ohm's law, its resistance will change:
a. as the voltage across the resistor changes.
b. as the current through the resistor changes.
c. as the energy given off by the electrons in their collisions changes.
d. none of the above, since resistance is a constant for the given resistor.

ANS: D PTS: 1 DIF: 1
TOP: 17.4 Resistance, Resistivity, and Ohm’s Law

21. A metallic conductor has a resistivity of 18 ´ 10^{-6} W×m. What is the resistance of a piece that is 30 m long and has a uniform cross sectional area of 3.0 ´ 10^{-6} m^2?
a. 0.056 W
b. 180 W
c. 160 W
d. 90 W

ANS: B PTS: 1 DIF: 2
TOP: 17.4 Resistance, Resistivity, and Ohm’s Law

22. Two cylindrical resistors are made of the same material and have the same resistance. The resistors, R_1 and R_2, have different radii, r_1 and r_2, and different lengths, L_1 and L_2. Which of the following relative values for radii and lengths would result in equal resistances?
a. $r_1 = r_2$ and $L_1 = 2L_2$
b. $2r_1 = r_2$ and $L_1 = 2L_2$
c. $r_1 = r_2$ and $4L_1 = L_2$
d. $2r_1 = r_2$ and $4L_1 = L_2$

ANS: D PTS: 1 DIF: 2
TOP: 17.4 Resistance, Resistivity, and Ohm’s Law

23. How long is a wire made from 100 cm^3 of copper if its resistance is 8.5 ohms? The resistivity of copper is 1.7 ´ 10^{-5} W·m.

a. 7.1 m
b. 1.7×10^{2} m
c. 2.2×10^{2} m
d. 3.0×10^{3} m

ANS: A PTS: 1 DIF: 3
TOP: 17.4 Resistance, Resistivity, and Ohm's Law

24. Two wires with the same resistance have the same diameter but different lengths. If wire 1 has length L_1 and wire 2 has length L_2, how do L_1 and L_2 compare if wire 1 is made from copper and wire 2 is made from aluminum? The resistivity of copper is 1.7×10^{-5} $\Omega \cdot$m and the resistivity of aluminum is 2.82×10^{-5} $\Omega \cdot$m.
a. $L_1 = 1.7\ L_2$
b. $L_1 = 0.60\ L_2$
c. $L_1 = 2.8\ L_2$
d. $L_1 = 0.36\ L_2$

ANS: A PTS: 1 DIF: 2
TOP: 17.4 Resistance, Resistivity, and Ohm's Law

25. Replacing a wire resistor with another of the same material and length but with three times the diameter will have the effect of changing the resistance by what factor?
a. 1/3
b. 1/9
c. 3
d. 9

ANS: B PTS: 1 DIF: 2
TOP: 17.4 Resistance, Resistivity, and Ohm's Law

26. A 0.20-m-long metal rod has a radius of 1.0 cm and a resistance of 3.2×10^{-5} Ω. What is the resistivity of the metal?
a. 1.6×10^{-8} $\Omega \cdot$m
b. 5.0×10^{-8} $\Omega \cdot$m
c. 16×10^{-8} $\Omega \cdot$m
d. 160×10^{-8} $\Omega \cdot$m

ANS: B PTS: 1 DIF: 2
TOP: 17.4 Resistance, Resistivity, and Ohm's Law

27. A Nichrome wire has a radius of 0.50 mm and a resistivity of 1.5×10^{-6} $\Omega \cdot$m. What is the resistance per unit length of this wire?
a. 0.001 5 Ω/m
b. 0.95 Ω/m
c. 1.6 Ω/m
d. 1.9 Ω/m

ANS: D PTS: 1 DIF: 2
TOP: 17.4 Resistance, Resistivity, and Ohm's Law

28. A Nichrome wire has a radius of 0.50 mm and a resistivity of 1.5×10^{-6} $\Omega \cdot$m. If the wire carries a current of 0.50 A, what is the potential difference per unit length along this wire?
a. 0.003 V/m
b. 0.95 V/m

c. 1.6 V/m
d. 1.9 V/m

ANS: B PTS: 1 DIF: 2
TOP: 17.4 Resistance, Resistivity, and Ohm’s Law

29. Number 10 copper wire (radius = 1.3 mm) is commonly used for electrical installations in homes. What is the voltage drop in 40 m of #10 copper wire if it carries a current of 10 A? (The resistivity of copper is 1.7 ´ 10^{-8} W×m.)
a. 1.3 V
b. 0.77 V
c. 0.50 V
d. 0.13 V

ANS: A PTS: 1 DIF: 3
TOP: 17.4 Resistance, Resistivity, and Ohm’s Law

30. A copper cable needs to carry a current of 200 A with a power loss of only 3.0 W/m. What is the required radius of the copper cable? (The resistivity of copper is 1.7 ´ 10^{-8} W×m).
a. 0.21 cm
b. 0.85 cm
c. 3.2 cm
d. 4.0 cm

ANS: B PTS: 1 DIF: 2
TOP: 17.4 Resistance, Resistivity, and Ohm’s Law

31. A resistor is made of a material that has a resistivity that is proportional to the current going through it. If the voltage across the resistor is doubled, what happens to the current through it?
a. It doubles.
b. It quadruples.
c. It increases by a factor of $2^{3/2}$.
d. It increases by a factor of $2^{1/2}$.

ANS: D PTS: 1 DIF: 3
TOP: 17.4 Resistance, Resistivity, and Ohm’s Law

32. A 20-W platinum wire at 20°C with a temperature coefficient of resistivity of 3.9 ´ 10^{-3} $(°C)^{-1}$ will have what resistance at 100°C?
a. 14 W
b. 20 W
c. 26 W
d. 28 W

ANS: C PTS: 1 DIF: 2
TOP: 17.5 Temperature Variation of Resistance

33. A metal wire has a resistance of 25.00 W under room temperature conditions of 25°C. When the wire is heated to 85°C the resistance increases by 0.75 W. What is the temperature coefficient of resistivity of this metal?
a. 5.0 ´ 10^{-4} $(°C)^{-1}$
b. 1.3 ´ 10^{-3} $(°C)^{-1}$
c. 1.5 ´ 10^{-3} $(°C)^{-1}$
d. 2.5 ´ 10^{-3} $(°C)^{-1}$

ANS: A PTS: 1 DIF: 2
TOP: 17.5 Temperature Variation of Resistance

34. A metal wire has a resistance of 10.00 W at a temperature of 20°C. If the same wire has a resistance of 10.55 W at 90°C, what is the resistance when its temperature is - 20°C?
a. 0.70 W
b. 9.69 W
c. 10.31 W
d. 13.8 W

ANS: B PTS: 1 DIF: 2
TOP: 17.5 Temperature Variation of Resistance

35. By what factor is the resistance of a copper wire changed when its temperature is increased from 20°C to 120°C? The temperature coefficient of resistivity for copper = 3.9 ´ 10^{-3} (°C)$^{-1}$.
a. 0.72
b. 1.06
c. 1.39
d. 1.44

ANS: C PTS: 1 DIF: 2
TOP: 17.5 Temperature Variation of Resistance

36. A certain material is in a room at 27°C. If the absolute temperature (K) of the material is tripled, its resistance doubles. (Water freezes at 273 K.) What is the value for *a*, the temperature coefficient of resistivity?
a. 1 (°C)$^{-1}$
b. 2 (°C)$^{-1}$
c. 0.001 7 (°C)$^{-1}$
d. 0.038 (°C)$^{-1}$

ANS: C PTS: 1 DIF: 3
TOP: 17.5 Temperature Variation of Resistance

37. The resistivity of a material is doubled when heated a certain amount. What happens to the resistance of a resistor made of this material when heated the same amount?
a. It doubles.
b. It quadruples.
c. It halves.
d. It stays the same.

ANS: A PTS: 1 DIF: 1
TOP: 17.5 Temperature Variation of Resistance

38. A tungsten wire is used to determine the melting point of indium. The resistance of the tungsten wire is 3.000 W at 20°C and increases to 4.850 W as the indium starts to melt. $a_{tungsten}$ = 4.50 ´ 10^{-3} (°C)$^{-1}$. What is the melting temperature of indium?
a. 132°C
b. 157°C
c. 351°C
d. 731°C

ANS: B PTS: 1 DIF: 2
TOP: 17.5 Temperature Variation of Resistance

39. The resistance of a platinum wire is to be calibrated for low-temperature work. A platinum wire with resistance 1.000 Wat 20°C is immersed in liquid nitrogen at 77 K (- 196°C). If the temperature response of the platinum wire is linear, what is the expected resistance of the platinum wire at - 196°C? [$a_{platinum}$ = 3.92 ´ 10^{-3} $(°C)^{-1}$].
a. 0.153 W
b. 0.232 W
c. 1.768 W
d. 1.847 W

ANS: A PTS: 1 DIF: 2
TOP: 17.5 Temperature Variation of Resistance

40. Carbon has a negative temperature coefficient of resistance of –0.5 ´ 10^{-3} $(°C)^{-1}$. What temperature increase would result in a resistance decrease of 1% for a carbon resistor?
a. 2°C
b. 20°C
c. 50°C
d. 100°C

ANS: B PTS: 1 DIF: 2
TOP: 17.5 Temperature Variation of Resistance

41. The temperature coefficient of resistivity is a quantity that is:
a. always positive.
b. always non-negative.
c. sometimes negative.
d. represented by the symbol s.

ANS: C PTS: 1 DIF: 1
TOP: 17.5 Temperature Variation of Resistance

42. The temperature coefficient of resistivity for a “perfect” ohmic material would be:
a. positive and constant.
b. zero.
c. negative.
d. positive and uniformly increasing.

ANS: B PTS: 1 DIF: 1
TOP: 17.5 Temperature Variation of Resistance

43. If a 9.0-V battery, with negligible internal resistance, and an 18-Wresistor are connected in series, what is the amount of electrical energy transformed to heat per coulomb of charge that flows through the circuit?
a. 0.50 J
b. 3.0 J
c. 9.0 J
d. 72 J

ANS: C PTS: 1 DIF: 2
TOP: 17.6 Electrical Energy and Power

44. A 60-W light bulb is in a socket supplied with 120 V. What is the current in the bulb?
a. 0.50 A
b. 2.0 A
c. 60 A

d. 7 200 A

ANS: A PTS: 1 DIF: 1
TOP: 17.6 Electrical Energy and Power

45. A resistor is connected to a battery with negligible internal resistance. If you replace the resistor with one that has twice the resistance, by what factor does the power dissipated in the circuit change?
a. 0.50
b. 0.25
c. 4.0
d. 2.0

ANS: A PTS: 1 DIF: 2
TOP: 17.6 Electrical Energy and Power

46. The quantity volt is equivalent to which of the following?
a. J×m
b. J×C
c. C/W
d. J/C

ANS: D PTS: 1 DIF: 1
TOP: 17.6 Electrical Energy and Power

47. The unit for rate of energy transformation, the watt, in an electric circuit is equivalent to which of the following?
a. V/s
b. A×W
c. V×A
d. V/W

ANS: C PTS: 1 DIF: 1
TOP: 17.6 Electrical Energy and Power

48. If a 500-W heater carries a current of 4.00 A, what is the voltage across the ends of the heating element?
a. 2 000 V
b. 125 V
c. 250 V
d. 0.008 V

ANS: B PTS: 1 DIF: 1
TOP: 17.6 Electrical Energy and Power

49. If a 500-W heater carries a current of 4.00 A, what is the resistance of the heating element?
a. 85.7 W
b. 42.8 W
c. 31.3 W
d. 11.2 W

ANS: C PTS: 1 DIF: 2
TOP: 17.6 Electrical Energy and Power

50. A 500-W heater carries a current of 4.0 A. How much does it cost to operate the heater for 30 min if electrical energy costs 6.0 cents per kWh?

a. 1.5 cents
b. 9.0 cents
c. 18 cents
d. 36 cents

ANS: A PTS: 1 DIF: 2
TOP: 17.6 Electrical Energy and Power

51. If a lamp has resistance of 120 W when it operates at 100 W, what is the applied voltage?
a. 110 V
b. 120 V
c. 125 V
d. 220 V

ANS: A PTS: 1 DIF: 2
TOP: 17.6 Electrical Energy and Power

52. If a lamp has a resistance of 120 W when it operates at 100 W, what current does it carry?
a. 2.10 A
b. 1.2 A
c. 0.91 A
d. 0.83 A

ANS: C PTS: 1 DIF: 2
TOP: 17.6 Electrical Energy and Power

53. An electric toaster requires 1 100 W at 110 V. What is the resistance of the heating coil?
a. 7.5 W
b. 9.0 W
c. 10.0 W
d. 11.0 W

ANS: D PTS: 1 DIF: 2
TOP: 17.6 Electrical Energy and Power

54. A light bulb, sold as long-lasting, is rated 100 W at 130 V. The “increased” lifetime comes from using it at 120 V. Assuming negligible change in resistance at the different voltage, what is its power consumption at 120 V?
a. 85 W
b. 92 W
c. 100 W
d. 108 W

ANS: A PTS: 1 DIF: 2
TOP: 17.6 Electrical Energy and Power

55. An electric clothes dryer draws 15 A at 220 V. If the clothes put into the dryer have a mass of 7.0 kg when wet and 4.0 kg dry, how long does it take to dry the clothes? (Assume all heat energy goes into vaporizing water, L_v = 2.26 ´ 10^6 J/kg).
a. 55 min
b. 34 min
c. 20 min
d. 16 min

ANS: B PTS: 1 DIF: 3

TOP: 17.6 Electrical Energy and Power

56. A steam turbine at an electric power plant delivers 4 500 kW of power to an electrical generator which converts 95% of this mechanical energy into electrical energy. What is the current delivered by the generator if it delivers at 3 600 V?
a. 0.66×10^3 A
b. 1.0×10^3 A
c. 1.2×10^3 A
d. 5.9×10^3 A

ANS: C PTS: 1 DIF: 2
TOP: 17.6 Electrical Energy and Power

57. The heating coil of a hot water heater has a resistance of 20 Ω and operates at 210 V. How long a time is required to raise the temperature of 200 kg of water from 15°C to 80°C? (The specific heat for water = 10^3 cal/kg·°C and 1.0 cal = 4.186 J).
a. 1.7 h
b. 3.8 h
c. 5.1 h
d. 6.9 h

ANS: D PTS: 1 DIF: 3
TOP: 17.6 Electrical Energy and Power

58. If electrical energy costs 5.5 cents per kWh, what does it cost to heat 200 kg water from 15°C to 80°C? (The specific heat of water = 10^3 cal/kg·°C and 1.0 cal = 4.186 J.)
a. 48 cents
b. 83 cents
c. 16 cents
d. 80 cents

ANS: B PTS: 1 DIF: 3
TOP: 17.6 Electrical Energy and Power

59. A light bulb has resistance of 240 Ω when operating at 120 V. Find the current in the light bulb.
a. 2.0 A
b. 1.0 A
c. 0.50 A
d. 0.20 A

ANS: C PTS: 1 DIF: 1
TOP: 17.6 Electrical Energy and Power

60. Ten coulombs of charge start from the negative terminal of a battery, flow through the battery and then leave the positive terminal through a wire, flow through a resistor and then return to the starting point on this closed circuit. In this complete process, the ten coulombs:
a. do positive work on the battery.
b. receive heat energy from the resistor.
c. have a net loss of potential energy.
d. have no net change in potential energy.

ANS: D PTS: 1 DIF: 2
TOP: 17.6 Electrical Energy and Power

61. Which process will double the power given off by a resistor?

a. doubling the current while doubling the resistance
b. doubling the current by making a resistance half as big
c. doubling the current by doubling the voltage
d. doubling the current while making the voltage half as big

ANS: B PTS: 1 DIF: 2
TOP: 17.6 Electrical Energy and Power

62. Which is a unit of power?
a. kWh
b. W/s
c. A×W
d. J/s

ANS: D PTS: 1 DIF: 1
TOP: 17.6 Electrical Energy and Power

63. Which is not a force?
a. gravity
b. electrical force
c. voltage
d. friction

ANS: C PTS: 1 DIF: 1
TOP: 17.6 Electrical Energy and Power

64. A water pump draws about 3.8 A when connected to 240 V. What is the cost (with electrical energy at 9 cents per kWh) of running the pump for 10 h?
a. 8.0 cents
b. 15 cents
c. 82 cents
d. 95 cents

ANS: C PTS: 1 DIF: 2
TOP: 17.6 Electrical Energy and Power

65. A high-voltage transmission line carries 1 000 A at 700 000 V. What is the power carried by the line?
a. 700 MW
b. 370 MW
c. 100 MW
d. 70 MW

ANS: A PTS: 1 DIF: 2
TOP: 17.6 Electrical Energy and Power

66. A high-voltage transmission line carries 1 000 A at 700 kV for a distance of 100 miles. If the resistance in the wire is 1 W/mile, what is the power loss due to resistive losses?
a. 10 kW
b. 100 kW
c. 10 MW
d. 100 MW

ANS: D PTS: 1 DIF: 2
TOP: 17.6 Electrical Energy and Power

67. An electric car is designed to run off a bank of 12-V batteries with total energy storage of 3.0×10^7 J. If the electric motor draws 6 000 W, what current will be delivered to the motor?
    a. 500 A
    b. 400 A
    c. 200 A
    d. 100 A

    ANS: A PTS: 1 DIF: 2
    TOP: 17.6 Electrical Energy and Power

68. An electric car is designed to run off a bank of 12-V batteries with total energy storage of 3.0×10^7 J. If the electric motor draws 6 000 W in moving the car at a steady speed of 10 m/s, how far will the car go before it is “out of juice?”
    a. 25 km
    b. 50 km
    c. 100 km
    d. 150 km

    ANS: B PTS: 1 DIF: 2
    TOP: 17.6 Electrical Energy and Power

69. A solar panel measures 80 cm × 50 cm. In direct sunlight, the panel delivers 3.2 A at 15 V. If the intensity of sunlight is 1 000 W/m^2, what is the efficiency of the solar panel in converting solar energy into electrical energy?
    a. 24%
    b. 18%
    c. 12%
    d. 6.0%

    ANS: C PTS: 1 DIF: 3
    TOP: 17.6 Electrical Energy and Power

70. Suppose that a voltage surge produces 140 V for a moment in a 120-V line. What will temporarily be the output of a 100-W light bulb assuming its resistance does not change?
    a. 109 W
    b. 118 W
    c. 127 W
    d. 136 W

    ANS: D PTS: 1 DIF: 2
    TOP: 17.6 Electrical Energy and Power

71. A resistor is made of a material that has a resistivity that is proportional to the current going through it. If the voltage across the resistor is doubled, what happens to the power dissipated by it?
    a. It doubles.
    b. It quadruples.
    c. It increases by a factor of $2^{3/2}$.
    d. It increases by a factor of $2^{1/2}$.

    ANS: C PTS: 1 DIF: 3
    TOP: 17.6 Electrical Energy and Power

72. An 8.00-Ω resistor is dissipating 100 watts. What are the current through it and the difference of potential across it?
    a. 12.5 A, 28.3 V

b. 3.54 A, 12.5 V
c. 3.54 A, 28.3 V
d. 28.3 A, 3.54 V

ANS: C PTS: 1 DIF: 2
TOP: 17.6 Electrical Energy and Power

73. A hot water heater operating at 240 V supplies to a quantity of water to warm it to the desired temperature of . What is the cost of the energy if the rate is $0.131/kWh?
a. The mass of the water is needed to answer this question.
b. The initial temperature of the water is needed to answer this question.
c. The mass of the water, the initial temperature of the water, and the time it took to heat the water is needed to answer this question.
d. $0.330.

ANS: D PTS: 1 DIF: 2
TOP: 17.6 Electrical Energy and Power

74. A light bulb with a tungsten filament is attached to a source of variable voltage. As the voltage is increased on the bulb,
a. the bulb's resistance decreases.
b. the bulb's resistance increases.
c. the current in the bulb decreases.
d. the power dissipated remains constant.

ANS: B PTS: 1 DIF: 1
TOP: 17.6 Electrical Energy and Power

75. Superconductivity was discovered by:
a. Volta.
b. Ohm.
c. Onnes.
d. Bednorz and Müller.

ANS: C PTS: 1 DIF: 1 TOP: 17.7. Superconductors

76. A superconducting wire's chief characteristic is which of the following?
a. an extremely great length
b. a large cross sectional area
c. an extremely high temperature
d. no resistance

ANS: D PTS: 1 DIF: 1 TOP: 17.7. Superconductors

77. When a superconductor's temperature drops below the critical temperature, its resistance:
a. equals that of a semiconductor of equal dimensions.
b. increases by two.
c. drops to zero.
d. reduces to one half.

ANS: C PTS: 1 DIF: 1 TOP: 17.7. Superconductors

78. Consider some material that has been cooled until it has become a superconductor. If it is cooled even further its resistance will:
a. increase.
b. decrease.

c. stay constant and non-zero.
d. None of the above.

ANS: D PTS: 1 DIF: 1 TOP: 17.7. Superconductors

79. When current is flowing in a superconductor, which statement is <u>not</u> true?
a. A battery is needed to keep the current going.
b. Electrical charges are moving.
c. The resistance is zero.
d. No power is given off in the form of heat.

ANS: A PTS: 1 DIF: 1 TOP: 17.7. Superconductors

80. Some superconductors are capable of carrying a very large quantity of current. If the measured current is 1.00×10^{5} A, how many electrons are moving through the superconductor per second? ($e = 1.60 \times 10^{-19}$ C)
a. 6.25×10^{23}
b. 3.12×10^{22}
c. 6.25×10^{21}
d. 3.12×10^{20}

ANS: A PTS: 1 DIF: 2 TOP: 17.7. Superconductors

81. A wire 1 mm in diameter is connected to one end of a wire of the same material 2 mm in diameter of twice the length. A voltage source is connected to the wires and a current is passed through the wires. If it takes time T for the average conduction electron to traverse the 1-mm wire, how long does it take for such an electron to traverse the 2-mm wire?
a. $T/4$
b. T
c. $4T$
d. $8T$

ANS: D PTS: 1 DIF: 3 TOP: Conceptual Questions

82. A wire has resistance R. A second wire has twice the length, twice the diameter, and twice the resistivity of the first wire. What is its resistance?
a. $8R$
b. R
c. $R/4$
d. The resistance is not given.

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Questions

83. Resistor A has twice the resistance of resistor B. When individually connected across a given potential difference, which one dissipates the most power; and when connected in series across the same potential difference, which one dissipates the most power?
a. A, A
b. A, B
c. B, B
d. B, A

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Questions

84. If a light bulb has half the resistance of a 100-W lightbulb, what would be its wattage? Assume both bulbs are attached to the same 120-V circuit.

a. 200 W
b. 50 W
c. 25 W
d. More information is needed.

ANS: A PTS: 1 DIF: 2 TOP: Conceptual Questions

85. When the voltage across a nonohmic resistor is doubled, the current through it triples. What happens to the power delivered to this resistor?
a. This cannot be answered with the information given.
b. The power decreases to 2/3 of the original amount.
c. The power increases to 1.5 times the original amount.
d. The power increases to 6 times the original amount.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Questions

CHAPTER 18—Direct-Current Circuits

MULTIPLE CHOICE

1. The two ends of a 3.0-Wresistor are connected to a 9.0-V battery. What is the current through the resistor?
   a. 27 A
   b. 6.3 A
   c. 3.0 A
   d. 0.33 A

   ANS: C PTS: 1 DIF: 1
   TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

2. The two ends of a 3.0-Wresistor are connected to a 9.0-V battery. What is the total power delivered by the battery to the circuit?
   a. 3.0 W
   b. 27 W
   c. 0.33 W
   d. 0.11 W

   ANS: B PTS: 1 DIF: 1
   TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

3. The basic function of an electromotive force in a circuit is to do which of the following?
   a. Convert electrical energy into some other form.
   b. Convert some other form of energy into electrical.
   c. Both choices (a) and (b) are valid.
   d. None of the above choices are valid.

   ANS: B PTS: 1 DIF: 1
   TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

4. Which voltage is not caused by a source of emf?
   a. the voltage across a charged capacitor
   b. the voltage across two copper-iron junctions at different temperatures
   c. the voltage across the terminals of a dry cell battery
   d. the voltage from an electric generator

   ANS: A PTS: 1 DIF: 1
   TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

5. The internal resistances of an ideal voltmeter and an ideal ammeter are respectively (*ideal* meaning the behavior of the system is not changed when using the meter):
   a. zero and zero.
   b. infinite and infinite.
   c. zero and infinite.
   d. infinite and zero.

   ANS: D PTS: 1 DIF: 2
   TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

6. When a 24.0-Wresistor is connected across a 12.0-V battery, a current of 482 mA flows. What is the internal resistance of the battery?

a. 0.02 W
b. 0.9 W
c. 25.0 W
d. 49.8 W

ANS: B PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

7. When a 24.0-Wresistor is connected across a 12.0-V battery, a current of 482 mA flows. What is the power output delivered by the emf of the battery?
a. 0.21 W
b. 5.57 W
c. 5.78 W
d. 6.00 W

ANS: C PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

8. When a 24.0-Wresistor is connected across a 12.0-V battery, a current of 482 mA flows. What is the resulting terminal voltage of the battery?
a. 0.4 V
b. 5.8 V
c. 11.6 V
d. 12.0 V

ANS: C PTS: 1 DIF: 3
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

9. Three 8.0-Wresistors are connected in series. What is their equivalent resistance?
a. 24.0 W
b. 8.0 W
c. 0.38 W
d. 0.13 W

ANS: A PTS: 1 DIF: 1
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

10. Three resistors connected in series each carry currents labeled I_1, I_2 and I_3. Which of the following expresses the value of the total current I_T in the system made up of the three resistors in series?
a. $I_T = I_1 + I_2 + I_3$
b. $I_T = (1/I_1 + 1/I_2 + 1/I_3)$
c. $I_T = I_1 = I_2 = I_3$
d. $I_T = (1/I_1 + 1/I_2 + 1/I_3)^{-1}$

ANS: C PTS: 1 DIF: 1
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

11. Three resistors connected in series have individual voltages labeled DV_1, DV_2 and DV_3, respectively. Which of the following expresses the value of the total voltage DV_T taken over the three resistors together?
a. $DV_T = DV_1 + DV_2 + DV_3$
b. $DV_T = (1/DV_1 + 1/DV_2 + 1/DV_3)$
c. $DV_T = DV_1 = DV_2 = DV_3$
d. $DV_T = (1/DV_1 + 1/DV_2 + 1/DV_3)^{-1}$

ANS: A PTS: 1 DIF: 1
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

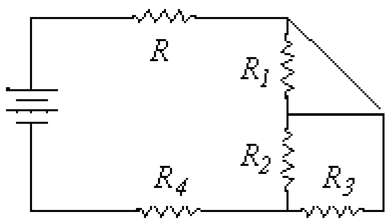
12. Three resistors with values of R_1, R_2 and R_3, respectively, are connected in series. Which of the following expresses the total resistance, R_T, of the three resistors?
a. $R_T = R_1 + R_2 + R_3$
b. $R_T = (1/R_1 + 1/R_2 + 1/R_3)$
c. $R_T = R_1 = R_2 = R_3$
d. $R_T = (1/R_1 + 1/R_2 + 1/R_3)^{-1}$

ANS: A PTS: 1 DIF: 1
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

13. Three resistors, with values of 2.0, 4.0 and 8.0 W, respectively, are connected in series. What is the overall resistance of this combination?
a. 0.58 W
b. 1.1 W
c. 7.0 W
d. 14.0 W

ANS: D PTS: 1 DIF: 1
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

14. Which resistor is in series with resistor R?



a. R_1
b. R_2
c. R_3
d. R_4

ANS: D PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

15. Three resistors, each with resistance R_1, are in series in a circuit. They are replaced by one equivalent resistor, R. Comparing this resistor to the first resistor of the initial circuit, which of the following is true?
a. The current through R equals the current through R_1.
b. The voltage across R equals the voltage across R_1.
c. The power given off by R equals the power given off by R_1.
d. R is less than R_1.

ANS: A PTS: 1 DIF: 1
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

16. If $R_1 < R_2 < R_3$, and if these resistors are connected in series in a circuit, which one dissipates the greatest power?
a. R_1
b. R_2
c. R_3

d. All are equal in power dissipation.

ANS: C PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

17. When a light bulb is turned on, its resistance increases until it reaches operating temperature. What happens to the current in the bulb as it is warming up?
a. It stays constant.
b. It increases.
c. It decreases.
d. It increases at first and then decreases.

ANS: C PTS: 1 DIF: 1
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

18. Resistors of values 8.0 W, 12.0 W, and 24.0 Ware connected in series across a battery with a small internal resistance. Which resistor dissipates the greatest power?
a. the 8.0-Wresistor
b. the 12.0-Wresistor
c. the 24.0-Wresistor
d. The answer depends on the internal resistance of the battery.

ANS: C PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

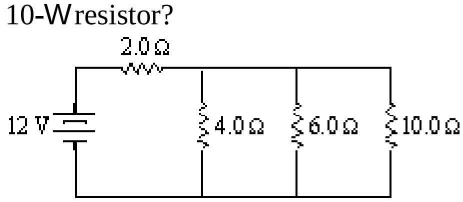
19. Three 8.0-Wresistors are connected in parallel. What is their equivalent resistance?
a. 0.054 W
b. 0.13 W
c. 0.38 W
d. 2.7 W

ANS: D PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

20. Three 4.0-Wresistors are connected in parallel to a 12.0-V battery. What is the current in any one of the resistors?
a. 16 A
b. 9.0 A
c. 3.0 A
d. 48 A

ANS: C PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

21. Three resistors connected in parallel have individual values of 4.0, 6.0 and 10.0 W, respectively. If this combination is connected in series with a 12-V battery and a 2.0-Wresistor, what is the current in the 10-Wresistor?



a. 0.59 A
b. 1.0 A
c. 11 A

d. 16 A

ANS: A PTS: 1 DIF: 3
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

22. Three resistors connected in parallel each carry currents labeled I_1, I_2 and I_3. Which of the following expresses the value of the total current I_T in the combined system?
a. $I_T = I_1 + I_2 + I_3$
b. $I_T = (1/I_1 + 1/I_2 + 1/I_3)$
c. $I_T = I_1 = I_2 = I_3$
d. $I_T = (1/I_1 + 1/I_2 + 1/I_3)^{-1}$

ANS: A PTS: 1 DIF: 1
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

23. Three resistors connected in parallel have the individual voltages labeled DV_1, DV_2 and DV_3, respectively. Which of the following expresses the total voltage DV_T across the three resistors when connected in this manner?
a. $DV_T = DV_1 + DV_2 + DV_3$
b. $DV_T = (1/DV_1 + 1/DV_2 + 1/DV_3)$
c. $DV_T = DV_1 = DV_2 = DV_3$
d. $DV_T = (1/DV_1 + 1/DV_2 + 1/DV_3)^{-1}$

ANS: C PTS: 1 DIF: 1
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

24. Three resistors with values R_1, R_2 and R_3, respectively, are connected in parallel. Which of the following expresses the total resistance, R_T, of the three resistors when connected in parallel?
a. $R_T = R_1 + R_2 + R_3$
b. $R_T = (1/R_1 + 1/R_2 + 1/R_3)$
c. $R_T = R_1 = R_2 = R_3$
d. $R_T = (1/R_1 + 1/R_2 + 1/R_3)^{-1}$

ANS: D PTS: 1 DIF: 1
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

25. Three resistors, with values of 2.0, 4.0 and 8.0 W, respectively, are connected in parallel. What is the overall resistance of this combination?
a. 0.58 W
b. 1.1 W
c. 7.0 W
d. 14.0 W

ANS: B PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

26. Two resistors of values 6.0 and 12.0 Ware connected in parallel. This combination in turn is hooked in series with a 4.0-Wresistor. What is the overall resistance of this combination?
a. 0.50 W
b. 2.0 W
c. 8.0 W
d. 22.0 W

ANS: C PTS: 1 DIF: 2

TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

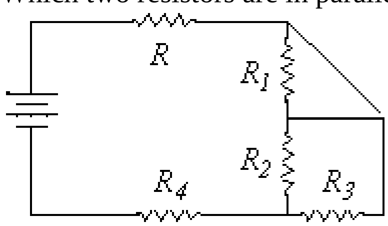
27. Two resistors of values 6.0 and 12.0 Ware connected in parallel. This combination in turn is hooked in series with a 2.0-Wresistor and a 24-V battery. What is the current in the 2-Wresistor?
   a. 2.0 A
   b. 4.0 A
   c. 6.0 A
   d. 12 A

ANS: B PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

28. Two resistors of values 6.0 and 12.0 Ware connected in parallel. This combination in turn is hooked in series with a 4.0-Wresistor and a 24-V battery. What is the current in the 6-Wresistor?
   a. 2.0 A
   b. 3.0 A
   c. 6.0 A
   d. 12 A

ANS: A PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

29. Which two resistors are in parallel with each other?



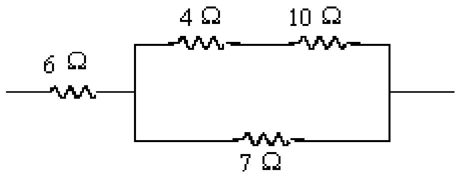
   a. R and R_4
   b. R_2 and R_3
   c. R_2 and R_4
   d. R and R_1

ANS: B PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

30. Three resistors, each with resistance R_1, are in parallel in a circuit. They are replaced by one equivalent resistor, R. Compare this resistor to the first resistor of the initial circuit. Which of the following statements is true?
   a. The current through R equals the current through R_1.
   b. The voltage across R equals the voltage across R_1.
   c. The power given off by R equals the power given off by R_1.
   d. R is greater than R_1.

ANS: B PTS: 1 DIF: 1
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

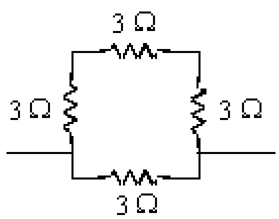
31. Resistors of values 6.0W, 4.0W, 10.0Wand 7.0Ware combined as shown. What is the equivalent resistance for this combination?



a. 2.3 W
b. 3.0 W
c. 10.7 W
d. 27 W

ANS: C PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

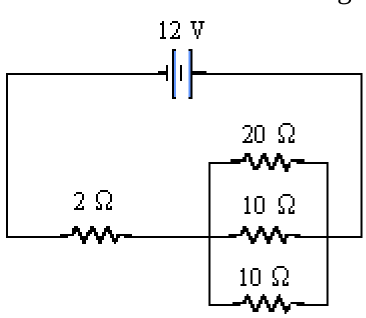
32. What is the equivalent resistance for these 3.00-Wresistors?



a. 1.33 W
b. 2.25 W
c. 3.00 W
d. 7.50 W

ANS: B PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

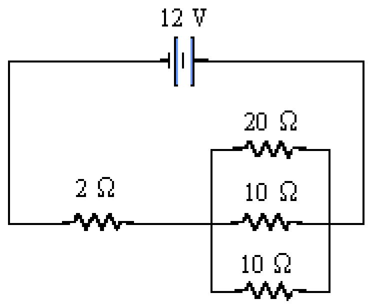
33. How much current is flowing in one of the 10-Wresistors?



a. 0.8 A
b. 2.0 A
c. 1.6 A
d. 2.4 A

ANS: A PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

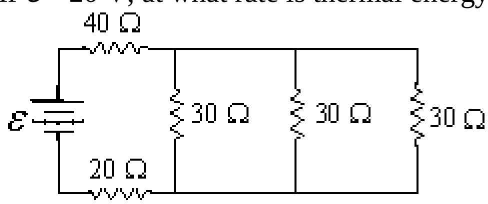
34. How much power is being dissipated by one of the 10-Wresistors?



a. 24 W
b. 9.6 W
c. 16 W
d. 6.4 W

ANS: D PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

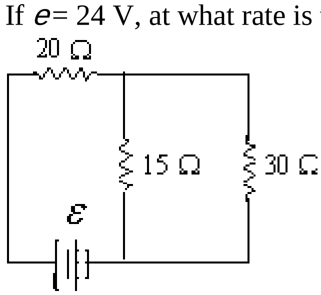
35. If *e*= 20 V, at what rate is thermal energy being generated in the 20-Wresistor?



a. 6.5 W
b. 1.6 W
c. 15 W
d. 26 W

ANS: B PTS: 1 DIF: 3
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

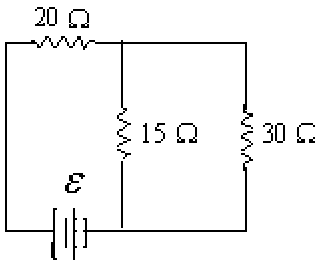
36. If *e*= 24 V, at what rate is thermal energy generated in the 20-Wresistor?



a. 13 W
b. 3.2 W
c. 23 W
d. 39 W

ANS: A PTS: 1 DIF: 3
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

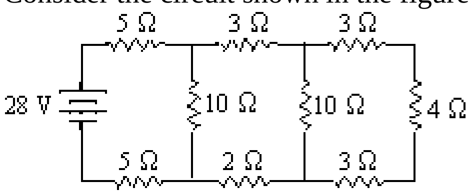
37. If *e*= 9.0 V, what is the current in the 15-Wresistor?



a. 0.20 A
b. 0.30 A
c. 0 10 A
d. 0.26 A

ANS: A PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

38. Consider the circuit shown in the figure. What power is dissipated by the entire circuit?



a. 14 W
b. 28 W
c. 52 W
d. 112 W

ANS: C PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

39. If $R_1 < R_2 < R_3$, and if these resistors are connected in parallel in a circuit, which one has the highest current?
a. R_1
b. R_2
c. R_3
d. All have the same current.

ANS: A PTS: 1 DIF: 1
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

40. Resistors of values 8.0 W, 12.0 W, and 24.0 Ware connected in parallel across a fresh battery. Which resistor dissipates the greatest power?
a. the 8.0-Wresistor
b. the 12.0-Wresistor
c. the 24.0-Wresistor
d. All dissipate the same power when in parallel.

ANS: A PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

41. Resistors having values of , , and are connected in series in the order given.The combination is then connected to a battery with the free end of the 4.0-Wresistor connected to the positive terminal and the free end of the 8.0-Wresistor connected to the negative terminal. When connected, the battery has a terminal voltage of . If the negative battery terminal has an electric potential of , what is the potential at the connection between the 4.0-Wand the 8.0-Wresistors?

a. 7.2 V
b. 7.0 V
c. 4.0 V
d. 7.4 V

ANS: B PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

42. Resistors having values of , , and are connected in series in the order given.The combination is then connected to a battery with the free end of the 4.0-Wresistor connected to the positive terminal and the free end of the 8.0-Wresistor connected to the negative terminal. When connected, the battery has a terminal voltage of . If the battery is disconnected, its terminal voltage is 9.4 V. What is the internal resistance of the battery?

a. 0.4
b. 0.8
c. 0.05
d. 0.02

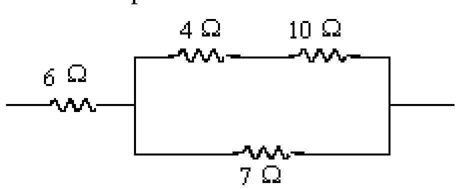
ANS: B PTS: 1 DIF: 2
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

43. Resistors having values of , , and are connected in series in the order given.The combination is then connected to a battery with the free end of the 4.0-Wresistor connected to the positive terminal and the free end of the 8.0-Wresistor connected to the negative terminal. When connected, the battery has a terminal voltage of . If the battery is disconnected, its terminal voltage is 9.4 V. When the battery is connected, what is the power dissipated by the internal resistance?

a. 0.2 W
b. 0.4 W
c. 3 W
d. 0.3 W

ANS: A PTS: 1 DIF: 3
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

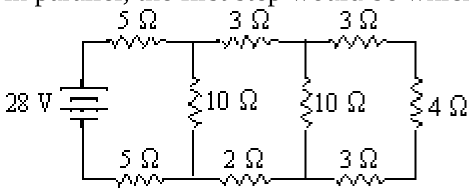
44. To find the equivalent resistance of the combination of resistors shown below by the method of possibly repeated applications of combining resistors in series and /or combining resistors in parallel, the first step would be which of the following?



a. Combine the 6.0 Wand the 7.0 Win series.
b. Combine either the 4.0 W and the 10.0 Win parallel or the 7.0 W and the 10.0 Win parallel first, since either could be the first step with the other the second step.
c. Combine the 4.0 Wand the 10.0 Win series.
d. Combine the 6.0 W, the 4.0 W, and the 10.0 Win series in a single step.

ANS: C PTS: 1 DIF: 1
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

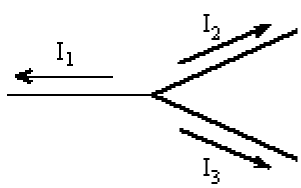
45. To find the equivalent resistance of the combination of resistors shown across the 28-V battery by the method of possibly repeated applications of combining resistors in series and /or combining resistors in parallel, the first step would be which of the following?



a. Combine the two 10 W in parallel since they can be done in your head.
b. Combine, in series, the two 3-W resistors and the 4-W resistor in the right-hand branch of the circuit.
c. Combine the seven resistors (two 5 W, three 3 W, one 2 W and one 4 W) in the outer loop of the circuit in series.
d. This problem cannot be done by combining series and parallel resistors.

ANS: B PTS: 1 DIF: 1
TOP: 18.1 Sources of emf | 18.2 Resistors in Series | 18.3 Resistors in Parallel

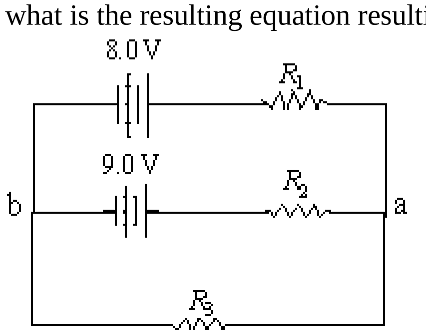
46. What is Kirchhoff's 1st equation for this junction?



a. $I_1 = I_2 + I_3$
b. $I_2 = I_1 + I_2$
c. $I_3 = I_1 + I_2$
d. $I_1 + I_2 + I_3 = 0$

ANS: D PTS: 1 DIF: 1
TOP: 18.4 Kirchhoff's Rules and Complex DC Circuits

47. If I_1 goes to the right through R_1, I_2 goes to the right through R_2, and I_3 goes to the right through R_3, what is the resulting equation resulting from applying Kirchhoff's junction rule at point b?

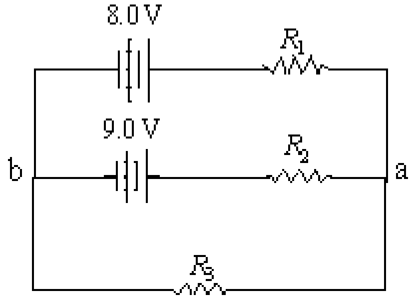


a. $I_1 + I_2 + I_3 = 0$
b. $I_1 + I_2 - I_3 = 0$
c. $I_1 - I_2 + I_3 = 0$
d. $I_1 - I_2 - I_3 = 0$

ANS: A PTS: 1 DIF: 1

TOP: 18.4 Kirchhoff's Rules and Complex DC Circuits

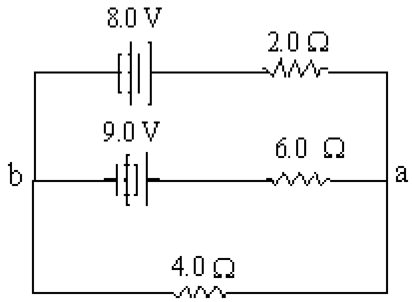
48. If I_1 goes to the right through R_1, I_2 goes to the right through R_2, and I_3 goes to the right through R_3, what is the resulting equation resulting from applying Kirchhoff's loop rule for a clockwise loop around the perimeter of the circuit?



a. $8.0\text{ V} + I_1R_1 + I_3R_3 = 0$
b. $8.0\text{ V} + I_1R_1 - I_3R_3 = 0$
c. $8.0\text{ V} - I_1R_1 + I_3R_3 = 0$
d. $-8.0\text{ V} + I_1R_1 + I_3R_3 = 0$

ANS: C PTS: 1 DIF: 2
TOP: 18.4 Kirchhoff's Rules and Complex DC Circuits

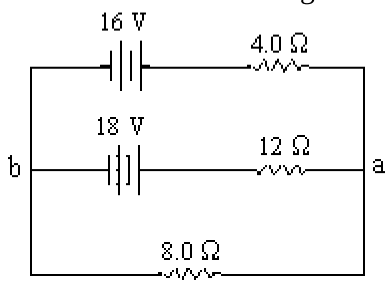
49. What is the current through the 2-Wresistor?



a. 1.0 A
b. 0.50 A
c. 1.5 A
d. 2.0 A

ANS: A PTS: 1 DIF: 3
TOP: 18.4 Kirchhoff's Rules and Complex DC Circuits

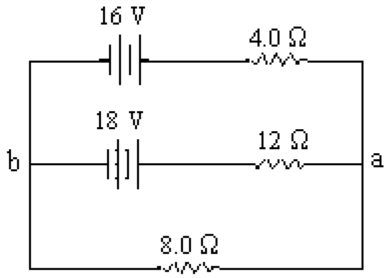
50. What is the current through the 8-Wresistor?



a. 1.0 A
b. 0.50 A
c. 1.5 A
d. 2.0 A

ANS: C PTS: 1 DIF: 3
TOP: 18.4 Kirchhoff's Rules and Complex DC Circuits

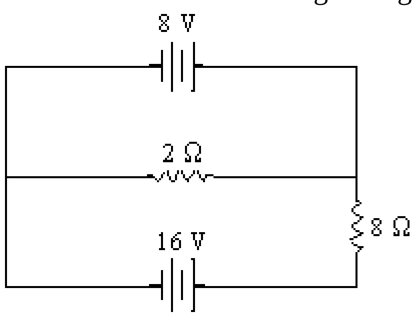
51. What is the potential difference between points a and b?



a. 6 V
b. 8 V
c. 12 V
d. 24 V

ANS: C PTS: 1 DIF: 3
TOP: 18.4 Kirchhoff's Rules and Complex DC Circuits

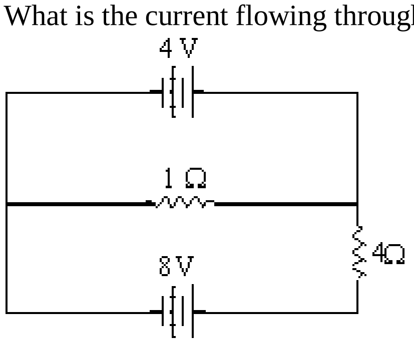
52. What is the current flowing through the 2-Wresistor?



a. 2 A
b. 3 A
c. 4 A
d. 6 A

ANS: C PTS: 1 DIF: 2
TOP: 18.4 Kirchhoff's Rules and Complex DC Circuits

53. What is the current flowing through the 4-Wresistor?



a. 1 A
b. 2 A
c. 3 A
d. 6 A

ANS: A PTS: 1 DIF: 2

TOP: 18.4 Kirchhoff's Rules and Complex DC Circuits

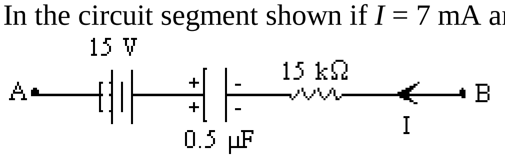
54. Four 1.5-volt AA batteries in series power a transistor radio. If the batteries hold a total charge of 240 C, how long will they last if the radio has a resistance of 200 W?
    a. 1.1 h
    b. 2.2 h
    c. 4.1 h
    d. 13 h

ANS: B PTS: 1 DIF: 2
TOP: 18.4 Kirchhoff's Rules and Complex DC Circuits

55. In a circuit, a current of 2.0 A is drawn from a battery. The current then divides and passes through two resistors in parallel. One of the resistors has a value of 64 W and the current through it is 0.40 A. What is the value of the other resistor?
    a. 8.0 W
    b. 16 W
    c. 24 W
    d. 32 W

ANS: B PTS: 1 DIF: 2
TOP: 18.4 Kirchhoff's Rules and Complex DC Circuits

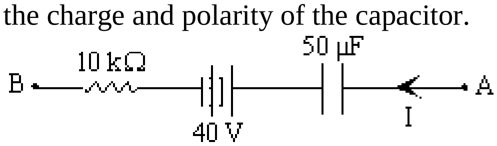
56. In the circuit segment shown if I = 7 mA and Q = 50 μC, what is the potential difference, $V_A - V_B$?



    a. - 40 V
    b. +40 V
    c. +20 V
    d. –20 V

ANS: D PTS: 1 DIF: 3
TOP: 18.4 Kirchhoff's Rules and Complex DC Circuits

57. If I = 2.0 mA and the potential difference, $V_A - V_B$ = +30 V in the circuit segment shown, determine the charge and polarity of the capacitor.



    a. 1.5 mC, left plate is positive
    b. 1.5 mC, right plate is positive
    c. 0.50 mC, left plate is positive
    d. 0.50 mC, right plate is positive

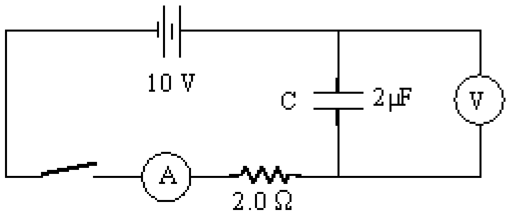
ANS: A PTS: 1 DIF: 3
TOP: 18.4 Kirchhoff's Rules and Complex DC Circuits

58. If one doubles the emfs in a circuit and doubles the resistances in the circuit at the same time, what happens to the currents through the resistors? Assume there are only emfs and resistors in the circuit.
    a. They stay the same.
    b. They double.
    c. They quadruple.

d. They halve.

ANS: A PTS: 1 DIF: 2
TOP: 18.4 Kirchhoff's Rules and Complex DC Circuits

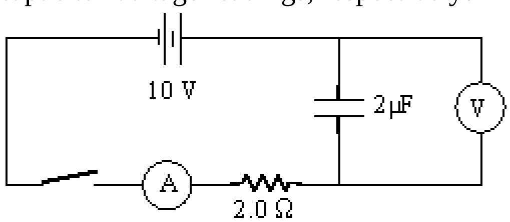
59. A 10-V-emf battery is connected in series with the following: a 2-μF capacitor, a 2-Wresistor, an ammeter, and a switch, initially open; a voltmeter is connected in parallel across the capacitor. At the instant the switch is closed, what are the current and capacitor voltage readings, respectively?



a. zero A, 10 V
b. zero A, zero V
c. 5 A, zero V
d. 5 A, 10 V

ANS: C PTS: 1 DIF: 2 TOP: 18.5 RC Circuits

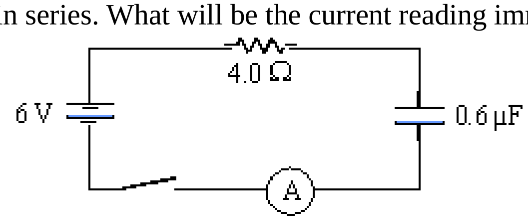
60. A 10-V-emf battery is connected in series with the following: a 2-nF capacitor, a 2-Wresistor, an ammeter, and a switch, initially open; a voltmeter is connected in parallel across the capacitor. After the switch has been closed for a relatively long period (several seconds, say), what are the current and capacitor voltage readings, respectively?



a. zero A, 10 V
b. zero A, zero V
c. 5 A, zero V
d. 5 A, 10 V

ANS: A PTS: 1 DIF: 2 TOP: 18.5 RC Circuits

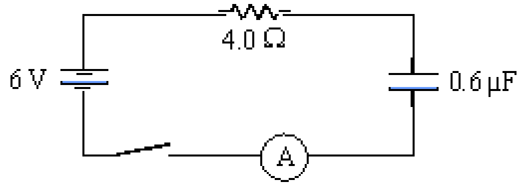
61. A circuit contains a 6.0-V battery, a 4.0-Wresistor, a 0.60-μF capacitor, an ammeter, and a switch all in series. What will be the current reading immediately after the switch is closed?



a. zero
b. 0.75 A
c. 1.5 A
d. 10 A

ANS: C PTS: 1 DIF: 2 TOP: 18.5 RC Circuits

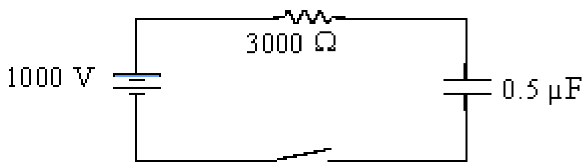
62. A circuit contains a 6.0-V battery, a 4.0-Wresistor, a 0.60-μF capacitor, an ammeter, and a switch in series. What will be the charge on the capacitor 10 min after the switch is closed?



a. zero
b. 0.10 *m*C
c. 3.6 *m*C
d. 2.4 *m*C

ANS: C PTS: 1 DIF: 2 TOP: 18.5 RC Circuits

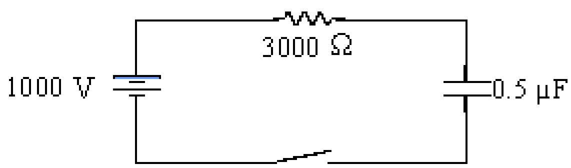
63. A 1 000-V battery, a 3 000-Wresistor, and a 0.50-μF capacitor are connected in series with a switch. The capacitor is initially uncharged. What is the value of the current the moment after the switch is closed?



a. 0.39 A
b. 0.33 A
c. 0.84 A
d. 2 000 A

ANS: B PTS: 1 DIF: 2 TOP: 18.5 RC Circuits

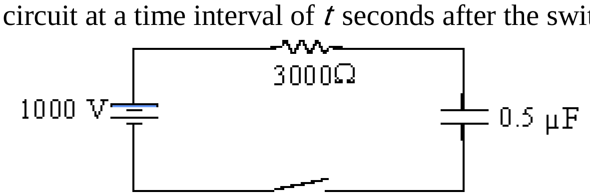
64. A 1 000-V battery, a 3 000-Wresistor and a 0.50-μF capacitor are connected in series with a switch. The time constant for such a circuit, designated by the Greek letter, *t*, is defined as the time required to charge the capacitor to 63% of its capacity after the switch is closed. What is the value of *t* for this circuit?



a. 6.0 ´ 10^{9} s
b. 1.7 ´ 10^{-10} s
c. 1.7 ´ 10^{-7} s
d. 1.5 ´ 10^{-3} s

ANS: D PTS: 1 DIF: 2 TOP: 18.5 RC Circuits

65. A 1 000-V battery, a 3 000-Wresistor, and a 0.50-*m*F capacitor are connected in series with a switch. The time constant for such a circuit, designated by the Greek letter, *t*, is defined as the time that the capacitor takes to charge to 63% of its capacity after the switch is closed. What is the current in the circuit at a time interval of *t* seconds after the switch has been closed?



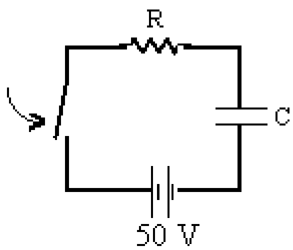
a. 0.14 A
b. 0.21 A
c. 0.12 A
d. 0.32 A

ANS: C PTS: 1 DIF: 3 TOP: 18.5 RC Circuits

66. A certain capacitor is charged to 10 V and then, at $t = 0$, allowed to discharge through a certain resistor. There will be a certain time before the voltage across the capacitor reaches 5 V. This time can be decreased for this circuit by increasing:
a. the size of the capacitor.
b. the size of the resistor.
c. the size of the time constant.
d. None of the above.

ANS: D PTS: 1 DIF: 2 TOP: 18.5 RC Circuits

67. A series *RC* circuit has a time constant of 1.0 s. The battery has a voltage of 50 V and the maximum current just after closing the switch is 500 mA. The capacitor is initially uncharged. What is the charge on the capacitor 2.0 s after the switch is closed?



a. 0.43 C
b. 0 66 C
c. 0.86 C
d. 0.99 C

ANS: A PTS: 1 DIF: 3 TOP: 18.5 RC Circuits

68. A voltage source of 10 V is connected to a series *RC* circuit where $R = 2.0 \times 10^{6}\ \Omega$, and $C = 3.0\ \mu\text{F}$. Find the amount of time required for the current in the circuit to decay to 5% of its original value. Hint: This is the same amount of time for the capacitor to reach 95% of its maximum charge.
a. 3.0 s
b. 6.0 s
c. 9.0 s
d. 18 s

ANS: D PTS: 1 DIF: 3 TOP: 18.5 RC Circuits

69. A series *RC* circuit, which is made from a battery, a switch, a resistor, and a 3.0-μF capacitor, has a time constant of 9.0 ms. If an additional 6.0-μF is added in series to the 3.0-μF capacitor, what is the resulting time constant?
a. 4.0 ms
b. 6.0 ms
c. 10 ms
d. This cannot be found without the value of the resistance being given.

ANS: B PTS: 1 DIF: 3 TOP: 18.5 RC Circuits

70. The following three appliances are connected to a 120-V house circuit: i) toaster, 1 200 W, ii) coffee pot, 750 W, and iii) microwave, 800 W. If all were operated at the same time, what total current would they draw?
  a. 3.0 A
  b. 5.0 A
  c. 10 A
  d. 23 A

  ANS: D PTS: 1 DIF: 2
  TOP: 18.6 Household Circuits | 18.7 Electrical Safety

71. What is the maximum number of 60-W light bulbs you can connect in parallel in a 120-V home circuit without tripping the 30-A circuit breaker?
  a. 11
  b. 35
  c. 59
  d. 3 600

  ANS: C PTS: 1 DIF: 2
  TOP: 18.6 Household Circuits | 18.7 Electrical Safety

72. A hair dryer draws 1 200 W, a curling iron draws 800 W, and an electric light fixture draws 500 W. If all three of these appliances are operating in parallel on a 120-V circuit, what is the total current drawn?
  a. 19.4 A
  b. 20.8 A
  c. 25.4 A
  d. 36.7 A

  ANS: B PTS: 1 DIF: 2
  TOP: 18.6 Household Circuits | 18.7 Electrical Safety

73. Household circuits are wired in ________.
  a. series
  b. parallel
  c. both series and parallel
  d. neither series nor parallel

  ANS: B PTS: 1 DIF: 1
  TOP: 18.6 Household Circuits | 18.7 Electrical Safety

74. In applications where electrical shocks may be more likely, such as around water in kitchens and bathrooms, special outlets called GFI's are used. What does GFI stand for?
  a. get free instantly
  b. ground-fault interrupter
  c. give fast interruption
  d. gravity-free insulator

  ANS: B PTS: 1 DIF: 1
  TOP: 18.6 Household Circuits | 18.7 Electrical Safety

75. Household 120-V outlets are made to accept three-pronged plugs. One of the prongs attaches to the "live" wire at 120 V, and another attaches to the "neutral" wire that is connected to ground. What is the round third prong for?
  a. It serves as a backup to the hot wire.

b. It lets the appliance run if the neutral wire breaks.
c. It connects the case of the appliance directly to ground for safety purposes.
d. Nothing electrical, it is for mechanical sturdiness.

ANS: C PTS: 1 DIF: 1
TOP: 18.6 Household Circuits | 18.7 Electrical Safety

76. Three resistors, each of different value, are used in a circuit with a power source supplying 12 volts. For which of the following resistor combinations is the total power supplied the greatest?
a. all three resistors in series
b. all three resistors in parallel
c. two of the resistors in parallel with the third resistor in series with the parallel pair
d. This cannot be found until it is known which resistor is in series with the parallel pair.

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Questions

77. Kirchhoff's rules are the junction rule and the loop rule. Which of the following statements is true?
a. Both rules are based on the conservation of charge.
b. Both rules are based on the conservation of energy.
c. The junction rule is based on the conservation of charge, and the loop rule is based on the conservation of energy.
d. The junction rule is based on the conservation of energy, and the loop rule is based on the conservation of charge.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Questions

78. Using a capacitor and two different value resistors, which of the following combinations in an *RC* circuit would give the greatest time constant?
a. the capacitor in series with both resistors in series with each other
b. the capacitor in series with both resistors in parallel with each other
c. the capacitor in series with the higher value resistor
d. the capacitor in series with the lower value resistor

ANS: A PTS: 1 DIF: 2 TOP: Conceptual Questions

79. Using a resistor and two different value capacitors, which of the following combinations in an RC circuit would give the greatest time constant?
a. the resistor in series with both capacitors in series with each other
b. the resistor in series with both capacitors in parallel with each other
c. the resistor in series with the larger value capacitor
d. the resistor in series with the lower value capacitor

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Questions

80. In an RC circuit using two capacitors in series with two resistors, which of the following combinations would give the greatest time constant?
a. both capacitors in series placed in series with both resistors in series
b. both capacitors in parallel placed in series with both resistors in parallel
c. both capacitors in series placed in series with both resistors in parallel
d. both capacitors in parallel placed in series with both resistors in series

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Questions

CHAPTER 19—Magnetism

MULTIPLE CHOICE

1. Electrical charges and magnetic poles have many similarities, but one difference is:
   a. opposite magnetic poles repel.
   b. one magnetic pole cannot create magnetic poles in other materials.
   c. a magnetic pole cannot be isolated.
   d. magnetic poles do not produce magnetic fields.

   ANS: C PTS: 1 DIF: 1 TOP: 19.1 Magnets

2. A *soft* magnetic material has which property?
   a. It cannot be magnetized.
   b. It is easy to magnetize.
   c. It is hard to magnetize.
   d. It attracts slowly moving charges.

   ANS: B PTS: 1 DIF: 1 TOP: 19.1 Magnets

3. Which of the following is <u>not</u> a *hard* magnetic material?
   a. iron
   b. cobalt
   c. nickel
   d. both b and c

   ANS: A PTS: 1 DIF: 1 TOP: 19.1 Magnets

4. Geophysicists today generally attribute the existence of the Earth's magnetic field to which of the following?
   a. convection currents within the liquid interior
   b. iron ore deposits in the crust
   c. nickel-iron deposits in the crust
   d. solar flares

   ANS: A PTS: 1 DIF: 1 TOP: 19.2 Earth's Magnetic Field

5. The term magnetic declination refers to which of the following?
   a. angle between Earth's magnetic field and Earth's surface
   b. Earth's magnetic field strength at the equator
   c. tendency for Earth's field to reverse itself
   d. angle between directions to true north and magnetic north

   ANS: D PTS: 1 DIF: 1 TOP: 19.2 Earth's Magnetic Field

6. The magnetic field of the Earth is believed responsible for which of the following?
   a. deflection of both charged and uncharged cosmic rays
   b. deflection of charged cosmic rays
   c. ozone in the upper atmosphere
   d. solar flares

   ANS: B PTS: 1 DIF: 1 TOP: 19.2 Earth's Magnetic Field

7. The magnetic pole of the Earth nearest the geographic North Pole corresponds to which of the following?
   a. a magnetic north pole
   b. a magnetic south pole
   c. a magnetic arctic pole
   d. a magnetic Antarctic pole

   ANS: B PTS: 1 DIF: 1 TOP: 19.2 Earth's Magnetic Field

8. Which of the following locations has the smallest (in magnitude) magnetic declination?
   a. Washington state
   b. the South Carolina – Georgia border
   c. the San Francisco – Oakland area
   d. western Colorado

   ANS: B PTS: 1 DIF: 1 TOP: 19.2 Earth's Magnetic Field

9. The dip angle is:
   a. another term for magnetic declination.
   b. a measure of the tendency for a compass to point south.
   c. close to or at zero near the equator.
   d. close to or at zero just north of Hudson Bay.

   ANS: C PTS: 1 DIF: 1 TOP: 19.2 Earth's Magnetic Field

10. An electron which moves with a speed of 3.0×10^{4} m/s parallel to a uniform magnetic field of 0.40 T experiences a force of what magnitude? ($e = 1.6 \times 10^{-19}$ C)
    a. 4.8×10^{-14} N
    b. 1.9×10^{-15} N
    c. 2.2×10^{-24} N
    d. zero

    ANS: D PTS: 1 DIF: 1 TOP: 19.3 Magnetic Fields

11. The force on a charged particle created by its motion in a magnetic field is maximum at what angle between the particle velocity and field?
    a. zero
    b. 180°
    c. 90°
    d. 45°

    ANS: C PTS: 1 DIF: 1 TOP: 19.3 Magnetic Fields

12. Assume that a uniform magnetic field is directed into this page. If an electron is released with an initial velocity directed from the bottom edge to the top edge of the page, which of the following describes the direction of the resultant force acting on the electron?
    a. out of the page
    b. to the right
    c. to the left
    d. into the page

    ANS: B PTS: 1 DIF: 1 TOP: 19.3 Magnetic Fields

13. A proton is released such that its initial velocity is from right to left across this page. The proton's path, however, is deflected in a direction toward the bottom edge of the page due to the presence of a uniform magnetic field. What is the direction of this field?
a. out of the page
b. into the page
c. from bottom edge to top edge of the page
d. from right to left across the page

ANS: B PTS: 1 DIF: 2 TOP: 19.3 Magnetic Fields

14. A proton is released such that it has an initial speed of 4.0×10^{5} m/s from left to right across the page. A magnetic field of 1.2 T is present at an angle of 30° to the horizontal direction (or positive *x* axis). What is the magnitude of the force experienced by the proton? ($q_p = 1.6 \times 10^{-19}$ C)
a. 4.8×10^{-25} N
b. 1.3×10^{-19} N
c. 3.8×10^{-14} N
d. 7.5×10^{3} N

ANS: C PTS: 1 DIF: 2 TOP: 19.3 Magnetic Fields

15. A proton moving at a speed of 3.8×10^{6} m/s cuts across the lines of a magnetic field at an angle of 70°. The strength of the field is 0.25×10^{-4} T. What is the magnitude of the force acting on the proton? ($q_p = 1.6 \times 10^{-19}$ C)
a. 5.1×10^{-18} N
b. 9.0×10^{-18} N
c. 1.4×10^{-17} N
d. 2.3×10^{-17} N

ANS: C PTS: 1 DIF: 2 TOP: 19.3 Magnetic Fields

16. A proton moves across the Earth's equator in a northeasterly direction. At this point the Earth's magnetic field has a direction due north and is parallel to the surface. What is the direction of the force acting on the proton at this instant?
a. toward the northwest
b. out of the Earth's surface
c. into the Earth's surface
d. toward the northeast

ANS: B PTS: 1 DIF: 1 TOP: 19.3 Magnetic Fields

17. The right-hand rule allows one to find a property of the interaction of a magnetic field with a charged particle. The right-hand rule applied to moving charges:
a. results in positive charges moving clockwise.
b. results in negative charges moving clockwise.
c. can be used for positive charges only.
d. gives the direction of the force on a charge moving in a magnetic field.

ANS: D PTS: 1 DIF: 1 TOP: 19.3 Magnetic Fields

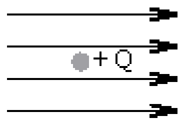
18. Different units can be used to measure the same physical quantity, differing only by some multiplicative factor. The cgs unit for magnetic field, the gauss, is equal to ________ tesla.
a. 10^{4}
b. 10^{-4}
c. 0.5
d. These units do not measure the same physical quantity.

ANS: B PTS: 1 DIF: 1 TOP: 19.3 Magnetic Fields

19. If a proton is released at the equator and falls toward the Earth under the influence of gravity, the magnetic force on the proton will be toward the:
a. north.
b. south.
c. east.
d. west.

ANS: C PTS: 1 DIF: 1 TOP: 19.3 Magnetic Fields

20. A stationary positive charge $+Q$ is located in a magnetic field B, which is directed toward the right as indicated. The direction of the magnetic force on Q is:



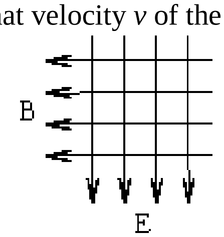
a. toward the right.
b. up.
c. down.
d. There is no magnetic force.

ANS: D PTS: 1 DIF: 1 TOP: 19.3 Magnetic Fields

21. There is a magnetic force on a particle. It is possible that the particle is:
a. uncharged.
b. stationary.
c. moving in the direction of the magnetic field.
d. not part of a wire.

ANS: D PTS: 1 DIF: 1 TOP: 19.3 Magnetic Fields

22. An electron moves through a region of crossed electric and magnetic fields. The electric field E = 2 000 V/m and is directed straight down. The magnetic field B = 0.80 T and is directed to the left. For what velocity v of the electron into the paper will the electric force exactly cancel the magnetic force?



a. 2 500 m/s
b. 4 000 m/s
c. 5 000 m/s
d. 8 000 m/s

ANS: A PTS: 1 DIF: 2 TOP: 19.3 Magnetic Fields

23. A proton and a deuteron are moving with equal velocities perpendicular to a uniform magnetic field. A deuteron has the same charge as the proton but has twice its mass. The ratio of the magnetic force on the proton to that on the deuteron is:
a. 0.5.
b. 1.
c. 2.
d. There is no magnetic force in this case.

ANS: B PTS: 1 DIF: 2 TOP: 19.3 Magnetic Fields

24. A proton and a deuteron are moving with equal velocities perpendicular to a uniform magnetic field. A deuteron has the same charge as the proton but has twice its mass. The ratio of the acceleration of the proton to that of the deuteron is:
    a. 0.5.
    b. 1.
    c. 2.
    d. There is no acceleration in this case.

ANS: C PTS: 1 DIF: 2 TOP: 19.3 Magnetic Fields

25. A 2.0-m wire segment carrying a current of 0.60 A oriented parallel to a uniform magnetic field of 0.50 T experiences a force of what magnitude?
    a. 6.7 N
    b. 0.30 N
    c. 0.15 N
    d. zero

ANS: D PTS: 1 DIF: 2
TOP: 19.4 Magnetic Force on a Current-Carrying Conductor

26. A copper wire of length 25 cm is in a magnetic field of 0.20 T. If it has a mass of 10 g, what is the minimum current through the wire that would cause a magnetic force equal to its weight?
    a. 1.3 A
    b. 1.5 A
    c. 2.0 A
    d. 4.9 A

ANS: C PTS: 1 DIF: 2
TOP: 19.4 Magnetic Force on a Current-Carrying Conductor

27. Which of the following devices makes use of an electromagnet?
    a. loudspeaker
    b. galvanometer
    c. both A and B
    d. None of the above.

ANS: C PTS: 1 DIF: 1
TOP: 19.4 Magnetic Force on a Current-Carrying Conductor

28. The force exerted on a current-carrying wire located in an external magnetic field is directly proportional to which of the following?
    a. current strength
    b. field strength
    c. both A and B
    d. None of the above are valid.

ANS: C PTS: 1 DIF: 1
TOP: 19.4 Magnetic Force on a Current-Carrying Conductor

29. The direction of the force on a current carrying wire located in an external magnetic field is which of the following?
    a. perpendicular to the current
    b. perpendicular to the field

c. Both choices A and B are valid.
d. None of the above are valid.

ANS: C PTS: 1 DIF: 1
TOP: 19.4 Magnetic Force on a Current-Carrying Conductor

30. A current-carrying wire of length 50 cm is positioned perpendicular to a uniform magnetic field. If the current is 10.0 A and it is determined that there is a resultant force of 3.0 N on the wire due to the interaction of the current and field, what is the magnetic field strength?
a. 0.60 T
b. 1.5 T
c. 1.8×10^{-3} T
d. 6.7×10^{-3} T

ANS: A PTS: 1 DIF: 2
TOP: 19.4 Magnetic Force on a Current-Carrying Conductor

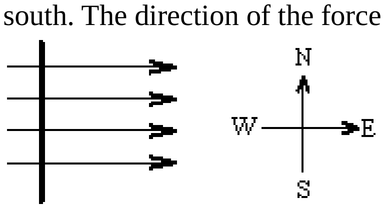
31. A horizontal wire of length 3.0 m carries a current of 6.0 A and is oriented so that the current direction is 50° S of W. The Earth's magnetic field is due north at this point and has a strength of 0.14×10^{-4} T. What is the size of the force on the wire?
a. 0.28×10^{-4} N
b. 2.5×10^{-4} N
c. 1.9×10^{-4} N
d. 1.6×10^{-4} N

ANS: D PTS: 1 DIF: 2
TOP: 19.4 Magnetic Force on a Current-Carrying Conductor

32. A horizontal wire of length 3.0 m carries a current of 6.0 A and is oriented so that the current direction is 50° S of W. The Earth's magnetic field is due north at this point and has a strength of 0.14×10^{-4} T. What is the direction of the force on the wire?
a. out of the Earth’s surface
b. toward the Earth’s surface
c. due east
d. 40° S of E

ANS: B PTS: 1 DIF: 2
TOP: 19.4 Magnetic Force on a Current-Carrying Conductor

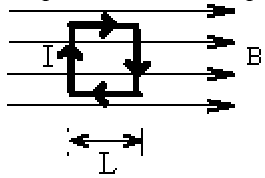
33. A wire is lying horizontally in the north-south direction and the horizontal magnetic field is toward the east. Some positive charges in the wire move north and an equal number of negative charges move south. The direction of the force on the wire will be:



a. east.
b. down, into the page.
c. up, out of the page.
d. There is no magnetic force.

ANS: B PTS: 1 DIF: 2
TOP: 19.4 Magnetic Force on a Current-Carrying Conductor

34. There is a current I flowing in a clockwise direction in a square loop of wire that is in the plane of the paper. If the magnetic field B is toward the right, and if each side of the loop has length L, then the net magnetic <u>force</u> acting on the loop is:



a. 2*ILB*.
b. *ILB*.
c. IBL^2.
d. zero.

ANS: D PTS: 1 DIF: 2
TOP: 19.4 Magnetic Force on a Current-Carrying Conductor

35. A circular current loop is placed in an external magnetic field. How is the torque related to the radius of the loop?
a. directly proportional to radius
b. inversely proportional to radius
c. directly proportional to radius squared
d. inversely proportional to radius squared

ANS: C PTS: 1 DIF: 1
TOP: 19.5 Torque on a Current Loop and Electric Motors

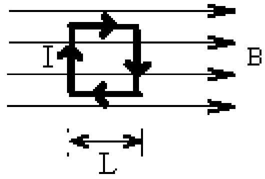
36. A circular loop carrying a current of 1.0 A is oriented in a magnetic field of 0.35 T. The loop has an area of 0.24 m^2 and is mounted on an axis, perpendicular to the magnetic field, which allows the loop to rotate. If the plane of the loop is oriented parallel to the field, what torque is created by the interaction of the loop current and the field?
a. 5.8 N×m
b. 0.68 N×m
c. 0.084 N×m
d. 0.017 N×m

ANS: C PTS: 1 DIF: 2
TOP: 19.5 Torque on a Current Loop and Electric Motors

37. A circular loop carrying a current of 1.0 A is oriented in a magnetic field of 0.35 T. The loop has an area of 0.24 m^2 and is mounted on an axis, perpendicular to the magnetic field, which allows the loop to rotate. What is the torque on the loop when its plane is oriented at a 25° angle to the field?
a. 4.6 N×m
b. 0.076 N×m
c. 0.051 N×m
d. 0.010 N×m

ANS: B PTS: 1 DIF: 3
TOP: 19.5 Torque on a Current Loop and Electric Motors

38. There is a current I flowing in a clockwise direction in a square loop of wire that is in the plane of the paper. If the magnetic field B is toward the right, and if each side of the loop has length L, then the net magnetic torque acting on the loop is:



a. 2*ILB*.
b. *ILB*.
c. IBL^2.
d. zero.

ANS: C PTS: 1 DIF: 2
TOP: 19.5 Torque on a Current Loop and Electric Motors

39. A rectangular coil (0.20 m $\times$ 0.80 m) has 200 turns and is in a uniform magnetic field of 0.30 T. If the orientation of the coil is varied through all possible positions, the maximum torque on the coil by magnetic forces is 0.080 N·m. What is the current in the coil?
a. 5.0 mA
b. 1.7 A
c. 8.3 mA
d. 1.0 A

ANS: C PTS: 1 DIF: 3
TOP: 19.5 Torque on a Current Loop and Electric Motors

40. A circular coil (radius = 0.40 m) has 160 turns and is in a uniform magnetic field. If the orientation of the coil is varied through all possible positions, the maximum torque on the coil by magnetic forces is 0.16 N·m when the current in the coil is 4.0 mA. What is the magnitude of the magnetic field?
a. 0.37 T
b. 1.6 T
c. 0.50 T
d. 1.2 T

ANS: C PTS: 1 DIF: 3
TOP: 19.5 Torque on a Current Loop and Electric Motors

41. A proton moving with a speed of 3.0×10^5 m/s perpendicular to a uniform magnetic field of 0.20 T will follow which of the paths described below? ($q_p = 1.6 \times 10^{-19}$ C and $m_p = 1.67 \times 10^{-27}$ kg)
a. a straight line path
b. a circular path of 1.6 cm radius
c. a circular path of 3.1 cm radius
d. a circular path of 0.78 cm radius

ANS: B PTS: 1 DIF: 2
TOP: 19.6 Motion of a Charged Particle in a Magnetic Field

42. A deuteron, with the same charge but twice the mass of a proton, moves with a speed of 3.0×10^5 m/s perpendicular to a uniform magnetic field of 0.20 T. Which of the paths described below would it follow? ($q_p = 1.6 \times 10^{-19}$ C and $m_d = 3.34 \times 10^{-27}$ kg)
a. a straight line path
b. a circular path of 1.6 cm radius
c. a circular path of 3.1 cm radius
d. a circular path of 0.78 cm radius

ANS: C PTS: 1 DIF: 2

TOP: 19.6 Motion of a Charged Particle in a Magnetic Field

43. The path of a charged particle moving parallel to a uniform magnetic field will be a:
    a. straight line.
    b. circle.
    c. ellipse.
    d. parabola.

    ANS: A PTS: 1 DIF: 1
    TOP: 19.6 Motion of a Charged Particle in a Magnetic Field

44. A proton, which moves perpendicular to a magnetic field of 1.2 T in a circular path of radius 0.080 m, has what speed? ($q_p = 1.6 \times 10^{-19}$ C and $m_p = 1.67 \times 10^{-27}$ kg)
    a. 3.4×10^6 m/s
    b. 4.6×10^6 m/s
    c. 9.6×10^6 m/s
    d. 9.2×10^6 m/s

    ANS: D PTS: 1 DIF: 2
    TOP: 19.6 Motion of a Charged Particle in a Magnetic Field

45. Two singly ionized isotopes, X and Y, of the same element move with the same speed perpendicular to a uniform magnetic field. Isotope X follows a path of radius 3.35 cm while isotope Y moves along a path 3.43 cm in radius. What is the ratio of the two isotope masses, m_X/m_Y?
    a. 0.977
    b. 1.02
    c. 1.05
    d. 0.954

    ANS: A PTS: 1 DIF: 2
    TOP: 19.6 Motion of a Charged Particle in a Magnetic Field

46. If a charged particle is moving in a uniform magnetic field, its path can be:
    a. a straight line.
    b. a circle.
    c. a helix.
    d. any of the above.

    ANS: D PTS: 1 DIF: 2
    TOP: 19.6 Motion of a Charged Particle in a Magnetic Field

47. When a magnetic field causes a charged particle to move in a circular path, the only quantity listed below which the magnetic force changes significantly as the particle goes around in a circle is the particle's:
    a. energy.
    b. momentum.
    c. radius for the circle.
    d. time to go around the circle once.

    ANS: B PTS: 1 DIF: 1
    TOP: 19.6 Motion of a Charged Particle in a Magnetic Field

48. In a mass spectrometer, an ion will have a smaller radius for its circular path if:
    a. its speed is greater.
    b. its mass is greater.

c. its charge is greater.
d. the magnetic field is weaker.

ANS: C PTS: 1 DIF: 2
TOP: 19.6 Motion of a Charged Particle in a Magnetic Field

49. A proton, mass 1.67×10^{-27} kg and charge $+1.6 \times 10^{-19}$ C, moves in a circular orbit perpendicular to a uniform magnetic field of 0.75 T. Find the time for the proton to make one complete circular orbit.
a. 4.3×10^{-8} s
b. 8.7×10^{-8} s
c. 4.9×10^{-7} s
d. 9.8×10^{-7} s

ANS: B PTS: 1 DIF: 3
TOP: 19.6 Motion of a Charged Particle in a Magnetic Field

50. At the Fermilab accelerator in Weston, Illinois, singly-charged ions with momentum 4.8×10^{-16} kg×m/s are held in a circular orbit of radius 1 km by an upward magnetic field. What *B*-field must be used to maintain the ions in this orbit? ($q_{ion} = 1.6 \times 10^{-19}$ C)
a. 1 T
b. 2 T
c. 3 T
d. 4 T

ANS: C PTS: 1 DIF: 2
TOP: 19.6 Motion of a Charged Particle in a Magnetic Field

51. A proton with initial kinetic energy E is moving in circular motion in a uniform magnetic field. When it has completed one eighth of a revolution, what is its kinetic energy?
a. 1.4 E
b. 0.71 E
c. E
d. The value is not given.

ANS: C PTS: 1 DIF: 2
TOP: 19.6 Motion of a Charged Particle in a Magnetic Field

52. An electron is moving at a speed of 6.0×10^{6} m/s at an angle of 30° with respect to a uniform magnetic field of 8.0×10^{-4} T. What is the radius of the resulting helical path? ($m_e = 9.11 \times 10^{-31}$ kg, $q_e = 1.6 \times 10^{-19}$ C)
a. 8.5 cm
b. 4.3 cm
c. 3.7 cm
d. 2.1 cm

ANS: D PTS: 1 DIF: 3
TOP: 19.6 Motion of a Charged Particle in a Magnetic Field

53. A 100-m-long wire carrying a current of 4.0 A will be accompanied by a magnetic field of what strength at a distance of 0.050 m from the wire? (magnetic permeability in empty space $\mu_0 = 4\pi \times 10^{-7}$ T×m/A)
a. 4.0×10^{-5} T
b. 2.0×10^{-5} T
c. 1.6×10^{-5} T

d. zero

ANS: C PTS: 1 DIF: 2
TOP: 19.7 Magnetic Field of a Long, Straight Wire and Ampere's Law

54. The current in a long wire creates a magnetic field in the region around the wire. How is the strength of the field at distance r from the wire center related to the magnitude of the field?
a. field directly proportional to r
b. field inversely proportional to r
c. field directly proportional to r^2
d. field inversely proportional to r^2

ANS: B PTS: 1 DIF: 1
TOP: 19.7 Magnetic Field of a Long, Straight Wire and Ampere's Law

55. Magnetism had been a known phenomenon for some time before its relation to electric currents was found. That a current in a wire produces a magnetic field was discovered by:
a. Maxwell.
b. Ampere.
c. Oersted.
d. Tesla.

ANS: C PTS: 1 DIF: 1
TOP: 19.7 Magnetic Field of a Long, Straight Wire and Ampere's Law

56. A current in a long, straight wire produces a magnetic field. The magnetic field lines:
a. go out from the wire to infinity.
b. come in from infinity to the wire.
c. form circles that pass through the wire.
d. form circles that go around the wire.

ANS: D PTS: 1 DIF: 1
TOP: 19.7 Magnetic Field of a Long, Straight Wire and Ampere's Law

57. A superconducting wire carries a current of 10^4 A. Find the magnetic field at a distance of 1.0 m from the wire. ($\mu_0 = 4\pi \times 10^{-7}$ T·m/A)
a. 2×10^{-3} T
b. 8×10^{-3} T
c. 1.6×10^{-2} T
d. 3.2×10^{-2} T

ANS: A PTS: 1 DIF: 2
TOP: 19.7 Magnetic Field of a Long, Straight Wire and Ampere's Law

58. An incredible amount of electrical energy passes down the funnel of a large tornado every second. Measurements taken in Oklahoma at a distance of 9.00 km from a large tornado showed an almost constant magnetic field of 1.50×10^{-8} T associated with the tornado. What was the average current going down the funnel? ($\mu_0 = 4\pi \times 10^{-7}$ T·m/A)
a. 450 A
b. 675 A
c. 950 A
d. 1 500 A

ANS: B PTS: 1 DIF: 2
TOP: 19.7 Magnetic Field of a Long, Straight Wire and Ampere's Law

59. A high-voltage power line 20 m above the ground carries a current of 2 000 A. What is the magnetic field due to the current directly underneath the power line? ($\mu_0 = 4\pi \times 10^{-7}$ T·m/A)
 a. 20 μT
 b. 35 μT
 c. 14 mT
 d. 0.30 T

ANS: A PTS: 1 DIF: 2
TOP: 19.7 Magnetic Field of a Long, Straight Wire and Ampere’s Law

60. Two long parallel wires 20 cm apart carry currents of 5.0 A and 8.0 A in the same direction. Is there any point between the two wires where the magnetic field is zero?
 a. yes, midway between the wires
 b. yes, 12 cm from the 5-A wire
 c. yes, 7.7 cm from the 5-A wire
 d. no

ANS: C PTS: 1 DIF: 3
TOP: 19.7 Magnetic Field of a Long, Straight Wire and Ampere’s Law

61. Niobium metal becomes a superconductor (with electrical resistance equal to zero) when cooled below 9 K. If superconductivity is destroyed when the surface magnetic field exceeds 0.100 T, determine the maximum current a 4.00-mm-diameter niobium wire can carry and remain superconducting. ($\mu_0 = 4\pi \times 10^{-7}$ T·m/A)
 a. 125 A
 b. 250 A
 c. 500 A
 d. 1 000 A

ANS: D PTS: 1 DIF: 3
TOP: 19.7 Magnetic Field of a Long, Straight Wire and Ampere’s Law

62. Two long parallel wires 40 cm apart are carrying currents of 10 A and 20 A in the same direction. What is the magnitude of the magnetic field halfway between the wires?
 a. 1.0×10^{-5} T
 b. 2.0×10^{-5} T
 c. 3.0×10^{-5} T
 d. 4.0×10^{-5} T

ANS: A PTS: 1 DIF: 2
TOP: 19.7 Magnetic Field of a Long, Straight Wire and Ampere’s Law

63. Two long parallel wires 40 cm apart are carrying currents of 10 A and 20 A in the opposite direction. What is the magnitude of the magnetic field halfway between the wires?
 a. 1.0×10^{-5} T
 b. 2.0×10^{-5} T
 c. 3.0×10^{-5} T
 d. 4.0×10^{-5} T

ANS: C PTS: 1 DIF: 2
TOP: 19.7 Magnetic Field of a Long, Straight Wire and Ampere’s Law

64. Two parallel conductors are carrying currents in the same direction. The currents are non-zero and not necessarily equal. The magnitude of the magnetic field midway between them is 40 mT. If one of the currents then has its direction reversed, what is the resulting magnitude of the magnetic field midway between them?

a. a value greater than 40 mT
b. 40 mT
c. a value less than 40 mT
d. It could be any value.

ANS: A PTS: 1 DIF: 2
TOP: 19.7 Magnetic Field of a Long, Straight Wire and Ampere's Law

65. Two parallel conductors are carrying currents in the opposite direction. The currents are non-zero and not necessarily equal. The magnitude of the magnetic field midway between them is 40 mT. If one of the currents then has its direction reversed, what is the resulting magnitude of the magnetic field midway between them?

a. a value greater than 40 mT
b. 40 mT
c. a value less than 40 mT
d. It could be any value.

ANS: C PTS: 1 DIF: 2
TOP: 19.7 Magnetic Field of a Long, Straight Wire and Ampere's Law

66. A coaxial cable consists of a thin insulated straight wire carrying a current of 2.00 A surrounded by a cylindrical conductor carrying a current of 3.50 A in the opposite direction. The cylindrical conductor has a radius of 0.420 cm. What is the magnitude of the magnetic field between the inner and outer conductors at a distance of 0.300 cm from the central wire?

a.
b.
c.
d.

ANS: B PTS: 1 DIF: 1
TOP: 19.7 Magnetic Field of a Long, Straight Wire and Ampere's Law

67. A coaxial cable consists of a thin insulated straight wire carrying a current of 2.00 A surrounded by a cylindrical conductor carrying a current of 3.50 A in the opposite direction. The cylindrical conductor has a radius of 0.420 cm. What is the magnitude of the magnetic field outside of the cylindrical conductor 2.00 cm from the central wire?

a.
b.
c.
d.

ANS: D PTS: 1 DIF: 2
TOP: 19.7 Magnetic Field of a Long, Straight Wire and Ampere's Law

68. Two coaxial cables each consist of a thin insulated straight wire surrounded by a cylindrical conductor of radius 0.900 cm. The cables are positioned 4.00 cm apart with the central wires parallel to one another. Each central wire is carrying a current of 2.20 A in directions antiparallel to one another. Each cylindrical conductor is carrying a current of 3.70 A in directions parallel to one another. What is the magnitude of the magnetic field midway between the cables?

a.

b.
c.
d.

ANS: B PTS: 1 DIF: 3
TOP: 19.7 Magnetic Field of a Long, Straight Wire and Ampere’s Law

69. Two parallel conductors each of 0.50 m length, separated by 5.0×10^{-3} m and carrying 3.0 A in opposite directions, will experience what type and magnitude of mutual force? (magnetic permeability in empty space $\mu_0 = 4\pi \times 10^{-7}$ T·m/A)
a. attractive, 0.06×10^{-4} N
b. repulsive, 0.60×10^{-4} N
c. attractive, 1.8×10^{-4} N
d. repulsive, 1.8×10^{-4} N

ANS: D PTS: 1 DIF: 2
TOP: 19.8 Magnetic Force Between Two Parallel Conductors

70. Consider two long, straight parallel wires, each carrying a current *I*. If the currents are flowing in opposite directions:
a. the two wires will attract each other.
b. the two wires will repel each other.
c. the two wires will exert a torque on each other.
d. neither wire will exert a force on the other.

ANS: B PTS: 1 DIF: 2
TOP: 19.8 Magnetic Force Between Two Parallel Conductors

71. Two parallel wires are separated by 0.25 m. Wire A carries 5.0 A and Wire B carries 10 A, both currents in the same direction. The force on 0.80 m of Wire A is:
a. half that on 0.80 m of wire B.
b. one-fourth that on 0.80 m of wire B.
c. toward Wire B.
d. away from Wire B.

ANS: C PTS: 1 DIF: 1
TOP: 19.8 Magnetic Force Between Two Parallel Conductors

72. Two parallel wires are separated by 0.25 m. Wire A carries 5.0 A and Wire B carries 10 A, both currents in the same direction. The force on 0.80 m of Wire A is:
a. 3.2×10^{-5} N.
b. 2.6×10^{-5} N.
c. 1.6×10^{-5} N.
d. less than 1.0×10^{-5} N.

ANS: A PTS: 1 DIF: 2
TOP: 19.8 Magnetic Force Between Two Parallel Conductors

73. Two insulated current-carrying straight wires of equal length are arranged in the lab so that Wire A carries a current northward and Wire B carries a current eastward, the wires crossing at their midpoints separated only by their insulation. Which of the following statements are true?
a. The net force on Wire B is southward.
b. The net force on Wire A is westward.
c. There are no forces in this situation.
d. There are forces, but the net force on each wire is zero.

ANS: D PTS: 1 DIF: 2
TOP: 19.8 Magnetic Force Between Two Parallel Conductors

74. A solenoid with 500 turns, 0.10 m long, carrying a current of 4.0 A and with a radius of 10^{-2} m will have what strength magnetic field at its center? (magnetic permeability in empty space $\mu_0 = 4\pi \times 10^{-7}$ T·m/A)
a. 31×10^{-4} T
b. 62×10^{-4} T
c. 125×10^{-4} T
d. 250×10^{-4} T

ANS: D PTS: 1 DIF: 2
TOP: 19.9 Magnetic Fields of Current Loops and Solenoids

75. A current in a solenoid coil creates a magnetic field inside that coil. The field strength is directly proportional to:
a. the coil area.
b. the current.
c. Both A and B are valid choices.
d. None of the above choices are valid.

ANS: B PTS: 1 DIF: 1
TOP: 19.9 Magnetic Fields of Current Loops and Solenoids

76. A current in a solenoid with *N* turns creates a magnetic field at the center of that loop. The field strength is directly proportional to:
a. number of turns in the loop.
b. current strength.
c. Both choices A and B are valid.
d. None of the above are valid.

ANS: C PTS: 1 DIF: 1
TOP: 19.9 Magnetic Fields of Current Loops and Solenoids

77. Superconductors can carry very large currents with no resistance. If a superconducting wire is formed into a solenoid of length 50.0 cm with 500 turns, what is the magnetic field inside the solenoid when the current is 10^4 A? ($\mu_0 = 4\pi \times 10^{-7}$ T·m/A)
a. 1.25 T
b. 2.50 T
c. 6.28 T
d. 12.6 T

ANS: D PTS: 1 DIF: 2
TOP: 19.9 Magnetic Fields of Current Loops and Solenoids

78. A superconducting solenoid is to be designed to generate a magnetic field of 5.00 T. If the solenoid winding has 1 000 turns/m, what is the required current? ($\mu_0 = 4\pi \times 10^{-7}$ T·m/A)
a. 1 000 A
b. 1 990 A
c. 3 980 A
d. 5 000 A

ANS: C PTS: 1 DIF: 2
TOP: 19.9 Magnetic Fields of Current Loops and Solenoids

79. The magnetic domains in a non-magnetized piece of iron are characterized by which orientation?
   a. parallel to the magnetic axis
   b. anti-parallel (opposite direction) to the magnetic axis
   c. random
   d. perpendicular to the magnetic axis

   ANS: C PTS: 1 DIF: 1 TOP: 19.10 Magnetic Domains

80. When an electromagnet has an iron core inserted, what happens to the strength of the magnet?
   a. It increases.
   b. It remains the same.
   c. It decreases.
   d. Since it depends on the metal used in the wires of the electromagnet, any of the above.

   ANS: A PTS: 1 DIF: 1 TOP: 19.10 Magnetic Domains

81. A square coil and a triangular coil each have sides of length *L*. The triangular coil has twice as many turns as the square coil. If a the same current is sent through each coil, when the coils are placed in the same uniform magnetic field making an angle of 30° with the planes of the coils, which coil experiences the greater torque?
   a. the square coil
   b. the triangular coil
   c. Both coils experience the same torque.
   d. It depends on the magnitude of the magnetic field that the coils are placed in.

   ANS: A PTS: 1 DIF: 2 TOP: Conceptual Questions

82. Two parallel wires carry the a current *I* in the same direction. Midway between these wires is a third wire, also parallel to the other two, which carries a current 0.5 *I*, but in the direction opposite from the first two wires. In which direction are the net forces on the outer wires?
   a. Since the net forces are zero, there is no direction.
   b. Both forces are toward the center wire.
   c. Both forces are away from the center wire.
   d. Both forces on the two wires are in the same direction in space.

   ANS: A PTS: 1 DIF: 2 TOP: Conceptual Questions

83. Square coil A has 2*N* turns and sides of length *L*, and square coil B has *N* turns and sides of length 2*L*. When a current of 2 amps is sent through coil A and a current of 1 amp is sent through coil B, which coil has the greater magnetic moment?
   a. coil A
   b. coil B
   c. Both have the same magnetic moment.
   d. More information is needed.

   ANS: C PTS: 1 DIF: 2 TOP: Conceptual Questions

84. Solenoid #1 has a length *L*, cross-sectional area *A*, and *N* turns. Solenoid #2 has a length 2*L*, cross-sectional area 2*A*, and 2*N* turns. Which solenoid has the greater magnetic field at its center when equal currents are going through them?
   a. #1
   b. #2
   c. Both have the same magnetic field.
   d. Since it depends on the values of *A* and *L*, none of the above are correct.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Questions

85. A beam of electrons is sent in the positive *x*-direction in a region with a uniform magnetic field B in the positive *y*-direction and a uniform electric field E in the positive *z*-direction. At which of the following speeds would the electrons be deflected in the positive *z*-direction?

a. $v < E/B$
b. $v = E/B$
c. $v > E/B$
d. There is no speed for which this will happen.

ANS: D PTS: 1 DIF: 3 TOP: Conceptual Questions

CHAPTER 20—Induced Voltages and Inductance

MULTIPLE CHOICE

1. A uniform 4.5-T magnetic field passes perpendicularly through the plane of a wire loop 0.10 m^2 in area. What flux passes through the loop?
   a. 5.0 T×m^2
   b. 0.45 T×m^2
   c. 0.25 T×m^2
   d. 0.135 T×m^2

   ANS: B PTS: 1 DIF: 1
   TOP: 20.1 Induced emf and Magnetic Flux

2. A uniform 4.5-T magnetic field passes through the plane of a wire loop 0.10 m^2 in area. What flux passes through the loop when the direction of the 4.5-T field is at a 30° angle to the normal of the loop plane?
   a. 5.0 T×m^2
   b. 0.52 T×m^2
   c. 0.39 T×m^2
   d. 0.225 T×m^2

   ANS: C PTS: 1 DIF: 2
   TOP: 20.1 Induced emf and Magnetic Flux

3. A loop of area 0.250 m^2 is in a uniform 0.020 0-T magnetic field. If the flux through the loop is 3.83 ´ 10^{-3} T·m^2, what angle does the normal to the plane of the loop make with the direction of the magnetic field?
   a. 40.0°
   b. 50.0°
   c. 37.5°
   d. This is not possible.

   ANS: A PTS: 1 DIF: 3
   TOP: 20.1 Induced emf and Magnetic Flux

4. A coil in a magnetic field encloses a flux of 0.256 T·m^2 when the angle between the normal to the coil and the direction of the magnetic field is 70.0°. What flux would go through the coil if the angle were changed to 40.0°?
   a. 0.332 T·m^2
   b. 0.198 T·m^2
   c. 0.114 T·m^2
   d. 0.573 T·m^2

   ANS: D PTS: 1 DIF: 3
   TOP: 20.1 Induced emf and Magnetic Flux

5. A coil is placed in a magnetic field and has a flux Φ_B through it. The coil is stressed so that its area reduces to 75% of its original value. If the plane of the coil stays the same and the flux through it remains the same, how must the magnetic field change?
   a. It must increase by 25%.
   b. It must increase by 33%.
   c. It must increase by 125%.

d. It must decrease by 25%.

ANS: B PTS: 1 DIF: 2
TOP: 20.1 Induced emf and Magnetic Flux

6. The units $T \cdot m^2/s$ are equivalent to:
   a. W.
   b. V.
   c. N/m.
   d. webers.

ANS: B PTS: 1 DIF: 1
TOP: 20.2 Faraday's Law of Induction and Lenz's Law

7. A sensitive ammeter is connected to a wire loop and placed within the magnetic field of a strong horseshoe magnet. The ammeter shows a deflection when:
   a. the wire is moved parallel to the field.
   b. the wire is moved perpendicularly to the field.
   c. neither wire nor magnet is moving.
   d. the wire's axis is parallel to the field.

ANS: B PTS: 1 DIF: 1
TOP: 20.2 Faraday's Law of Induction and Lenz's Law

8. According to Lenz's law the direction of an induced current in a conductor will be that which tends to produce which of the following effects?
   a. enhance the effect which produces it
   b. produce a greater heating effect
   c. produce the greatest voltage
   d. oppose the effect which produces it

ANS: D PTS: 1 DIF: 1
TOP: 20.2 Faraday's Law of Induction and Lenz's Law

9. "GFI" stands for:
   a. grand flux indicator.
   b. ground forcing indicator.
   c. ground fault interrupter.
   d. gauss-free invention.

ANS: C PTS: 1 DIF: 1
TOP: 20.2 Faraday's Law of Induction and Lenz's Law

10. The principle or law that says "an induced emf in a circuit loop produces a current whose magnetic field opposes further change of magnetic flux" is credited to:
   a. Faraday.
   b. Lenz.
   c. Ampere.
   d. Volta.

ANS: B PTS: 1 DIF: 1
TOP: 20.2 Faraday's Law of Induction and Lenz's Law

11. A square coil, enclosing an area with sides 2.0 cm long, is wrapped with 2 500 turns of wire. A uniform magnetic field perpendicular to its plane is turned on and increases to 0.25 T during an interval of 1.0 s. What average voltage is induced in the coil?

a. 0.25 V
b. 0.12 V
c. 2.0 V
d. 2.5 V

ANS: A PTS: 1 DIF: 2
TOP: 20.2 Faraday's Law of Induction and Lenz's Law

12. A 10-turn square coil of area 0.036 m^2 and a 20-turn circular coil are both placed perpendicular to the same changing magnetic field. The voltage induced in each of the coils is the same. What is the area of the circular coil?
a. 0.072 m^2
b. 0.60 m^2
c. 0.018 m^2
d. 0.036 m^2

ANS: C PTS: 1 DIF: 2
TOP: 20.2 Faraday's Law of Induction and Lenz's Law

13. A bar magnet is falling through a loop of wire with constant velocity. The south pole enters first. As the magnet leaves the wire, the induced current (as viewed from above):
a. is clockwise.
b. is counterclockwise.
c. is zero.
d. is along the length of the magnet.

ANS: B PTS: 1 DIF: 2
TOP: 20.2 Faraday's Law of Induction and Lenz's Law

14. A flat coil of wire consisting of 20 turns, each with an area of 50 cm^2, is positioned perpendicularly to a uniform magnetic field that increases its magnitude at a constant rate from 2.0 T to 6.0 T in 2.0 s. If the coil has a total resistance of 0.40 W, what is the magnitude of the induced current?
a. 70 mA
b. 140 mA
c. 500 mA
d. 800 mA

ANS: C PTS: 1 DIF: 2
TOP: 20.2 Faraday's Law of Induction and Lenz's Law

15. A planar loop consisting of four turns of wire, each of which encloses 200 cm^2, is oriented perpendicularly to a magnetic field that increases uniformly in magnitude from 10 mT to 25 mT in a time of 5.0 ms. What is the resulting induced current in the coil if the resistance of the coil is 5.0 W?
a. 60 mA
b. 12 mA
c. 0.24 mA
d. 48 mA

ANS: D PTS: 1 DIF: 2
TOP: 20.2 Faraday's Law of Induction and Lenz's Law

16. A coil is placed in a changing magnetic field and an emf is induced. What happens to the induced emf if the rate of change of magnetic field quadruples?
a. There is no change.
b. The emf doubles.

c. The emf quadruples.
d. The emf increases by a factor of 16.

ANS: C PTS: 1 DIF: 1
TOP: 20.2 Faraday's Law of Induction and Lenz's Law

17. The operation of a tape player to play music depends on which of the following?
a. the Doppler effect
b. the photoelectric effect
c. the force acting on a current-carrying wire in a magnetic field
d. induced current from the motion of a magnet past a wire

ANS: D PTS: 1 DIF: 1
TOP: 20.2 Faraday's Law of Induction and Lenz's Law

18. A bar magnet is falling through a loop of wire with constant velocity. The north pole enters first. The induced current will be greatest in magnitude when the magnet is located so that:
a. the loop is near either the north or the south pole.
b. the loop is near the north pole only.
c. the loop is near the middle of the magnet.
d. with no acceleration, the induced current is zero.

ANS: A PTS: 1 DIF: 2
TOP: 20.2 Faraday's Law of Induction and Lenz's Law

19. A bar magnet is falling through a loop of wire with constant velocity. The north pole enters first. As the south pole leaves the loop of wire, the induced current (as viewed from above) will be:
a. clockwise.
b. counterclockwise.
c. zero.
d. along the length of the magnet.

ANS: A PTS: 1 DIF: 2
TOP: 20.2 Faraday's Law of Induction and Lenz's Law

20. Two loops of wire are arranged so that a changing current in one will induce a current in the other. If the current in the first is increasing clockwise by 1.0 A every second, the induced current in the second loop will:
a. be increasing counterclockwise.
b. stay constant.
c. increase clockwise also.
d. stay zero.

ANS: B PTS: 1 DIF: 3
TOP: 20.2 Faraday's Law of Induction and Lenz's Law

21. If a bar magnet is falling through a loop of wire, the induced current in the loop of wire sets up a field which exerts a force on the magnet. This force between the magnet and the loop will be attractive when:
a. the magnet enters the loop.
b. the magnet is halfway through.
c. the magnet is leaving the loop.
d. never.

ANS: C PTS: 1 DIF: 2
TOP: 20.2 Faraday's Law of Induction and Lenz's Law

22. If the induced current in a wire loop were such that the flux it produces were in the same direction as the change in external flux causing the current, which of the following conservation laws would end up being violated?
    a. momentum
    b. charge
    c. energy
    d. angular momentum

    ANS: C PTS: 1 DIF: 1
    TOP: 20.2 Faraday's Law of Induction and Lenz's Law

23. A straight wire lies along the *y*-axis initially carrying a current of 10 A in the positive *y*-direction. The current decreases and reverses to 10 A in the negative *y*-direction, the change in current happening at a uniform rate. In the 1st quadrant a square conducting coil has 2 sides parallel to the *y*-axis and the other 2 sides parallel to the *x*-axis. The side of the coil nearest and parallel to the straight wire is at a distance equal to the length of one of the sides of the square. As the current is going from 10 A in one direction to 10 A in the other, in which direction is the induced current in this side of the square coil nearest to the straight wire?
    a. It is in the positive *y*-direction.
    b. It is in the negative *y*-direction.
    c. At first it is in the positive *y*-direction, but after the current passes through zero, it is in the negative *y*-direction.
    d. At first it is in the negative *y*-direction but after the current passes through zero, it is in the positive *y*-direction.

    ANS: A PTS: 1 DIF: 2
    TOP: 20.2 Faraday's Law of Induction and Lenz's Law

24. A bar magnet is held above the center of a conducting ring in the horizontal plane. The magnet is dropped so it falls lengthwise toward the center of the ring. Will the falling magnet be attracted toward the ring or be repelled by the ring due to the magnetic interaction of the magnet and the ring?
    a. It will be attracted.
    b. It will be repelled.
    c. It will be attracted only if the north end of the magnet is the leading end as it falls toward the ring.
    d. It will be attracted only if the south end of the magnet is the leading end as it falls toward the ring.

    ANS: B PTS: 1 DIF: 2
    TOP: 20.2 Faraday's Law of Induction and Lenz's Law

25. A 0.200-m wire is moved parallel to a 0.500-T magnetic field at a speed of 1.50 m/s. What emf is induced across the ends of the wire?
    a. 2.25 V
    b. 1.00 V
    c. 0.600 V
    d. zero

    ANS: D PTS: 1 DIF: 2 TOP: 20.3. Motional emf

26. An airplane with a wingspan of 60.0 m flies parallel to the Earth's surface at a point where the downward component of the Earth's magnetic field is 0.400×10^{-4} T. If the induced potential between wingtips is 0.900 V, what is the plane's speed?
    a. 250 m/s

b. 338 m/s
c. 375 m/s
d. 417 m/s

ANS: C PTS: 1 DIF: 2 TOP: 20.3. Motional emf

27. A metal rod is falling toward the surface of the Earth near the equator. As it falls, one end of the rod becomes positively charged due to the motional emf of the rod through the Earth's magnetic field. The rod is oriented so that:
a. the rod is vertical with the positive end higher.
b. the rod is horizontal with the positive end toward the north.
c. the rod is horizontal with the positive end toward the east.
d. the rod is horizontal with the positive end toward the west.

ANS: C PTS: 1 DIF: 2 TOP: 20.3. Motional emf

28. The magnet moving past an object will produce eddy currents in the object if the object:
a. is magnetic material only.
b. is a conductor.
c. is an insulator.
d. is a liquid.

ANS: B PTS: 1 DIF: 1 TOP: 20.3. Motional emf

29. A large jetliner with a wingspan of 40 m flies horizontally and due north at a speed of 300 m/s in a region where the magnetic field of the earth is 60 μT directed 50° below the horizontal. What is the magnitude of the induced emf between the ends of the wing?
a. 250 mV
b. 350 mV
c. 550 mV
d. 750 mV

ANS: C PTS: 1 DIF: 3 TOP: 20.3. Motional emf

30. A straight wire of length is oriented east-west and is in a magnetic field *B* pointing north. The wire is moving downward at a constant speed *v*. Which end of the rod is positively charged?
a. neither
b. the east end
c. the west end
d. both ends

ANS: B PTS: 1 DIF: 2 TOP: 20.3. Motional emf

31. A straight wire of length is oriented east-west and is in a magnetic field *B* pointing north. The wire is moving downward at a constant speed *v*. If the resistance of the rod is *R*, what is the current through the rod?
a. $R/\mathbf{B}v$
b. Bv/R
c. $B^2\,{}^2v^2/R^2$
d. not given

ANS: D PTS: 1 DIF: 2 TOP: 20.3. Motional emf

32. The operation of an electric motor depends on which of the following effects?
a. the Doppler effect
b. the photoelectric effect

c. the force acting on a current-carrying wire in a magnetic field
d. current from the motion of a wire in a magnetic field

ANS: C PTS: 1 DIF: 1 TOP: 20.4 Generators

33. The wiring in a motor has resistance of 3.0 Wand produces a back emf of 1.0 V when connected to a 9.0-V battery of negligible resistance. Find the current flow through the motor.
a. 0.19 A
b. 0.44 A
c. 1.5 A
d. 2.7 A

ANS: D PTS: 1 DIF: 2 TOP: 20.4 Generators

34. The basic function of the electric generator is which of the following conversion processes?
a. mechanical energy to electrical
b. electrical energy to mechanical
c. low voltage to high or vice versa
d. alternating current to direct

ANS: A PTS: 1 DIF: 1 TOP: 20.4 Generators

35. The function of the electric motor is which one of the following conversion processes?
a. mechanical energy to electrical
b. electrical energy to mechanical
c. low voltage to high or vice versa
d. alternating current to direct

ANS: B PTS: 1 DIF: 1 TOP: 20.4 Generators

36. The back emf in an electric motor is its maximum value under which condition?
a. motor speed is zero
b. current is a maximum
c. voltage is a maximum
d. motor speed is a maximum

ANS: D PTS: 1 DIF: 1 TOP: 20.4 Generators

37. A 500-turn circular coil with an area of 0.050 0 m^2 is mounted on a rotating frame, which turns at a rate of 20.0 rad/s in the presence of a 0.050 0-T uniform magnetic field that is perpendicular to the axis of rotation. What is the instantaneous emf in the coil at the moment that the normal to its plane is parallel to the field?
a. zero
b. 125 V
c. 216 V
d. 250 V

ANS: A PTS: 1 DIF: 3 TOP: 20.4 Generators

38. A 500-turn circular coil with an area of 0.050 0 m^2 is mounted on a rotating frame, which turns at a rate of 20.0 rad/s in the presence of a 0.050 0-T uniform magnetic field that is perpendicular to the axis of rotation. What is the instantaneous emf in the coil at the moment that the normal to its plane is at a 90.0° angle to the field?
a. zero
b. 12.5 V
c. 21.6 V

d. 25.0 V

ANS: D PTS: 1 DIF: 3 TOP: 20.4 Generators

39. A 500-turn circular coil with an area of 0.050 0 m^2 is mounted on a rotating frame that turns at a rate of 20.0 rad/s in the presence of a 0.050 0-T uniform magnetic field that is perpendicular to the axis of rotation. What is the instantaneous emf in the coil at the moment that the normal to its plane is at a 30.0° angle to the field?
a. zero
b. 12.5 V
c. 21.6 V
d. 25.0 V

ANS: B PTS: 1 DIF: 3 TOP: 20.4 Generators

40. A motor with a coil resistance of 10 W is attached to a voltage supply of 90 V. What is the current in the motor when it is running at its maximum speed with a back emf of 60 V?
a. zero
b. 3.0 A
c. 6.0 A
d. 15 A

ANS: B PTS: 1 DIF: 2 TOP: 20.4 Generators

41. An electric motor draws a current of 2.50 A from a 15.0-V battery when it runs at normal speed. If the motor's armature is "jammed" so that it cannot rotate, the current suddenly rises to 10.0 A. What is the back emf of the motor when running at normal speed?
a. 18.8 V
b. 10.0 V
c. 12.5 V
d. 11.3 V

ANS: D PTS: 1 DIF: 3 TOP: 20.4 Generators

42. Electricity may be generated by rotating a loop of wire between the poles of a magnet. The induced current is greatest when:
a. the plane of the loop is parallel to the magnetic field.
b. the plane of the loop is perpendicular to the magnetic field.
c. the magnetic flux through the loop is a maximum.
d. the plane of the loop makes an angle of 45° with the magnetic field.

ANS: A PTS: 1 DIF: 1 TOP: 20.4 Generators

43. The "back emf" of a motor refers to a source of voltage that:
a. occurs when the motor runs backwards.
b. occurs when the motor is used as a generator.
c. is biggest when the current through the motor is biggest.
d. is biggest when the motor turns fastest.

ANS: D PTS: 1 DIF: 1 TOP: 20.4 Generators

44. A rectangular loop (area = 0.15 m^2) turns in a uniform magnetic field with B = 0.20 T. At an instant when the angle between the magnetic field and the normal to the plane of the loop is p/2 rads and increasing at the rate of 0.60 rad/s, what is the magnitude of the emf induced in the loop?
a. 24 mV
b. zero

c. 18 mV
d. 30 mV

ANS: C PTS: 1 DIF: 3 TOP: 20.4 Generators

45. A circular loop (area = 0.20 m^2) turns in a uniform magnetic field with B = 0.13 T. At an instant when the angle between the magnetic field and the normal to the plane of the loop is p rads and is decreasing at the rate of 0.50 rad/s, what is the magnitude of the emf induced in the loop?
a. zero
b. 13 mV
c. 26 mV
d. 20 mV

ANS: A PTS: 1 DIF: 3 TOP: 20.4 Generators

46. What is the minimum frequency with which a 200-turn, flat coil of cross sectional area 300 cm^2 can be rotated in a uniform 30-mT magnetic field if the maximum value of the induced emf is to equal 8.0 V?
a. 0.030 Hz
b. 2.9 Hz
c. 7.1 Hz
d. 8.4 Hz

ANS: C PTS: 1 DIF: 2 TOP: 20.4 Generators

47. In the United States, the value of w for commercially generated power is ________ in SI units.
a. 50
b. 60
c. 120
d. 377

ANS: D PTS: 1 DIF: 2 TOP: 20.4 Generators

48. When a voltage is generated by rotating a coil in a magnetic field at a constant rate, the period of the voltage equals the time that it takes for the coil to rotate through ________ radians.
a. 1
b. p/2
c. p
d. 2p

ANS: D PTS: 1 DIF: 1 TOP: 20.4 Generators

49. A coil is rotated in a magnetic field generating an emf given by emf = $NBAw$sin q, where $q = wt$. At which angle q is the emf half of its maximum value?
a. 0°
b. 30°
c. 45°
d. 60°

ANS: B PTS: 1 DIF: 2 TOP: 20.4 Generators

50. A motor has an internal resistance of 12 W. When running, the motor has a back emf of 30 V and draws a current of 4.0 A. What is the supply voltage in this case?
a. 30 V
b. 48 V
c. 78 V

d. 120 V

ANS: C PTS: 1 DIF: 2 TOP: 20.4 Generators

51. The current in a coil with a self-inductance of 1.5 mH increases from 0 to 1.0 A in a tenth of a second. What is the induced emf in the coil?
a. 15 mV
b. 30 mV
c. 0.10 V
d. 0.30 V

ANS: A PTS: 1 DIF: 2 TOP: 20.5 Self-Inductance

52. The self-inductance of a solenoid increases under which of the following conditions?
a. Only the solenoid length is increased.
b. Only the cross sectional area is decreased.
c. Only the number of coils per unit length is decreased.
d. Only the number of coils is increased.

ANS: D PTS: 1 DIF: 1 TOP: 20.5 Self-Inductance

53. In a circuit made up of inductor L, resistance R, ammeter, battery and switch in series, the current is greatest at which of the following times, as measured after the switch is closed?
a. zero
b. one time constant
c. at a time $t = L/R$
d. ten time constants

ANS: D PTS: 1 DIF: 2 TOP: 20.5 Self-Inductance

54. A coil with a self-inductance of 0.75 mH experiences a constant current buildup from zero to 10 A in 0.25 s. What is the induced emf during this interval?
a. 0.045 V
b. 0.030 V
c. 0.47 V
d. 0.019 V

ANS: B PTS: 1 DIF: 2 TOP: 20.5 Self-Inductance

55. What is the self-inductance in a coil that experiences a 3.0-V induced emf when the current is changing at a rate of 110 A/s?
a. 83 mH
b. 45 mH
c. 37 mH
d. 27 mH

ANS: D PTS: 1 DIF: 2 TOP: 20.5 Self-Inductance

56. By what factor is the self-inductance of an air solenoid changed if only its number of coil turns, N, is tripled?
a. 1/3
b. 3
c. 6
d. 9

ANS: D PTS: 1 DIF: 2 TOP: 20.5 Self-Inductance

57. By what factor is the self-inductance of an air solenoid changed if only its cross-sectional area, *A*, is tripled?
    a. 1/3
    b. 3
    c. 6
    d. 9

    ANS: B PTS: 1 DIF: 1 TOP: 20.5 Self-Inductance

58. By what factor is the self-inductance of an air solenoid changed if its length and number of coil turns are both tripled?
    a. 1/3
    b. 3
    c. 6
    d. 9

    ANS: B PTS: 1 DIF: 2 TOP: 20.5 Self-Inductance

59. Two loops of wire are arranged so that a changing current in one, the primary, will induce a current in the other, the secondary. The secondary loop has twice as many turns as the primary loop. As long as the current in the primary is steady at 3 A, the current in the secondary will be:
    a. 3 A.
    b. 6 A.
    c. 1.5 A.
    d. zero.

    ANS: D PTS: 1 DIF: 2 TOP: 20.5 Self-Inductance

60. Two loops of wire are arranged so that a changing current in one, the primary, will induce a current in the other, the secondary. The secondary loop has twice as many turns as the primary loop. The current in the primary at this moment is 3 A and increasing. The current in the secondary must be:
    a. 3 A.
    b. 6 A.
    c. zero.
    d. There is insufficient information to work this problem.

    ANS: D PTS: 1 DIF: 2 TOP: 20.5 Self-Inductance

61. The magnetic field going through a stationary circular loop increases from zero to 5 T in a certain time *t.* The induced current in the loop will depend on the radius of the loop, *r*, the resistance of the loop, *R*, and the time, *t.* If two of these stay constant, the induced current can be directly proportional to:
    a. *t.*
    b. *r*.
    c. *R.*
    d. none of these

    ANS: D PTS: 1 DIF: 2 TOP: 20.5 Self-Inductance

62. The unit of inductance, the henry, is equivalent to:
    a. V·s/A.
    b. V/m.
    c. J/C.
    d. none of the units given.

    ANS: A PTS: 1 DIF: 2 TOP: 20.5 Self-Inductance

63. An air-core inductor has 1 000 turns/m and an internal volume of 3.0 cm^3. What is its inductance?
a. 3.8 μH
b. 38 mH
c. 0.38 H
d. Insufficient information is given.

ANS: A PTS: 1 DIF: 2 TOP: 20.5 Self-Inductance

64. An inductor, battery, resistance, and ammeter and switch are connected in series. If the switch, initially open, is now closed, what is the current's final value?
a. zero
b. battery voltage divided by inductance
c. battery voltage times inductance
d. battery voltage divided by resistance

ANS: D PTS: 1 DIF: 1 TOP: 20.6 RL Circuits

65. In a circuit made up of inductor, resistance, ammeter, battery and switch in series, at which of the following times after the switch is closed is the rate of current increase greatest?
a. zero
b. one time constant
c. reciprocal of one time constant
d. ten time constants

ANS: A PTS: 1 DIF: 1 TOP: 20.6 RL Circuits

66. An *RL* series circuit has the following components: 5.0-mH coil, 1.0-Ω resistor, 12-V battery, ammeter and switch. What is the time constant of this circuit?
a. 12×10^{-3} s
b. 5.0×10^{-3} s
c. 2.5×10^{-2} s
d. 200 s

ANS: B PTS: 1 DIF: 2 TOP: 20.6 RL Circuits

67. An *RL* series circuit has: 5.0-mH coil, 1.0-Ω resistor, 12-V battery, ammeter and switch. After the switch is closed for a long time, find the final value of the current.
a. 2.5 A
b. 12 A
c. 0.015 A
d. 2 400 A

ANS: B PTS: 1 DIF: 2 TOP: 20.6 RL Circuits

68. A 12-V battery is connected in series with a switch, resistor and coil. If the circuit's time constant is 2.0×10^{-4} s and the final steady current after the switch is closed becomes 1.0 A, what is the value of the inductance?
a. 1.2 mH
b. 2.4 mH
c. 9.6 mH
d. 48 mH

ANS: B PTS: 1 DIF: 2 TOP: 20.6 RL Circuits

69. A series circuit contains a 12-V battery, a 2.0-Wresistor, and a 3.0-mH inductor. If the switch to the battery is closed at t = 0, find the time required for the current in the circuit to reach 63% of its final value.
    a. 1.5 ms
    b. 3.0 ms
    c. 4.0 ms
    d. 5.0 ms

    ANS: A PTS: 1 DIF: 2 TOP: 20.6 RL Circuits

70. A circuit consists of a 10-mH coil, a 12-Wresistor, a 6.0-Wresistor, a 9.0-V battery and a switch, all in series. What is the time constant of this circuit?
    a. 9.0 ´ 10^{-2} s
    b. 2.5 ´ 10^{-3} s
    c. 1.4 ´ 10^{-4} s
    d. 5.6 ´ 10^{-4} s

    ANS: D PTS: 1 DIF: 2 TOP: 20.6 RL Circuits

71. A circuit consists of a 10-mH coil, a 9.0-V battery, a parallel combination of a 12-Wresistor and a 6.0-Wresistor, and a switch, all in series. What is the time constant of this circuit?
    a. 9.0 ´ 10^{-2} s
    b. 2.5 ´ 10^{-3} s
    c. 5.6 ´ 10^{-4} s
    d. This circuit has 2 time constants.

    ANS: B PTS: 1 DIF: 3 TOP: 20.6 RL Circuits

72. An emf of 0.32 V is induced in a 0.40-H inductor. What is the rate of change of current through the inductor?
    a. 0.80 A/s
    b. 0.13 A/s
    c. 1.3 A/s
    d. 0.64 A/s

    ANS: A PTS: 1 DIF: 2 TOP: 20.6 RL Circuits

73. What is the stored energy in a 0.50-mH coil carrying a current of 4.0 A?
    a. 2.0 ´ 10^{-3} J
    b. 4.0 ´ 10^{-3} J
    c. 8.0 ´ 10^{-3} J
    d. 12 ´ 10^{-3} J

    ANS: B PTS: 1 DIF: 2
    TOP: 20.7 Energy Stored in a Magnetic Field

74. How is the energy stored in a current-carrying inductor related to its self-inductance, L?
    a. directly proportional to L^2
    b. directly proportional to $L^{1/2}$
    c. directly proportional to L
    d. inversely proportional to L

    ANS: C PTS: 1 DIF: 1
    TOP: 20.7 Energy Stored in a Magnetic Field

75. How is the energy stored in a current-carrying inductor related to the current value, I?
a. directly proportional to I^2
b. directly proportional to $I^{1/2}$
c. directly proportional to I
d. inversely proportional to I

ANS: A PTS: 1 DIF: 1
TOP: 20.7 Energy Stored in a Magnetic Field

76. A 12-V battery is connected in series with a switch, 6.0-Ω resistor and coil. What energy is stored in the coil when the current is 2.0 A? The time constant is 4.0×10^{-4} s.
a. 4.8×10^{-3} J
b. 9.6×10^{-3} J
c. 14×10^{-3} J
d. 29×10^{-3} J

ANS: A PTS: 1 DIF: 2
TOP: 20.7 Energy Stored in a Magnetic Field

77. Superconductors have been discussed as a means for electrical energy storage. Because they are resistanceless, a current once started in a loop would continue without loss. If a current of 1.0×10^4 A were started in a huge toroidal coil of radius 1.0 km and inductance 50 H, how much electrical energy (in kWh) could be stored?
a. 300 kWh
b. 480 kWh
c. 690 kWh
d. 840 kWh

ANS: C PTS: 1 DIF: 2
TOP: 20.7 Energy Stored in a Magnetic Field

78. An RL circuit has $L = 0.40$ H and $R = 5.0\ \Omega$. It is connected to a battery with $\varepsilon = 22$ V at time $t = 0$. Find the energy stored in the inductor when the current in the circuit is 0.50 A.
a. 50 mJ
b. 1.0 J
c. 2.0 J
d. 5.0 J

ANS: A PTS: 1 DIF: 2
TOP: 20.7 Energy Stored in a Magnetic Field

79. A double loop of wire (making 2 turns) is in the x-y plane centered at the origin. A uniform magnetic field is increasing at a constant rate in the positive z-direction.Viewed from the positive z-axis, in which direction is the induced magnetic field in the loop?
a. in the positive z-direction
b. in the negative z-direction
c. There is no induced field because of the double loop.
d. There is no induced field because the rate of change of the magnetic field is constant.

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Questions

80. A circular loop of wire has its radius reduced in half in time Δt. A uniform magnetic field is at an angle of 60° to the plane of the coil, and the magnetic field doubles its intensity in the same time interval Δt. During this interval, what happens to the flux through the coil?
a. It increases.

b. It decreases.
c. It remains the same.
d. More information is needed to make this conclusion.

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Questions

81. Two solenoids, wound from wire from the same spool, have the same length and cross-sectional area, but solenoid #1 has half the turns of solenoid #2. If these solenoids are each connected to a circuit, and the only non-negligible resistance is that of the solenoids, which solenoid gives the greater time constant and by what factor?
a. #1 by a factor of 2
b. #2 by a factor of 2
c. #2 by a factor of 4
d. No answer above is completely correct.

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Questions

82. One time constant after an *RL* circuit has its switch closed, how does the current I in it compare to the maximum current I_{max} that occurs for this circuit?
a. $I > I_{max}/2$
b. $I = I_{max}/2$
c. $I < I_{max}/2$
d. Without knowing R and L, this cannot be determined.

ANS: A PTS: 1 DIF: 2 TOP: Conceptual Questions

83. Three loops of wire, one circular, one rectangular, and one square, are made from identical lengths of wire. If the loops are in the same increasing magnetic field perpendicular to the plane of the coils, which loop has the greatest induced emf?
a. the circular one
b. the rectangular one
c. the square one
d. All three would have the same emf induced.

ANS: A PTS: 1 DIF: 3 TOP: Conceptual Questions

CHAPTER 21—Alternating Current Circuits and Electromagnetic Waves

MULTIPLE CHOICE

1. What is the effective (rms) current value for an AC current with an amplitude of 10 A?
   a. 28 A
   b. 3.1 A
   c. 7.1 A
   d. 14 A

   ANS: C PTS: 1 DIF: 2
   TOP: 21.1 Resistors in an AC Circuit

2. In an AC series circuit, the current in a pure resistor differs in phase with the applied voltage by what angle?
   a. zero
   b. 45°
   c. 90°
   d. 180°

   ANS: A PTS: 1 DIF: 1
   TOP: 21.1 Resistors in an AC Circuit

3. The rate of heat dissipation in an AC circuit with resistance, R, and effective current, I_{rms}, is given by which of the following?
   a. 0.5 ´ $(I_{rms})^2R$
   b. $(I_{rms})^2R$
   c. 2.0 ´ $(I_{rms})^2R$
   d. 4.0 ´ $(I_{rms})^2R$

   ANS: B PTS: 1 DIF: 1
   TOP: 21.1 Resistors in an AC Circuit

4. An AC voltage source, with a peak output of 200 V, is connected to a 50-Wresistor. What is the effective (or rms) current in the circuit?
   a. 2.8 A
   b. 4.0 A
   c. 5.6 A
   d. 2.0 A

   ANS: A PTS: 1 DIF: 2
   TOP: 21.1 Resistors in an AC Circuit

5. An AC voltage source, with a peak output of 200 V, is connected to a 50-Wresistor. What is the rate of energy dissipated due to heat in the resistor?
   a. 200 W
   b. 400 W
   c. 566 W
   d. 800 W

   ANS: B PTS: 1 DIF: 2
   TOP: 21.1 Resistors in an AC Circuit

6. The rms current is equal to the direct current that:

a. produces the same average voltage across a resistor as in an AC circuit.
b. dissipates an equal amount of energy in a resistor at the same rate as in an AC circuit.
c. provides the same average current in a resistor as in an AC circuit.
d. results in the same peak power in a resistor as in an AC circuit.

ANS: B PTS: 1 DIF: 1
TOP: 21.1 Resistors in an AC Circuit

7. An AC voltage source, with a peak output of 120 V, results in dissipation of energy in a resistor at rate of 100 W. What is the value of the resistance?
a. 144 W
b. 120 W
c. 100 W
d. 72 W

ANS: D PTS: 1 DIF: 2
TOP: 21.1 Resistors in an AC Circuit

8. The peak voltage of an AC source is 200 V. What is the rms voltage?
a. 282 V
b. 200 V
c. 141 V
d. 100 V

ANS: C PTS: 1 DIF: 1
TOP: 21.1 Resistors in an AC Circuit

9. In the typical household AC voltage of 120 V, what is the peak voltage?
a. 240 V
b. 170 V
c. 120 V
d. 85 V

ANS: B PTS: 1 DIF: 1
TOP: 21.1 Resistors in an AC Circuit

10. The frequency in an AC series circuit is doubled. By what factor does this change the capacitive reactance?
a. 1/2
b. 1/4
c. 2
d. 4

ANS: A PTS: 1 DIF: 1
TOP: 21.2 Capacitors in an AC Circuit

11. In an AC series circuit the capacitive reactance is 200 Wand frequency is 100 Hz. What is the capacitance?
a. 3.2 *m*F
b. 6.28 *m*F
c. 8.0 *m*F
d. 50.0 *m*F

ANS: C PTS: 1 DIF: 2
TOP: 21.2 Capacitors in an AC Circuit

12. A 12.0-mF capacitor is connected to an AC source with an rms voltage of 120 V and a frequency of 60.0 Hz. What is the rms current in the capacitor?
a. 1.41 A
b. 0.768 A
c. 0.543 A
d. 0 A

ANS: C PTS: 1 DIF: 3
TOP: 21.2 Capacitors in an AC Circuit

13. When a 50-mF capacitor is attached to an AC source, its capacitive reactance is 40 W. If instead a 100-mF capacitor is attached to the same source, what will be its capacitive reactance?
a. 80 O
b. 57 O
c. 28 O
d. 20 O

ANS: D PTS: 1 DIF: 2
TOP: 21.2 Capacitors in an AC Circuit

14. In a capacitor in an AC circuit, the voltage:
a. leads the current by 90°.
b. lags the current by 90°.
c. may lead or lag the current depending on the frequency.
d. is in phase with 70.7% of the current.

ANS: B PTS: 1 DIF: 1
TOP: 21.2 Capacitors in an AC Circuit

15. In the inductor of a 60-Hz AC series circuit, the peak voltage precedes the peak current in each cycle by what time interval?
a. 2.1 ´ 10^{-3} s
b. 4.2 ´ 10^{-3} s
c. 8.3 ´ 10^{-3} s
d. 1.7 ´ 10^{-3} s

ANS: B PTS: 1 DIF: 2
TOP: 21.3 Inductors in an AC Circuit

16. In an AC series circuit, the voltage in the inductor differs in phase with the voltage in the capacitor by what angle?
a. zero
b. 45°
c. 90°
d. 180°

ANS: D PTS: 1 DIF: 1
TOP: 21.3 Inductors in an AC Circuit

17. In an AC series circuit the inductive reactance is 50 W and the frequency is 100 Hz. What is the inductance in the circuit?
a. 80 mH
b. 240 mH
c. 500 mH

d. 740 mH

ANS: A PTS: 1 DIF: 2
TOP: 21.3 Inductors in an AC Circuit

18. The current in an inductor connected to an AC voltage source lags the voltage. This lag is caused by the:
a. back emf in the coil.
b. voltage across the coil.
c. time required for electrical signals to travel through all the coils of an inductance.
d. resistance of the coil.

ANS: A PTS: 1 DIF: 2
TOP: 21.3 Inductors in an AC Circuit

19. What is the impedance of an AC series circuit that is constructed of a 10.0-Wresistor along with 12.0 Winductive reactance and 7.0 Wcapacitive reactance?
a. 37.0 W
b. 27.7 W
c. 27.1 W
d. 11.2 W

ANS: D PTS: 1 DIF: 2 TOP: 21.4 The RLC Series Circuit

20. What is the phase angle of an AC series circuit that is constructed of a 10.0-Wresistor along with 12.00 Winductive reactance and 7.00 Wcapacitive reactance?
a. 26.6°
b. 18.4°
c. 87.0°
d. 63.4°

ANS: A PTS: 1 DIF: 2 TOP: 21.4 The RLC Series Circuit

21. An AC series circuit has 12.0 Wresistance, 15.00 Winductive reactance and 10.00 Wcapacitive reactance. If an effective (rms) emf of 120 V is applied, what is the effective (rms) current value?
a. 5.31 A
b. 9.23 A
c. 10.8 A
d. 26.0 A

ANS: B PTS: 1 DIF: 2 TOP: 21.4 The RLC Series Circuit

22. Consider an AC series circuit containing a coil, capacitor and resistance. Tripling the frequency will change the inductive reactance by what factor?
a. 1/3
b. 1.0
c. 1.73
d. 3.0

ANS: D PTS: 1 DIF: 1 TOP: 21.4 The RLC Series Circuit

23. Consider an AC series circuit containing a coil, capacitor and resistance. Tripling the frequency will change the capacitive reactance by what factor?
a. 1/3
b. 1.0

c. 1.73
d. 3.0

ANS: A PTS: 1 DIF: 1 TOP: 21.4 The RLC Series Circuit

24. Consider an AC series circuit containing a coil, capacitor and resistance. Tripling the frequency will change the circuit's impedance by what factor?
a. 1/3
b. 1.0
c. 3.0
d. Information is insufficient to determine answer.

ANS: D PTS: 1 DIF: 1 TOP: 21.4 The RLC Series Circuit

25. A resistor and capacitor are connected in series with an applied AC voltage source. Separate voltmeter readings across the resistor and capacitor give values of 50 V and 75 V (rms), respectively. What is the effective (rms) voltage of the source?
a. 25 V
b. 63 V
c. 90 V
d. 125 V

ANS: C PTS: 1 DIF: 2 TOP: 21.4 The RLC Series Circuit

26. A resistor, inductor, and capacitor are connected in series, each with effective (rms) voltage of 65 V, 140 V, and 80 V, respectively. What is the value of the effective (rms) voltage of the applied source in the circuit?
a. 48 V
b. 88 V
c. 95 V
d. 285 V

ANS: B PTS: 1 DIF: 2 TOP: 21.4 The RLC Series Circuit

27. A resistor, inductor, and capacitor are connected in series, each with an effective (rms) voltage of 65 V, 140 V, and 80 V, respectively. What is the magnitude of the phase angle in this circuit?
a. 22°
b. 28°
c. 37°
d. 43°

ANS: D PTS: 1 DIF: 3 TOP: 21.4 The RLC Series Circuit

28. In an AC circuit, the ratio of average current to maximum current is:
a. zero.
b. 0.5.
c. 0.707.
d. 1.0.

ANS: A PTS: 1 DIF: 2 TOP: 21.4 The RLC Series Circuit

29. A 50-Wresistor, a 0.1-H inductor, and a 10-μF capacitor are connected in series to a 60-Hz source. The rms current in the circuit is 3 A. Find the rms voltage across the resistor, the inductor, and the capacitor.
a. 150 V, 113 V, 796 V (all rms)
b. 0.06 V, 80 V, 562 V (all rms)

c. 150 V, 113 V, 562 V (all rms)
d. 60 V, 80 V, 796 V (all rms)

ANS: A PTS: 1 DIF: 3 TOP: 21.4 The RLC Series Circuit

30. A series circuit has equal values for resistance, capacitive reactance, and inductive reactance. The phase angle for this circuit is:
a. 60°.
b. –60°.
c. 180°.
d. not given.

ANS: D PTS: 1 DIF: 2 TOP: 21.4 The RLC Series Circuit

31. In an RLC series circuit the capacitive reactance is 24 W. If the AC frequency doubles, what will be the resulting capacitive reactance?
a. 24 W
b. 12 W
c. 48 W
d. Additional information is need to find the value.

ANS: B PTS: 1 DIF: 2 TOP: 21.4 The RLC Series Circuit

32. In an RLC series circuit the phase angle between the current and voltages is 30°. If the AC frequency doubles, what is the resulting phase angle?
a. 30°
b. more than 30°
c. less than 30°
d. Additional information is needed to reach a determination.

ANS: B PTS: 1 DIF: 3 TOP: 21.4 The RLC Series Circuit

33. In an RLC series circuit, if the AC frequency is increased to a very large value, what value does the phase angle between the current and voltage approach?
a. 90°
b. 0°
c. –90°
d. 45°

ANS: A PTS: 1 DIF: 2 TOP: 21.4 The RLC Series Circuit

34. In an RLC series circuit, if the AC frequency is decreased to a very small value, what value does the phase angle between the current and voltage approach?
a. 90°
b. 0°
c. –90°
d. 45°

ANS: C PTS: 1 DIF: 2 TOP: 21.4 The RLC Series Circuit

35. An AC series circuit has 12.0 W resistance, 15.00 W inductive reactance and 10.00 W capacitive reactance. If an effective (rms) emf of 120 V is applied, what is the power output?
a. 1 540 W
b. 1 300 W
c. 1 160 W

d. 1 020 W

ANS: D PTS: 1 DIF: 2
TOP: 21.5 Power in an AC Circuit

36. The power dissipated in an AC series circuit increases as the phase angle approaches what value?
a. zero
b. 45°
c. 90°
d. 180°

ANS: A PTS: 1 DIF: 1
TOP: 21.5 Power in an AC Circuit

37. The power factor in an AC series circuit is equal to which of the following ratios?
a. resistance to inductive reactance
b. capacitive reactance to inductive reactance
c. inductive reactance to capacitive reactance
d. resistance to impedance

ANS: D PTS: 1 DIF: 2
TOP: 21.5 Power in an AC Circuit

38. A resistor, inductor and capacitor are connected in series, each with effective (rms) voltage of 65 V, 140 V and 80 V, respectively. If the resistor is rated at 24 W, what is the average power dissipated in the circuit?
a. 88 W
b. 176 W
c. 238 W
d. 323 W

ANS: B PTS: 1 DIF: 2
TOP: 21.5 Power in an AC Circuit

39. What is the average power dissipation in a series *RC* circuit if R = 5.00 kW, C = 2.00 μF, and V = (170 V) cos 300t?
a. 2.60 W
b. 2.74 W
c. 28.2 W
d. 157 W

ANS: A PTS: 1 DIF: 3
TOP: 21.5 Power in an AC Circuit

40. A 200-Wresistor is connected in series with a 10-μF capacitor and a 60-Hz, 120-V (rms) line voltage. If electrical energy costs 5.0¢ per kWh, how much does it cost to leave this circuit connected for 24 hours?
a. 62¢
b. 31¢
c. 5.2¢
d. 3.1¢

ANS: D PTS: 1 DIF: 3
TOP: 21.5 Power in an AC Circuit

41. Resonance occurs in an AC series circuit when which of the following conditions is met?

a. resistance equals capacitive reactance
b. resistance equals inductive reactance
c. capacitive reactance equals inductive reactance
d. capacitive reactance equals zero

ANS: C PTS: 1 DIF: 1
TOP: 21.6 Resonance in a Series RLC Circuit

42. An AC series circuit contains a resistor of 20 W, a capacitor of 0.75 mF and an inductor of 120 mH. What frequency should be used to create a resonance condition in the circuit?
a. 160 Hz
b. 320 Hz
c. 640 Hz
d. 530 Hz

ANS: D PTS: 1 DIF: 2
TOP: 21.6 Resonance in a Series RLC Circuit

43. A series *RLC* AC circuit is at resonance. It contains a resistor of 30 W, a capacitor of 0.35 mF and an inductor of 90 mH. If an effective (rms) voltage of 150 V is applied, what is the effective (rms) current when the circuit is in resonance?
a. 3.3 A
b. 5.0 A
c. 9.4 A
d. 16.1 A

ANS: B PTS: 1 DIF: 2
TOP: 21.6 Resonance in a Series RLC Circuit

44. An AC series circuit contains a resistor of 20 W, an inductor of 30 mH and a variable capacitor. If the frequency of the applied voltage is 500 Hz, to what setting should the capacitor be set if resonance is achieved?
a. 0.8 μF
b. 1.6 μF
c. 2.4 μF
d. 3.4 μF

ANS: D PTS: 1 DIF: 2
TOP: 21.6 Resonance in a Series RLC Circuit

45. A series *RLC* circuit in a radio is in resonance with AM 600 kHz. If the radio station is changed to AM 1 200 kHz, by what factor must the capacitance be multiplied to again achieve resonance?
a. 4
b. 2
c. 1/2
d. 1/4

ANS: D PTS: 1 DIF: 2
TOP: 21.6 Resonance in a Series RLC Circuit

46. Find the resonant frequency for a series *RLC* circuit where R = 20.0 W, C = 10.0 μF, and L = 4.0 mH.
a. 507 Hz
b. 796 Hz
c. 1.59 kHz
d. 5.00 kHz

ANS: B PTS: 1 DIF: 2
TOP: 21.6 Resonance in a Series RLC Circuit

47. What is the average power dissipation in an *RLC* series circuit in which *R* = 100 W, *L* = 0.1 H, and *C* = 10 μF driven at resonance by a 100-V (rms) source?
a. 100 W
b. 500 W
c. 1 000 W
d. 2 W

ANS: A PTS: 1 DIF: 2
TOP: 21.6 Resonance in a Series RLC Circuit

48. An AM radio tuning circuit has a coil with an inductance of 6.00 mH and a capacitor set at 7.50 ´ 10^{-6} *m*F. What frequency will it detect?
a. 550 kHz
b. 750 kHz
c. 1 060 kHz
d. 1 520 kHz

ANS: B PTS: 1 DIF: 2
TOP: 21.6 Resonance in a Series RLC Circuit

49. An FM radio tuning circuit has a coil with an inductance of 0.003 0 mH. What is the value of the capacitance if the set is tuned to 98 MHz?
a. 1.8 ´ 10^{-6} *m*F
b. 12 ´ 10^{-6} *m*F
c. 0.98 ´ 10^{-6} *m*F
d. 0.88 ´ 10^{-6} *m*F

ANS: D PTS: 1 DIF: 2
TOP: 21.6 Resonance in a Series RLC Circuit

50. Which of the following combinations of circuit components can be used to make a tuner for a radio, to select the desired frequency?
a. fixed inductor, variable resistor
b. fixed resistor, variable inductor
c. fixed inductor, variable capacitor
d. fixed capacitor, variable resistor

ANS: C PTS: 1 DIF: 1
TOP: 21.6 Resonance in a Series RLC Circuit

51. When an RLC series circuit is in resonance, its impedance is:
a. zero.
b. equal to its resistance.
c. a maximum.
d. p/2 W.

ANS: B PTS: 1 DIF: 2
TOP: 21.6 Resonance in a Series RLC Circuit

52. A series RLC circuit has a inductive reactance of 4 W and a capacitive reactance of 1/4 W. By what factor should the AC frequency be changed to put this circuit into resonance?

a. 4
b. 1/4
c. 1/2
d. This circuit cannot be made to achieve resonance.

ANS: B PTS: 1 DIF: 2
TOP: 21.6 Resonance in a Series RLC Circuit

53. The primary winding of an electric train transformer has 400 turns, and the secondary has 50. If the input voltage is 120 V(rms), what is the output voltage?
a. 480 V
b. 60 V
c. 15 V
d. 10 V

ANS: C PTS: 1 DIF: 1 TOP: 21.7 The Transformer

54. A transformer consists of a 500-turn primary coil and a 2 000-turn secondary coil. If the current in the secondary is 3.00 A, what is the primary current?
a. 0.750 A
b. 1.33 A
c. 12.0 A
d. 48.0 A

ANS: C PTS: 1 DIF: 2 TOP: 21.7 The Transformer

55. An AC power generator produces 50 A (rms) at 3 600 V. The voltage is stepped up to 100 000 V by an ideal transformer, and the energy transmitted through a long-distance power line with a total resistance of 100 W. What is the rms current in the long-distance line?
a. 1.0 A
b. 1.8 A
c. 24 A
d. 1 000 A

ANS: B PTS: 1 DIF: 2 TOP: 21.7 The Transformer

56. An AC power generator produces 25 A (rms) at 3 600 V. The energy is transmitted through a long-distance power line, which has a total resistance of 100 W. What percentage of the power delivered by the generator is dissipated as heat in the long-distance line if a step-up transformer is not used?
a. 0.09%
b. 1.8%
c. 32%
d. 69%

ANS: D PTS: 1 DIF: 2 TOP: 21.7 The Transformer

57. A transformer is to be designed to increase the 30-kV (rms) output of a generator to the transmission line voltage of 345 kV (rms). If the primary winding has 80 turns, how many turns must the secondary have?
a. 6
b. 70
c. 920
d. 9 200

ANS: C PTS: 1 DIF: 2 TOP: 21.7 The Transformer

58. An ideal transformer is one that:
    a. has a turn ratio, N_2/N_1, equal to 1.
    b. works with direct current.
    c. experiences no power loss.
    d. has an output frequency of 60 Hz.

    ANS: C PTS: 1 DIF: 1 TOP: 21.7 The Transformer

59. Which one of the following scientists made the theoretical prediction that electromagnetic waves travel through a vacuum at the speed of light?
    a. Hertz
    b. Faraday
    c. Maxwell
    d. Lenz

    ANS: C PTS: 1 DIF: 1
    TOP: 21.8 Maxwell’s Predictions | 21.9 Hertz’s Confirmation of Maxwell’s Predictions

60. Which one of the following scientists first built and operated devices that could emit and detect man-made electromagnetic radiation?
    a. Hertz
    b. Ampere
    c. Maxwell
    d. Lenz

    ANS: C PTS: 1 DIF: 1
    TOP: 21.8 Maxwell’s Predictions | 21.9 Hertz’s Confirmation of Maxwell’s Predictions

61. Maxwell developed his theory of electromagnetism by combining previous discoveries. He added his own original hypothesis that:
    a. electric charges produce electric fields.
    b. moving electric charges produce magnetic fields.
    c. changing electric fields produce magnetic fields.
    d. changing magnetic fields produce electric fields.

    ANS: C PTS: 1 DIF: 1
    TOP: 21.8 Maxwell’s Predictions | 21.9 Hertz’s Confirmation of Maxwell’s Predictions

62. Maxwell guessed that visible light was an electromagnetic wave because of its:
    a. frequency.
    b. wavelength.
    c. speed.
    d. energy.

    ANS: C PTS: 1 DIF: 1
    TOP: 21.8 Maxwell’s Predictions | 21.9 Hertz’s Confirmation of Maxwell’s Predictions

63. An electromagnetic wave is made up of which of the following oscillating quantities?
    a. electrons only
    b. electric fields only
    c. magnetic fields only
    d. electric and magnetic fields

    ANS: C PTS: 1 DIF: 1
    TOP: 21.10 Production of Electromagnetic Waves by an Antenna | 21.11 Properties of Electromagnetic Waves

64. An electromagnetic wave with a peak electric field component of 1.2×10^{2} N/C has what associated peak magnetic field value? ($\varepsilon_0 = 8.85 \times 10^{-12}$ $C^2/N{\cdot}m^2$, $\mu_0 = 4\pi \times 10^{-7}$ T·m/A and $c = 3.00 \times 10^{8}$ m/s)
a. 4.0×10^{-7} T
b. 3.6×10^{10} T
c. 2.5×10^{6} T
d. 2.8×10^{-11} T

ANS: C PTS: 1 DIF: 1
TOP: 21.10 Production of Electromagnetic Waves by an Antenna | 21.11 Properties of Electromagnetic Waves

65. Which condition of motion must be met with regard to a charged particle if it is in the process of emitting electromagnetic radiation?
a. moves at constant velocity
b. accelerates
c. moves at the speed of light
d. moves parallel to a uniform magnetic field

ANS: B PTS: 1 DIF: 1
TOP: 21.10 Production of Electromagnetic Waves by an Antenna | 21.11 Properties of Electromagnetic Waves

66. The electric field, , in an electromagnetic wave is oriented in what direction with respect to its associated magnetic field, ?
a. parallel to
b. anti-parallel to
c. perpendicular to
d. at a 45° angle to

ANS: C PTS: 1 DIF: 1
TOP: 21.10 Production of Electromagnetic Waves by an Antenna | 21.11 Properties of Electromagnetic Waves

67. An electromagnetic wave with a peak magnetic field component of 1.5×10^{-7} T has an associated peak electric field component of what value? ($\mu_0 = 4\pi \times 10^{-7}$ T·m/A, $\varepsilon_0 = 8.85 \times 10^{-12}$ $C^2/N{\cdot}m^2$ and $c = 3.00 \times 10^{8}$ m/s)
a. 0.50×10^{-15} N/C
b. 2.00×10^{-5} N/C
c. 2.20×10^{4} N/C
d. 45 N/C

ANS: C PTS: 1 DIF: 1
TOP: 21.10 Production of Electromagnetic Waves by an Antenna | 21.11 Properties of Electromagnetic Waves

68. An electromagnetic wave with a peak magnetic field component of 1.5×10^{-7} T carries what average power per unit area? ($\mu_0 = 4\pi \times 10^{-7}$ T·m/A, $\varepsilon_0 = 8.85 \times 10^{-12}$ $C^2/N{\cdot}m^2$ and $c = 3.00 \times 10^{8}$ m/s)
a. 12 W/m^2
b. 2.7 W/m^2
c. 3.0 W/m^2
d. 1.3 W/m^2

ANS: C PTS: 1 DIF: 1

TOP: 21.10 Production of Electromagnetic Waves by an Antenna | 21.11 Properties of Electromagnetic Waves

69. A radio wave transmits 1.2 W/m^2 average power per unit area. What is the peak value of the associated magnetic field? ($\mu_0 = 4\pi \times 10^{-7}$ T·m/A and $c = 3.00 \times 10^8$ m/s)
a. 1.0×10^{-7} T
b. 8.4×10^{-3} T
c. 1.2 T
d. 30 T

ANS: C PTS: 1 DIF: 1
TOP: 21.10 Production of Electromagnetic Waves by an Antenna | 21.11 Properties of Electromagnetic Waves

70. How is the direction of propagation of an electromagnetic wave oriented relative to the associated and fields?
a. parallel to both and
b. perpendicular to both and
c. parallel to , perpendicular to
d. parallel to , perpendicular to

ANS: C PTS: 1 DIF: 1
TOP: 21.10 Production of Electromagnetic Waves by an Antenna | 21.11 Properties of Electromagnetic Waves

71. What is the maximum value of the electric field *E* at 1.0 m from a 100-W light bulb radiating in all directions? ($\mu_0 = 4\pi \times 10^{-7}$ T·m/A, $c = 3.00 \times 10^8$ m/s)
a. 77 V/m
b. 2 000 V/m
c. 4 000 V/m
d. 6 000 V/m

ANS: C PTS: 1 DIF: 1
TOP: 21.10 Production of Electromagnetic Waves by an Antenna | 21.11 Properties of Electromagnetic Waves

72. Determine the amount of energy carried in l.0 m of a 3.5-mW He-Ne laser beam if the cross-sectional area of the beam is 5.0×10^{-6} m^2.
a. 0.012 J
b. 4.1×10^{-8} J
c. 1.2×10^{-11} J
d. 1.0 J

ANS: C PTS: 1 DIF: 1
TOP: 21.10 Production of Electromagnetic Waves by an Antenna | 21.11 Properties of Electromagnetic Waves

73. The Earth is 1.49×10^{11} m from the Sun. If the solar radiation at the top of the Earth's atmosphere is 1 340 W/m^2, what is the total power output of the Sun?
a. 7.48×10^{27} W
b. 2.34×10^{30} W
c. 6.62×10^{26} W
d. 3.74×10^{26} W

ANS: C PTS: 1 DIF: 1

TOP: 21.10 Production of Electromagnetic Waves by an Antenna | 21.11 Properties of Electromagnetic Waves

74. If the radiant energy from the Sun comes in as a plane EM wave of intensity 1 340 W/m^2, calculate the peak values of E and B. ($\mu_0 = 4\pi \times 10^{-7}$ T·m/A)
    a. 330 V/m, 3.0×10^{-4} T
    b. 1 010 V/m, 3.35×10^{-6} T
    c. 330 V/m, 3.35×10^{-6} T
    d. 1 010 V/m, 3.0×10^{-4} T

ANS: C PTS: 1 DIF: 1
TOP: 21.10 Production of Electromagnetic Waves by an Antenna | 21.11 Properties of Electromagnetic Waves

75. Peak values for a neodymium-glass laser are 600 J for 1 nanosecond. If the cross-section of the laser beam is 1 cm^2, what are the maximum values of E and B? ($\mu_0 = 4\pi \times 10^{-7}$ T·m/A, $c = 3.00 \times 10^8$ m/s)
    a. 2×10^9 V/m, 2 T
    b. 4×10^8 V/m, 7 T
    c. 2×10^9 V/m, 7 T
    d. 4×10^8 V/m, 2 T

ANS: C PTS: 1 DIF: 1
TOP: 21.10 Production of Electromagnetic Waves by an Antenna | 21.11 Properties of Electromagnetic Waves

76. A solar cell has a light-gathering area of 10 cm^2 and produces 0.20 A at 0.80 V (dc) when illuminated with sunlight of intensity 1 000 W/m^2. What is the efficiency of the solar cell?
    a. 16%
    b. 7%
    c. 23%
    d. 4%

ANS: C PTS: 1 DIF: 1
TOP: 21.10 Production of Electromagnetic Waves by an Antenna | 21.11 Properties of Electromagnetic Waves

77. In a space lab a 25- sheet of aluminum foil is subjected to a laser beam of intensity on one side and to a beam of intensity on the opposite side, the radiation in each case hitting with normal incidence. What is the net force on the aluminum foil if both sides are considered to be totally reflective?
    a.
    b.
    c.
    d.

ANS: B PTS: 1 DIF: 2
TOP: 21.11 Properties of Electromagnetic Waves

78. In a space lab a 25- sheet of aluminum foil having mass is subjected to a laser beam of intensity on one side and to a beam of intensity on the opposite side, the radiation in each case hitting with normal incidence. If both of the aluminum foil sides are considered to be totally reflective and the foil is floating in the space lab, what acceleration of the foil will result from the net force from the incident beams?
    a.
    b.

c.
d.

ANS: D PTS: 1 DIF: 2
TOP: 21.11 Properties of Electromagnetic Waves

79. In a northern latitude an experiment is performed on 3.50- sheet of roofing material which is placed in sunlight of intensity making normal incidence on its top surface. The ambient temperature surrounding the material on both top and bottom is 275 K. If the material acts as a perfect blackbody and sheds half of the incident radiation by thermal radiation, what equilibrium temperature does is reach?
a. 375 K
b. 336 K
c. 310 K
d. 294 K

ANS: C PTS: 1 DIF: 3
TOP: 21.11 Properties of Electromagnetic Waves

80. In order of increasing frequency, which of the following is correct?
a. visible, radio, ultraviolet and x-ray
b. infrared, visible, ultraviolet and gamma
c. visible, gamma, ultraviolet and x-ray
d. infrared, x-ray, visible and gamma

ANS: C PTS: 1 DIF: 1
TOP: 21.12 The Spectrum of Electromagnetic Waves

81. A radar pulse returns 3.0×10^{-4} seconds after it is sent out, having been reflected by an object. What is the distance between the radar antenna and the object? ($c = 3.00 \times 10^{8}$ m/s)
a. 9.0×10^{4} m
b. 4.5×10^{4} m
c. 6.0×10^{4} m
d. 1.0×10^{4} m

ANS: C PTS: 1 DIF: 1
TOP: 21.12 The Spectrum of Electromagnetic Waves

82. In order to keep its food hot, a restaurant will place it under which type of lamp?
a. infrared
b. visible light
c. ultraviolet
d. x-ray

ANS: C PTS: 1 DIF: 1
TOP: 21.12 The Spectrum of Electromagnetic Waves

83. Glass panes are opaque to a certain type of radiation, which passes through quartz. What type of radiation is it? This radiation is important in ozone layer reactions.
a. microwave
b. gamma
c. x-ray
d. ultraviolet

ANS: C PTS: 1 DIF: 1

TOP: 21.12 The Spectrum of Electromagnetic Waves

84. A radio wave signal, which transmits at a frequency of 7.20 MHz, has what wavelength? ($c = 3.00 \times 10^8$ m/s)
   a. 41.7 m
   b. 4.17 m
   c. 28.8 m
   d. 2.4×10^{-2} m

ANS: C PTS: 1 DIF: 1
TOP: 21.12 The Spectrum of Electromagnetic Waves

85. A radar pulse sent out to an airplane at a distance of 20.0 km will return as an echo to the source in what time interval? ($c = 3.00 \times 10^8$ m/s)
   a. 33.3×10^{-6} s
   b. 66.7×10^{-6} s
   c. 133×10^{-6} s
   d. $0.033\,3 \times 10^{-6}$ s

ANS: C PTS: 1 DIF: 1
TOP: 21.12 The Spectrum of Electromagnetic Waves

86. The human eye is sensitive to light with wavelength down to 390 nm. What is the frequency of radiation at this wavelength? (1 nm = 10^{-9} m and $c = 3.00 \times 10^8$ m/s)
   a. 1.8×10^8 Hz
   b. 8.5×10^8 Hz
   c. 1.1×10^{11} Hz
   d. 7.7×10^{14} Hz

ANS: C PTS: 1 DIF: 1
TOP: 21.12 The Spectrum of Electromagnetic Waves

87. An ultraviolet light wave has a wavelength of 300 nm and speed of 2.1×10^8 m/s through a transparent medium. What is the frequency of this wave in the medium? (1 nm = 10^{-9} m and $c = 3.00 \times 10^8$ m/s)
   a. 6.3×10^2 Hz
   b. 9.0×10^2 Hz
   c. 7.0×10^{14} Hz
   d. 10×10^{14} Hz

ANS: C PTS: 1 DIF: 1
TOP: 21.12 The Spectrum of Electromagnetic Waves

88. Microwave radiation is useful in which of the following?
   a. sending phone messages
   b. cooking food
   c. aircraft navigation
   d. All of the above are valid choices.

ANS: C PTS: 1 DIF: 1
TOP: 21.12 The Spectrum of Electromagnetic Waves

89. Temperature variation of different parts of a person's body can be detected by analyzing the emission pattern of which type of electromagnetic radiation?
   a. microwave

b. infrared
c. ultraviolet
d. x-rays

ANS: C PTS: 1 DIF: 1
TOP: 21.12 The Spectrum of Electromagnetic Waves

90. Of the various types of electromagnetic radiation, which is the most penetrating through all forms of matter?
a. infrared
b. gamma
c. visible light
d. ultraviolet

ANS: C PTS: 1 DIF: 1
TOP: 21.12 The Spectrum of Electromagnetic Waves

91. What value of inductance should be used in a series circuit with a capacitor of 1.8×10^{-3} μF when designed to radiate a wavelength of 35 m? ($c = 3.00 \times 10^{8}$ m/s)
a. 3.8 mH
b. 2.6×10^{-2} mH
c. 3.8×10^{-3} mH
d. 1.9×10^{-4} mH

ANS: C PTS: 1 DIF: 1
TOP: 21.12 The Spectrum of Electromagnetic Waves

92. As an electromagnetic wave travels through free space, its speed can be increased by:
a. increasing its frequency.
b. increasing its energy only.
c. increasing both its energy and momentum.
d. None of the above will increase its speed.

ANS: C PTS: 1 DIF: 1
TOP: 21.12 The Spectrum of Electromagnetic Waves

93. An object that is giving off only infrared electromagnetic waves is giving off heat through:
a. convection.
b. conduction.
c. radiation.
d. visible light.

ANS: C PTS: 1 DIF: 1
TOP: 21.12 The Spectrum of Electromagnetic Waves

94. The electromagnetic radiation that causes tanning:
a. can produce cancer.
b. rarely passes through glass windows.
c. is absorbed by ozone.
d. is all of the above.

ANS: C PTS: 1 DIF: 1
TOP: 21.12 The Spectrum of Electromagnetic Waves

95. What is the wavelength of 100-MHz television EM waves? ($c = 3 \times 10^{8}$ m/s)

a. 0.3 cm
b. 3 m
c. 9 km
d. 10 m

ANS: C PTS: 1 DIF: 1
TOP: 21.12 The Spectrum of Electromagnetic Waves

96. Find the frequency of x-rays of wavelength 10^{-10} m. ($c = 3 \times 10^8$ m/s)
a. 3×10^{18} Hz
b. 3×10^{16} Hz
c. 6×10^9 Hz
d. 3×10^8 Hz

ANS: C PTS: 1 DIF: 1
TOP: 21.12 The Spectrum of Electromagnetic Waves

97. In the Doppler effect for electromagnetic waves, which of the following gives the greatest shift in frequency?
a. the source moving toward the non-moving observer at speed v
b. the observer moving toward the non-moving source at speed v
c. the source moving toward the approaching observer, both at speed v/2
d. All of the above give the same shift.

ANS: C PTS: 1 DIF: 1
TOP: 21.13 The Doppler Effect for Electromagnetic Waves

98. The Doppler shift for electromagnetic radiation from distant galaxies moving away from the observer is called a:
a. red shift.
b. blue shift.
c. black shift.
d. vacuum shift.

ANS: C PTS: 1 DIF: 1
TOP: 21.13 The Doppler Effect for Electromagnetic Waves

99. An observer is moving in space toward a distant star at 100 km/s while the star is moving toward the observer at 200 km/s; the relative velocity being 300 km/s of approach. What relative change in frequency of the light from the star as seen by the observer? (The speed of light in space is 3.00×10^5 km/s).
a. 0.10% increase
b. 0.10% decrease
c. 0.067% increase
d. 0.033% decrease

ANS: C PTS: 1 DIF: 1
TOP: 21.13 The Doppler Effect for Electromagnetic Waves

100. In an *RLC* circuit, the maximum current is 1 amp. What is the average current?
a. A
b. A
c. (1/2) A
d. None of the above.

ANS: C PTS: 1 DIF: 1 TOP: Conceptual Questions

101. In an *RC* circuit, which of the following is a possible phase angle?
   a. 45°
   b. –45°
   c. 135°
   d. –135°

ANS: C PTS: 1 DIF: 1 TOP: Conceptual Questions

102. In a 60-Hz *RLC* circuit, the phase angle is positive. The values of the resistance, inductance, and the capacitance are now doubled. Which of the following is now true about the phase angle?
   a. It is still positive.
   b. It could be zero.
   c. It will be negative.
   d. It could be positive, negative, or zero, but it cannot be greater than its original value.

ANS: C PTS: 1 DIF: 1 TOP: Conceptual Questions

103. A monochromatic light wave in vacuum has frequency f_0 and wavelength λ_0. Which of the following are also possible frequency and wavelength combinations for a monochromatic light wave in vacuum?
   a. $2f_0$, $2\lambda_0$
   b. $f_0/2$, $\lambda_0/2$
   c. $2f_0$, $\lambda_0/2$
   d. None of the above are possible.

ANS: C PTS: 1 DIF: 1 TOP: Conceptual Questions

104. An *RLC* circuit has resistance R_0, inductance L_0, and capacitance C_0. If the resistance value is now doubled, which values of inductance and capacitance will result in the same resonant frequency as before.
   a. $2L_0$, $2C_0$
   b. $L_0/2$, $C_0/2$
   c. $2L_0$, $C_0/2$
   d. $2L_0$, C_0

ANS: C PTS: 1 DIF: 1 TOP: Conceptual Questions

CHAPTER 22—Reflection and Refraction of Light

MULTIPLE CHOICE

1. According to the photon energy formula, tripling the frequency of the radiation from a monochromatic source will change the energy content of the individually radiated photons by what factor?
   a. 0.33
   b. 1.0
   c. 1.73
   d. 3.0

   ANS: D PTS: 1 DIF: 2 TOP: 22.1 The Nature of Light

2. Tripling the wavelength of the radiation from a monochromatic source will change the energy content of the individually radiated photons by what factor?
   a. 0.33
   b. 1.0
   c. 1.73
   d. 3.0

   ANS: A PTS: 1 DIF: 2 TOP: 22.1 The Nature of Light

3. Photon A has an energy of 2.0×10^{-19} J. Photon B has 4 times the frequency of Photon A. What is the energy of Photon B?
   a. 0.50×10^{-19} J
   b. 1.0×10^{-19} J
   c. 8.0×10^{-19} J
   d. 32×10^{-19} J

   ANS: C PTS: 1 DIF: 2 TOP: 22.1 The Nature of Light

4. According to present theories of light, in some experiments light seems to be:
   a. composed of particles which can neither be created nor destroyed.
   b. a particle whose quantized energy depends on its velocity.
   c. a wave that moves from one place to another if there is material to vibrate.
   d. none of the above.

   ANS: D PTS: 1 DIF: 2 TOP: 22.1 The Nature of Light

5. The wave-particle duality of light means that, in the same experiment:
   a. light will act both like a wave and like a particle.
   b. light will act either like a wave or like a particle.
   c. light will not act like either a wave or a particle.
   d. light always exists as two waves or as two particles.

   ANS: B PTS: 1 DIF: 1 TOP: 22.1 The Nature of Light

6. What is the energy of a photon of frequency 5.00×10^{14} Hz? ($h = 6.626 \times 10^{-34}$ J·s)
   a. 3.31×10^{-19} J
   b. 3.31×10^{-47} J
   c. 1.33×10^{-48} J
   d. 1.33×10^{-24} J

   ANS: A PTS: 1 DIF: 2 TOP: 22.1 The Nature of Light

7. One phenomenon that demonstrates the particle nature of light is:
   a. the photoelectric effect.
   b. diffraction effects.
   c. interference effects.
   d. the prediction by Maxwell's electromagnetic theory.

   ANS: A   PTS: 1   DIF: 1   TOP: 22.1 The Nature of Light

8. One phenomenon that demonstrates the wave nature of light is:
   a. the photoelectric effect.
   b. quantization effects.
   c. absorption of light by an electron.
   d. interference effects.

   ANS: D   PTS: 1   DIF: 1   TOP: 22.1 The Nature of Light

9. Helium-neon laser light has a wavelength in air of 632.8 nm. What is the energy of a single photon in the beam? ($h = 6.626 \times 10^{-34}$ J·s and $c = 3.00 \times 10^{8}$ m/s).
   a. 3.14×10^{-19} J
   b. 5.40×10^{-19} J
   c. 7.62×10^{-19} J
   d. 1.15×10^{-18} J

   ANS: A   PTS: 1   DIF: 2   TOP: 22.1 The Nature of Light

10. Newton's theory of light treated light as ________ while Young demonstrated that light behaved as ________ with ________ behavior.
    a. particles, waves, refractive
    b. particles, waves, interference
    c. waves, particles, interference
    d. waves, particles, refractive

    ANS: B   PTS: 1   DIF: 2   TOP: 22.1 The Nature of Light

11. The photoelectric effect was discovered by:
    a. Maxwell.
    b. Einstein.
    c. Hertz.
    d. Planck.

    ANS: C   PTS: 1   DIF: 1   TOP: 22.1 The Nature of Light

12. Who formulated the theory explaining the photoelectric effect?
    a. Hertz
    b. Maxwell
    c. Newton
    d. Einstein

    ANS: D   PTS: 1   DIF: 1   TOP: 22.1 The Nature of Light

13. A ray of light strikes a thick sheet of glass (n = 1.5) at an angle of 25° with the normal. Find the angle of the ray reflected off the glass surface with respect to the normal.
    a. 56°
    b. 46°

c. 39°
d. 25°

ANS: D PTS: 1 DIF: 1
TOP: 22.2 Reflection and Refraction

14. As the angle of incidence is increased for a ray incident on a reflecting surface, the angle between the incident and reflected rays ultimately approaches what value?
a. zero
b. 45°
c. 90°
d. 180°

ANS: D PTS: 1 DIF: 1
TOP: 22.2 Reflection and Refraction

15. Which of the following describes what will happen to a light ray incident on an air-to-glass boundary?
a. total reflection
b. total transmission
c. partial reflection, partial transmission
d. partial reflection, total transmission

ANS: C PTS: 1 DIF: 1
TOP: 22.2 Reflection and Refraction

16. Light from a 560-nm monochromatic source is incident upon the surface of fused quartz (n = 1.56) at an angle of 60°. What is the angle of reflection from the surface?
a. 15°
b. 34°
c. 60°
d. 75°

ANS: C PTS: 1 DIF: 1
TOP: 22.2 Reflection and Refraction

17. A line representing a wave front for a wave should be drawn:
a. from the source to the receiver.
b. from one crest to the preceding crest.
c. along one of the crests of the wave.
d. in the direction the wave is moving.

ANS: C PTS: 1 DIF: 1
TOP: 22.2 Reflection and Refraction

18. When light of one wavelength from air hits a smooth piece of glass at an angle, which of the following will not occur?
a. reflection
b. refraction
c. dispersion
d. All of the above will occur.

ANS: C PTS: 1 DIF: 1
TOP: 22.2 Reflection and Refraction

19. When viewing your image in a hand-held mirror, if you move the mirror away at a speed v, the image appears to:

a. also move away at v.
b. move away at 2v.
c. move away at v/2.
d. not move.

ANS: B PTS: 1 DIF: 2
TOP: 22.2 Reflection and Refraction

20. When light reflects and produces a clear image, this reflection is referred to as:
a. specular reflection.
b. diffuse reflection.
c. retroreflection.
d. double reflection.

ANS: A PTS: 1 DIF: 1
TOP: 22.2 Reflection and Refraction

21. Water has an index of refraction of 1.333. What is the speed of light through it? ($c = 3.00 \times 10^8$ m/s)
a. 4.00×10^8 m/s
b. 2.25×10^8 m/s
c. 4.46×10^8 m/s
d. 1.46×10^8 m/s

ANS: B PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

22. A ray of light strikes a thick sheet of glass (n = 1.5) at an angle of 25° with the normal. Find the angle of the refracted ray within the glass with respect to the normal.
a. 56°
b. 46°
c. 25°
d. 16°

ANS: D PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

23. Dez pours carbon tetrachloride (n = 1.46) into a container made of crown glass (n = 1.52). The light ray in glass incident on the glass-to-liquid boundary makes an angle of 30° with the normal. Find the angle of the corresponding refracted ray.
a. 55.5°
b. 29.4°
c. 31.4°
d. 19.2°

ANS: C PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

24. A monochromatic beam of light in air has a wavelength of 589 nm in air. It passes through glass (n = 1.52) and then through carbon disulfide (n = 1.63). What is its wavelength in the carbon disulfide?
a. 361 nm
b. 387.5 nm
c. 895 nm
d. 960 nm

ANS: A PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

25. A light ray in air is incident on an air-to-glass boundary at an angle of 30.0° and is refracted in the glass at an angle of 21.0° with the normal. Find the index of refraction of the glass.

a. 2.13
b. 1.74
c. 1.23
d. 1.40

ANS: D PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

26. A beam of light in air is incident at an angle of 30° to the surface of a rectangular block of clear plastic (n = 1.46). The light beam first passes through the block and re-emerges from the opposite side into air at what angle to the normal to that surface?
a. 42°
b. 23°
c. 30°
d. 59°

ANS: C PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

27. A beam of light in air is incident on the surface of a rectangular block of clear plastic (n = 1.49). If the velocity of the beam before it enters the plastic is 3.00×10^8 m/s, what is its velocity inside the block?
a. 3.00×10^8 m/s
b. 1.93×10^8 m/s
c. 2.01×10^8 m/s
d. 1.35×10^8 m/s

ANS: C PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

28. A light ray in air enters and passes through a block of glass. What can be stated with regard to its speed after it emerges from the block?
a. Speed is less than when in glass.
b. Speed is less than before it entered glass.
c. Speed is same as that in glass.
d. Speed is same as that before it entered glass.

ANS: D PTS: 1 DIF: 1 TOP: 22.3 The Law of Refraction

29. As a monochromatic light ray is transmitted through an air-to-glass boundary, what happens to the wavelength?
a. increases
b. decreases
c. remains unchanged
d. approaches zero value

ANS: B PTS: 1 DIF: 1 TOP: 22.3 The Law of Refraction

30. Monochromatic light hits a piece of glass. What happens to the wavelength in the glass as the index of refraction increases?
a. decreases
b. increases
c. remains constant
d. approaches 3×10^8 m

ANS: A PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

31. If the speed of light through an unknown liquid is measured at 1.80×10^8 m/s, what is the index of refraction of this liquid? ($c = 3.00 \times 10^8$ m/s)

a. 1.80
b. 1.67
c. 1.20
d. 0.600

ANS: B PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

32. If the wavelength of a monochromatic source is 490 nm in vacuum, what is the wavelength from the same source when it passes through a liquid where the speed of light is 2.40×10^8 m/s? ($c = 3.00 \times 10^8$ m/s)
a. 671 nm
b. 612.5 nm
c. 490 nm
d. 392 nm

ANS: D PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

33. What is the angle of incidence on an air-to-glass boundary if the angle of refraction in the glass (n = 1.52) is 25°?
a. 16°
b. 25°
c. 40°
d. 43°

ANS: C PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

34. A monochromatic light source emits a wavelength of 490 nm in air. When passing through a liquid, the wavelength reduces to 429 nm. What is the liquid's index of refraction?
a. 1.26
b. 1.49
c. 1.14
d. 1.33

ANS: C PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

35. Fused quartz has an index of refraction of 1.56 for light from a 560-nm source. What is the speed of light for this wavelength within the quartz? ($c = 3.00 \times 10^8$ m/s)
a. 1.56×10^8 m/s
b. 1.92×10^8 m/s
c. 2.19×10^8 m/s
d. 4.68×10^8 m/s

ANS: B PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

36. If light from a 560-nm monochromatic source in air is incident upon the surface of fused quartz (n = 1.56) at an angle of 60°, what is the wavelength of the ray refracted within the quartz?
a. 192 nm
b. 359 nm
c. 560 nm
d. 874 nm

ANS: B PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

37. A ray of light travels from a glass-to-liquid interface at an angle of 35.0°. Indices of refraction for the glass and liquid are, respectively, 1.52 and 1.63. What is the angle of refraction for the ray moving through the liquid?
a. 23.2°
b. 32.3°
c. 38.4°
d. 46.0°

ANS: B PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

38. A ray of light is incident on a liquid-to-glass interface at an angle of 35°. Indices of refraction for the liquid and glass are, respectively, 1.63 and 1.52. What is the angle of refraction for the ray moving through the glass?
a. 23°
b. 30°
c. 38°
d. 46°

ANS: C PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

39. A beam of monochromatic light goes from material 1 with index of refraction n_1 into material 2 with index of refraction n_2. The frequency of light in material 1 is f_1 and in material 2 is f_2. What is the ratio of f_1/f_2?
a. n_1/n_2
b. n_2/n_1
c. 1
d. The values of n_1 and n_2 must be known to find the answer.

ANS: C PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

40. A fish is 1.2 m beneath the surface of a still pond of water. At what maximum angle can the fish look toward the surface (measured with respect to the normal to the surface) in order to see a fisherman sitting on a distant bank? (for water, n = 1.333)
a. 18.6°
b. 37.2°
c. 48.6°
d. The fish will not see the fisherman at any angle.

ANS: C PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

41. A light ray passes from air through a thin plastic slab (n = 1.3) with parallel sides. If the ray in air makes an angle of 45° with the normal after leaving the slab, what is the angle of incidence for the ray in air as it impinges upon the other side of the slab?
a. 33°
b. 45°
c. 67°
d. 58.5°

ANS: B PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

42. A ray of light is incident on the mid-point of a glass prism surface at an angle of 20° with the normal. For the glass, n = 1.60, and the prism apex angle is 35°. What is the angle of incidence at the glass-to-air surface on the side opposite where the ray exits the prism?
a. 38.0°
b. 35.1°

c. 22.7°
d. 12.3°

ANS: C PTS: 1 DIF: 3 TOP: 22.3 The Law of Refraction

43. A ray of light is incident on the mid-point of a glass prism surface at an angle of 25.0° with the normal. For the glass, n = 1.55, and the prism apex angle is 30.0°. What is the angle of refraction as the ray enters the air on the far side of the prism?
a. 14.1°
b. 22.3°
c. 28.4°
d. 46.0°

ANS: B PTS: 1 DIF: 3 TOP: 22.3 The Law of Refraction

44. An oil film floats on a water surface. The indices of refraction for water and oil, respectively, are 1.333 and 1.466. If a ray of light is incident on the air-to-oil surface at an angle of 37.0° with the normal, what is the incident angle at the oil-to-water surface?
a. 18.1°
b. 24.2°
c. 27.3°
d. 37.0°

ANS: B PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

45. An oil film floats on a water surface. The indices of refraction for water and oil, respectively, are 1.333 and 1.466. If a ray of light is incident on the air-to-oil surface at an angle of 37.0° with the normal, what is the angle of the refracted ray in the water?
a. 18.1°
b. 24.2°
c. 26.8°
d. 37.0°

ANS: C PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

46. When light from air hits a smooth piece of glass (n = 1.5) with the ray perpendicular to the glass surface, which of the following will occur?
a. reflection and transmission with q_2 = 0°
b. refraction with q_2 = 41.8°
c. interference
d. All of the above will occur.

ANS: A PTS: 1 DIF: 1 TOP: 22.3 The Law of Refraction

47. When light from air hits a smooth piece of glass with the ray perpendicular to the glass surface, the part of the light passing into the glass:
a. will not change its speed.
b. will not change its frequency.
c. will not change its wavelength.
d. will not change its intensity.

ANS: B PTS: 1 DIF: 1 TOP: 22.3 The Law of Refraction

48. Light in air enters a diamond (n = 2.42) at an angle of incidence of 48.0°. What is the angle of refraction inside the diamond?
a. 17.9°

b. 19.8°
c. 24.7°
d. 45.6°

ANS: A PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

49. An underwater scuba diver sees the sun at an apparent angle of 30.0° from the vertical. How far is the sun above the horizon? (n_{water} = 1.333)
a. 22.0°
b. 41.8°
c. 48.2°
d. 68.0°

ANS: C PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

50. A light beam is incident upon a still water surface. What is the maximum possible value for the angle of refraction? (n_{water} = 1.333).
a. 76.2°
b. 67.5°
c. 54.4°
d. 48.6°

ANS: D PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

51. A beam of light is incident upon a flat piece of glass (n = 1.50) at an angle of incidence of 45°. Part of the beam is transmitted and part is reflected. What is the angle between the reflected and transmitted rays?
a. 28°
b. 73°
c. 107°
d. 152°

ANS: C PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

52. The lowest possible value for the index of refraction is:
a. 0.
b. 1.
c. 0.707.
d. $3^{-1/2}$.

ANS: B PTS: 1 DIF: 1 TOP: 22.3 The Law of Refraction

53. Three materials with $n_1 < n_2 < n_3$ are arranged in layers of uniform thickness. A light ray in air enters the first layer at an angle of incidence of 30° and the ray eventually exits the third layer at the refracted angle q in air. What is the value of q?
a. Some angle less than 30°.
b. 30°.
c. Some angle more than 30°.
d. Insufficient information to answer.

ANS: B PTS: 1 DIF: 3 TOP: 22.3 The Law of Refraction

54. Of the values listed below, which is the greatest possible value for the index of refraction?
a. 1.5
b.

c. 2.0
d. 2.4

ANS: D PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

55. Two mirrors are joined together along a common side, the planes of the mirrors separated by the angle *è*. If the joined mirrors can be used as a retroreflector when a beam of light strikes both surfaces (one after the other), what is the value of *è*?
a. 30°
b. 45°
c. 90°
d. 135°

ANS: C PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

56. Three slabs of different types of glass of uniform thickness are in contact with one another.The materials have indices of refraction , , and where and . A beam of light starting in air is incident on the surface of material 1 at an angle of incidence of 35°. The beam continues through material 1, material 2, and material 3, finally emerging into the air again. In which of materials 1, 2, or 3, does the beam experience the smallest angle of refraction?
a. material 1
b. material 2
c. material 3
d. This cannot be answered unless one knows the values of , , and since the answer depends upon their relative ratios.

ANS: C PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

57. Three slabs of different types of glass of uniform thickness are in contact with one another.The materials have indices of refraction , , and where and . A beam of light starting in air is incident on the surface of material 1 at an angle of incidence of 35°. The beam continues through material 1, material 2, and material 3, finally emerging into the air again. In which of materials 1, 2, or 3, or air (when the beam emerges back into the air) does the beam experience the largest angle of refraction?
a. material 1
b. material 2
c. material 3
d. air

ANS: D PTS: 1 DIF: 2 TOP: 22.3 The Law of Refraction

58. A ray of white light, incident upon a glass prism, is dispersed into its various color components. Which one of the following colors experiences the greatest angle of deviation?
a. orange
b. violet
c. red
d. green

ANS: B PTS: 1 DIF: 2 TOP: 22.4 Dispersion and Prisms

59. Dispersion occurs when:
a. some materials bend light more than other materials.
b. a material slows down some wavelengths more than others.
c. a material changes some frequencies more than others.
d. light has different speeds in different materials.

ANS: B PTS: 1 DIF: 2 TOP: 22.4 Dispersion and Prisms

60. A certain kind of glass has n_{blue} = 1.650 for blue light and n_{red} = 1.610 for red light. If a beam of white light (containing all colors) is incident at an angle of 30.0°, what is the angle between the red and blue light inside the glass?
a. 0.22°
b. 0.45°
c. 1.90°
d. 1.81°

ANS: B PTS: 1 DIF: 2 TOP: 22.4 Dispersion and Prisms

61. When white light disperses as it passes through a prism, which of the following colors moves at the lowest speed in the prism?
a. blue
b. green
c. yellow
d. red

ANS: A PTS: 1 DIF: 2 TOP: 22.4 Dispersion and Prisms

62. When light passing through a prism undergoes dispersion, the effect is a result of:
a. different wavelengths traveling at different speeds.
b. different wavelengths having different indices of refraction.
c. different wavelengths refracting differently.
d. All of the above.

ANS: D PTS: 1 DIF: 1 TOP: 22.4 Dispersion and Prisms

63. A rainbow is a result of:
a. different color droplets of water.
b. dispersion.
c. interference.
d. the Huygens Effect.

ANS: B PTS: 1 DIF: 1 TOP: 22.5 The Rainbow

64. What is the maximum possible arc that can be subtended by a rainbow? (Consider all possible viewing geometries).
a. 90°
b. 180°
c. 270°
d. 360°

ANS: D PTS: 1 DIF: 1 TOP: 22.5 The Rainbow

65. Huygens's wave theory requires which of the following with regard to the relative speeds of light in glass and in air?
a. Speed in air is greater than in glass.
b. Speed in air is less than in glass.
c. Speed in air equals that in glass.
d. Speed in glass equals square root of that in air.

ANS: A PTS: 1 DIF: 1 TOP: 22.6 Huygens's Principle

66. In Huygens's construction, all points on a wave front:
a. act as point sources for the production of secondary spherical waves.

b. act as particles.
c. demonstrate the dual nature of light.
d. must be sources of plane waves.

ANS: A PTS: 1 DIF: 1 TOP: 22.6 Huygens's Principle

67. Diamond has an index of refraction of 2.419. What is the critical angle for internal reflection inside a diamond that is in air?
a. 24.4°
b. 48.8°
c. 155°
d. 131°

ANS: A PTS: 1 DIF: 2
TOP: 22.7 Total Internal Reflection

68. A container of flint glass (n = 1.66) holds a small quantity of benzene (n = 1.501). What is the critical angle for internal reflection of a ray in the glass when it is incident on the glass-to-liquid surface?
a. 89.5°
b. 64.7°
c. 41.1°
d. 37.0°

ANS: B PTS: 1 DIF: 3
TOP: 22.7 Total Internal Reflection

69. Which of the following describes what will happen to a light ray incident on an air-to-glass boundary at less than the critical angle?
a. total reflection
b. total transmission
c. partial reflection, partial transmission
d. partial reflection, total transmission

ANS: C PTS: 1 DIF: 1
TOP: 22.7 Total Internal Reflection

70. Which of the following describes what will happen to a light ray incident on a glass-to-air boundary at greater than the critical angle?
a. total reflection
b. total transmission
c. partial reflection, partial transmission
d. partial reflection, total transmission

ANS: A PTS: 1 DIF: 1
TOP: 22.7 Total Internal Reflection

71. A ray of light travels across a liquid-to-glass interface. If the indices of refraction for the liquid and glass are, respectively, 1.75 and 1.52, what is the critical angle at this interface?
a. 30.0°
b. 52.2°
c. 60.3°
d. Critical angle does not exist.

ANS: C PTS: 1 DIF: 2
TOP: 22.7 Total Internal Reflection

72. A fiber optic cable (n = 1.50) is submerged in water (n = 1.33). What is the critical angle for light to stay inside the cable?
a. 83.1°
b. 62.5°
c. 41.8°
d. 27.6°

ANS: B PTS: 1 DIF: 2
TOP: 22.7 Total Internal Reflection

73. If total internal reflection occurs at a glass-air surface:
a. no light is refracted.
b. no light is reflected.
c. light is leaving the air and hitting the glass with an incident angle greater than the critical angle.
d. light is leaving the air and hitting the glass with an incident angle less than the critical angle.

ANS: A PTS: 1 DIF: 1
TOP: 22.7 Total Internal Reflection

74. An optical fiber is made of clear plastic with index of refraction n = 1.50. For what angles with the surface will light remain within the plastic "guide"?
a. j < 66.6°
b. j < 57.1°
c. j < 51.7°
d. j < 48.2°

ANS: D PTS: 1 DIF: 2
TOP: 22.7 Total Internal Reflection

75. A small underwater pool light is 1 m below the surface of a swimming pool. What is the radius of the circle of light on the surface, from which light emerges from the water? (n_{water} = 1.333).
a. 0.57 m
b. 0.77 m
c. 1.13 m
d. 1.43 m

ANS: C PTS: 1 DIF: 3
TOP: 22.7 Total Internal Reflection

76. Before light can undergo total internal reflection when incident on material 2 from material 1, what must be true of the indices of refraction?
a. $n_1 = n_2$
b. $n_1 < n_2$
c. $n_1 > n_2$
d. Either n_1 or n_2 must be equal to 1.

ANS: C PTS: 1 DIF: 2
TOP: 22.7 Total Internal Reflection

77. Fiber optics has to do with:
a. the color of fabrics.
b. light having fiber characteristics as well as wave and particle characteristics.
c. string theory.

d. none of the above.

ANS: D PTS: 1 DIF: 1
TOP: 22.7 Total Internal Reflection

78. A light ray incident on the interface between air and glass can undergo total internal reflection:
a. only in the glass.
b. only in the air.
c. in either the glass or the air.
d. in the air only if the index of refraction of the glass is greater than the .

ANS: A PTS: 1 DIF: 1
TOP: 22.7 Total Internal Reflection

79. Three flat layers of transparent material are stacked upon one another. The top layer has index of refraction n_1, the middle has n_2 and the bottom one has n_3. If $n_1 < n_2 < n_3$, at what angle of incidence will a ray of light traverse the three layers in a single straight line?
a.
b.
c.
d. There is such an angle, but it is not given.

ANS: D PTS: 1 DIF: 1 TOP: Conceptual Questions

80. Three flat layers of transparent material are stacked upon one another. The top layer has index of refraction n_1, the middle has n_2 and the bottom one has n_3. If $n_1 > n_2 > n_3$, and if a ray of light strikes the top layer at an angle of incidence , in which layer is the angle of refraction the greatest?
a. the top layer
b. the middle layer
c. the bottom layer
d. Once the ray enters the touching layers, the angle of refraction remains constant.

ANS: A PTS: 1 DIF: 2 TOP: Conceptual Questions

81. Three flat layers of transparent material are stacked upon one another. The top layer has index of refraction n_1, the middle n_2 and the bottom one n_3. If $n_1 > n_2 > n_3$, and a ray of light in air strikes the top layer, at which surface given can total internal reflection occur first?
a. the top surface
b. the surface between materials with indices n_1 and n_2
c. the surface between materials with indices n_2 and n_3
d. Total internal reflection cannot occur at any of these surfaces.

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Questions

82. Light of colors 1 and 2 are sent through a prism and the rays of light of color 2 bend more. Which of the following is not true?
a. The index of refraction for color 2 is greater than that for color 1.
b. The two colors of light have different frequencies associated with them.
c. The speed of light for color 2 is greater than that for color 1 in this prism.
d. The wavelength for color 1 is different than that for color 2 in this prism.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Questions

83. White light is sent through a prism, and the various colors are separated in typical fashion. Which of the following colors would have the highest index of refraction in this prism?
a. red

b. green
c. yellow
d. blue

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Questions

CHAPTER 23—Mirrors and Lenses

MULTIPLE CHOICE

1. You stand two feet away from a plane mirror. How far is it from you to your image?
   a. 2.0 ft
   b. 3.0 ft
   c. 4.0 ft
   d. 5.0 ft

   ANS: C PTS: 1 DIF: 1 TOP: 23.1 Flat Mirrors

2. Which of the following best describes the image from a plane mirror?
   a. virtual and magnification greater than one
   b. real and magnification less than one
   c. virtual and magnification equal to one
   d. real and magnification equal to one

   ANS: C PTS: 1 DIF: 1 TOP: 23.1 Flat Mirrors

3. When the reflection of an object is seen in a plane mirror, the image is:
   a. real and upright.
   b. real and inverted.
   c. virtual and upright.
   d. virtual and inverted.

   ANS: C PTS: 1 DIF: 1 TOP: 23.1 Flat Mirrors

4. When the reflection of an object is seen in a plane mirror, the distance from the mirror to the image depends on:
   a. the wavelength of light used for viewing.
   b. the distance from the object to the mirror.
   c. the distance of both the observer and the object to the mirror.
   d. the size of the object.

   ANS: B PTS: 1 DIF: 1 TOP: 23.1 Flat Mirrors

5. If a man wishes to use a plane mirror on a wall to view both his head and his feet as he stands in front of the mirror, the required length of the mirror:
   a. is equal to the height of the man.
   b. is equal to one half the height of the man.
   c. depends on the distance the man stands from the mirror.
   d. depends on both the height of the man and the distance from the man to the mirror.

   ANS: B PTS: 1 DIF: 2 TOP: 23.1 Flat Mirrors

6. The lateral magnification for a flat mirror:
   a. is a function of the object distance.
   b. is a function of the image distance.
   c. is a function of the object and image distance.
   d. is 1.

   ANS: D PTS: 1 DIF: 1 TOP: 23.1 Flat Mirrors

7. How large should a wall-mounted mirror be to view the upper half of one's height, h?
   a. h
   b. h/2
   c. h/4
   d. The answer is not given.

   ANS: C PTS: 1 DIF: 2 TOP: 23.1 Flat Mirrors

8. The real image of an object is located 45.0 cm away from a concave mirror, which has a focal length of 10.0 cm. How far is the object from the mirror?
   a. 40.0 cm
   b. 35.0 cm
   c. 22.5 cm
   d. 12.9 cm

   ANS: D PTS: 1 DIF: 2
   TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

9. A concave mirror forms a real image at 25.0 cm from the mirror surface along the principal axis. If the corresponding object is at a 10.0-cm distance, what is the mirror's focal length?
   a. 1.43 cm
   b. 16.7 cm
   c. 12.4 cm
   d. 7.14 cm

   ANS: D PTS: 1 DIF: 2
   TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

10. If a virtual image is formed along the principal axis 10 cm from a concave mirror with the focal length 15 cm, what is the object distance from the mirror?
    a. 30 cm
    b. 10 cm
    c. 12 cm
    d. 6.0 cm

    ANS: D PTS: 1 DIF: 2
    TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

11. If a virtual image is formed 10.0 cm along the principal axis from a convex mirror of focal length –15.0 cm, how far is the object from the mirror?
    a. 30.0 cm
    b. 10.0 cm
    c. 6.00 cm
    d. 3.00 cm

    ANS: A PTS: 1 DIF: 2
    TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

12. A woman looking in a makeup mirror sees her face at twice its actual size and right-side up. If she is 28.0 cm from the mirror, what is its focal length?
    a. 18.6 cm
    b. 44.0 cm
    c. 48.3 cm
    d. 56.0 cm

    ANS: D PTS: 1 DIF: 2

TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

13. Which best describes the image of a concave mirror when the object is located somewhere between the focal point and twice the focal point distance from the mirror?
    a. virtual, upright and magnification greater than one
    b. real, inverted and magnification less than one
    c. virtual, upright and magnification less than one
    d. real, inverted and magnification greater than one

    ANS: D PTS: 1 DIF: 2
    TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

14. Which of the following best describes the image of a concave mirror when the object is at a distance greater than twice the focal point distance from the mirror?
    a. virtual, upright and magnification greater than one
    b. real, inverted and magnification less than one
    c. virtual, upright and magnification less than one
    d. real, inverted and magnification greater than one

    ANS: B PTS: 1 DIF: 2
    TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

15. Which of the following best describes the image of a concave mirror when the object's distance from the mirror is less than the focal point distance?
    a. virtual, upright and magnification greater than one
    b. real, inverted and magnification less than one
    c. virtual, upright and magnification less than one
    d. real, inverted and magnification greater than one

    ANS: A PTS: 1 DIF: 2
    TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

16. Which of the following best describes the image of a convex mirror when the object's distance from the mirror is less than the absolute value of the focal point distance?
    a. virtual, upright and magnification greater than one
    b. real, inverted and magnification less than one
    c. virtual, upright and magnification less than one
    d. real, inverted and magnification greater than one

    ANS: C PTS: 1 DIF: 2
    TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

17. A convex mirror with focal length of - 20 cm forms an image 12 cm behind the surface. Where is the object located as measured from the surface?
    a. 7.5 cm
    b. 15 cm
    c. 22 cm
    d. 30 cm

    ANS: D PTS: 1 DIF: 2
    TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

18. A convex mirror with a focal length of - 20 cm forms an image 15 cm behind the surface. If the object height is 1.2 cm what is the image height?
    a. 0.30 cm

b. 0.75 cm
c. 0.94 cm
d. 3.0 cm

ANS: A PTS: 1 DIF: 2
TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

19. An object placed 12 cm from a concave mirror produces a real image 8.0 cm from the mirror. If the object is now moved to a new position 18.0 cm from the mirror, where is the new image located as measured from the mirror?
a. 3.0 cm
b. 6.5 cm
c. 9.2 cm
d. 14.6 cm

ANS: B PTS: 1 DIF: 2
TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

20. An object is held at a distance of 12 cm from a convex mirror creating an image that is 1/3 the object size. What is the focal length of the mirror?
a. - 6.0 cm
b. - 3.0 cm
c. - 9.0 cm
d. - 18 cm

ANS: A PTS: 1 DIF: 2
TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

21. When the reflection of an object is seen in a concave mirror the image will:
a. always be real.
b. always be virtual.
c. may be either real or virtual.
d. will always be enlarged.

ANS: C PTS: 1 DIF: 1
TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

22. When the reflection of an object is seen in a convex mirror the image will:
a. always be real.
b. always be virtual.
c. may be either real or virtual.
d. will always be enlarged.

ANS: B PTS: 1 DIF: 1
TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

23. Parallel rays of light that hit a concave mirror will come together:
a. at the center of curvature.
b. at the focal point.
c. at a point half way to the focal point.
d. at infinity.

ANS: B PTS: 1 DIF: 1
TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

24. A girl is standing in front of a concave mirror. Consider two rays of light, one from her nose and one from her mouth that are parallel as they are traveling toward the mirror. These rays will come together:
   a. at the focal point.
   b. at the center of curvature.
   c. at the image point.
   d. behind the mirror if she is too close to the mirror.

   ANS: A PTS: 1 DIF: 1
   TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

25. A candle is 49.0 cm in front of a convex spherical mirror of radius of curvature 70.0 cm. What are the image distance and the magnification, respectively?
   a. - 20.4 cm, +0.417
   b. +20.4 cm, - 0.417
   c. +122.5 cm, +2.50
   d. - 20.4 cm, - 0.417

   ANS: A PTS: 1 DIF: 2
   TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

26. An object 2 cm high is placed 10 cm in front of a mirror. What type of mirror and what radius of curvature is needed for an image that is upright and 4 cm tall?
   a. Concave, R = 20 cm
   b. Concave, R = 40 cm
   c. Convex, R = - 10 cm
   d. Convex, R = - 20 cm

   ANS: B PTS: 1 DIF: 2
   TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

27. An object is 12.0 cm from the surface of a spherical Christmas tree ornament that is 8.00 cm in diameter. What is the magnification of the image?
   a. - 0.200
   b. - 0.500
   c. +0.143
   d. +0.250

   ANS: C PTS: 1 DIF: 2
   TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

28. An object is placed 10 cm in front of a mirror, and an image is formed that has a magnification of 2. Which of the following statements is true?
   a. The focal length of the mirror is 30 cm.
   b. The image is real.
   c. There is not enough information to select the correct answer.
   d. This is the only true statement.

   ANS: D PTS: 1 DIF: 3
   TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

29. An object is placed 10 cm in front of a mirror, and an image is formed that has a magnification of 2. Which of the following statements is false?
   a. The focal length of the mirror is 20 cm.
   b. The image is virtual.
   c. There is enough information to select the correct answer.

d. This is the only true statement.

ANS: D PTS: 1 DIF: 3
TOP: 23.2 Images Formed by Concave Mirrors | 23.3 Convex Mirrors and Sign Conventions

30. Ron fills a beaker with glycerin (n = 1.473) to a depth of 5.0 cm. If he looks straight down through the glycerin surface, he will perceive the liquid to be what apparent depth?
a. 7.4 cm
b. 5.0 cm
c. 3.4 cm
d. 1.0 cm

ANS: C PTS: 1 DIF: 2
TOP: 23.4 Images Formed by Refraction

31. A solid glass sphere with a radius of 5.00 cm and index of refraction of 1.52 has a small coin embedded 3.00 cm from the front surface of the sphere. For the viewer looking at the coin through the glass, at what distance from the front surface of the glass does the coin's image appear to be located?
a. 2.48 cm
b. 3.20 cm
c. 5.00 cm
d. 6.85 cm

ANS: A PTS: 1 DIF: 3
TOP: 23.4 Images Formed by Refraction

32. A glass block, for which n = 1.52, has a blemish located 3.2 cm from one surface. At what distance from that surface does the image of the blemish appear to the outside observer?
a. 1.6 cm
b. 2.1 cm
c. 4.9 cm
d. 6.4 cm

ANS: B PTS: 1 DIF: 2
TOP: 23.4 Images Formed by Refraction

33. A goldfish is swimming in water (n = 1.33) inside a spherical plastic bowl of index of refraction 1.33. If the goldfish is 10 cm from the front wall of the 15-cm radius bowl, where does the goldfish appear to an observer in front of the bowl?
a. 6.0 cm behind the plastic
b. 7.0 cm behind the plastic
c. 8.0 cm behind the plastic
d. 9.0 cm behind the plastic

ANS: D PTS: 1 DIF: 3
TOP: 23.4 Images Formed by Refraction

34. A container is filled with fluid 1 and the apparent depth of the fluid is 5 cm. The container is next filled with fluid 2, and the apparent depth of this fluid is 4 cm. What is the ratio of the indices of refraction of these fluids?
a. n1/n2 = 5/4
b. n1/n2 = 4/5
c. n1/n2 =
d. More information is needed to find the ratio.

ANS: B PTS: 1 DIF: 2

TOP: 23.4 Images Formed by Refraction

35. A container is filled with fluid 1, and the apparent depth of the fluid is 5.00 cm. The container is next filled with fluid 2, and the apparent depth of this fluid is 4.00 cm. If the index of refraction of the first fluid is 1.60, what is the index of refraction of the second fluid?
    a. 2.00
    b. 1.79
    c. 1.28
    d. More information is needed to find the value.

    ANS: A PTS: 1 DIF: 2
    TOP: 23.4 Images Formed by Refraction

36. An object of length 3.00 cm is inside a plastic block with index of refraction 1.40. If the object is viewed from directly above, what is the length of its image?
    a. 3.00 cm
    b. 4.20 cm
    c. 2.13 cm
    d. 0.467 cm

    ANS: A PTS: 1 DIF: 2
    TOP: 23.4 Images Formed by Refraction

37. An object of length 3.00 cm is inside a plastic block with index of refraction 1.40. If the object is viewed through the top surface of the block at a non-zero angle from the normal, where is the object relative to its image?
    a. in the same direction as its image
    b. above the direction of its image
    c. below the direction of its image
    d. More information is needed.

    ANS: C PTS: 1 DIF: 1
    TOP: 23.4 Images Formed by Refraction

38. Atmospheric refraction of light rays is responsible for:
    a. spherical aberration.
    b. mirages.
    c. chromatic aberration.
    d. light scattering.

    ANS: B PTS: 1 DIF: 1
    TOP: 23.5 Atmospheric Refraction

39. If atmospheric refraction did not occur, how would the apparent time of sunrise and sunset be changed?
    a. Both would be later.
    b. Both would be earlier.
    c. Sunrise would be later and sunset earlier.
    d. Sunrise would be earlier and sunset later.

    ANS: C PTS: 1 DIF: 1
    TOP: 23.5 Atmospheric Refraction

40. A 3.0 cm tall object is placed along the principal axis of a thin convex lens of 30.0 cm focal length. If the object distance is 40.0 cm, which of the following best describes the image distance and height, respectively?
a. 17.3 cm and 7.0 cm
b. 120 cm and 9.0 cm
c. 17.3 cm and 1.3 cm
d. 120 cm and 1.0 cm

ANS: B PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

41. Which of the following best describes the image for a thin convex lens that forms whenever the object is at a distance less than one focal length from the lens?
a. inverted, enlarged and real
b. upright, enlarged and virtual
c. upright, diminished and virtual
d. inverted, diminished and real

ANS: B PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

42. Which of the following best describes the image for a thin concave lens that forms whenever the magnitude of the object distance is less than that of the lens' focal length?
a. inverted, enlarged and real
b. upright, enlarged and virtual
c. upright, diminished and virtual
d. inverted, diminished and real

ANS: C PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

43. An object is placed at a distance of 30 cm from a thin convex lens along its axis. The lens has a focal length of 10 cm. What are the values, respectively, of the image distance and magnification?
a. 60 cm and 2.0
b. 15 cm and 2.0
c. 60 cm and - 0.50
d. 15 cm and - 0.50

ANS: D PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

44. Sally places an object 6.0 cm from a thin convex lens along its axis. The lens has a focal length of 9.0 cm. What are the respective values of the image distance and magnification?
a. - 18 cm and 3.0
b. 18 cm and 3.0
c. 3.0 cm and - 0.50
d. - 18 cm and - 3.0

ANS: A PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

45. Ansel places an object 30 cm from a thin convex lens along the axis. If a real image forms at a distance of 10 cm from the lens, what is the focal length of the lens?
a. 30 cm
b. 15 cm
c. 10 cm
d. 7.5 cm

ANS: D PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

46. An object is placed at a distance of 50 cm from a thin lens along the axis. If a real image forms at a distance of 40 cm from the lens, on the opposite side from the object, what is the focal length of the lens?
a. 22 cm
b. 45 cm
c. 90 cm
d. 200 cm

ANS: A PTS: 1 DIF: 1 TOP: 23.6 Thin Lenses

47. Ellen places an object 40.0 cm from a concave lens. If a virtual image appears 10.0 cm from the lens on the same side as the object, what is the focal length of the lens?
a. - 50.0 cm
b. - 13.3 cm
c. - 10.0 cm
d. - 8.00 cm

ANS: B PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

48. Two thin lenses with focal lengths 25.0 cm and 30.0 cm are placed in contact in an orientation so that their optic axes coincide. What is the focal length of the two in combination? (Hint: A thin lens is one whose thickness is negligible).
a. 13.6 cm
b. 27.5 cm
c. 55.0 cm
d. 150 cm

ANS: A PTS: 1 DIF: 3 TOP: 23.6 Thin Lenses

49. Two thin lenses, with focal lengths of 25.0 cm and - 30.0 cm are placed in contact in an orientation so that their optic axes coincide. What is the focal length of the two in combination? {Hint: A thin lens is one whose thickness is negligible).
a. - 5.0 cm
b. 13.6 cm
c. 55.5 cm
d. 150 cm

ANS: D PTS: 1 DIF: 3 TOP: 23.6 Thin Lenses

50. Two thin lenses with 10.0-cm focal lengths at are mounted at opposite ends of a 30.0-cm long tube. An object is located 45.0 cm from one end of the tube. How far from the opposite end is the final image?
a. 12.8 cm
b. 24.0 cm
c. 25.6 cm
d. 33.6 cm

ANS: B PTS: 1 DIF: 3 TOP: 23.6 Thin Lenses

51. A projector lens is needed to form an image on a screen 10 times the size of its corresponding object. The screen is located 8.0 m from the lens. What is the required focal length of the lens?
a. 0.32 m
b. 0.54 m
c. 0.73 m
d. 1.25 m

ANS: C PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

52. An object, located 90 cm from a concave lens, forms an image 60 cm from the lens on the same side as the object. What is the focal length of the lens?
   a. - 36 cm
   b. - 75 cm
   c. - 180 cm
   d. - 150 cm

ANS: C PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

53. Two convex thin lenses with focal lengths 10.0 cm and 20.0 cm are aligned on a common axis, running left to right, the 10-cm lens being on the left. A distance of 20.0 cm separates the lenses. An object is located at a distance of 15.0 cm to the left of the 10-cm lens. Where will the final image appear as measured from the 20-cm lens?
   a. - 13.3 cm
   b. - 6.67 cm
   c. +6.67 cm
   d. +13.3 cm

ANS: C PTS: 1 DIF: 3 TOP: 23.6 Thin Lenses

54. An object and a screen are separated by 20.00 cm. A convex lens is placed between them, 5.00 cm from the object. In this position it causes a sharp image of the object to form on the screen. What is the focal length of the lens?
   a. 15.0 cm
   b. 5.00 cm
   c. 3.75 cm
   d. 2.00 cm

ANS: C PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

55. For a converging lens with two curved surfaces, the radius of curvature for both surfaces is 10 cm. If the focal length is 10 cm, what must the index of refraction be?
   a. 1.5
   b. 2.0
   c. 2.5
   d. 3.0

ANS: A PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

56. For a diverging lens with one flat surface, the radius of curvature for the curved surface is 20.0 cm. What must the index of refraction be so that the focal length is - 15.0 cm?
   a. 0.333
   b. 1.33
   c. 2.33
   d. 5.00

ANS: C PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

57. A converging lens with two convex surfaces has a front surface with radius of curvature of 10.0 cm; the back surface has radius of curvature of 20.0 cm, and it is made from material with an index of refraction of 2.50. What is the focal length of the lens?
   a. 4.44 cm
   b. 13.3 cm

c. - 13.3 cm
d. 0.250 cm

ANS: A PTS: 1 DIF: 3 TOP: 23.6 Thin Lenses

58. What is the image distance of an object 1.00 m in front of a converging lens of focal length 20.0 cm?
a. +16.7 cm
b. +20.0 cm
c. +25.0 cm
d. +33.3 cm

ANS: C PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

59. When an image is inverted compared to the object, it is also:
a. virtual.
b. reversed left to right.
c. enlarged.
d. diminished.

ANS: B PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

60. A contact lens is made of plastic with an index of refraction 1.50. The lens has an outer radius of curvature of +2.0 cm and an inner radius of curvature of +2.5 cm. What is its focal length?
a. - 20 cm
b. +6.7 cm
c. +10 cm
d. +20 cm

ANS: D PTS: 1 DIF: 3 TOP: 23.6 Thin Lenses

61. A 100-cm focal length thin lens is placed in contact with one of 66.7 cm focal length. An object is placed 50 cm in front of the combination. What is the image distance?
a. 40 cm
b. –25 cm
c. 67 cm
d. 200 cm

ANS: D PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

62. A 100-cm focal length thin lens is placed in contact with one of 66.7 cm focal length. A 3.0 cm tall object is placed 50 cm in front of the combination. What is the size of the image?
a. 3.8 cm
b. 1.9 cm
c. 4.0 cm
d. 12 cm

ANS: D PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

63. Three thin lenses, each of focal length f, are placed in contact. What is the resulting focal length of the combination?
a. f
b. $3f$
c. $f/3$
d. $3/f$

ANS: C PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

64. An image is formed using a convex lens, the image being 15 cm past the lens. A second lens is placed 25 cm past the first lens and another image is formed, this time 10 cm past the second lens. Which of the following statements is true?
   a. The last image is inverted with regard to the original object.
   b. The last image must be larger than the object.
   c. The first image is virtual.
   d. None of the above statements is true.

   ANS: D PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

65. An image is formed using a convex lens, the image being 15 cm past the lens. A second lens is placed 25 cm past the first lens and another image is formed, this time 10 cm past the second lens. Which of the following statements is always true?
   a. Both of the lenses have positive focal lengths.
   b. The first lens is diverging, and the second is converging.
   c. The first lens is converging, and the second is diverging.
   d. None of the above statements is true.

   ANS: A PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

66. An object is placed 25 cm to the left of a lens of focal length 20 cm. 75 cm to the right of this lens is a plane mirror. Where does the final image form?
   a. 25 cm to the right of the mirror
   b. 25 cm to the left of the mirror
   c. 50 cm to the left of the lens
   d. 100 cm to the left of the lens

   ANS: C PTS: 1 DIF: 3 TOP: 23.6 Thin Lenses

67. A lens has a focal length of 60 cm in air. If this lens were immersed in water, what focal length would result? The index of refraction of the lens is 1.500 and that of water is 1.333. The focal length of a thin lens with index n_1 submerged in a liquid with index n_2 is given by the modified lens maker's formula: .
   a. 240 cm
   b. 68 cm
   c. 53 cm
   d. 15 cm

   ANS: A PTS: 1 DIF: 3 TOP: 23.6 Thin Lenses

68. A concave mirror with focal length 24.0 cm is placed 40.0 cm to the left of the object. A convex lens of focal length 12.0 cm is placed 40.0 cm to the right of the object. Where is the image formed by both the mirror and the lens?
   a. 20.0 cm to the right of the object
   b. 30.0 cm to the right of the lens
   c. 60.0 cm to the right of the object
   d. 12.0 cm to the right of the lens

   ANS: B PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

69. An object is placed 40.0 cm to the right of a concave mirror with focal length 24.0 cm and 10.0 cm to the left of a lens with focal length –20.0 cm. Where is the image formed by both the mirror and the lens?
   a. 6.67 cm to the right of the object
   b. 6.67 cm to the right of the lens

c. 40.0 cm to the right of the lens
d. 20.0 cm to the right of the lens

ANS: D PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

70. A lens of 12.0-cm focal length is placed 20 cm to the right of the object and a mirror of focal length –20.0 cm is placed 50.0 cm to the right of the lens. Where is the image formed by the mirror?
a. 40.0 cm to the right of the mirror
b. 5.00 cm to the left of the mirror
c. 17.1 cm to the left of the lens
d. 10.0 cm to the right of the mirror

ANS: D PTS: 1 DIF: 2 TOP: 23.6 Thin Lenses

71. A lens of 12.0-cm focal length is placed 20 cm to the right of the object and a mirror of focal length –20.0 cm is placed 50.0 cm to the right of the lens. Where is the final image formed?
a. 15.0 cm to the left of the lens
b. 17.1 cm to the left of the lens
c. 10.0 cm to the right of the mirror
d. 10.0 cm to the left of the mirror

ANS: A PTS: 1 DIF: 3 TOP: 23.6 Thin Lenses

72. Which of the following effects is the result of the fact that the index of refraction of glass will vary with wavelength?
a. spherical aberration
b. mirages
c. chromatic aberration
d. light scattering

ANS: C PTS: 1 DIF: 1
TOP: 23.7 Lens and Mirror Aberrations

73. In an ideal case rays coming from an object toward a lens or mirror should be reasonably close to the optic axis. To the extent that this condition is not completely met, which one of the following effects occurs?
a. spherical aberration
b. mirages
c. chromatic aberration
d. light scattering

ANS: A PTS: 1 DIF: 1
TOP: 23.7 Lens and Mirror Aberrations

74. A fused combination of a diverging and converging lens pair each made from a different index of refraction glass, is used to reduce the occurrence of which of the following effects?
a. spherical aberration
b. mirages
c. chromatic aberration
d. light scattering

ANS: C PTS: 1 DIF: 1
TOP: 23.7 Lens and Mirror Aberrations

75. Reducing the lens aperture size is a scheme one can use to reduce the occurrence of which of the following effects?

a. spherical aberration
b. mirages
c. chromatic aberration
d. light scattering

ANS: A PTS: 1 DIF: 1
TOP: 23.7 Lens and Mirror Aberrations

76. Use of a parabolic mirror, instead of one made of a circular arc surface, can be used to reduce the occurrence of which of the following effects?
a. spherical aberration
b. mirages
c. chromatic aberration
d. light scattering

ANS: A PTS: 1 DIF: 1
TOP: 23.7 Lens and Mirror Aberrations

77. A thin lens has a focal length of 10.00 cm for red light. If the index of refraction for the lens material tends to decrease with increasing wavelength, what is the focal length of the lens for blue light?
a. also 10.00 cm
b. less that 10.00 cm
c. more than 10.00 cm
d. It depends on whether the lens is converging or diverging.

ANS: B PTS: 1 DIF: 2
TOP: 23.7 Lens and Mirror Aberrations

78. An eyeglass lens is cut with one surface having a radius R_1 and the other surface having a radius R_2, with $R_1 < R_2$. Both positive radii are measured from the same side with R_1 being the side closer to the eye. Is this convex-concave lens a converging lens or a diverging lens?
a. This is a converging lens.
b. This is a diverging lens.
c. This can be either a converging or diverging lens, as more information is needed for a final determination.
d. This is neither, since a lens cannot be made this way.

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Questions

79. A concave mirror has radius R. When an object is located a distance 2R from the lens, which describes the image formed?
a. real, inverted, diminished
b. real, inverted, enlarged
c. virtual, upright, diminished
d. real, inverted, of equal size

ANS: A PTS: 1 DIF: 2 TOP: Conceptual Questions

80. A convex lens has a focal length of magnitude F. At which of the following distances from this lens would a real object give an inverted virtual image?
a. 1/2 F
b. 2F
c. Any value greater than 2F.
d. This cannot be done with a convex lens.

ANS: D PTS: 1 DIF: 3 TOP: Conceptual Questions

81. A real object is place a distance d from a converging lens. The object is then moved to a distance 2d from the converging lens. Which of the following statements is false?

a. The image in the first case with the object at distance d can be the larger one.
b. The image in the second case with the object at distance 2d can be the larger one.
c. If both images are real, the image in the second case is smaller.
d. If the image in the first case is real, the image in the second case is upright.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Questions

82. A real object is place to the left of a converging lens and an image forms. Then, to the right of the converging lens a diverging lens is placed. A real, inverted final image forms to the right of the diverging lens. Which of the following could give this result?

a. An upright virtual image caused by the first lens forms between the two lenses.
b. An inverted real image caused by the first lens forms between the two lenses.
c. A real, upright image was formed by the first lens to the right of where the diverging lens is to be placed.
d. A real, inverted image was formed by the first lens to the right of where the diverging lens is to be placed.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Questions

CHAPTER 24—Wave Optics

MULTIPLE CHOICE

1. Interference effects observed in the early 1800s were instrumental in supporting a concept of the existence of which property of light?
   a. polarization
   b. particle nature
   c. wave nature
   d. electromagnetic character

   ANS: C PTS: 1 DIF: 1
   TOP: 24.2 Young’s Double-Slit Experiment

2. If a wave from one slit of a Young’s double-slit set-up arrives at a point on the screen one wavelength behind the wave from the other slit, what is observed at that point?
   a. dark fringe
   b. bright fringe
   c. multi-colored fringe
   d. gray fringe, neither dark nor bright

   ANS: B PTS: 1 DIF: 1
   TOP: 24.2 Young’s Double-Slit Experiment

3. A Young’s double slit has a slit separation of 2.50×10^{-5} m on which a monochromatic light beam is directed. The resultant bright fringes on a screen 1.00 m from the double slit are separated by 2.30×10^{-2} m. What is the wavelength of this beam? (1 nm = 10^{-9} m)
   a. 373 nm
   b. 454 nm
   c. 575 nm
   d. 667 nm

   ANS: C PTS: 1 DIF: 2
   TOP: 24.2 Young’s Double-Slit Experiment

4. Two narrow slits are 0.025 mm apart. When a laser shines on them, bright fringes form on a screen that is a meter away. These fringes are 3.0 cm apart. What is the separation between the second order bright fringe and the central fringe?
   a. 8.6 cm
   b. 6.0 cm
   c. 5.3 cm
   d. 2.6 cm

   ANS: B PTS: 1 DIF: 2
   TOP: 24.2 Young’s Double-Slit Experiment

5. In order to produce a sustained interference pattern by light waves from multiple sources, which of the following conditions must be met?
   a. Sources are coherent.
   b. Sources are monochromatic.
   c. Both choices above are valid.
   d. None of the choices above are valid.

   ANS: C PTS: 1 DIF: 1

TOP: 24.2 Young's Double-Slit Experiment

6. In a Young's double-slit interference apparatus, by what factor is the distance between adjacent light and dark fringes changed when the separation between slits is doubled?
   a. 1/4
   b. 1/2
   c. 1
   d. 2

   ANS: B PTS: 1 DIF: 1
   TOP: 24.2 Young's Double-Slit Experiment

7. In a Young's double-slit interference apparatus, the distance from the slits to the screen is doubled. The distance between adjacent light and dark fringes changes by a factor of:
   a. 1/4.
   b. 1/2.
   c. 1.
   d. 2.

   ANS: D PTS: 1 DIF: 1
   TOP: 24.2 Young's Double-Slit Experiment

8. In a Young's double-slit interference apparatus, by what factor is the distance between adjacent light and dark fringes changed when the wavelength of the source is doubled?
   a. 1/4
   b. 1/2
   c. 1
   d. 2

   ANS: D PTS: 1 DIF: 1
   TOP: 24.2 Young's Double-Slit Experiment

9. A Young's double-slit apparatus is set up so that a screen is positioned 1.6 m from the double slits, and the spacing between the two slits is 0.040 mm. What is the distance between alternating bright fringes on the screen if the light source has a wavelength of 630 nm? (1 nm = 10^{-9} m)
   a. 0.016 m
   b. 0.025 m
   c. 0.032 m
   d. 0.047 m

   ANS: B PTS: 1 DIF: 2
   TOP: 24.2 Young's Double-Slit Experiment

10. A Young's double-slit apparatus is set up. A screen is positioned 1.60 m from the double slits, and the spacing between the two slits is 0.040 0 mm. The distance between alternating bright fringes is 1.42 cm. What is the light source wavelength? (1 nm = 10^{-9} m)
    a. 710 nm
    b. 490 nm
    c. 280 nm
    d. 355 nm

    ANS: D PTS: 1 DIF: 2
    TOP: 24.2 Young's Double-Slit Experiment

11. A Young’s double-slit apparatus is set up where a screen is positioned 0.80 m from the double slits. If the distance between alternating bright fringes is 0.95 cm, and the light source has a wavelength of 580 nm, what is the separation of the double slits? (1 nm = 10^{-9} m)
   a. 2.8×10^{-5} m
   b. 4.9×10^{-5} m
   c. 5.6×10^{-5} m
   d. 6.0×10^{-5} m

   ANS: B PTS: 1 DIF: 2
   TOP: 24.2 Young’s Double-Slit Experiment

12. A Young’s double-slit apparatus is set up. The source wavelength is 430 nm, and the double-slit spacing is 0.040 mm. At what distance from the double slits should the screen be placed if the spacing between alternating bright fringes is to be 2.4 cm? (1 nm = 10^{-9} m)
   a. 1.6 m
   b. 2.2 m
   c. 2.4 m
   d. 2.9 m

   ANS: B PTS: 1 DIF: 2
   TOP: 24.2 Young’s Double-Slit Experiment

13. A light source simultaneously emits light of two wavelengths, 480 nm and 560 nm, respectively. The source is used in a double-slit interference experiment where the slit spacing is a 0.040 mm, and the distance between double slits and the screen is 1.2 m. What is the separation between the second-order bright fringes of the two wavelengths as they appear on the screen? (1 nm = 10^{-9} m)
   a. 0.16 cm
   b. 0.32 cm
   c. 0.48 cm
   d. 0.64 cm

   ANS: C PTS: 1 DIF: 2
   TOP: 24.2 Young’s Double-Slit Experiment

14. Waves from a radio station with a wavelength of 600 m arrive at a home receiver a distance 50 km away from the transmitter by two paths. One is a direct-line path and the second by reflection from a mountain directly behind the receiver. What is the minimum distance between the mountain and receiver such that destructive interference occurs at the location of the listener? Assume no phase change on reflection.
   a. 150 m
   b. 300 m
   c. 450 m
   d. 600 m

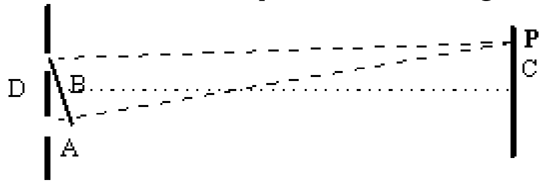
   ANS: A PTS: 1 DIF: 2
   TOP: 24.2 Young’s Double-Slit Experiment

15. Two beams of coherent light are shining on the same piece of white paper. With respect to the crests and troughs of such waves, darkness will occur on the paper where:
   a. the crest from one wave overlaps with the crest from the other.
   b. the crest from one wave overlaps with the trough from the other.
   c. the troughs from both waves overlap.
   d. darkness cannot occur as the two waves are coherent.

   ANS: B PTS: 1 DIF: 1

TOP: 24.2 Young’s Double-Slit Experiment

16. After light from a source passes through two slits, a first order bright spot is seen on the wall at point P. Which distance is equal to the wavelength of the light?



a. the extra distance one beam must travel
b. the distance between beams as they leave the slit
c. the distance of point P from the central point of the interference pattern
d. the distance between slits

ANS: A PTS: 1 DIF: 1
TOP: 24.2 Young’s Double-Slit Experiment

17. If the 2nd order fringe in Young’s double-slit experiment occurs at an angle of 45.0°, what is the relationship between the wavelength l and the distance between slits, *d*?
a. *d* = 1.41l
b. *d* = 2.00l
c. *d* = 2.83l
d. *d* = 4.00l

ANS: C PTS: 1 DIF: 2
TOP: 24.2 Young’s Double-Slit Experiment

18. A Young’s interference experiment is conducted with blue-green argon laser light (l = 515 nm). The separation between the slits is 0.50 mm, and the interference pattern appears on a screen 3.3 m away. What is the spacing between the bright fringes? (1 nm = 10^{-9} m)
a. 1.7 mm
b. 3.4 mm
c. 5.1 mm
d. 6.8 mm

ANS: B PTS: 1 DIF: 2
TOP: 24.2 Young’s Double-Slit Experiment

19. That light can undergo interference is evidence that it:
a. has electric properties.
b. is made of corpuscles.
c. behaves like a wave.
d. has a phase of 180°.

ANS: C PTS: 1 DIF: 1
TOP: 24.2 Young’s Double-Slit Experiment

20. In a Young’s experiment, the paths from the slits to a point on the screen differ in length causing constructive interference at the point. Which of the following path difference would cause this constructive interference?
a. 5ë/2
b. 3ë/4
c. 4ë
d. None of the above.

ANS: C PTS: 1 DIF: 1
TOP: 24.2 Young’s Double-Slit Experiment

21. In a Young’s experiment, the paths from the slits to a point on the screen differ in length, causing destructive interference at the point. Which of the following path difference would cause this destructive interference?
a. 5ë/2
b. 3ë/4
c. 4ë
d. None of the above.

ANS: A PTS: 1 DIF: 1
TOP: 24.2 Young’s Double-Slit Experiment

22. Laser light sent through a double slit produces an interference patter on a screen 3.00 m from the slits. If the second order maximum occurs at an angle of 12.0°, at what angle does the eighth order maximum occur?
a. No eighth order maximum occurs.
b. 48.0°
c. 56.3°
d. Not enough information is given.

ANS: C PTS: 1 DIF: 3
TOP: 24.2 Young’s Double-Slit Experiment

23. In a Young’s double-slit experiment, how many maxima occur between the 4^{th} order maxima?
a. 6
b. 7
c. 8
d. Three more than the number of minima.

ANS: B PTS: 1 DIF: 2
TOP: 24.2 Young’s Double-Slit Experiment

24. The blue tint of a coated camera lens is largely caused by what effects?
a. diffraction
b. refraction
c. polarization
d. interference

ANS: D PTS: 1 DIF: 1
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

25. What is the minimum thickness of a glycerin film (n = 1.47) on which light of wavelength 600 nm shines that results in constructive interference of the reflected light? Assume the film is surrounded front and back by air.
a. 75 nm
b. 102 nm
c. 150 nm
d. 204 nm

ANS: B PTS: 1 DIF: 2
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

26. Light of wavelength 500 nm shines on a soap bubble film (n = 1.46). For what soap film thickness, other than the minimum thickness, will constructive interference occur?
    a. 63 nm
    b. 86 nm
    c. 172 nm
    d. 257 nm

    ANS: D PTS: 1 DIF: 2
    TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

27. A silicon monoxide thin film (n = 1.45) of thickness 90.0 nm is applied to a camera lens made of glass (n = 1.55). This will result in a destructive interference for reflected light of what wavelength?
    a. 720 nm
    b. 558 nm
    c. 522 nm
    d. 450 nm

    ANS: C PTS: 1 DIF: 2
    TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

28. The dark spot observed in the center of a Newton's rings pattern is attributed to which of the following?
    a. polarization of light when reflected
    b. polarization of light when refracted
    c. phase shift of light when reflected
    d. phase shift of light when refracted

    ANS: C PTS: 1 DIF: 1
    TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

29. What wavelength monochromatic source in the visible region (390 to 710 nm) can be used to constructively reflect off a soap film (n = 1.46) if the film is 77 nm thick?
    a. 409 nm
    b. 430 nm
    c. 450 nm
    d. 558 nm

    ANS: C PTS: 1 DIF: 2
    TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

30. What wavelength monochromatic source in the visible region (390 to 710 nm) can be used to constructively reflect off a soap film (n = 1.46) if the film is 240 nm thick?
    a. 467 nm
    b. 562 nm
    c. 587 nm
    d. 480 nm

    ANS: A PTS: 1 DIF: 2
    TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

31. A silicon monoxide (n = 1.45) film of 100 nm thickness is used to coat a glass camera lens (n = 1.56). What wavelength of light in the visible region (390 to 710 nm) will be most efficiently transmitted by this system? (1 nm = 10^{-9} m)
    a. 400 nm
    b. 492 nm

c. 624 nm
d. 580 nm

ANS: D PTS: 1 DIF: 2
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

32. A silicon monoxide (n = 1.45) film of 270 nm thickness is used to coat a glass camera lens (n = 1.56). What wavelength of light in the visible region (390 to 710 nm) will be most efficiently transmitted by this system? (1 nm = 10^{-9} m)
a. 409 nm
b. 492 nm
c. 522 nm
d. 638 nm

ANS: C PTS: 1 DIF: 2
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

33. A beam of light of wavelength 650 nm is incident along the normal to two closely spaced parallel glass plates. For what air gap separation between the plates will the transmitted beam be of maximum intensity? (1 nm = 10^{-9} m)
a. 81 nm
b. 163 nm
c. 325 nm
d. 488 nm

ANS: C PTS: 1 DIF: 2
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

34. Two closely spaced parallel glass plates are separated by 750 nm. What wavelength light source in the visible region (390 nm to 710 nm) will experience maximum transmission through the two plates?
a. 500 nm
b. 429 nm
c. 600 nm
d. 684 nm

ANS: A PTS: 1 DIF: 2
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

35. Two flat glass plates are in contact along one end and are separated by a sheet of paper 4.0 ´ 10^{-6} m thick at the other end. The top plate is illuminated by a monochromatic light source of wavelength 490 nm. How many dark parallel bands will be evident across the top plate? (1 nm = 10^{-9} m)
a. 7
b. 9
c. 13
d. 17

ANS: D PTS: 1 DIF: 3
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

36. Two flat glass plates are in contact along one end and are separated by a sheet of tissue paper at the other end. A monochromatic source of wavelength 490 nm illuminates the top plate. If 21 dark bands are counted across the top plate, what is the paper thickness? (1 nm = 10^{-9} m)
a. 2.7 ´ 10^{-6} m
b. 3.4 ´ 10^{-6} m
c. 4.9 ´ 10^{-6} m

d. 5.8×10^{-6} m

ANS: C PTS: 1 DIF: 3
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

37. When light shines on a lens placed on a flat piece of glass, interference occurs which causes circular fringes called Newton's rings. The two beams that are interfering come:
a. from the top and bottom surface of the lens.
b. from the top surface of the lens and the top surface of the piece of glass.
c. from the bottom surface of the lens and the top surface of the piece of glass.
d. from the top and bottom surface of the flat piece of glass.

ANS: C PTS: 1 DIF: 1
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

38. The center spot of Newton's rings is dark. This destructive interference occurs because:
a. the two beams travel distances that are different by half a wavelength.
b. both waves change phase by 180° as they are reflected.
c. one beam changes phase by 180° when it is reflected.
d. both waves have a trough.

ANS: C PTS: 1 DIF: 1
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

39. When light passes from a material with a high index of refraction into material with a low index of refraction:
a. none of the light is reflected.
b. some light is reflected without a change of phase.
c. some light is reflected with a 180° change of phase.
d. the light that is not reflected has a 180° change of phase.

ANS: B PTS: 1 DIF: 1
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

40. Light is reflecting off a wedge-shaped thin piece of glass producing bright and dark interference fringes. If a certain location has a bright fringe, a nearby point will have a dark fringe if the thickness of the glass increases by:
a. 1/8 of a wavelength of the light.
b. 1/4 of a wavelength of the light.
c. 1/2 of a wavelength of the light.
d. one wavelength of the light.

ANS: B PTS: 1 DIF: 1
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

41. Upon reflection, light undergoes a 180° phase change:
a. always.
b. if the incident medium has the higher index of refraction.
c. if the incident medium has the lower index of refraction.
d. whenever the incident angle is less than the critical angle.

ANS: C PTS: 1 DIF: 1
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

42. A soap bubble (n = 1.35) is floating in air. If the thickness of the bubble wall is 300 nm, which of the following wavelengths of visible light is strongly reflected?

a. 620 nm (red)
b. 580 nm (yellow)
c. 540 nm (green)
d. 500 nm (blue)

ANS: C PTS: 1 DIF: 2
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

43. A puddle of water (n = 1.33) is covered with a very thin layer of oil (n = 1.20). How thick is the oil in the region that strongly reflects light with a wavelength of 550 nm?
a. 207 nm
b. 229 nm
c. 458 nm
d. 550 nm

ANS: B PTS: 1 DIF: 3
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

44. A possible means for making an airplane radar-invisible is to coat the plane with an antireflective polymer. If radar waves have a wavelength of 4.8 cm, and the index of refraction of the polymer is n = 1.6, how thick would the coating be if a 180° phase change occurs at both surfaces?
a. 32 mm
b. 24 mm
c. 7.5 mm
d. 6.0 mm

ANS: C PTS: 1 DIF: 2
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

45. A hair is placed at one edge between two flat glass plates. When this arrangement is illuminated with yellow light of wavelength (λ = 600 nm), a total of 121 dark bands are counted starting at the point of contact between the plates. How thick is the hair? (1 nm = 10^{-9} m)
a. 3.6×10^{-5} m
b. 1.8×10^{-5} m
c. 3.6×10^{-4} m
d. 1.8×10^{-4} m

ANS: A PTS: 1 DIF: 3
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

46. Newton's rings:
a. are a sound that light can cause.
b. require oil to occur.
c. are a result of Fraunhofer diffraction.
d. are an interference phenomenon.

ANS: D PTS: 1 DIF: 1
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

47. Two thin layers of material with different indices of refraction are coated on a glass plate. The outer first material has n_1 = 1.404, the inner second material has n_2 = 1.531, and the glass has n_{glass} = 1.62. If light is incident from air on the first layer, what is the phase change for light that reflects from the glass?
a. 0°
b. 180°

c. 360°
d. 540°

ANS: B PTS: 1 DIF: 2
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

48. A surface is coated with a material having index of refraction 1.50. If light in air has a wavelength of 450 nm and is normally incident on this surface, and it is found through interference effects with this light that the surface is 10 wavelengths thick, which of the following is the thickness of the surface?
a. 1.5 ìm
b. 3.0 ìm
c. 4.5 ìm
d. 6.8 ìm

ANS: B PTS: 1 DIF: 2
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

49. "Perfect mirrors" are made by
a. coating a glass surface with an extremely pure layer of silver or aluminum.
b. coating a glass surface with an extremely pure layer of silver or aluminum and then coating the metal surface with a quarter-wavelength thickness of the dielectric magnesium fluoride.
c. stacking thin layers of different dielectric materials on a glass surface.
d. heating an ordinary mirror almost to its melting point.

ANS: C PTS: 1 DIF: 1
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

50. Dielectric mirrors are made to have extremely high reflectance
a. by stacking thin layers of a single dielectric material on a glass backing so that the reflections from the surfaces of the layers undergoconstructive interference.
b. by stacking thin layers of a single dielectric material on a glass backing so that the reflections from the surfaces of the layers undergo destructive interference.
c. by stacking thin layers of different dielectric materials on a glass backing so that the reflections from the surfaces of the layers undergo constructive interference.
d. by stacking thin layers of different dielectric materials on a glass backing so that the reflections from the surfaces of the layers undergo destructive interference.

ANS: C PTS: 1 DIF: 2
TOP: 24.3 Change of Phase Due to Reflection | 24.4 Interference in Thin Films

51. A Fraunhofer diffraction pattern is created by monochromatic light shining through which of the following?
a. single slit
b. double slit
c. triple slit
d. more than 3 slits

ANS: A PTS: 1 DIF: 1
TOP: 24.6 Diffraction | 24.7 Single-Slit Diffraction

52. Light of wavelength 540 nm is incident on a slit of width 0.150 mm, and a diffraction pattern is produced on a screen that is 2.00 m from the slit. What is the width of the central bright fringe? (1 nm = 10^{-9} m)
a. 0.720 cm

b. 1.44 cm
c. 1.76 cm
d. 2.16 cm

ANS: B PTS: 1 DIF: 2
TOP: 24.6 Diffraction | 24.7 Single-Slit Diffraction

53. Light of wavelength 610 nm is incident on a slit of width 0.20 mm, and a diffraction pattern is produced on a screen that is 1.5 m from the slit. What is the distance of the second dark fringe from the center of the bright fringe? (1 nm = 10^{-9} m)
a. 0.68 cm
b. 0.92 cm
c. 1.2 cm
d. 1.4 cm

ANS: B PTS: 1 DIF: 2
TOP: 24.6 Diffraction | 24.7 Single-Slit Diffraction

54. A Fraunhofer diffraction pattern is produced from a light source of wavelength 580 nm. The light goes through a single slit and onto a screen 1.0 m away. The first dark fringe is 5.0 mm from the central bright fringe. What is the slit width? (1 nm = 10^{-9} m)
a. 0.24 mm
b. 0.12 mm
c. 0.10 mm
d. 0.081 mm

ANS: B PTS: 1 DIF: 2
TOP: 24.6 Diffraction | 24.7 Single-Slit Diffraction

55. Helium-neon laser light (l = 632.8 nm) is sent through a single slit of width 0.30 mm. What is the width of the central maximum on a screen 1.0 m in back of the slit? (1 nm = 10^{-9} m)
a. 2.0 mm
b. 3.1 mm
c. 4.2 mm
d. 5.3 mm

ANS: C PTS: 1 DIF: 2
TOP: 24.6 Diffraction | 24.7 Single-Slit Diffraction

56. In the straight-ahead direction (= 0°) in Fraunhofer diffraction, which of the following is observed on the screen?
a. a minimum equal in width to the adjacent minima
b. a minimum double in width to the adjacent minima
c. a maximum equal in width to the adjacent maxima
d. a maximum double in width to the adjacent maxima

ANS: D PTS: 1 DIF: 1
TOP: 24.6 Diffraction | 24.7 Single-Slit Diffraction

57. A multiple slit diffraction grating has a slit separation of 2.00 ´ 10^{-6} m. Find the wavelength of the monochromatic light that will have its second order bright fringe diffracted through an angle of 38.0°. (1 nm = 10^{-9} m)
a. 120 nm
b. 500 nm
c. 616 nm

d. 687 nm

ANS: C PTS: 1 DIF: 2
TOP: 24.8. The Diffraction Grating

58. A diffraction grating with 10 000 lines/cm will exhibit the first order maximum for light of wavelength 510 nm at what angle? (1 nm = 10^{-9} m)
a. 0.51°
b. 0.62°
c. 15.3°
d. 31°

ANS: D PTS: 1 DIF: 2
TOP: 24.8. The Diffraction Grating

59. What is the highest order maximum for wavelength 450 nm that can be obtained with a grating with 600 lines per mm?
a. 3
b. 4
c. 6
d. 7

ANS: A PTS: 1 DIF: 2
TOP: 24.8. The Diffraction Grating

60. At what angle will the highest order maximum appear for a wavelength 450 nm using a grating with 600 lines per mm?
a. 36°
b. 54°
c. 81°
d. 90°

ANS: B PTS: 1 DIF: 3
TOP: 24.8. The Diffraction Grating

61. A wavelength of 573 nm yields a first order maximum at 35° with a grating. At what angle will the second order maximum appear for this wavelength?
a. 17.5°
b. –35°
c. 70°
d. No second order maximum exists in this case.

ANS: D PTS: 1 DIF: 3
TOP: 24.8. The Diffraction Grating

62. A diffraction grating has 4000 lines/cm. What is the slit separation?
a. 4.0 ìm
b. 2.5 ìm
c. 400 nm
d. 250 nm

ANS: B PTS: 1 DIF: 2
TOP: 24.8. The Diffraction Grating

63. At what angle will the second order maximum occur for a wavelength of 400 nm using a diffraction grating with 10 000 lines per cm?

a. 15.5°
b. 24°
c. 53°
d. No second order maximum will occur in this case.

ANS: C PTS: 1 DIF: 2
TOP: 24.8. The Diffraction Grating

64. A beam of unpolarized light in air strikes a flat piece of glass at an angle of incidence of 54.2°. If the reflected beam is completely polarized, what is the index of refraction of the glass?
a. 1.60
b. 1.39
c. 1.52
d. 2.48

ANS: B PTS: 1 DIF: 2
TOP: 24.9 Polarization of Light Waves

65. Polarization of light can be achieved using a dichroic material like Polaroid by which of the following processes?
a. reflection
b. double refraction
c. selective absorption
d. scattering

ANS: C PTS: 1 DIF: 1
TOP: 24.9 Polarization of Light Waves

66. A beam of polarized light of intensity I_0 passes through a sheet of ideal polarizing material. The polarization axis of the beam and the transmission axis of the sheet differ by 30°. What is the intensity of the emerging light?
a. 0.87 I_0
b. 0.75 I_0
c. 0.50 I_0
d. 0.25 I_0

ANS: B PTS: 1 DIF: 2
TOP: 24.9 Polarization of Light Waves

67. When the sun is located near one of the horizons, an observer looking at the sky directly overhead will view partially polarized light. This effect is due to which of the following processes?
a. reflection
b. double refraction
c. selective absorption
d. scattering

ANS: D PTS: 1 DIF: 1
TOP: 24.9 Polarization of Light Waves

68. An unpolarized beam of light is incident on a pane of glass (n = 1.56) such that the reflected component coming off the glass is completely polarized. What is the angle of incidence in this case?
a. 32.7°
b. 41.0°
c. 49.0°
d. 57.3°

ANS: D PTS: 1 DIF: 2
TOP: 24.9 Polarization of Light Waves

69. At what angle is the sun above the horizon if its light is found to be completely polarized when it is reflected from the top surface of a slab of glass (n = 1.65)?
a. 31.2°
b. 44.4°
c. 58.8°
d. 66.6°

ANS: A PTS: 1 DIF: 2
TOP: 24.9 Polarization of Light Waves

70. Polaroid sunglasses help when skiing on snow on a sunny day by reducing the sunlight from the snow. This light from the snow has been polarized by:
a. selective absorption.
b. reflection.
c. double refraction.
d. scattering.

ANS: B PTS: 1 DIF: 1
TOP: 24.9 Polarization of Light Waves

71. The intensity of unpolarized light passing through a single sheet of polarizing material changes by a factor of:
a. 1.
b. 0.5.
c. $\cos\theta$.
d. $\cos^2\theta$.

ANS: B PTS: 1 DIF: 1
TOP: 24.9 Polarization of Light Waves

72. Unpolarized light of intensity I_0 passes through two sheets of ideal polarizing material. If the transmitted intensity is 0.25 I_0, what is the angle between the polarizer and the analyzer?
a. 60°
b. 45°
c. 30°
d. 22.5°

ANS: B PTS: 1 DIF: 2
TOP: 24.9 Polarization of Light Waves

73. The blue light from the sky has been polarized by:
a. selective absorption.
b. reflection.
c. double refraction.
d. scattering.

ANS: D PTS: 1 DIF: 1
TOP: 24.9 Polarization of Light Waves

74. A material is optically active if it:
a. absorbs light passing through it.
b. transmits all light passing through it.

c. exhibits interference.
d. rotates the plane of polarization of the light passing through it.

ANS: D PTS: 1 DIF: 1
TOP: 24.9 Polarization of Light Waves

75. How far above the horizon is the moon when its image reflected in calm water is completely polarized? (n_{water} = 1.333)
a. 53.12°
b. 18.44°
c. 22.20°
d. 36.88°

ANS: D PTS: 1 DIF: 2
TOP: 24.9 Polarization of Light Waves

76. Sunlight reflected from a smooth ice surface is completely polarized. Determine the angle of incidence. (n_{ice} = 1.309)
a. 25.60°
b. 47.89°
c. 52.62°
d. 56.26°

ANS: C PTS: 1 DIF: 2
TOP: 24.9 Polarization of Light Waves

77. If the polarizing angle for diamond is 67.5°, what is the index of refraction of this material?
a. 2.00
b. 2.20
c. 2.41
d. 2.65

ANS: C PTS: 1 DIF: 2
TOP: 24.9 Polarization of Light Waves

78. The critical angle for sapphire surrounded by air is 34.4°. Calculate the polarizing angle for sapphire.
a. 60.5°
b. 59.7°
c. 58.6°
d. 56.3°

ANS: A PTS: 1 DIF: 3
TOP: 24.9 Polarization of Light Waves

79. Unpolarized light is passed through polarizer 1. The light then goes though polarizer 2 with its plane of polarization at 45.0° to that of polarizer 1. What fraction of the intensity of the original light gets though the second polarizer?
a. 0.707
b. 0.500
c. 0.250
d. 0.125

ANS: C PTS: 1 DIF: 2
TOP: 24.9 Polarization of Light Waves

80. Unpolarized light is passed through polarizer 1. The light then goes though polarizer 2 with its plane of polarization at 45.0° to that of polarizer 1. Polarizer 3 is placed after polarizer 2. Polarizer 3 has its plane of polarization at 45° to the plane of polarization of polarizer 2 and at 90° to that of polarizer 1. What fraction of the intensity of the original light gets though the last polarizer?
a. 0.707
b. 0.500
c. 0.250
d. 0.125

ANS: D PTS: 1 DIF: 2
TOP: 24.9 Polarization of Light Waves

81. Plane polarized light is sent through two consecutive polarizers, the first having its plane of polarization in the same direction as the incident light and the second having its plane at 90° to the original plane of polarization. A third polarizer, with plane of polarization at 30° to the original plane of polarization, is placed between the two other polarizers. What fraction of the original intensity now gets through?
a. 0
b. 0.56
c. 0.25
d. 0.19

ANS: D PTS: 1 DIF: 3
TOP: 24.9 Polarization of Light Waves

82. LCD stands for:
a. linearly collimated diffraction.
b. longitudinally combined depolarization.
c. liquid crystal display.
d. lighted compact disk.

ANS: C PTS: 1 DIF: 1
TOP: 24.9 Polarization of Light Waves

83. A beam of plane polarized light is incident on 3 polarizers, the first with an axis at 30° to the original plane of polarization, the second at 60° to the original plane of polarization, and the third at 90° to the original plane of polarization. What angle does the plane of polarization of the transmitted light make with the original plane of polarization of the original beam?
a. 30°
b. 90°
c. 180°
d. The answer is not given.

ANS: B PTS: 1 DIF: 2
TOP: 24.9 Polarization of Light Waves

84. In a Young's double-slit experiment, both the wavelength and the slit separation are increased by 50%. What happens to the distance between two adjacent bright fringes?
a. It increases by 50%.
b. It decreases by 50%.
c. The distance stays the same.
d. The distance increases by a 100% or more.

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Questions

85. In a Young's double-slit experiment, what happens to the angular separation between the fringes when the wavelength is increased at the same time that the slit separation is decreased?

a. It increases.
b. It decreases.
c. It stays the same.
d. The relative sizes of the changes need to be known before a definite answer can be given.

ANS: A PTS: 1 DIF: 2 TOP: Conceptual Questions

86. A Young's double-slit experiment is performed in air and then the apparatus is submerged in water. What happens to the fringe separation, and what can be used to explain the change, if any?

a. The separation stays the as it is the same experiment independent of the medium.
b. The separation decreases because the frequency of the light decreases in the water.
c. The separation increases because the wavelength of the light increases in the water.
d. The separation decreases because the wavelength of the light decreases in the water.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Questions

87. Diffraction grating #1 has half the lines/cm that diffraction grating #2 does. When used with a certain wavelength of light, both gratings give first order maxima. Which of the following statements is true for the same wavelength of light.

a. Both gratings must also give second order maxima.
b. Grating #1 must give a second order maximum.
c. Grating #2 must give a second order maximum.
d. It is possible that neither grating gives a second order maximum.

ANS: B PTS: 1 DIF: 3 TOP: Conceptual Questions

88. Light travels from outside a building to inside through a pane of glass. Which of the following is true regarding the phase change upon reflection in the case?

a. No phase change occurs at either the inside surface or the outside surface of the glass.
b. A 180^{o} phase change occurs at both the inside surface and the outside surface.
c. A 180^{o} phase change occurs at the inside surface but not at the outside surface.
d. A 180^{o} phase change occurs at the outside surface but not at the inside surface.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Questions

CHAPTER 25—Optical Instruments

MULTIPLE CHOICE

1. What is the *f*-number of a camera lens that has an aperture-opening diameter of 0.10 cm and a focal length of 1.0 cm?
   a. 0.10
   b. 0.1
   c. 10
   d. 1.0

   ANS: C PTS: 1 DIF: 1 TOP: 25.1 The Camera

2. A camera lens is initially set at *f*/32 for a shutter speed of 1/15 s. If the amount of lighting on the subject is unchanged, and the lens is set at *f*/16, what is the proper shutter speed at this setting?
   a. 1/60 s
   b. 1/2 s
   c. 1/125 s
   d. 1/30 s

   ANS: A PTS: 1 DIF: 2 TOP: 25.1 The Camera

3. Quadrupling the aperture diameter of a camera lens will change the *f*-number by what factor?
   a. 1/16
   b. 1/4
   c. 4
   d. 16

   ANS: B PTS: 1 DIF: 2 TOP: 25.1 The Camera

4. Tripling the focal length in a telephoto lens, while keeping the aperture size constant, will change the *f*-number by what factor?
   a. 1/9
   b. 1/3
   c. 3
   d. 9

   ANS: C PTS: 1 DIF: 2 TOP: 25.1 The Camera

5. Doubling the aperture diameter of a camera lens will change the light intensity admitted to the film by what factor?
   a. 0.25
   b. 0.5
   c. 2.0
   d. 4.0

   ANS: D PTS: 1 DIF: 2 TOP: 25.1 The Camera

6. Tripling the focal length of a telephoto lens, while holding aperture size constant, will change the light intensity admitted to the film by what factor?
   a. 0.11
   b. 0.33
   c. 3.0
   d. 9.0

ANS: A PTS: 1 DIF: 2 TOP: 25.1 The Camera

7. Tripling the *f*-number of a camera lens will change the light intensity admitted to the film by what factor?
   a. 1/9
   b. 1/3
   c. 3
   d. 9

ANS: A PTS: 1 DIF: 2 TOP: 25.1 The Camera

8. I take two pictures of my dog Kaycee. I use the same film and level of illumination for both pictures, but I triple the *f*-number for the second picture. By what factor will the required time of exposure change if the film is to receive the same total light energy?
   a. 0.11
   b. 0.33
   c. 3.0
   d. 9.0

ANS: D PTS: 1 DIF: 2 TOP: 25.1 The Camera

9. A camera uses a:
   a. converging lens to form a real image.
   b. converging lens to form an imaginary image.
   c. diverging lens to form a real image.
   d. diverging lens to form an imaginary image.

ANS: A PTS: 1 DIF: 1 TOP: 25.1 The Camera

10. Changing the *f*-number of a camera by three stops by going from *f*/5.6 to *f*/16 will change the intensity of the light hitting the film by a factor of:
    a. 8.
    b. 4.
    c. 1/4.
    d. 1/8.

ANS: D PTS: 1 DIF: 2 TOP: 25.1 The Camera

11. A 1.6-m tall woman stands 7.0-m in front of a camera with a 6.0-cm focal length lens. What is the size of the image formed on film?
    a. 26.3 cm
    b. 1.9 cm
    c. 1.4 cm
    d. 67.2 cm

ANS: C PTS: 1 DIF: 2 TOP: 25.1 The Camera

12. A low *f*-number:
    a. allows a smaller depth of field.
    b. allows using a faster shutter speed.
    c. causes less spherical aberration.
    d. is not related to any of the above options.

ANS: A PTS: 1 DIF: 1 TOP: 25.1 The Camera

13. A camera has a lens of focal length 70 mm and a speed of *f*/2.0. What is the diameter of the lens?
    a. 17.5 mm
    b. 35 mm
    c. 70 mm
    d. 140 mm

    ANS: B PTS: 1 DIF: 2 TOP: 25.1 The Camera

14. A camera is used to photograph the full moon, which has an angular diameter of 0.51°. The image on the film is 3.2 mm in diameter. What is the focal length of the lens?
    a. 3.2 mm
    b. 720 mm
    c. 360 mm
    d. 1130 mm

    ANS: C PTS: 1 DIF: 2 TOP: 25.1 The Camera

15. A converging lens will be prescribed by the eye doctor to correct which of the following?
    a. farsightedness
    b. glaucoma
    c. nearsightedness
    d. astigmatism

    ANS: C PTS: 1 DIF: 1 TOP: 25.2 The Eye

16. The ciliary muscle is instrumental in changing the shape of which eye part?
    a. iris
    b. lens
    c. pupil
    d. retina

    ANS: B PTS: 1 DIF: 1 TOP: 25.2 The Eye

17. The ciliary muscle of the eye is relaxed under which condition?
    a. eye is focused on a distant object
    b. eye is focused on a nearby object
    c. subject being viewed is well illuminated
    d. subject being viewed is dimly illuminated

    ANS: A PTS: 1 DIF: 1 TOP: 25.2 The Eye

18. The pupil of the eye increases in size under which condition?
    a. eye is focused on a distant object
    b. eye is focused on a nearby object
    c. object viewed is dimly illuminated
    d. object viewed is well illuminated

    ANS: C PTS: 1 DIF: 1 TOP: 25.2 The Eye

19. A diverging lens will be prescribed by the eye doctor to correct which of the following?
    a. myopia
    b. presbyopia
    c. hyperopia
    d. astigmatism

    ANS: A PTS: 1 DIF: 1 TOP: 25.2 The Eye

20. Which term below identifies the eye defect characterized by an inability to see distant objects clearly?
    a. myopia
    b. presbyopia
    c. hyperopia
    d. astigmatism

    ANS: A PTS: 1 DIF: 1 TOP: 25.2 The Eye

21. Which term identifies the defect where the lens produces a line image of a point source?
    a. myopia
    b. presbyopia
    c. hyperopia
    d. astigmatism

    ANS: D PTS: 1 DIF: 1 TOP: 25.2 The Eye

22. Which eye defect is corrected by a lens having different curvatures in two perpendicular directions?
    a. myopia
    b. presbyopia
    c. hyperopia
    d. astigmatism

    ANS: D PTS: 1 DIF: 2 TOP: 25.2 The Eye

23. A lens with a focal length of 10 cm has what power?
    a. 10.0 diopters
    b. 0.1 diopters
    c. 1 diopters
    d. -10.0 diopters

    ANS: A PTS: 1 DIF: 2 TOP: 25.2 The Eye

24. Two thin lenses in combination are placed in contact with each other along a common axis. They have powers of 50 and -30 diopters, respectively. What is their combined power?
    a. 10 diopters
    b. 20 diopters
    c. 80 diopters
    d. –10 diopters

    ANS: B PTS: 1 DIF: 2 TOP: 25.2 The Eye

25. The "normal" eye has a near point of 25 cm. If a given individual's near point is 73 cm, for what problem will the eye doctor prescribe correction?
    a. myopia
    b. presbyopia
    c. hyperopia
    d. astigmatism

    ANS: C PTS: 1 DIF: 1 TOP: 25.2 The Eye

26. You are designing eyeglasses for someone whose near point is 70 cm. What focal length lens should you prescribe so that an object can be clearly seen when placed at 25 cm in front of the eye?
    a. - 18 cm
    b. 18 cm
    c. 39 cm

d. 70 cm

ANS: C PTS: 1 DIF: 2 TOP: 25.2 The Eye

27. A given individual is unable to see objects clearly when they are beyond 100 cm. What focal length lens should be used to correct this problem?
a. - 100 cm
b. - 33.3 cm
c. - 20 cm
d. 75 cm

ANS: A PTS: 1 DIF: 2 TOP: 25.2 The Eye

28. While a camera has film where the image is formed, the eye forms the image on the:
a. pupil.
b. cornea.
c. retina.
d. optic nerve.

ANS: C PTS: 1 DIF: 1 TOP: 25.2 The Eye

29. The eye changes its *f*-number by:
a. using the iris to change the size of the pupil.
b. using the ciliary muscle to change the focal length of the lens.
c. Both a & b are correct.
d. The eye does not change its *f*-number.

ANS: C PTS: 1 DIF: 1 TOP: 25.2 The Eye

30. In the normal eye the ciliary muscles that control the lens will relax:
a. when viewing objects at the near point.
b. when viewing objects at infinity.
c. when viewing objects at a distance of 20 ft.
d. only when a person has his/her eyes closed.

ANS: B PTS: 1 DIF: 1 TOP: 25.2 The Eye

31. If a person has hyperopia that person:
a. may have an unusually long eyeball.
b. cannot see near objects clearly.
c. cannot relax the ciliary muscle adequately.
d. cannot form images behind the retina.

ANS: B PTS: 1 DIF: 1 TOP: 25.2 The Eye

32. A farsighted person with astigmatism would be prescribed a lens that is:
a. diverging only.
b. both converging and cylindrical.
c. diverging only.
d. both converging and cylindrical.

ANS: D PTS: 1 DIF: 1 TOP: 25.2 The Eye

33. If a person is farsighted the corrective lens will:
a. take an object at the near point and form an image at 25 cm.
b. take an object at 25 cm and form an image at the near point.

c. take an object at infinity and form an image at 25 cm.
d. take an object at infinity and form an image at the near point.

ANS: B PTS: 1 DIF: 1 TOP: 25.2 The Eye

34. Glaucoma occurs because:
a. the eye cannot accommodate properly.
b. the shape or size of the eye is not normal.
c. there is too much pressure in the fluid in the eyeball.
d. the lens is partially or totally opaque.

ANS: C PTS: 1 DIF: 1 TOP: 25.2 The Eye

35. A nearsighted person cannot see objects clearly beyond 70 cm (the far point). If the patient has no astigmatism and contact lenses are prescribed, what is the power of the lens required to correct the patient's vision?
a. - 0.7 diopters
b. - 1.4 diopters
c. - 2.9 diopters
d. - 7.0 diopters

ANS: B PTS: 1 DIF: 2 TOP: 25.2 The Eye

36. A person has a near point of 40 cm and a far point of 2.0 m. When looking through lenses of focal length –2.0 m, what is the nearest an object can be to be seen clearly?
a. 33 cm
b. 50 cm
c. 100 cm
d. 240 cm

ANS: B PTS: 1 DIF: 2 TOP: 25.2 The Eye

37. Young children that need glasses are rarely prescribed bifocals. Why?
a. They are almost always nearsighted.
b. They are almost always farsighted.
c. They have considerable accommodation power.
d. Parents don’t go for the additional expense.

ANS: C PTS: 1 DIF: 2 TOP: 25.2 The Eye

38. Two thin lenses have powers P_1 and P_2, measured in diopters. If these lenses are placed in contact with one another, the resulting power is:
a. more than both P_1 and P_2.
b. less than both P_1 and P_2.
c. half-way between P_1 and P_2.
d. $P_1 + P_2$.

ANS: D PTS: 1 DIF: 2 TOP: 25.2 The Eye

39. A person with limited accommodation is prescribed lenses of power –1.0 diopters for distant vision. Bifocal inserts are added to these lenses to allow vision at 30 cm. What is the power of the inserts?
a. 2.3 diopters
b. 3.3 diopters
c. 4.3 diopters
d. This does not work with negative diopter distance lenses.

ANS: B PTS: 1 DIF: 3 TOP: 25.2 The Eye

40. A thin lens of focal length 20 cm is placed in contact with a 20-diopter thin lens. What is the power of the combined lenses?
a. 1/2 diopter
b. 15 diopters
c. 25 diopters
d. 40 diopters

ANS: C PTS: 1 DIF: 2 TOP: 25.2 The Eye

41. A person's prescription for bifocals is –0.12 diopter for distant vision and +3.20 diopters for near vision, the near vision being accomplished by inserts into the distant vision lens. What is the net power of the near vision correction?
a. 3.08 diopters
b. 3.20 diopters
c. 3.32 diopters
d. More information is needed.

ANS: A PTS: 1 DIF: 3 TOP: 25.2 The Eye

42. A simple magnifier makes an image appear at the near point distance from the eye of the viewer (25 cm). What is the magnifying power of the magnifier if it is constructed of a lens of focal length of 5.0 cm?
a. 1.2
b. 5.0
c. 6.0
d. 63

ANS: C PTS: 1 DIF: 2 TOP: 25.3 The Simple Magnifier

43. A magnifying lens with a focal length of 10 cm has what maximum magnification? (Assume the near point is 25 cm).
a. 1.4
b. 2.5
c. 11
d. 3.5

ANS: D PTS: 1 DIF: 2 TOP: 25.3 The Simple Magnifier

44. A magnifying lens with a focal length of 20 cm has what magnification when the viewing eye is relaxed?
a. 7.14
b. 1.3
c. 1.8
d. 2.3

ANS: B PTS: 1 DIF: 2 TOP: 25.3 The Simple Magnifier

45. A magnifier uses a:
a. converging lens to form a real image.
b. converging lens to form a virtual image.
c. diverging lens to form a virtual image.
d. diverging lens to form a real image.

ANS: B PTS: 1 DIF: 1 TOP: 25.3 The Simple Magnifier

46. A lens with focal length 5.0 cm is used as a magnifying glass. To obtain maximum magnification, how far in front of the lens should the object be placed?
a. 5.0 cm
b. 4.2 cm
c. 10 cm
d. 25 cm

ANS: B PTS: 1 DIF: 2 TOP: 25.3 The Simple Magnifier

47. A lens is used as a magnifier. Which of the following statements is incorrect?
a. The lens is convex.
b. The dioptric power of the lens is positive.
c. The magnification is greatest when the eye focuses at the near point.
d. The focal length of the lens must be negative.

ANS: D PTS: 1 DIF: 2 TOP: 25.3 The Simple Magnifier

48. What is the approximate magnification of a compound microscope with objective and eyepiece focal lengths of 0.20 cm and 4.5 cm, respectively, and a separation between lenses of 40 cm?
a. 440
b. 50
c. 44
d. 1110

ANS: D PTS: 1 DIF: 3
TOP: 25.4 The Compound Microscope

49. You are building a compound microscope with an objective lens of focal length 0.60 cm and an eyepiece lens of focal length 3.0 cm. You mount the lenses 25 cm apart. What is the maximum magnification of your microscope?
a. 13
b. 26
c. 170
d. 350

ANS: D PTS: 1 DIF: 3
TOP: 25.4 The Compound Microscope

50. Doubling the focal length of the objective lens of a compound microscope will change the magnification by what factor?
a. 1/4
b. 1/2
c. 2
d. 4

ANS: B PTS: 1 DIF: 2
TOP: 25.4 The Compound Microscope

51. A compound microscope has an eyepiece that:
a. uses a real image from the objective as the object and forms its own real image.
b. uses a real image from the objective as the object and forms a virtual image.
c. uses a virtual image from the objective as the object and forms its own real image.
d. uses a virtual image from the objective as the object and forms its own virtual image.

ANS: B PTS: 1 DIF: 2

TOP: 25.4 The Compound Microscope

52. If the objective lens of a compound microscope is replaced with a lens of double the focal length while the eyepiece also has its focal length doubled, what will happen to the overall magnification of the microscope?
    a. This will result in no change in the magnification.
    b. The magnification doubles.
    c. The magnification quadruples.
    d. The magnification decreases.

ANS: D PTS: 1 DIF: 2
TOP: 25.4 The Compound Microscope

53. A telescope has an objective lens with a focal length of 200 cm and an eyepiece of focal length 3.0 cm. What is the angular magnification of the telescope?
    a. 15
    b. 67
    c. 75
    d. 230

ANS: B PTS: 1 DIF: 2 TOP: 25.5 The Telescope

54. Even relatively small astronomical telescopes are ordinarily not used for terrestrial observation because:
    a. their images are too bright.
    b. their images are too dim.
    c. their images are inverted.
    d. their images are not in color.

ANS: C PTS: 1 DIF: 1 TOP: 25.5 The Telescope

55. A refracting astronomical telescope has objective and eyepiece lenses of focal lengths 20.0 cm and 0.10 cm, respectively. What is the angular magnification of this instrument?
    a. 67
    b. 130
    c. 200
    d. 380

ANS: C PTS: 1 DIF: 2 TOP: 25.5 The Telescope

56. The Yerkes refracting telescope has a 1-m diameter objective lens of focal length 20 m and an eyepiece of focal length 3.1 cm. What is the magnification of the planet Mars as seen through this telescope?
    a. 160
    b. 320
    c. 650
    d. 1 000

ANS: C PTS: 1 DIF: 2 TOP: 25.5 The Telescope

57. The Palomar reflecting telescope has a parabolic mirror with an 80 m focal length. What is the magnification achieved when an eyepiece of focal length 3.2 cm is used?
    a. 625
    b. 800
    c. 1250

d. 2500

ANS: D PTS: 1 DIF: 2 TOP: 25.5 The Telescope

58. An astronomical telescope has an objective lens with focal length f_o and has an eyepiece with focal length f_e. A second telescope has objective and eyepiece lenses with triple the focal length of the first telescope. Which telescope gives the greater magnification and by what factor?
a. The first telescope gives 9 times the magnification of the second.
b. The second telescope gives 9 times the magnification of the first.
c. Both telescopes give the same magnification.
d. The actual focal lengths must be known to answer this question.

ANS: C PTS: 1 DIF: 2 TOP: 25.5 The Telescope

59. Light with a wavelength of 460 nm shines through a lens with an aperture diameter of 0.70 cm. Use Rayleigh's criterion to determine the limiting angle of resolution. (1 nm = 10^{-9} m)
a. 8.0 ´ 10^{-5} rad
b. 2.7 ´ 10^{-9} rad
c. 1.8 ´ 10^{-4} rad
d. 5.9 ´ 10^{-7} rad

ANS: A PTS: 1 DIF: 2
TOP: 25.6 Resolution of Single-Slit and Circular Apertures

60. What is the resolving power of a diffraction grating that is capable of just distinguishing between two wavelengths of 568.10 nm and 569.70 nm? (1 nm = 10^{-9} m)
a. 1.10
b. 355
c. 426
d. 710

ANS: B PTS: 1 DIF: 2
TOP: 25.6 Resolution of Single-Slit and Circular Apertures

61. A microscope has an objective lens with an aperture diameter 0.70 cm. A monochromatic light source of wavelength 580 nm is used to illuminate the object. It is determined that the minimum angle of resolution is 1.13 ´ 10^{-4} rad. If the present lens were replaced by one with an aperture of diameter 0.90 cm, what would the minimum angle of resolution now become? (1 nm = 10^{-9} m)
a. 2.6 ´ 10^{-4} rad
b. 3.6 ´ 10^{-4} rad
c. 1.8 ´ 10^{-4} rad
d. 1.5 ´ 10^{-4} rad

ANS: D PTS: 1 DIF: 3
TOP: 25.6 Resolution of Single-Slit and Circular Apertures

62. A microscope has an objective lens with an aperture of diameter 0.50 cm where a monochromatic light source of wavelength 580 nm is used to illuminate the object. It is determined that the minimum angle of resolution is 1.15 ´ 10^{-4} rad. If the illuminating source were replaced by an violet source of wavelength 420 nm, what would the minimum angle of resolution now become? (1 nm = 10^{-9} m)
a. 1.7 ´ 10^{-4} rad
b. 1.0 ´ 10^{-4} rad
c. 0.83 ´ 10^{-4} rad
d. 0.50 ´ 10^{-4} rad

ANS: C PTS: 1 DIF: 3
TOP: 25.6 Resolution of Single-Slit and Circular Apertures

63. An individual's eye pupil changes from a diameter of 3.4 mm to 1.4 mm as the illumination is increased. By what factor does the minimum angle of resolution change?
a. 0.48
b. 0.69
c. 2.1
d. 2.4

ANS: D PTS: 1 DIF: 2
TOP: 25.6 Resolution of Single-Slit and Circular Apertures

64. If different filters are used with an astronomical telescope, which of the following would give the best resolution?
a. red
b. yellow
c. green
d. All yield the same resolution.

ANS: C PTS: 1 DIF: 2
TOP: 25.6 Resolution of Single-Slit and Circular Apertures

65. What resolving power must a diffraction grating have in order to distinguish wavelengths of 635.40 nm and 636.60 nm? (1 nm = 10^{-9} m)
a. 318
b. 530
c. 636
d. 848

ANS: B PTS: 1 DIF: 2
TOP: 25.6 Resolution of Single-Slit and Circular Apertures

66. The pupil of a cat's eye narrows to a slit of width 0.7 mm in daylight. Assuming a wavelength of 500 nm, what is the angular resolution? (1 nm = 10^{-9} m)
a. 0.7 ´ 10^{-3} rad
b. 6 ´ 10^{-3} rad
c. 0.7 ´ 10^{-4} rad
d. 6 ´ 10^{-4} rad

ANS: A PTS: 1 DIF: 2
TOP: 25.6 Resolution of Single-Slit and Circular Apertures

67. The 2.4-m diameter Hubble space telescope has been placed into Earth orbit by the space shuttle. Assuming a wavelength of 653 nm, what angular resolution could this telescope achieve by Rayleigh's criterion? (1 nm = 10^{-9} m)
a. 3.7 ´ 10^{-6} rad
b. 4.5 ´ 10^{-6} rad
c. 2.7 ´ 10^{-6} rad
d. 3.3 ´ 10^{-7} rad

ANS: D PTS: 1 DIF: 2
TOP: 25.6 Resolution of Single-Slit and Circular Apertures

68. A binary star system in the constellation Orion has an angular separation between the stars of $5*10^{-5}$ radians. Assuming a wavelength of 500 nm, what is the smallest aperture (diameter) telescope that will just resolve the two stars? (1 nm = 10^{-9} m)
a. 1 cm
b. 1.2 mm
c. 1.2 cm
d. 4 cm

ANS: C PTS: 1 DIF: 2
TOP: 25.6 Resolution of Single-Slit and Circular Apertures

69. Find the radius of a star image formed on the retina of the eye if the aperture diameter (the pupil) at night is 0.70 cm and the length of the eye is 3.1 cm. Assume the wavelength of starlight in the eye is 500 nm. (1 nm = 10^{-9} m)
a. 2.7×10^{-4} m
b. 5.4×10^{-4} m
c. 3.1×10^{-5} m
d. 2.7×10^{-6} m

ANS: D PTS: 1 DIF: 3
TOP: 25.6 Resolution of Single-Slit and Circular Apertures

70. What must be the resolving power of a grating allowing a spectral line at 785.40 nm to be distinguished from another line differing by 0.37 nm? (1 nm = 10^{-9} m)
a. 2100
b. 46
c. 4500000
d. 230

ANS: A PTS: 1 DIF: 2
TOP: 25.6 Resolution of Single-Slit and Circular Apertures

71. How many lines in a grating must be illuminated to obtain a resolving power of 300 in a third-order spectrum?
a. 900
b. 100
c. 300
d. 10

ANS: B PTS: 1 DIF: 2
TOP: 25.6 Resolution of Single-Slit and Circular Apertures

72. Which of the following primarily determines the resolution of a telescope?
a. the barrel length
b. the focal length of the objective
c. the diameter of the objective
d. the diameter of the eyepiece

ANS: C PTS: 1 DIF: 1
TOP: 25.6 Resolution of Single-Slit and Circular Apertures

73. The Michelson interferometer is a device that may be used to measure:
a. magnifying power of lenses.
b. light wavelength.
c. atomic masses.

d. electron charge.

ANS: B PTS: 1 DIF: 1
TOP: 25.7 The Michelson Interferometer

74. The Michelson interferometer can make precise length measurements using which of the following phenomena?
a. force
b. interference
c. magnification
d. resolving power

ANS: B PTS: 1 DIF: 1
TOP: 25.7 The Michelson Interferometer

75. When using 536-nm light, how far is the adjustable mirror of a Michelson interferometer moved when 200 fringe shifts are counted?
a. 1.34×10^{-6} m
b. 2.68×10^{-5} m
c. 5.36×10^{-5} m
d. 1.34×10^{-4} m

ANS: B PTS: 1 DIF: 2
TOP: 25.7 The Michelson Interferometer

76. A fringe shift occurs for every ________ wavelength movement of the adjustable mirror in a Michelson interferometer.
a. whole
b. half
c. quarter
d. eighth

ANS: C PTS: 1 DIF: 1
TOP: 25.7 The Michelson Interferometer

77. Using a camera with a fixed focal length lens, how will decreasing the f-number affect the depth of field and the intensity of the light reaching the ccd (or film)?
a. The depth of field will increase as will the intensity of light reaching the ccd.
b. The depth of field will increase but the intensity of light reaching the ccd will decrease.
c. The depth of field will decrease as will the intensity of light reaching the ccd.
d. The depth of field will decrease but the intensity of light reaching the ccd will increase.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Questions

78. A person can see well in the distance, but cannot do so at an arm's-length distance. To correct this, lenses that are ________ having a ________ power could be used.
a. thicker at their center than at the edges, positive
b. thicker at their center than at the edges, negative
c. thinner at their center than at the edges, positive
d. thinner at their center than at the edges, negative

ANS: A PTS: 1 DIF: 2 TOP: Conceptual Questions

79. The eye parts iris, retina, cornea, and ciliary muscle, play roles related to ________, ________, ________, and ________ in a camera.

a. the aperture, the lens, the ccd, focusing
b. the aperture, the ccd, the lens, focusing
c. the lens, the aperture, focusing, the ccd
d. the lens, focusing, the ccd, the aperture

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Questions

80. A magnifying lens of power d (in diopters) gives what magnification when the viewing eye is relaxed assuming a near point of 25 cm?
a. 25d
b. 0.25/d
c. d/4
d. The correct answer is not given.

ANS: C PTS: 1 DIF: 3 TOP: Conceptual Questions

81. Why is it easier to see fine print in brighter light than in dimmer light?
a. This is not so, it is easier to see fine print in dimmer light than in brighter light.
b. Because the power (in diopters) of the eye increases as the light intensity increases.
c. In brighter light, the longer wavelengths dominate.
d. In brighter light, the f-number of the eye increases.

ANS: D PTS: 1 DIF: 3 TOP: Conceptual Questions

CHAPTER 26—Relativity

MULTIPLE CHOICE

1. Which characterizes the main result of the Michelson-Morley experiment?
   a. verified the existence of ether
   b. involved measuring the speed of sound from a moving source
   c. detected no difference in the speed of light regardless of speed of the source relative to observer
   d. was designed purposely to verify Einstein's theory of relativity

   ANS: C PTS: 1 DIF: 1 TOP: 26.2 The Speed of Light

2. The experiment that dispelled the idea that light travels in the ether is called the:
   a. Michelson-Morley experiment.
   b. Hafele and Keating experiment.
   c. Fitzgerald-Kennedy experiment.
   d. twin paradox.

   ANS: A PTS: 1 DIF: 1 TOP: 26.2 The Speed of Light

3. The Michelson-Morley experiment was designed to make use of ________ to find the motion of the Earth relative to the luminiferous ether.
   a. sound waves
   b. interference fringes
   c. electromagnetic wind
   d. none of the above

   ANS: B PTS: 1 DIF: 1 TOP: 26.2 The Speed of Light

4. The significant result of the Michelson-Morley experiment was that it found:
   a. the ether moved with the sun.
   b. the ether moved with the Earth.
   c. the speed of the ether wind was greater than expected.
   d. no effect.

   ANS: D PTS: 1 DIF: 2 TOP: 26.2 The Speed of Light

5. Einstein’s theory of relativity is based in part on which one of the following postulates?
   a. Mass and energy are equivalent.
   b. Space and time are absolutes.
   c. Energy is conserved only in elastic collisions.
   d. Speed of light in a vacuum is same for all observers regardless of source velocity.

   ANS: D PTS: 1 DIF: 1
   TOP: 26.3 Einstein’s Principle of Relativity

6. According to a postulate of Einstein, which of the following describes the nature of the laws of physics as one observes processes taking place in various inertial frames of reference?
   a. Laws are same only in inertial frames with zero velocity.
   b. Laws are same only in inertial frames moving at low velocities.
   c. Laws are same only in inertial frames moving at near speed of light.
   d. Laws are same in all inertial frames.

ANS: D PTS: 1 DIF: 1
TOP: 26.3 Einstein’s Principle of Relativity

7. I am stationary in a reference system but if my reference system is not an inertial reference system, then, relative to me, a system that is an inertial reference system must:
   a. remain at rest.
   b. move with constant velocity.
   c. be accelerating.
   d. be none of the above.

ANS: C PTS: 1 DIF: 2
TOP: 26.3 Einstein’s Principle of Relativity

8. The speed of light is equal to:
   a. 5.28×10^{7} miles per hour.
   b. one meter per nanosecond.
   c. one light-year per year.
   d. none of the above.

ANS: C PTS: 1 DIF: 1
TOP: 26.3 Einstein’s Principle of Relativity

9. That the speed of light in a vacuum has the same value for all inertial frames is:
   a. inconsistent with the results of the Michelson-Morley experiment.
   b. consistent with the results of the Michelson-Morley experiment.
   c. not related to the results of the Michelson-Morley experiment.
   d. not true.

ANS: B PTS: 1 DIF: 1
TOP: 26.3 Einstein’s Principle of Relativity

10. A mass is bouncing on the end of a spring with a period T when measured by a ground observer. What would the period of oscillation be (as measured by the same observer) if the mass and spring were moving past the ground observer at a speed of 0.80 c?
    a. 0.44 T
    b. 0.60 T
    c. 1.0 T
    d. 1.7 T

ANS: D PTS: 1 DIF: 2
TOP: 26.4 Consequences of Special Relativity

11. The observed relativistic length of a super rocket moving by the observer at 0.70 c will be what factor times that of the measured rocket length if it were at rest?
    a. 0.45
    b. 0.71
    c. 0.82
    d. 1.4

ANS: B PTS: 1 DIF: 2
TOP: 26.4 Consequences of Special Relativity

12. The relativistic effect of time dilation has been verified by which of the following?
    a. the discovery of black holes
    b. muon experiments

c. twin experiments
d. red shift in distant galaxies

ANS: B PTS: 1 DIF: 1
TOP: 26.4 Consequences of Special Relativity

13. According to the special theory of relativity, which of the following happens to the size of the time interval between two events occurring in an inertial frame of reference as the frame's velocity with respect to the observer increases?
a. interval increases
b. interval decreases
c. interval remains constant
d. interval vanishes to zero when velocity equals half speed of light

ANS: A PTS: 1 DIF: 2
TOP: 26.4 Consequences of Special Relativity

14. Doubling the momentum of:
a. a particle doubles its relativistic total energy.
b. a particle quadruples its relativistic total energy.
c. a photon doubles its relativistic total energy.
d. a photon quadruples its relativistic total energy.

ANS: C PTS: 1 DIF: 2
TOP: 26.4 Consequences of Special Relativity

15. According to the special theory of relativity, which of the following happens to the length of an object, measured in the dimension parallel to the motion of its inertial frame of reference, as the velocity of this frame increases with respect to a stationary observer?
a. length increases
b. length decreases
c. length remains constant
d. length vanishes to zero when velocity equals half speed of light

ANS: B PTS: 1 DIF: 1
TOP: 26.4 Consequences of Special Relativity

16. According to the special theory of relativity, if a 30-year old astronaut sent on a space mission is accelerated to speeds close to that of light, and then returns to earth after 20 years as measured on earth, what would be his biological age upon returning?
a. less than 50 years
b. 50 years
c. more than 50 years
d. exactly 100 years

ANS: A PTS: 1 DIF: 1
TOP: 26.4 Consequences of Special Relativity

17. The period of a pendulum is 2.0 s in a stationary inertial frame of reference. What is its period when measured by an observer moving at a speed of 0.60 c with respect to the inertial frame of reference?
a. 1.2 s
b. 1.6 s
c. 2.5 s
d. 3.3 s

ANS: C PTS: 1 DIF: 2

TOP: 26.4 Consequences of Special Relativity

18. The period of an oscillating weight on a spring in an inertial frame of reference is 0.80 s. What would be its speed if it were to move by an observer who measures its period as 1.2 s? ($c = 3.00 \times 10^8$ m/s)
    a. 1.1×10^8 m/s
    b. 2.2×10^8 m/s
    c. 2.5×10^8 m/s
    d. 2.9×10^8 m/s

    ANS: B PTS: 1 DIF: 2
    TOP: 26.4 Consequences of Special Relativity

19. A tuning fork has a frequency of 400 Hz and hence a period of 2.50×10^{-3} s. If the tuning fork is in an inertial frame of reference moving by the observer at speed of 0.750 *c*, what is the frequency of the fork as measured by the observer? (Assume that measurements are strictly by optical means and that the speed of sound waves in air is not pertinent here).
    a. 265 Hz
    b. 302 Hz
    c. 454 Hz
    d. 605 Hz

    ANS: A PTS: 1 DIF: 3
    TOP: 26.4 Consequences of Special Relativity

20. A ground observer measures the period of a pendulum moving as a part of an inertial frame of reference to be 2.30 s as the inertial frame moves by at a velocity of 0.600 *c*. What would the observed period be of the same pendulum if its inertial frame were at rest with respect to the observer?
    a. 4.25 s
    b. 2.07 s
    c. 3.03 s
    d. 1.84 s

    ANS: D PTS: 1 DIF: 3
    TOP: 26.4 Consequences of Special Relativity

21. A space probe has an 18.0-m length when measured at rest. What length does an observer at rest measure when the probe is going by at a speed of 0.700 *c*?
    a. 25.2 m
    b. 12.9 m
    c. 12.6 m
    d. 9.18 m

    ANS: B PTS: 1 DIF: 2
    TOP: 26.4 Consequences of Special Relativity

22. A rocket ship is 80.0 m in length when measured before leaving the launching pad. What would its velocity be if a ground observer measured its length as 60.0 m while it is in flight? ($c = 3.00 \times 10^8$ m/s)
    a. 0.980×10^8 m/s
    b. 1.15×10^8 m/s
    c. 1.33×10^8 m/s
    d. 1.98×10^8 m/s

    ANS: D PTS: 1 DIF: 2
    TOP: 26.4 Consequences of Special Relativity

23. An earth observer sees a spaceship at an altitude of 980 m moving downward toward the earth at a speed of 0.800 *c*. What is the spaceship's altitude as measured by an observer in the spaceship?
   a. 1 630 m
   b. 1 270 m
   c. 893 m
   d. 588 m

   ANS: D PTS: 1 DIF: 2
   TOP: 26.4 Consequences of Special Relativity

24. How fast would a rocket have to move past a ground observer if the latter were to observe a 4.0% length shrinkage in the rocket length? ($c = 3.00 \times 10^8$ m/s)
   a. 0.12×10^8 m/s
   b. 0.28×10^8 m/s
   c. 0.84×10^8 m/s
   d. 1.2×10^8 m/s

   ANS: C PTS: 1 DIF: 2
   TOP: 26.4 Consequences of Special Relativity

25. An astronaut at rest has a heart rate of 65 beats/min. What will her heart rate be as measured by an earth observer when the astronaut's spaceship goes by the earth at a speed of 0.60 *c*?
   a. 39 beats/min
   b. 52 beats/min
   c. 108 beats/min
   d. 81 beats/min

   ANS: B PTS: 1 DIF: 3
   TOP: 26.4 Consequences of Special Relativity

26. The astronaut whose heart rate on Earth is 60 beats/min increases his velocity to $v = 0.80\ c$. Now what is his heart rate as measured by an Earth observer?
   a. 36 beats/min
   b. 48 beats/min
   c. 75 beats/min
   d. 100 beats/min

   ANS: A PTS: 1 DIF: 3
   TOP: 26.4 Consequences of Special Relativity

27. A meter stick moving in a direction parallel to its length appears to be only 40.0 cm long to an observer. What is the meter stick's speed relative to the observer? ($c = 3.00 \times 10^8$ m/s)
   a. 1.19×10^8 m/s
   b. 2.52×10^8 m/s
   c. 2.75×10^8 m/s
   d. 2.93×10^8 m/s

   ANS: C PTS: 1 DIF: 2
   TOP: 26.4 Consequences of Special Relativity

28. From a stationary position, I observe a moving boxcar, which has a mirror along the front wall, but it is open at the back of the boxcar. I send a flash of light from my flashlight and time the flash of light as it goes to the front of the boxcar and returns to the back of the boxcar. A passenger in the boxcar also times the round trip of the flash of light. Compare the times recorded on our watches.
   a. The time recorded on his watch is longer.

b. The time recorded on the two watches is the same.
c. The time recorded on his watch is shorter.
d. The answer depends on the reference system you are in.

ANS: C PTS: 1 DIF: 3
TOP: 26.4 Consequences of Special Relativity

29. From a stationary position, I observe a moving boxcar, which has a mirror along the front wall, but it is open at the back of the boxcar. I send a flash of light from my flashlight and time the flash of light as it goes to the front of the boxcar and returns to the back of the boxcar. A passenger in the boxcar also times the round trip of the flash of light. Previously I had measured the time required for the round trip of a flash of light when the boxcar was stationary, and I call this the stationary time. Which two times are the same?
a. the time recorded on my watch and the previous stationary time
b. the time recorded on the passenger's watch and the previous stationary time
c. the time recorded on my watch and the time recorded on the passenger's watch
d. None of the times are the same.

ANS: B PTS: 1 DIF: 3
TOP: 26.4 Consequences of Special Relativity

30. The short lifetime of muons created in the upper atmosphere of the Earth would not allow them to reach the surface of the Earth unless their lifetime increased by time dilation. From the reference system of the muons, the muons can reach the surface of the Earth because:
a. time dilation increases their velocity.
b. time dilation increases their energy.
c. length contraction decreases the distance to the Earth.
d. the relativistic speed of the Earth toward them is added to their velocity.

ANS: C PTS: 1 DIF: 2
TOP: 26.4 Consequences of Special Relativity

31. A boxcar without a front or a back is moving toward the right. Two flashes of light move through the boxcar, one moving from back to front toward the right, the other moving from front to back toward the left. A passenger in the boxcar records how long it takes each flash of light to pass from one end of the boxcar to the other end. According to the passenger, which took longer?
a. the flash going from back to front
b. the flash going from front to back
c. They both took the same time.
d. It depends on whether the passenger is sitting at the front or the back of the boxcar.

ANS: C PTS: 1 DIF: 2
TOP: 26.4 Consequences of Special Relativity

32. A boxcar without a front or a back is moving toward the right. Two electrons move through the boxcar, one moving from back to front toward the right, the other moving from front to back toward the left. According to me, each electron is moving with a speed of 0.8 c, and the boxcar is moving with a speed of 0.6 c. A passenger in the boxcar records how long it takes each electron to pass from one end of the boxcar to the other end. According to the passenger, which took longer?
a. the electron going from back to front
b. the electron going from front to back
c. They both took the same time.
d. Since nothing can go faster than light, an electron cannot move toward the left with a speed of 0.8 c through a boxcar moving toward the right with a speed of 0.6 c.

ANS: A PTS: 1 DIF: 3
TOP: 26.4 Consequences of Special Relativity

33. A knight on horseback holds a 10-m lance. The horse can run at 0.70 *c*. (It wins most of its races!) How long will the lance appear to a person that is standing still on the ground as the horse runs past?
   a. 7.1 m
   b. 10 m
   c. 14 m
   d. 15 m

ANS: A PTS: 1 DIF: 2
TOP: 26.4 Consequences of Special Relativity

34. At what speed would a clock have to be moving in order to run at a rate that is one-third the rate of a clock at rest?
   a. 0.79 *c*
   b. 0.89 *c*
   c. 0.94 *c*
   d. 0.97 *c*

ANS: C PTS: 1 DIF: 3
TOP: 26.4 Consequences of Special Relativity

35. A muon formed high in the Earth's atmosphere travels at a speed 0.990 *c* for a distance of 4.60 km before it decays. What is the muon's lifetime as measured in its reference frame?
   a. 1.55×10^{-5} s
   b. 2.18×10^{-6} s
   c. 3.04×10^{-6} s
   d. 4.65×10^{-6} s

ANS: B PTS: 1 DIF: 3
TOP: 26.4 Consequences of Special Relativity

36. A muon formed high in Earth's atmosphere travels at a speed 0.990 0 *c* for a distance (as we see it) of 4 600 m before it decays. How far does the muon travel as measured in its frame?
   a. 4 554 m
   b. 2 596 m
   c. 1 298 m
   d. 649 m

ANS: D PTS: 1 DIF: 2
TOP: 26.4 Consequences of Special Relativity

37. Muons at speed 0.999 4 *c* are sent round and round a circular storage ring of radius 500 m. If a muon at rest decays into other particles after an average $T = 2.2 \times 10^{-6}$ s, how many trips around the storage ring do we expect the 0.999 4 *c* muons to make before they decay?
   a. 0.2
   b. 2
   c. 4
   d. 6

ANS: D PTS: 1 DIF: 3
TOP: 26.4 Consequences of Special Relativity

38. If astronauts could travel at $v = 0.95\ c$, we on Earth would say it takes (4.2/0.95) = 4.4 years to reach Alpha Centauri, 4.2 lightyears away. The astronauts disagree. How much time passes on the astronaut's clocks?
a. 1.4 years
b. 1.9 years
c. 2.4 years
d. 3.0 years

ANS: A PTS: 1 DIF: 2
TOP: 26.4 Consequences of Special Relativity

39. Our best measurements from Earth indicate that the star system Alpha Centauri is 4.2 lightyears away. Suppose some of our astronauts traveled there at a speed $v = 0.95\ c$. What would the astronauts measure as the distance to Alpha Centauri?
a. 4.0 lightyears
b. 2.7 lightyears
c. 1.9 lightyears
d. 1.3 lightyears

ANS: D PTS: 1 DIF: 2
TOP: 26.4 Consequences of Special Relativity

40. A spaceship of triangular shape, having a length twice its width, is capable of relativistic speeds. How fast would it have to move so that to a stationary observer its length would equal its width?
a. 0.500 *c*
b. 0.750 *c*
c. 0.866 *c*
d. This is not possible.

ANS: C PTS: 1 DIF: 2
TOP: 26.4 Consequences of Special Relativity

41. A proton with mass 1.67×10^{-27} kg moves with a speed of 0.600 *c* in an accelerator. What is its relativistic momentum? ($c = 3.00 \times 10^{8}$ m/s)
a. 0.530×10^{-19} kg·m/s
b. 2.40×10^{-19} kg·m/s
c. 3.76×10^{-19} kg·m/s
d. 6.67×10^{-19} kg·m/s

ANS: C PTS: 1 DIF: 2
TOP: 26.5 Relativistic Momentum

42. An electron of mass 9.11×10^{-31} kg moves with a speed of 0.600 *c*. What is its momentum? ($c = 3.00 \times 10^{8}$ m/s)
a. 1.34×10^{-22} kg·m/s
b. 2.05×10^{-22} kg·m/s
c. 4.12×10^{-22} kg·m/s
d. 6.03×10^{-22} kg·m/s

ANS: B PTS: 1 DIF: 2
TOP: 26.5 Relativistic Momentum

43. Including relativistic effects, doubling the speed of a object:
a. doubles its momentum.
b. more than doubles its momentum.

c. less than doubles its momentum.
d. has no effect on its momentum.

ANS: B PTS: 1 DIF: 2
TOP: 26.5 Relativistic Momentum

44. As the speed of an object increases, its relativistic momentum:
a. stays the same as its classical momentum.
b. increases more than its classical momentum.
c. increases less than it classical momentum.
d. does not change since momentum is a conserved quantity.

ANS: C PTS: 1 DIF: 2
TOP: 26.5 Relativistic Momentum

45. An electron of mass 9.11 ´ 10^{-31} kg has a momentum of 3.64 ´ 10^{-22} kg·m/s. What is its speed?
a. 0.467 *c*
b. 0.632 *c*
c. 0.800 *c*
d. It cannot have this momentum since it would require a speed greater than *c*.

ANS: C PTS: 1 DIF: 3
TOP: 26.5 Relativistic Momentum

46. At what speed is the momentum of an object double that found classically?
a. *c*/2
b. 3*c*/4
c. 0.866*c*
d. 2*c*

ANS: C PTS: 1 DIF: 2
TOP: 26.5 Relativistic Momentum

47. Spacecraft A is traveling at in the positive *x*-direction, and Spacecraft B is traveling in the negative *x*-direction with a velocity of , both velocities with respect to an Earth-based observer at rest. What is the magnitude of the velocity of Spacecraft A as observed from Spacecraft B?
a.
b.
c.
d.

ANS: B PTS: 1 DIF: 2
TOP: 26.6 Relative Velocity in Special Relativity

48. Spacecraft A is traveling at in the positive *x*-direction with respect to the Earth frame. An observer in Spacecraft C measures the velocity of Spacecraft A as . What is the speed of Spacecraft C with repect to the Earth's frame, assuming that A and C are moving along the same line of motion?
a.
b.
c.
d.

ANS: C PTS: 1 DIF: 2
TOP: 26.6 Relative Velocity in Special Relativity

49. Spaceship #1 is moving at a speed of to the right, and Spaceship #2 is moving to the left also at , both speeds measured with respect to the Earth. What is the speed of #1 as measured by an observer on #2?
a.
b.
c.
d.

ANS: B PTS: 1 DIF: 2
TOP: 26.6 Relative Velocity in Special Relativity

50. A spaceship traveling away from the Earth at fires a deep-space probe in the forward direction. If the speed of the probe relative to the Earth is , what is its speed relative to the spaceship?
a.
b.
c.
d.

ANS: C PTS: 1 DIF: 2
TOP: 26.6 Relative Velocity in Special Relativity

51. In a test of equipment the following procedure is carried out. Spacecraft #1 is traveling at 0.75 *c* and fires a laser pulse in the forward direction at Spacecraft #2, which is testing its device that measures the speed of laser pulses as they pass by the spacecraft. Spacecraft #2 is traveling at 0.95 *c* in a direction away from Spacecraft # 1. The device is working properly, and the speed of the pulse as it passes is successfully measured. What is the speed of the laser pulse measured in this case?
a. 0.80 *c*
b. 0.70 *c*
c. *c*
d. This is a question that cannot be answered without knowing in which reference frames the speeds given in the problem. If you agree, then this is the answer that you should choose.

ANS: C PTS: 1 DIF: 1
TOP: 26.6 Relative Velocity in Special Relativity

52. An object moves by an observer at 0.500 *c* (1/2 the speed of light). The total energy of the object will be what factor times that of the rest energy?
a. 0.600
b. 0.970
c. 1.15
d. 1.67

ANS: C PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

53. The total energy of a particle:
a. is not related to its relativistic momentum.
b. increases with increasing relativistic momentum.
c. decreases with increasing relativistic momentum.
d. is a constant.

ANS: B PTS: 1 DIF: 1
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

54. What is the total energy of a proton moving at a speed of 2.00×10^8 m/s? (proton mass is 1.67×10^{-27} kg and $c = 3.00 \times 10^8$ m/s)

a. 1.11×10^{-27} J
b. 2.24×10^{-27} J
c. 2.02×10^{-10} J
d. 2.70×10^{-10} J

ANS: C PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

55. What is the relativistic kinetic energy of an electron moving at a speed of 1.50×10^{8} m/s? (electron mass is 9.11×10^{-31} kg and $c = 3.00 \times 10^{8}$ m/s)
a. 1.27×10^{-14} J
b. 7.10×10^{-14} J
c. 9.47×10^{-14} J
d. 11.6×10^{-14} J

ANS: A PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

56. A nuclear reaction, which gives off a total of 1.0×10^{17} J of energy, expends how much mass in the process? ($c = 3.00 \times 10^{8}$ m/s)
a. 11 kg
b. 1.1 kg
c. 0.11 kg
d. 90 kg

ANS: B PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

57. A proton with mass 1.67×10^{-27} kg moves with a speed of 0.600 c in an accelerator. What is its kinetic energy? ($c = 3.00 \times 10^{8}$ m/s)
a. 7.52×10^{-11} J
b. 9.02×10^{-11} J
c. 3.76×10^{-11} J
d. 1.88×10^{-10} J

ANS: C PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

58. If a proton with mass 1.67×10^{-27} kg moves in an accelerator such that its total energy is three times its rest energy, what is its speed? ($c = 3.00 \times 10^{8}$ m/s)
a. 2.83×10^{8} m/s
b. 1.41×10^{8} m/s
c. 2.12×10^{8} m/s
d. 1.00×10^{8} m/s

ANS: A PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

59. An unknown particle in an accelerator moving at a speed of 2.00×10^{8} m/s has a measured total energy of 1.80×10^{-9} J. What is its mass? ($c = 3.00 \times 10^{8}$ m/s)
a. 0.650×10^{-26} kg
b. 0.810×10^{-26} kg
c. 1.01×10^{-26} kg

d. 1.49×10^{-26} kg

ANS: D PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

60. A proton with mass 1.67×10^{-27} kg moves in an accelerator with a speed of 0.800 *c*. What is its total energy? ($c = 3.00 \times 10^8$ m/s)
a. 0.540×10^{-10} J
b. 1.08×10^{-10} J
c. 2.51×10^{-10} J
d. 3.26×10^{-10} J

ANS: C PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

61. A proton with mass 1.67×10^{-27} kg moves in an accelerator with speed of 0.850 *c*. What is its kinetic energy? ($c = 3.00 \times 10^8$ m/s)
a. 1.00×10^{-10} J
b. 1.35×10^{-10} J
c. 2.51×10^{-10} J
d. 3.70×10^{-10} J

ANS: B PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

62. If the mass of a proton is 1.67×10^{-27} kg, what is the rest energy of the proton? ($c = 3.00 \times 10^8$ m/s and 1 eV = 1.6×10^{-19} J)
a. 1.2×10^8 eV
b. 3.7×10^8 eV
c. 4.1×10^8 eV
d. 9.4×10^8 eV

ANS: D PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

63. When a one-megaton nuclear bomb is exploded, approximately 4.5×10^{15} J of energy is released. How much mass would this represent in a mass-to-energy conversion? ($c = 3.00 \times 10^8$ m/s)
a. 1.5×10^6 kg
b. 0.050 kg
c. 5.3×10^{10} kg
d. 1.7×10^3 kg

ANS: B PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

64. An electron of mass 9.11×10^{-31} kg moves with a speed of 0.600 *c*. What is its total energy? ($c = 3.00 \times 10^8$ m/s)
a. 4.80×10^{-14} J
b. 7.30×10^{-14} J
c. 9.20×10^{-14} J
d. 10.2×10^{-14} J

ANS: D PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

65. An electron of mass 9.11×10^{-31} kg moves with a speed of 0.600 c. What is its kinetic energy? (c = 3.00×10^{8} m/s)
a. 2.05×10^{-14} J
b. 3.90×10^{-14} J
c. 4.74×10^{-14} J
d. 6.22×10^{-14} J

ANS: A PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

66. If the total energy of an electron in an accelerator is four times its rest energy, what is its speed? (c = 3.00×10^{8} m/s)
a. 1.98×10^{8} m/s
b. 2.32×10^{8} m/s
c. 2.90×10^{8} m/s
d. 2.99×10^{8} m/s

ANS: C PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

67. At what speed must an object be moving in order that it has a kinetic energy 1.50 times its rest energy? (c = 3.00×10^{8} m/s)
a. 1.91×10^{8} m/s
b. 2.52×10^{8} m/s
c. 2.75×10^{8} m/s
d. 2.90×10^{8} m/s

ANS: C PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

68. Suppose an object whose mass is m is moving with a speed of 0.8 c. Which is the correct expression for its kinetic energy?
a. $K = mv^2/2$
b. $K = \gamma mc^2$
c. $K = (\gamma - 1)mc^2$
d. Answers a and c are both correct.

ANS: C PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

69. The mass of a proton at rest is m. If the proton is moving so fast that its total energy is three times its rest energy, then what is the kinetic energy of the proton?
a. mc^2
b. $2mc^2$
c. $3mc^2$
d. $4mc^2$

ANS: B PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

70. A spaceship of mass 10^{6} kg is to be accelerated to 0.80 c. How much energy does this require?
a. 2.5×10^{23} J
b. 1.5×10^{23} J

c. 7.2×10^{22} J
d. 6.0×10^{22} J

ANS: D PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

71. A satellite is powered by a small nuclear generator that puts out 15 W. How much matter is converted into energy over the 10 year life span of the generator?
a. 53 μg
b. 53 g
c. 16 g
d. 16 kg

ANS: A PTS: 1 DIF: 2
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

72. A lump of uranium has a mass of 2.0 kg, and begins at rest. Half of the lump's mass is going to be totally converted into kinetic energy of the other half. After this is done, how fast is the remaining half going?
a. 0.60 c
b. 0.80 c
c. 0.87 c
d. 1.0 c

ANS: C PTS: 1 DIF: 3
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

73. In an x-ray tube, high-speed electrons are slammed into a lead target, giving off x-rays. If the electrons are accelerated from rest through a potential difference of 50 000 volts, what speed do they have when they strike the target? ($q_e = 1.6 \times 10^{-19}$ C, $m_e = 9.11 \times 10^{-31}$ kg, and $c = 3.00 \times 10^8$ m/s)
a. 0.17 c
b. 0.41 c
c. 0.83 c
d. 0.91 c

ANS: B PTS: 1 DIF: 3
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

74. Through what potential difference would an electron initially at rest need to be accelerated to have its total energy be double its rest energy? ($m_e = 9.11 \times 10^{-31}$ kg, $c = 3.00 \times 10^8$ m/s, and $q_e = 1.6 \times 10^{-19}$ C)
a. 1.6×10^{-19} V
b. 2.6×10^5 V
c. 5.1×10^5 V
d. 1.0×10^6 V

ANS: C PTS: 1 DIF: 3
TOP: 26.7 Relativistic Energy and the Equivalent of Mass and Energy

75. Relativity dealing with gravitation is known as:
a. inertial relativity.
b. gravitational relativity.
c. Galilean relativity.
d. general relativity.

ANS: D PTS: 1 DIF: 1 TOP: 26.8 General Relativity

76. The gravitational field is equivalent to:
a. the inertial mass.
b. an accelerated frame of reference.
c. an event horizon.
d. a clock running slowly.

ANS: B PTS: 1 DIF: 1 TOP: 26.8 General Relativity

77. A spaceship is moving away from an observer at relativistic speed. Its length at rest is 100 m, but the observer measures its length as 50 m. A time interval of 100 s on the spaceship would be measured by the observer to be which of the following?
a. 50 s
b. 100 s
c. 150 s
d. 200 s

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Questions

78. A spaceship, which has length 50 m and width 10 m when at rest, is moving in a direction along its length at a speed where its length contraction results in a 40-m length measured by a stationary observer. What would the measured width be in this case?
a. between 12 and 13 m
b. 10 m
c. 8 m
d. less than 8 m

ANS: B PTS: 1 DIF: 1 TOP: Conceptual Questions

79. When one compares the relativistic kinetic energy to the classically calculated kinetic energy for a moving object, at which of the speeds listed below does the classical calculation give a greater value than the relativistic calculation?
a. 0.2 c
b. 0.5 c
c. 0.707 c
d. None of the above values will give such a result.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Questions

80. If the nonzero momentum of a particle with mass is doubled, what happens to its total energy?
a. It also doubles.
b. It increases, more than doubling.
c. It stays the same since total energy is a constant for a given particle.
d. It increases, but less than doubling.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Questions

81. Which form of relativity applies for observers who are accelerating?
a. Special relativity applies.
b. General relativity applies.
c. Both special relativity and general relativity apply.
d. Neither applies since the observer must be in an inertial frame to use either one.

ANS: B PTS: 1 DIF: 1 TOP: Conceptual Questions

CHAPTER 27—Quantum Physics

MULTIPLE CHOICE

1. Planck's quantum theory is compatible with the experimental data related to which of the following?
   a. blackbody radiation
   b. the photoelectric effect
   c. line spectra emitted by hydrogen gas
   d. all of the above

   ANS: D PTS: 1 DIF: 1
   TOP: 27.1 Blackbody Radiation and Planck's Hypothesis

2. As the temperature of a radiation emitting blackbody becomes higher, what happens to the peak wavelength of the radiation?
   a. increases
   b. decreases
   c. remains constant
   d. is directly proportional to temperature

   ANS: B PTS: 1 DIF: 1
   TOP: 27.1 Blackbody Radiation and Planck's Hypothesis

3. A quantum of radiation has an energy of 2.0 keV. What is its frequency? ($h = 6.63 \times 10^{-34}$ J⋅s and 1 eV $= 1.60 \times 10^{-19}$ J)
   a. 3.2×10^{17} Hz
   b. 4.8×10^{17} Hz
   c. 6.3×10^{17} Hz
   d. 7.3×10^{17} Hz

   ANS: B PTS: 1 DIF: 2
   TOP: 27.1 Blackbody Radiation and Planck's Hypothesis

4. If a quantum of radiation has an energy of 2.0 keV, what is its wavelength? ($h = 6.63 \times 10^{-34}$ J⋅s, 1 eV $= 1.60 \times 10^{-19}$ J, $c = 3.00 \times 10^{8}$ m/s, and 1 nm $= 10^{-9}$ m)
   a. 0.32 nm
   b. 0.41 nm
   c. 0.62 nm
   d. 1.02 nm

   ANS: C PTS: 1 DIF: 2
   TOP: 27.1 Blackbody Radiation and Planck's Hypothesis

5. According to Wien's displacement law, if the absolute temperature of a radiating blackbody is tripled, then the peak wavelength emitted will change by what factor?
   a. 1/3
   b. 1
   c. 3
   d. 9

   ANS: A PTS: 1 DIF: 1
   TOP: 27.1 Blackbody Radiation and Planck's Hypothesis

6. What is the surface temperature of a distant star (which emits light as if it were a blackbody) where the peak wavelength is 480 nm? (Hint: The surface of the human body at 35° C has a peak wavelength of 941 ìm). (1 nm = 10^{-9} m = 10^{-3} ìm)
   a. 4 510 K
   b. 5 100 K
   c. 6 040 K
   d. 6 350 K

   ANS: C PTS: 1 DIF: 2
   TOP: 27.1 Blackbody Radiation and Planck's Hypothesis

7. Classical theories predict that most of the energy from a blackbody should be radiated:
   a. as thermal radiation in the infrared region.
   b. at the wavelength given by Wien's displacement law.
   c. as ultraviolet light.
   d. a blackbody should not radiate.

   ANS: C PTS: 1 DIF: 1
   TOP: 27.1 Blackbody Radiation and Planck's Hypothesis

8. The ultraviolet catastrophe predicts that:
   a. all objects should radiate extreme amounts of ultraviolet light.
   b. as an object gets hotter its light will change from dull red to blue white.
   c. a black body can absorb an infinite amount of radiation if the radiation is in the ultraviolet region.
   d. the radiated energy approaches zero as the wavelength approaches zero.

   ANS: A PTS: 1 DIF: 1
   TOP: 27.1 Blackbody Radiation and Planck's Hypothesis

9. Star A has the peak of its blackbody radiation at $ë_A$. Star B has its peak at $ë_B$, which is one-fourth that of $ë_A$. If Star A's surface temperature is T_A, how does the surface temperature T_B of Star B compare?
   a. $T_B = 16\ T_A$
   b. $T_B = 4\ T_A$
   c. $T_B = T_A/4$
   d. $T_B = T_A/16$

   ANS: B PTS: 1 DIF: 2
   TOP: 27.1 Blackbody Radiation and Planck's Hypothesis

10. If a blackbody is at 2000° C, what will be the peak wavelength emitted?
    a. 1.67 ìm
    b. 1.45 ìm
    c. 1.27 ìm
    d. 580 nm

    ANS: C PTS: 1 DIF: 2
    TOP: 27.1 Blackbody Radiation and Planck's Hypothesis

11. Blue light will not eject electrons from a certain metal; however, which one of the following may possibly eject electrons from that metal?
    a. infrared
    b. ultraviolet
    c. red
    d. green

ANS: B PTS: 1 DIF: 1
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

12. Light of wavelength 6.5×10^{-7} m has an energy of: ($h = 6.63 \times 10^{-34}$ J⋅s, $c = 3.00 \times 10^{8}$ m/s)
a. 3.1×10^{-19} J
b. 3.3×10^{-19} J
c. 1.5×10^{-19} J
d. 1.7×10^{-19} J

ANS: A PTS: 1 DIF: 2
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

13. If a monochromatic light beam with quantum energy value of 3.0 eV incident upon a photocell where the work function of the target metal is 1.60 eV, what is the maximum kinetic energy of ejected electrons?
a. 4.6 eV
b. 4.8 eV
c. 1.4 eV
d. 2.4 eV

ANS: C PTS: 1 DIF: 1
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

14. Which of the following devices represent(s) a practical application of the photoelectric effect?
a. hologram
b. photocell
c. both of the above choices
d. none of the above choices

ANS: B PTS: 1 DIF: 1
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

15. According to Einstein, what is true of the stopping potential for a photoelectric current as the wavelength of incident light becomes shorter?
a. increases
b. decreases
c. remains constant
d. stopping potential is directly proportional to wavelength

ANS: A PTS: 1 DIF: 1
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

16. According to Einstein, as the wavelength of the incident monochromatic light beam becomes shorter, the work function of a target material in a phototube:
a. increases.
b. decreases.
c. remains constant.
d. is directly proportional to wavelength.

ANS: C PTS: 1 DIF: 1
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

17. What is the frequency of monochromatic light where the photon energy is 5.5×10^{-19} J? ($h = 6.63 \times 10^{-34}$ J⋅s)
a. 2.2×10^{14} Hz

b. 4.4×10^{14} Hz
c. 8.3×10^{14} Hz
d. 9.8×10^{14} Hz

ANS: C PTS: 1 DIF: 2
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

18. What is the wavelength of a monochromatic light beam, where the photon energy is 5.00×10^{-19} J? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, and 1 nm = 10^{-9} m)
a. 354 nm
b. 398 nm
c. 414 nm
d. 787 nm

ANS: B PTS: 1 DIF: 2
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

19. What is the wavelength of a monochromatic light beam, where the photon energy is 3.00 eV? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 nm = 10^{-9} m, and 1 eV = 1.6×10^{-19} J)
a. 311 nm
b. 414 nm
c. 622 nm
d. 1 243 nm

ANS: B PTS: 1 DIF: 2
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

20. A monochromatic light beam is incident on a barium target, which has a work function of 2.50 eV. If a stopping potential of 1.0 V is required, what is the light beam photon energy?
a. 1.0 eV
b. 1.5 eV
c. 2.5 eV
d. 3.5 eV

ANS: D PTS: 1 DIF: 1
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

21. A light beam is shining on a metal target that has a work function of 2.20 eV. If a stopping potential of 1.30 V is required, what is the wavelength of the incoming monochromatic light? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.60×10^{-19} J, and 1 nm = 10^{-9} m)
a. 355 nm
b. 497 nm
c. 744 nm
d. 1 421 nm

ANS: A PTS: 1 DIF: 2
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

22. Light of wavelength 450 nm is incident on a target metal that has a work function of 1.80 eV. What stopping potential is required for this combination in a phototube? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.60×10^{-19} J, and 1 nm = 10^{-9} m)
a. 0.57 V
b. 0.96 V
c. 2.76 V
d. 4.56 V

ANS: B PTS: 1 DIF: 3
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

23. If barium has a work function of 2.60 eV, what is its cutoff wavelength when used as a phototube target? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.60×10^{-19} J and 1 nm = 10^{-9} m)
a. 398 nm
b. 478 nm
c. 497 nm
d. 596 nm

ANS: B PTS: 1 DIF: 3
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

24. What is the energy of a photon whose frequency is 6.0×10^{20} Hz? ($h = 6.63 \times 10^{-34}$ J·s and 1 eV = 1.60×10^{-19} J)
a. 1.6 MeV
b. 2.5 MeV
c. 3.3 MeV
d. 4.8 MeV

ANS: B PTS: 1 DIF: 2
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

25. An ultraviolet light beam having a wavelength of 130 nm is incident on a molybdenum surface with work function of 4.2 eV. What is the stopping potential? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.6×10^{-19} J, and 1 nm = 10^{-9} m)
a. 1.3 V
b. 3.5 V
c. 5.4 V
d. 11.9 V

ANS: C PTS: 1 DIF: 2
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

26. Blue light (λ = 460 nm) is incident on a piece of potassium (ϕ = 2.20 eV). What is the maximum kinetic energy of the ejected photoelectrons? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.60×10^{-19} J, and 1 nm = 10^{-9} m)
a. 1.0 eV
b. 0.50 eV
c. 0.25 eV
d. 4.9 eV

ANS: B PTS: 1 DIF: 2
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

27. Light of wavelength 480 nm is incident on a metallic surface with a resultant photoelectric stopping potential of 0.55 V. What is the work function of the metal? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.60×10^{-19} J, and 1 nm = 10^{-9} m)
a. 2.04 eV
b. 3.19 eV
c. 2.59 eV
d. 0.55 eV

ANS: A PTS: 1 DIF: 2

TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

28. Which of the following statements best describes the relation between the quantum theory and the photoelectric effect experiment?
    a. Quantum theory explains the photoelectric effect.
    b. The photoelectric effect contradicts quantum theory.
    c. Quantum theory has no bearing on the photoelectric effect.
    d. The photoelectric effect explains quantum theory.

ANS: A PTS: 1 DIF: 1
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

29. A sodium vapor lamp has a power output of 300 W. If 590 nm is the average wavelength of the source, about how many photons are emitted per second? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, and 1 nm = 10^{-9} m)
    a. 10^{17}
    b. 10^{21}
    c. 10^{25}
    d. 10^{29}

ANS: B PTS: 1 DIF: 2
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

30. Of the following photons, which has the highest energy?
    a. infrared
    b. microwave
    c. visible
    d. ultraviolet

ANS: D PTS: 1 DIF: 1
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

31. According to Einstein, increasing the brightness of a beam of light without changing its color will increase:
    a. the number of photons.
    b. the energy of each photon.
    c. the speed of the photons.
    d. the frequency of the photons.

ANS: A PTS: 1 DIF: 1
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

32. A photon absorbed by an electron will give up more energy to the electron if the photon:
    a. is not spread out over many electrons.
    b. is moving faster.
    c. is moving slower.
    d. has a higher frequency.

ANS: D PTS: 1 DIF: 1
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

33. Which change will not change the kinetic energy of the most energetic electrons emitted in the photoelectric effect?
    a. changing the brightness of the light
    b. changing the frequency of the light

c. changing the metal the light is hitting
d. All of the above will change the electron's kinetic energy.

ANS: A PTS: 1 DIF: 2
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

34. A helium-neon laser emits red light having a wavelength of 632.8 nm and a power of 0.50 mW. How many photons are emitted each second? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, and 1 nm = 10^{-9} m)
a. 1.6×10^{15}
b. 3.3×10^{16}
c. 4.8×10^{17}
d. 2.6×10^{18}

ANS: A PTS: 1 DIF: 2
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

35. How much energy (in eV) does a photon of red light (λ = 700 nm) have? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.60×10^{-19} J, and 1 nm = 10^{-9} m)
a. 3.11 eV
b. 2.26 eV
c. 1.78 eV
d. 1.24 eV

ANS: C PTS: 1 DIF: 2
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

36. What is the maximum velocity of a photoelectron emitted from a surface with work function 5.00 eV when illuminated by 200 nm ultraviolet light? ($m_{\text{electron}} = 9.11 \times 10^{-31}$ kg, $h = 6.63 \times 10^{-34}$ J·s, 1 eV = 1.60×10^{-19} J, and 1 nm = 10^{-9} m)
a. 800 000 m/s
b. 653 000 m/s
c. 431 000 m/s
d. 212 000 m/s

ANS: B PTS: 1 DIF: 3
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

37. Of the following energies for photons, which is the least energy that could result in photoelectron production if the work function is 3.00 eV?
a. 1.50 eV
b. 2.90 eV
c. 3.50 eV
d. 6.01 eV

ANS: C PTS: 1 DIF: 1
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

38. Who was the first to successfully explain the photoelectric effect?
a. Planck
b. Young
c. Bohr
d. Einstein

ANS: D PTS: 1 DIF: 1
TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

39. Sources of red, blue, and yellow light each emit light with a power of 50 mW. Which source emits more photons per second?
   a. the red source
   b. the blue source
   c. the yellow source
   d. They all emit the same number per second.

   ANS: A PTS: 1 DIF: 1
   TOP: 27.2 The Photoelectric Effect and the Particle Theory of Light

40. What is the minimum x-ray wavelength produced when electrons are accelerated through a potential of 50 000 V? ($h = 6.63 \times 10^{-34}$ J⋅s, $c = 3.00 \times 10^{8}$ m/s, and 1 eV = 1.60×10^{-19} J)
   a. 12.4×10^{-12} m
   b. 16.5×10^{-12} m
   c. 19.8×10^{-12} m
   d. 24.9×10^{-12} m

   ANS: D PTS: 1 DIF: 2 TOP: 27.3 X-Rays

41. If the minimum x-ray wavelength produced is 13.5×10^{-12} m, through what potential are the electrons accelerated in order to generate this radiation? ($h = 6.63 \times 10^{-34}$ J⋅s, $c = 3.00 \times 10^{8}$ m/s, and 1 eV = 1.60×10^{-19} J)
   a. 33 300 V
   b. 46 200 V
   c. 75 000 V
   d. 92 100 V

   ANS: D PTS: 1 DIF: 2 TOP: 27.3 X-Rays

42. X-ray production occurs in which process?
   a. photons hitting a metal, emitting electrons
   b. electrons hitting a metal, emitting photons
   c. photons hitting a metal, emitting x-rays
   d. electrons hitting a metal and scattering elastically

   ANS: B PTS: 1 DIF: 1 TOP: 27.3 X-Rays

43. Changing the accelerating voltage of an x-ray machine without changing the target material must change:
   a. the work function of the material.
   b. the wavelength of all the x-rays produced.
   c. the wavelength of the minimum wavelength x-ray that will be produced.
   d. Both b and c are correct.

   ANS: C PTS: 1 DIF: 1 TOP: 27.3 X-Rays

44. What is the highest frequency of the photons produced by a 90-kV x-ray machine? ($h = 6.63 \times 10^{-34}$ J⋅s)
   a. 1.2×10^{19} Hz
   b. 1.1×10^{19} Hz
   c. 2.4×10^{19} Hz
   d. 2.2×10^{19} Hz

   ANS: D PTS: 1 DIF: 2 TOP: 27.3 X-Rays

45. If an x-ray machine were designed to operate at two separate accelerating voltages, one double the other, how would the shortest wavelength, ë$_{min,hv}$, and the maximum frequency, $f_{max,hv}$, at the higher voltage compare to those (ë$_{min,lv}$, $f_{max,lv}$) at the lower voltage?
ë$_{min,hv}$/ ë$_{min,lv}$ = ________, $f_{max,hv}$/ $f_{max,lv}$ =________:
a. 2, 2.
b. 2, 1/2.
c. 1/2, 2.
d. 1/2, 1/2.

ANS: C PTS: 1 DIF: 2 TOP: 27.3 X-Rays

46. The spacing between atoms in KCl crystal is 3.1 ´ 10^{-10} m. At what angle from the surface will a beam of 3.14 ´ 10^{-11} m x-rays be constructively scattered?
a. 57°
b. 2.9°
c. 90°
d. 10°

ANS: B PTS: 1 DIF: 2
TOP: 27.4 Diffraction of X-Rays by Crystals

47. An important use of x-ray diffraction was:
a. the observation of Compton scattering.
b. determining the structure of the DNA molecule.
c. production of positrons.
d. observation of the photoelectric effect.

ANS: B PTS: 1 DIF: 1
TOP: 27.4 Diffraction of X-Rays by Crystals

48. In an x-ray diffraction experiment, using x-rays of wavelength l = 0.500 ´ 10^{-10} m, a first-order maximum occurred at 5.00° off the crystal plane. Find the distance d between crystal planes.
a. 2.87 ´ 10^{-10} m
b. 1.36 ´ 10^{-10} m
c. 6.24 ´ 10^{-9} m
d. 1.93 ´ 10^{-9} m

ANS: A PTS: 1 DIF: 2
TOP: 27.4 Diffraction of X-Rays by Crystals

49. Bragg reflection results in a first-order maximum at 14.2°. In this case, at what angle would the second-order maximum occur?
a. 7.1°
b. 14.2°
c. 28.4°
d. 29.4°

ANS: D PTS: 1 DIF: 2
TOP: 27.4 Diffraction of X-Rays by Crystals

50. Who conceived the idea of using a crystal for observing diffraction of x-rays?
a. Roentgen
b. von Laue
c. W. L. Bragg

d. W. H. Bragg

ANS: B PTS: 1 DIF: 1
TOP: 27.4 Diffraction of X-Rays by Crystals

51. In Bragg’s law, 2*d* sin *è* = *më*, how is *è* measured?
a. from the reflecting crystal plane
b. from the normal to the reflecting crystal plane
c. from the direction of the incident beam
d. from the normal to the direction of the incident beam

ANS: A PTS: 1 DIF: 1
TOP: 27.4 Diffraction of X-Rays by Crystals

52. Rosalind Franklin was:
a. the maiden name of the wife of a president.
b. the producer of the x-ray diffraction photographs that led to the DNA structure.
c. the person who discovered that salt forms a crystal.
d. the discoverer of x-rays.

ANS: B PTS: 1 DIF: 1
TOP: 27.4 Diffraction of X-Rays by Crystals

53. The Compton experiment demonstrated which of the following when an x-ray photon collides with an electron?
a. Momentum is conserved.
b. Energy is conserved.
c. Momentum and energy are both conserved.
d. Wavelength of scattered photon equals that of incident photon.

ANS: C PTS: 1 DIF: 1 TOP: 27.5 The Compton Effect

54. X-rays of wavelength of 0.065 0 nm undergo Compton scattering from free electrons in carbon. What is the wavelength of photons scattered at 90.0° relative to the incident beam? (*h* = 6.63 ´ 10^{-34} J×s, m_e = 9.11 ´ 10^{-31} kg, *c* = 3.00 ´ 10^{8} m/s, and 1 nm = 10^{-9} m)
a. 0.002 4 nm
b. 0.067 4 nm
c. 0.068 7 nm
d. 0.062 6 nm

ANS: B PTS: 1 DIF: 2 TOP: 27.5 The Compton Effect

55. In regard to the Compton scattering experiment with x-rays incident upon a carbon block, as the scattering angle becomes larger, what happens to the magnitude of difference between the incident and scattered wavelengths?
a. increases
b. decreases
c. remains constant
d. difference is maximum at a 45° angle of scatter

ANS: A PTS: 1 DIF: 2 TOP: 27.5 The Compton Effect

56. Which process cannot occur if only one photon is involved?
a. Compton effect
b. pair production
c. the photoelectric effect

d. x-ray production

ANS: A PTS: 1 DIF: 2 TOP: 27.5 The Compton Effect

57. What is the energy of a photon with the Compton wavelength (0.002 43 nm)? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, and 1 eV = 1.60×10^{-19} J)
a. 1.02×10^{6} eV
b. 5.12×10^{5} eV
c. 2.46×10^{-13} eV
d. 8.19×10^{-14} eV

ANS: B PTS: 1 DIF: 2 TOP: 27.5 The Compton Effect

58. In the Compton effect, what is the greatest change in wavelength that can occur? ($h = 6.63 \times 10^{-34}$ J·s, $m_{electron} = 9.11 \times 10^{-31}$ kg, and $c = 3.00 \times 10^{8}$ m/s)
a. 2.43×10^{-12} m
b. 4.85×10^{-12} m
c. equal to the incident wavelength
d. infinite

ANS: B PTS: 1 DIF: 3 TOP: 27.5 The Compton Effect

59. According to the de Broglie hypothesis, which of the following statements is applicable to the wavelength of a moving particle?
a. directly proportional to its energy
b. directly proportional to its momentum
c. inversely proportional to its energy
d. inversely proportional to its momentum

ANS: D PTS: 1 DIF: 1
TOP: 27.6 The Dual Nature of Light and Matter

60. According to de Broglie, as the momentum of a moving particle is tripled, the corresponding wavelength changes by what factor?
a. 1/9
b. 1/3
c. 3
d. 9

ANS: B PTS: 1 DIF: 1
TOP: 27.6 The Dual Nature of Light and Matter

61. What is the de Broglie wavelength for a proton ($m = 1.67 \times 10^{-27}$ kg) moving at a speed of 6.0×10^{6} m/s? ($h = 6.63 \times 10^{-34}$ J·s)
a. 2.0×10^{-13} m
b. 0.33×10^{-13} m
c. 1.3×10^{-13} m
d. 0.66×10^{-13} m

ANS: D PTS: 1 DIF: 2
TOP: 27.6 The Dual Nature of Light and Matter

62. The de Broglie wavelength of a 0.060 kg golf ball is 4.28×10^{-34} m. What is its speed? ($h = 6.63 \times 10^{-34}$ J·s)
a. 15 m/s

b. 26 m/s
c. 31 m/s
d. 48 m/s

ANS: B PTS: 1 DIF: 2
TOP: 27.6 The Dual Nature of Light and Matter

63. The electron microscope's main advantage over the optical microscope is which of the following?
a. greater ease of portability
b. dispenses with need for a lens
c. higher power lens used
d. higher resolution possible

ANS: D PTS: 1 DIF: 1
TOP: 27.6 The Dual Nature of Light and Matter

64. Starting from rest, an electron accelerates through a potential difference of 40 V. What is its de Broglie wavelength? ($h = 6.63 \times 10^{-34}$ J×s, $m_e = 9.11 \times 10^{-31}$ kg, and 1 eV = 1.60×10^{-19} J)
a. 1.1×10^{-10} m
b. 1.5×10^{-10} m
c. 1.9×10^{-10} m
d. 2.3×10^{-10} m

ANS: C PTS: 1 DIF: 3
TOP: 27.6 The Dual Nature of Light and Matter

65. If an electron has a measured wavelength of 0.850×10^{-10} m, what is its kinetic energy? ($h = 6.63 \times 10^{-34}$ J×s, 1 eV = 1.6×10^{-19} J, and $m_e = 9.11 \times 10^{-31}$ kg)
a. 55.0 eV
b. 104 eV
c. 147 eV
d. 209 eV

ANS: D PTS: 1 DIF: 3
TOP: 27.6 The Dual Nature of Light and Matter

66. Due to the dual nature of light and matter, either can act in an experiment as if it is a wave or a particle. In which experiment is the wave aspect exhibited for matter?
a. the Davisson and Germer experiment
b. the photoelectric effect
c. pair production
d. Compton scattering

ANS: A PTS: 1 DIF: 1
TOP: 27.6 The Dual Nature of Light and Matter

67. An electron microscope operates with electrons of kinetic energy 50.0 keV. What is the wavelength of these electrons? Assume this speed is not relativistic. ($h = 6.63 \times 10^{-34}$ J×s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.60×10^{-19} J, and $m_e = 9.11 \times 10^{-31}$ kg)
a. 9.28×10^{-10} m
b. 7.14×10^{-11} m
c. 5.49×10^{-12} m
d. 2.75×10^{-13} m

ANS: C PTS: 1 DIF: 2

TOP: 27.6 The Dual Nature of Light and Matter

68. The “seeing” ability or resolution of radiation is determined by its wavelength. If the size of an atom is approximately 10^{-10} m, how fast must an electron travel to have a wavelength smaller than that of an atom? ($m_e = 9.11 \times 10^{-31}$ kg and $h = 6.63 \times 10^{-34}$ J·s)
   a. 7.3×10^{6} m/s
   b. 3.4×10^{6} m/s
   c. 1.0×10^{6} m/s
   d. 5.4×10^{5} m/s

   ANS: A PTS: 1 DIF: 3
   TOP: 27.6 The Dual Nature of Light and Matter

69. That light has a dual nature is referring to light:
   a. having high- or low-energy photons.
   b. acting as waves and particles.
   c. having energy and momentum.
   d. undergoing pair production.

   ANS: B PTS: 1 DIF: 1
   TOP: 27.6 The Dual Nature of Light and Matter

70. What is the energy of a photon that has the same wavelength as a 12-eV electron? ($h = 6.63 \times 10^{-34}$ J·s)
   a. $5.6 \times$ 10-16 eV
   b. 12 eV
   c. 24 eV
   d. 3.5 keV

   ANS: D PTS: 1 DIF: 3
   TOP: 27.6 The Dual Nature of Light and Matter

71. If the measured momentum of an electron is 3.20×10^{-27} kg·m/s with an uncertainty of 1.6×10^{-29} kg·m/s, what is the minimum uncertainty in the position? ($h = 6.63 \times 10^{-34}$ J·s)
   a. 2.6×10^{-8} m
   b. 3.3×10^{-6} m
   c. 0.63×10^{-4} m
   d. 1.1×10^{-3} m

   ANS: B PTS: 1 DIF: 2
   TOP: 27.7 The Wave Function | 27.8 The Uncertainty Principle

72. According to Heisenberg, as the uncertainty in the measurement of a particle’s momentum is reduced by a factor of 2, by what factor is the uncertainty in that same particle’s position changed?
   a. 1/2
   b. 1
   c. 2
   d. 4

   ANS: C PTS: 1 DIF: 1
   TOP: 27.7 The Wave Function | 27.8 The Uncertainty Principle

73. The wave function as derived in Schrödinger’s equation is best described as being a measure of which of the following?
   a. photon beam frequency

b. photon wavelength
c. particle wavelength
d. probability

ANS: D PTS: 1 DIF: 1
TOP: 27.7 The Wave Function | 27.8 The Uncertainty Principle

74. A proton (mass = 1.67×10^{-27} kg) has a kinetic energy of 1.00 MeV. If its momentum is measured with an uncertainty of 1.00%, what is the minimum uncertainty in its position? ($h = 6.63 \times 10^{-34}$ J×s and 1 eV = 1.6×10^{-19} J)
a. 9.08×10^{-13} m
b. 2.28×10^{-13} m
c. 9.08×10^{-14} m
d. 5.64×10^{-14} m

ANS: B PTS: 1 DIF: 3
TOP: 27.7 The Wave Function | 27.8 The Uncertainty Principle

75. The uncertainty principle was derived by whom?
a. Schrödinger
b. Heisenberg
c. de Broglie
d. Compton

ANS: B PTS: 1 DIF: 1
TOP: 27.7 The Wave Function | 27.8 The Uncertainty Principle

76. The Heisenberg uncertainty principle places restriction on the precision of simultaneously measuring both position and momentum. This principle can also be applied to the simultaneous measurement of two other variables, which are:
a. force and color.
b. energy and time interval.
c. mass and charge.
d. torque and frequency.

ANS: B PTS: 1 DIF: 1
TOP: 27.7 The Wave Function | 27.8 The Uncertainty Principle

77. Of photons of red, yellow, light, and blue light, which photons have the greatest energy?
a. red
b. yellow
c. green
d. blue

ANS: D PTS: 1 DIF: 1 TOP: Conceptual Questions

78. Surface #1 has work function , and when bombarded with photons of wavelength emits photoelectrons with maximum energy . Surface #2 has work function , and when bombarded by photons of wavelength emits photoelectrons with maximum energy . If , then which of the following must be true?
a.
b.
c. for surface #1 is greater than for surface #2.
d. for surface #2 is greater than for surface #1.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Questions

79. The Compton wavelength, $h/m_e c$, equals 0.002 43 nm. In Compton scattering, what is the greatest shift, Ä*ë*, in wavelength that can occur?
 a. Ä*ë* $> 2\ h/m_e c$
 b. Ä*ë* $= 2\ h/m_e c$
 c. Ä*ë* $= h/m_e c$
 d. $< h/m_e c$

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Questions

80. If a ^{1}H nucleus, a ^{2}H nucleus, and a ^{3}H nucleus all had the same momentum, which one has the greatest de Broglie wavelength?
 a. ^{1}H
 b. ^{2}H
 c. ^{3}H
 d. All three have the same de Broglie wavelength.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Questions

81. A proton and an electron each have the same de Broglie wavelength. (i) Which has the greater speed, and (ii) which has the greater kinetic energy?
 a. (i) the electron, (ii) Either one can have the greater kinetic energy.
 b. (i) the proton, (ii) Either one can have the greater kinetic energy.
 c. (i) the electron, (ii) the electron
 d. (i) the proton, (ii) the proton

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Questions

CHAPTER 28—Atomic Physics

MULTIPLE CHOICE

1. When a wire carries high current causing it to glow, it will emit which type of spectrum?
   a. line emission
   b. line absorption
   c. continuous
   d. monochromatic

   ANS: C PTS: 1 DIF: 1
   TOP: 28.1 Early Models of the Atom | 28.2 Atomic Spectra

2. When a high voltage is applied to a low-pressure gas causing it to glow, it will emit which type of spectrum?
   a. line emission
   b. line absorption
   c. continuous
   d. monochromatic

   ANS: A PTS: 1 DIF: 1
   TOP: 28.1 Early Models of the Atom | 28.2 Atomic Spectra

3. When a cool gas is placed between a glowing wire filament source and a diffraction grating, the resultant spectrum from the grating is which one of the following?
   a. line emission
   b. line absorption
   c. continuous
   d. monochromatic

   ANS: B PTS: 1 DIF: 1
   TOP: 28.1 Early Models of the Atom | 28.2 Atomic Spectra

4. What is the wavelength of the line in the Balmer series of hydrogen that is comprised of transitions from the n = 4 to the n = 2 level? ($R = 1.097 \times 10^{7}\ \text{m}^{-1}$ and 1 nm = 10^{-9} m)
   a. 380 nm
   b. 486 nm
   c. 523 nm
   d. 630 nm

   ANS: B PTS: 1 DIF: 2
   TOP: 28.1 Early Models of the Atom | 28.2 Atomic Spectra

5. An alpha particle is:
   a. a neutral helium atom.
   b. any positively charged nucleus.
   c. an x-ray.
   d. None of the above.

   ANS: D PTS: 1 DIF: 1
   TOP: 28.1 Early Models of the Atom | 28.2 Atomic Spectra

6. According to the Rutherford model of the atom, most of the volume of an atom:
   a. is empty space.

b. was occupied by the nucleus.
c. contained positive charges.
d. excluded electrons.

ANS: A PTS: 1 DIF: 1
TOP: 28.1 Early Models of the Atom | 28.2 Atomic Spectra

7. In contrast to Thomson’s model of the atom, Rutherford’s model:
a. had the positive charge spread uniformly through the atom.
b. had the positive charge concentrated in a small region.
c. was first to explain atoms emitting discrete frequencies.
d. eliminated radiation from accelerating charges.

ANS: B PTS: 1 DIF: 1
TOP: 28.1 Early Models of the Atom | 28.2 Atomic Spectra

8. The Lyman series of hydrogen is made up of those transitions made from higher levels to $n = 1$. If the first line in this series has a wavelength of 122 nm, what is the wavelength of the second line?
a. 49 nm
b. 103 nm
c. 364 nm
d. 486 nm

ANS: B PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

9. The ionization energy for the hydrogen atom is 13.6 eV. What is the energy of a photon that is emitted as a hydrogen atom makes a transition between the $n = 4$ and $n = 2$ states?
a. 0.85 eV
b. 2.55 eV
c. 3.40 eV
d. 6.80 eV

ANS: B PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

10. Of the various wavelengths emitted from a hydrogen gas discharge tube, those that are associated with transitions from higher levels down to the $n = 1$ level produce which of the following?
a. infrared
b. visible
c. mixture of infrared and visible
d. ultraviolet

ANS: D PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

11. Of the various wavelengths emitted from a hydrogen gas discharge tube, those associated with transitions from higher levels down to the $n = 2$ level produce which of the following?
a. infrared
b. visible
c. mixture of visible and ultraviolet
d. ultraviolet

ANS: C PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

12. What is the wavelength of the line in the Paschen series of hydrogen that is comprised of transitions from the $n = 4$ to the $n = 3$ levels? ($R = 1.097 \times 10^{7}$ m^{-1} and 1 nm = 10^{-9} m)
a. 1 282 nm
b. 1 875 nm

c. 1 923 nm
d. 2 251 nm

ANS: B PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

13. The ionization energy of the hydrogen atom is 13.6 eV. What is the energy of the *n* = 5 state?
a. 2.72 eV
b. –2.72 eV
c. 0.544 eV
d. –0.544 eV

ANS: D PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

14. The ionization energy of the hydrogen atom is 13.6 eV. What is the energy of a photon emitted corresponding to a transition from the *n* = 5 to *n* = 2 state?
a. 2.9 eV
b. 3.5 eV
c. 4.0 eV
d. 7.9 eV

ANS: A PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

15. If the radius of the electron orbit in the *n* = 1 level of the hydrogen atoms is 0.052 9 nm, what is its radius for the *n* = 5 level? (Assume the Bohr model is valid).
a. 0.106 nm
b. 0.265 nm
c. 0.846 nm
d. 1.32 nm

ANS: D PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

16. The Paschen series of hydrogen corresponds to electron transitions from higher levels to *n* = 3. What is the shortest wavelength in that series? ($R = 1.097 \times 10^{7}$ m^{-1} and 1 nm = 10^{-9} m)
a. 365 nm
b. 820 nm
c. 1 094 nm
d. 313 nm

ANS: B PTS: 1 DIF: 3 TOP: 28.3 The Bohr Model

17. The Lyman series of hydrogen corresponds to electron transitions from higher levels to *n* = 1. What is the longest wavelength in that series? ($R = 1.097 \times 10^{7}$ m^{-1} and 1 nm = 10^{-9} m)
a. 91.4 nm
b. 122 nm
c. 273 nm
d. 456 nm

ANS: B PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

18. The ionization energy of the hydrogen atom is 13.6 eV. What is the wavelength of a photon having this much energy? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.6×10^{-19} J, and 1 nm = 10^{-9} m)
a. 91.4 nm
b. 136 nm
c. 273 nm
d. 360 nm

ANS: A PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

19. The four visible colors emitted by hydrogen atoms are produced by electrons:
    a. that start in the ground state.
    b. that end up in the ground state.
    c. that start in the level with $n = 2$.
    d. that end up in the level with $n = 2$.

ANS: D PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

20. The visible lines from hydrogen are all members of the:
    a. Lyman series.
    b. Balmer series.
    c. Paschen series.
    d. Brackett series.

ANS: B PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

21. The emission of a line from the Balmer series is followed almost immediately by the emission of a line from the Lyman series. This will be true for:
    a. only the first line of the Balmer series and the first line of the Lyman series.
    b. all the lines of the Balmer series followed by only the first line of the Lyman series.
    c. only the first line of the Balmer series followed by any of the lines of the Lyman series.
    d. all the lines of the Balmer series followed by any of the lines of the Lyman series.

ANS: B PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

22. The Bohr theory does not predict that:
    a. hydrogen atoms will give off the lines from the Balmer series.
    b. the ground state of hydrogen is spherically symmetric.
    c. it requires 13.6 eV to ionize hydrogen.
    d. the approximate radius of a hydrogen atom is $5.3 ´ 10^{-11}$ m.

ANS: B PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

23. In the Bohr model of the atom, the orbits where electrons move fastest:
    a. have the lowest energy.
    b. have the highest energy.
    c. have the biggest radius.
    d. have the greatest angular momentum.

ANS: A PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

24. In the hydrogen atom the potential energy is negative, but the absolute value of the potential energy:
    a. is equal to the kinetic energy of the electron.
    b. is twice the kinetic energy of the electron.
    c. is half the kinetic energy of the electron.
    d. is equal to n^2 times the kinetic energy of the electron.

ANS: B PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

25. When an electron moves from the $n = 1$ to the $n = 2$ orbit:
    a. both the radius and the angular momentum double.
    b. both the radius and the angular momentum increase by a factor of 4.
    c. the radius doubles and the angular momentum increases by a factor of 4.
    d. the radius increases by a factor of 4, and the angular momentum doubles.

ANS: D PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

26. A muon behaves like an electron except that it has 207 times the mass of the electron. If a muon were bound to a proton, how would the energy levels in the Bohr model compare to those for a bound electron?
a. They would be the same.
b. They would be $(207)^2$ times as much as those for the electron.
c. They would be 207 times as much as those for the electron.
d. They would be (1/207) times as much as those for the electron.

ANS: C PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

27. A hydrogen atom in the ground state absorbs a 12.75-eV photon. To what level is the electron promoted? (The ionization energy of hydrogen is 13.6-eV).
a. $n = 2$
b. $n = 3$
c. $n = 4$
d. $n = 5$

ANS: C PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

28. A photon is emitted from a hydrogen atom that undergoes a transition from $n = 3$ to $n = 2$. Calculate the energy and wavelength of the photon. (The ionization energy of hydrogen is 13.6 eV, and $h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.60×10^{-19} J, and 1 nm = 10^{-9} m)
a. 1.89 eV, 658 nm
b. 2.21 eV, 563 nm
c. 1.89 eV, 460 nm
d. 3.19 eV, 658 nm

ANS: A PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

29. The speed of the electron in the Bohr theory of hydrogen is:
a. proportional to n.
b. proportional to n^2.
c. inversely proportional to n.
d. inversely proportional to n^2.

ANS: C PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

30. Which of the following transitions in hydrogen from an initial state (n_i) to a final state (n_f) results in the most energy emitted?
a. $n_i = 80$, $n_f = 2$
b. $n_i = 3$, $n_f = 95$
c. $n_i = 2$, $n_f = 1$
d. $n_i = 1$, $n_f = 3$

ANS: C PTS: 1 DIF: 3 TOP: 28.3 The Bohr Model

31. The Bohr model of the hydrogen atom accounts for which quantum number?
a. principal
b. orbital
c. orbital magnetic
d. All of the above.

ANS: A PTS: 1 DIF: 1 TOP: 28.3 The Bohr Model

32. Using quantum theories to study the hydrogen atom allows the prediction and experimental verification of many data about atoms such as He^{+} and Li^{2+}. Some quantities that can successfully be predicted about He^{+} and Li^{2+} in this manner are:
a. the color of the light they will emit.
b. their mass.
c. their abundance in nature.
d. All of the above.

ANS: A PTS: 1 DIF: 1 TOP: 28.3 The Bohr Model

33. In an analysis relating Bohr's theory to the de Broglie wavelength of electrons, when an electron moves from the $n = 1$ level to the $n = 2$ level, the circumference for its orbit becomes 4 times greater. This occurs because:
a. there are four times as many wavelengths in the new orbit.
b. the wavelength of the electron becomes four times as long.
c. there are twice as many wavelengths, and each wavelength is twice as long.
d. the electron is moving four times as fast.

ANS: C PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

34. What is the energy needed to change an He^{+} ion into an He^{++} ion? (The ionization energy of hydrogen is 13.6 eV).
a. 13.6 eV
b. 54.4 eV
c. 92.9 eV
d. 112.4 eV

ANS: B PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

35. An energy of 122 eV is needed to remove an electron from the $n = 1$ state of a lithium atom. If a single photon accomplishes this task, what wavelength is needed? ($h = 6.63 \times 10^{-34}$ J×s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.6×10^{-19} J, and 1 nm = 10^{-9} m)
a. 13.2 nm
b. 12.2 nm
c. 11.2 nm
d. 10.2 nm

ANS: D PTS: 1 DIF: 2 TOP: 28.3 The Bohr Model

36. The quantum mechanical model of the hydrogen atom requires that if the principal quantum number is 4, there will be how many different permitted orbital quantum number(s)?
a. one
b. two
c. four
d. five

ANS: C PTS: 1 DIF: 2
TOP: 28.4 Quantum Mechanics and the Hydrogen Atom

37. The quantum mechanical model of the hydrogen atom requires that if the orbital quantum number of the hydrogen atom is 4, there will be how many permitted orbital magnetic quantum numbers?
a. three
b. four
c. seven

d. nine

ANS: D PTS: 1 DIF: 2
TOP: 28.4 Quantum Mechanics and the Hydrogen Atom

38. The quantum mechanical model of the hydrogen atom requires that if the orbital magnetic quantum number is 3, there will be how many permitted spin magnetic quantum numbers?
a. two
b. three
c. four
d. seven

ANS: A PTS: 1 DIF: 2
TOP: 28.4 Quantum Mechanics and the Hydrogen Atom

39. How many possible substates are available in a hydrogen atom where the principal quantum number is 3?
a. 6
b. 9
c. 18
d. 36

ANS: C PTS: 1 DIF: 3
TOP: 28.4 Quantum Mechanics and the Hydrogen Atom

40. The quantum mechanical model of the hydrogen atom requires that if the principal quantum number = 5, there will be how many permitted orbital quantum numbers?
a. 3
b. 5
c. 10
d. 25

ANS: B PTS: 1 DIF: 2
TOP: 28.4 Quantum Mechanics and the Hydrogen Atom

41. The quantum mechanical model of the hydrogen atom requires that if the orbital quantum number = 7, there will be how many permitted orbital magnetic quantum numbers allowed?
a. 6
b. 7
c. 11
d. 15

ANS: D PTS: 1 DIF: 2
TOP: 28.4 Quantum Mechanics and the Hydrogen Atom

42. The quantum mechanical model of the hydrogen atom requires that if the principal quantum number = 4, there will be permitted how many orbital magnetic quantum numbers?
a. 4
b. 6
c. 8
d. 7

ANS: D PTS: 1 DIF: 3
TOP: 28.4 Quantum Mechanics and the Hydrogen Atom

43. The quantum mechanical model of the hydrogen atom requires that if the orbital quantum number = 5, there are permitted how many possible substates?
a. 8
b. 18
c. 22
d. 32

ANS: C PTS: 1 DIF: 3
TOP: 28.4 Quantum Mechanics and the Hydrogen Atom

44. If the principal quantum number for hydrogen is 5, which one of the following is not a permitted orbital magnetic quantum number for that atom?
a. 6
b. - 2
c. 0
d. 3

ANS: A PTS: 1 DIF: 1
TOP: 28.4 Quantum Mechanics and the Hydrogen Atom

45. The quantum number that can have only two possible values is the:
a. principal quantum number.
b. orbital quantum number.
c. orbital magnetic quantum number.
d. spin magnetic quantum number.

ANS: D PTS: 1 DIF: 1
TOP: 28.4 Quantum Mechanics and the Hydrogen Atom

46. The quantum mechanical model of the hydrogen atom suggests a visual picture of the electron as which of the following?
a. raisin in pudding
b. probability cloud
c. planetary orbiting body
d. light quantum

ANS: B PTS: 1 DIF: 1
TOP: 28.4 Quantum Mechanics and the Hydrogen Atom

47. The quantity _________, where Ø is the wave function, represents the probability per unit volume of finding an electron in that volume.
a. $Ø^{1/2}$
b. Ø
c. $Ø^{3/2}$
d. $Ø^2$

ANS: D PTS: 1 DIF: 1
TOP: 28.4 Quantum Mechanics and the Hydrogen Atom

48. In a plot of probability of finding the electron in the hydrogen ground state versus the distance from the nucleus, the maximum occurs:
a. at a_0, the first Bohr radius.
b. at slightly less than a_0.
c. at slightly more than a_0.
d. at 2 a_0.

ANS: A PTS: 1 DIF: 1
TOP: 28.4 Quantum Mechanics and the Hydrogen Atom

49. The restriction that no more than one electron may occupy a given quantum state in an atom was first stated by which of the following scientists?
a. Bohr
b. de Broglie
c. Heisenberg
d. Pauli

ANS: D PTS: 1 DIF: 1
TOP: 28.5 The Exclusion Principle and the Periodic Table

50. How many electrons are in bromine's (atomic number 35) next to outer shell (n = 3)?
a. 2
b. 4
c. 8
d. 18

ANS: D PTS: 1 DIF: 2
TOP: 28.5 The Exclusion Principle and the Periodic Table

51. Imagine that an electron had a spin of 5/2 so that its spin quantum number, m_s, could have the following six values: m_s = +5/2, +3/2, +1/2, -1/2, -3/2, and -5/2. If this were true, the first element with a filled shell would be:
a. He with 2 electrons.
b. Be with 4 electrons.
c. C with 6 electrons.
d. O with 8 electrons.

ANS: C PTS: 1 DIF: 3
TOP: 28.5 The Exclusion Principle and the Periodic Table

52. The ground state electronic configuration for aluminum is $1s^2 2s^2 2p^6 3s^2 3p^1$. In which shell is the last ($3p^1$) electron?
a. K
b. L
c. M
d. N

ANS: C PTS: 1 DIF: 1
TOP: 28.5 The Exclusion Principle and the Periodic Table

53. The ground state electronic configuration for aluminum is $1s^2 2s^2 2p^6 3s^2 3p^1$. What is the orbital quantum number of the last ($3p^1$) electron?
a. 0
b. 1
c. 2
d. 3

ANS: B PTS: 1 DIF: 2
TOP: 28.5 The Exclusion Principle and the Periodic Table

54. The x-rays that occur when a high energy electron beam is incident on a metal target will show what type of spectrum?

a. continuous
b. line
c. continuous spectrum superimposed with a line spectrum
d. absorption

ANS: C PTS: 1 DIF: 1 TOP: 28.6 Characteristic X-Rays

55. If the energy for the ground state level (n = 1) of hydrogen is - 13.6 eV, which of the following gives an approximate value for the energy of an electron of the K shell (n = 1) of the element oxygen for which the atomic number = 8?
a. - 95 eV
b. - 109 eV
c. - 666 eV
d. - 1 100 eV

ANS: C PTS: 1 DIF: 2 TOP: 28.6 Characteristic X-Rays

56. Which of the following demonstrated the relation between the atomic number of a given element and the wavelength of the K-alpha x-ray photon emitted by that element?
a. Bohr
b. Compton
c. Moseley
d. Pauli

ANS: C PTS: 1 DIF: 1 TOP: 28.6 Characteristic X-Rays

57. If a target element with atomic number Z used in the production of x-rays is replaced by another element for which the atomic number = 3Z, by what factor is the wavelength of the K-alpha x-ray line changed?
a. 1/9
b. 1/3
c. 3
d. 9

ANS: A PTS: 1 DIF: 2 TOP: 28.6 Characteristic X-Rays

58. In an x-ray machine, electrons are accelerated and then fired so that they are incident on a metal target. Which part of the process produces the characteristic x-ray spectra?
a. The incident electron loses energy.
b. The incident electron knocks an electron out of one of the metal atoms.
c. A vacancy in an energy level in a metal atom is filled.
d. The incident electron emits an x-ray.

ANS: C PTS: 1 DIF: 2 TOP: 28.6 Characteristic X-Rays

59. Characteristic x-rays are the result of:
a. outer electron transitions.
b. inner electron transitions.
c. nuclear electron states.
d. buckytubes.

ANS: B PTS: 1 DIF: 1 TOP: 28.6 Characteristic X-Rays

60. When a hydrogen atom absorbs a photon that raises it to the n = 4 state, how many different energies are possible for the photon(s) that may be emitted as the atom eventually returns to the ground state?

a. 3
b. 4
c. 5
d. The correct answer is not given.

ANS: C PTS: 1 DIF: 2
TOP: 28.7 Atomic Transitions and Lasers

61. When a hydrogen atom absorbs a photon that raises it to the $n = 4$ state, what is the greatest number of photons that can be emitted by that atom as it returns to the ground state?
a. 3
b. 4
c. 5
d. The correct answer is not given.

ANS: A PTS: 1 DIF: 2
TOP: 28.7 Atomic Transitions and Lasers

62. The stimulated emission of photons from the excited atoms in a gas laser is prompted by which of the following?
a. high voltage
b. high flux of electrons
c. nearby presence of photons of same wavelength as those emitted
d. high temperature

ANS: C PTS: 1 DIF: 1
TOP: 28.7 Atomic Transitions and Lasers

63. The red light from a HeNe laboratory laser results from a transition in Ne. Determine the wavelength of the light given off if the energy difference between states is 1.96 eV. ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.60×10^{-19} J, and 1 nm = 10^{-9} m)
a. 575 nm
b. 601 nm
c. 634 nm
d. 652 nm

ANS: C PTS: 1 DIF: 2
TOP: 28.7 Atomic Transitions and Lasers

64. The wavelength of coherent ruby laser light is 688.3 nm. What energy difference exists between the upper excited state involved and the lower unexcited ground state? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.60×10^{-19} J, and 1 nm = 10^{-9} m)
a. 1.75 eV
b. 1.81 eV
c. 1.86 eV
d. 1.94 eV

ANS: B PTS: 1 DIF: 2
TOP: 28.7 Atomic Transitions and Lasers

65. A ruby laser can deliver an 8.57 J pulse in approximately 50 nanoseconds. The wavelength of the light is 694.4 nm. At least how many atoms within the ruby rod had to be excited to allow this high-energy laser pulse? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.6×10^{-19} J, and 1 nm = 10^{-9} m)
a. 4×10^{18}
b. 8×10^{18}

c. 3×10^{19}
d. 6×10^{20}

ANS: C PTS: 1 DIF: 2
TOP: 28.7 Atomic Transitions and Lasers

66. Which of the following conditions must be satisfied for laser action?
a. A ruby or similar crystalline material must be used.
b. A population inversion must occur.
c. The photons must be red.
d. A binary system must be used.

ANS: B PTS: 1 DIF: 1
TOP: 28.7 Atomic Transitions and Lasers

67. In neon, the 20.66-eV level can undergo lasing action to the 18.70-eV level. What is the energy of the resulting photons?
a. 20.66 eV
b. 18.70 eV
c. 39.36 eV
d. 1.96 eV

ANS: D PTS: 1 DIF: 1
TOP: 28.7 Atomic Transitions and Lasers

68. Consider the hydrogen atom, singly ionized helium atom, and the doubly ionized lithium atom. Arrange these atoms from highest energy ground state to lowest energy ground state.
a. H, He^{+}, Li^{++}
b. Li^{++}, He^{+}, H
c. H, Li^{++}, He^{+}
d. Since each of these atoms has only one electron, they all have the same energy ground state.

ANS: A PTS: 1 DIF: 2 TOP: Conceptual Questions

69. In the n = 4 shell, how many distinct values of are possible?
a. 4
b. 8
c. 9
d. The correct value is not given.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Questions

70. Selenium has atomic number 34. In its ground state, how many electrons are in its n = 2 shell?
a. 2
b. 8
c. 10
d. 16

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Questions

71. If a hydrogen atom, originally in its ground state of energy –13.6 eV, absorbs a photon of energy 15.0 eV, what is the resulting kinetic energy of the electron if the proton has negligible kinetic energy?
a. Such a photon cannot be absorbed in this case.
b. –1.4 eV
c. 1.4 eV

d. 15.0 eV

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Questions

72. For the n = 4 shell, what are the lowest values possible for and respectively?

a. 0, 0
b. –4, –4
c. 0, –3
d. –3, –3

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Questions

CHAPTER 29—Nuclear Physics

MULTIPLE CHOICE

1. The nucleus of an atom is made up of which of the following?
   a. electrons and protons
   b. electrons and neutrons
   c. protons, electrons and neutrons
   d. protons and neutrons

   ANS: D PTS: 1 DIF: 1
   TOP: 29.1 Some Properties of Nuclei

2. The experiment, which gave the first evidence for the existence of the atomic nucleus, involved which of the following?
   a. x-ray scattering
   b. radioactive dating
   c. cosmic ray detection
   d. alpha scattering

   ANS: D PTS: 1 DIF: 1
   TOP: 29.1 Some Properties of Nuclei

3. The atomic number of a given element is equivalent to which of the following?
   a. proton number in the nucleus
   b. neutron number in the nucleus
   c. sum of the protons and neutrons in the nucleus
   d. number of electrons in the outer shells

   ANS: A PTS: 1 DIF: 1
   TOP: 29.1 Some Properties of Nuclei

4. Rutherford’s experiments involving the use of alpha particle beams directed onto thin metal foils demonstrated the existence of which of the following?
   a. neutron
   b. proton
   c. nucleus
   d. positron

   ANS: C PTS: 1 DIF: 1
   TOP: 29.1 Some Properties of Nuclei

5. The atomic mass number of a nucleus is equivalent to which of the following numbers?
   a. number of neutrons present
   b. number of protons present
   c. difference in neutron and proton numbers
   d. sum of neutron and proton numbers

   ANS: D PTS: 1 DIF: 1
   TOP: 29.1 Some Properties of Nuclei

6. The ratio of the numbers of neutrons to protons in the nucleus of naturally occurring isotopes tends to vary with atomic number in what manner?
   a. increases with greater atomic number

b. decreases with greater atomic number
c. is maximum for atomic number = 60
d. remains constant for entire range of atomic numbers

ANS: A PTS: 1 DIF: 1
TOP: 29.1 Some Properties of Nuclei

7. The beta radiation first classified by Rutherford was in fact which of the following?
a. helium nuclei
b. high energy quanta
c. electrons
d. positrons

ANS: C PTS: 1 DIF: 1
TOP: 29.1 Some Properties of Nuclei

8. The alpha radiation first classified by Rutherford was in fact which of the following?
a. helium nuclei
b. high energy quanta
c. electrons
d. positrons

ANS: A PTS: 1 DIF: 1
TOP: 29.1 Some Properties of Nuclei

9. The gamma radiation first classified by Rutherford was in fact which of the following?
a. helium nuclei
b. high energy quanta
c. electrons
d. positrons

ANS: B PTS: 1 DIF: 1
TOP: 29.1 Some Properties of Nuclei

10. The isotope ^{64}Zn has a nuclear radius of 4.8×10^{-15} m. Approximately what is the nuclear radius of the isotope ^{27}Al?
a. 2.0×10^{-15} m
b. 2.7×10^{-15} m
c. 3.6×10^{-15} m
d. 4.0×10^{-15} m

ANS: C PTS: 1 DIF: 2
TOP: 29.1 Some Properties of Nuclei

11. The isotope ^{64}Zn has a nuclear radius of 4.8×10^{-15} m. Which of the following is the mass number of an isotope for which the nuclear radius is 7.2×10^{-15} m?
a. 144
b. 96
c. 125
d. 216

ANS: D PTS: 1 DIF: 2
TOP: 29.1 Some Properties of Nuclei

12. If there are 146 neutrons in ^{238}U, how many neutrons are found in the nucleus of ^{235}U?

a. 141
b. 143
c. 145
d. 147

ANS: B PTS: 1 DIF: 2
TOP: 29.1 Some Properties of Nuclei

13. The mass of ^{12}C is 12 u where 1 u = $1.660\ 559 \times 10^{-27}$ kg. This mass is equal to:
a. the mass of the ^{12}C nucleus.
b. the mass of the ^{12}C nucleus plus 6 electrons.
c. the mass of the ^{12}C nucleus plus 12 electrons.
d. the mass of 6 protons and 6 neutrons.

ANS: B PTS: 1 DIF: 2
TOP: 29.1 Some Properties of Nuclei

14. For every stable nucleus except hydrogen, if the number of nucleons is doubled, the quantity that will change least is the:
a. mass.
b. charge.
c. volume.
d. density.

ANS: D PTS: 1 DIF: 2
TOP: 29.1 Some Properties of Nuclei

15. The molecular mass for chlorine is not an integer multiple of the molecular mass of hydrogen but is about 35.5 times the molecular mass of hydrogen. This is primarily because:
a. the proton and neutron have different masses.
b. there are different isotopes of chlorine.
c. of the binding energy of the chlorine nucleus.
d. the chlorine nucleus has 35.5 nucleons.

ANS: B PTS: 1 DIF: 1
TOP: 29.1 Some Properties of Nuclei

16. Neglecting recoil of the gold nucleus, how much kinetic energy must an alpha particle (charge = $2 \times 1.6 \times 10^{-19}$ C) have to approach to within 1.00×10^{-14} m of a gold nucleus (charge = $79 \times 1.6 \times 10^{-19}$ C)? ($k_e = 8.99 \times 10^9\ N\cdot m^2/C^2$ and 1 MeV = 1.6×10^{-13} J)
a. 11.7 MeV
b. 14.6 MeV
c. 18.2 MeV
d. 22.7 MeV

ANS: D PTS: 1 DIF: 3
TOP: 29.1 Some Properties of Nuclei

17. Certain stars at the end of their lives are thought to collapse combining their protons and electrons together to form a neutron star. Such a star could be thought of as a giant atomic nucleus. If a star of mass equal to that of the sun ($M = 1.99 \times 10^{30}$ kg) collapsed into neutrons ($m_n = 1.67 \times 10^{-27}$ kg), what would be the radius of such a star? (Hint: $r = r_0A^{1/3}$, where $r_0 = 1.20 \times 10^{-15}$ m).
a. 25.4 km
b. 18.7 km
c. 12.7 km

d. 6.40 km

ANS: C PTS: 1 DIF: 3
TOP: 29.1 Some Properties of Nuclei

18. What energy must be added or given off in a reaction where two hydrogen atoms and two neutrons are combined to form a helium atom? (Atomic masses for each: hydrogen, 1.007 825 u; neutron, 1.008 665 u; helium, 4.002 602 u; also, 1 u = 931.5 MeV/c^2)
a. 20.7 MeV added
b. 20.7 MeV given off
c. 28.3 MeV given off
d. 28.3 MeV added

ANS: C PTS: 1 DIF: 3 TOP: 29.2 Binding Energy

19. What is the binding energy per nucleon of ^{197}Au (atomic number = 79)? (The following information regarding atomic masses will be needed: ^{197}Au, 196.966 543 u; hydrogen, 1.007 825 u; neutron, 1.008 665 u; also 1 u = 931.5 MeV/c^2)
a. 7.3 MeV
b. 7.7 MeV
c. 7.9 MeV
d. 8.3 MeV

ANS: C PTS: 1 DIF: 3 TOP: 29.2 Binding Energy

20. The binding energy of a nucleus is equal to:
a. the energy needed to remove one of the nucleons.
b. the average energy with which any nucleon is bound in the nucleus.
c. the energy needed to separate all the nucleons from each other.
d. the mass of the nucleus times c^2.

ANS: C PTS: 1 DIF: 1 TOP: 29.2 Binding Energy

21. The mass of ^{238}U is not quite an integer multiple of ^{1}H mass. This is primarily because:
a. the proton and neutron have different masses.
b. there are several isotopes of uranium.
c. of the binding energy of uranium.
d. uranium is radioactive.

ANS: C PTS: 1 DIF: 2 TOP: 29.2 Binding Energy

22. If the stable nuclei are plotted with neutron number vs. proton number, the curve formed by the stable nuclei does not follow the line $N = Z$. This is predicted by examining how the binding energy is influenced by:
a. the volume of the nucleus.
b. the size of the nuclear surface.
c. the Coulomb repulsion.
d. the proton-neutron mass difference.

ANS: C PTS: 1 DIF: 2 TOP: 29.2 Binding Energy

23. The fact that the binding energy per nucleon does not depend very strongly on the volume of the nucleus indicates that:
a. the strong nuclear force saturates.
b. nucleons don’t move throughout the nucleus.
c. all nuclei have the same volume.

d. the radius of a nucleus is directly proportional to the number of nucleons.

ANS: A PTS: 1 DIF: 2 TOP: 29.2 Binding Energy

24. Calculate the binding energy per nucleon of the tritium nucleus, , given that the mass of the tritium nucleus is 3.016 05 u. (m_p = 1.007 276 u, mn = 1.008 665, and 1 u = 931.5 MeV/c^2)
a. 2.24 MeV/nucleon
b. 2.45 MeV/nucleon
c. 2.66 MeV/nucleon
d. 2.86 MeV/nucleon

ANS: C PTS: 1 DIF: 2 TOP: 29.2 Binding Energy

25. An element is emitting alpha, beta, and gamma radiation. Rank order them in terms of the thickness of protective shielding they will need for safety, from least to most.
a. alpha, beta and gamma
b. gamma, beta and alpha
c. beta, gamma and alpha
d. alpha, gamma and beta

ANS: A PTS: 1 DIF: 1 TOP: 29.3 Radioactivity

26. A radioactive material initially is observed to have an activity of 1 000 decays/sec. If three hours later it is observed to have an activity of 125 decays/sec, what is its half-life?
a. 1/2 hour
b. 1 hour
c. 3 hours
d. 8 hours

ANS: B PTS: 1 DIF: 1 TOP: 29.3 Radioactivity

27. If a fossil bone is found to contain 1/8th as much Carbon-14 as the bone of a living animal, what is the approximate age of the fossil? (half-life of ^{14}C = 5 730 years)
a. 7 640 years
b. 17 200 years
c. 22 900 years
d. 45 800 years

ANS: B PTS: 1 DIF: 2 TOP: 29.3 Radioactivity

28. There are samples of two different isotopes, X and Y. Both contain the same number of radioactive atoms. Sample X has a half-life twice that of Y. How do their decay rates compare?
a. X has a greater rate than Y.
b. X has a smaller rate than Y.
c. The rates of X and Y are equal.
d. The rate depends on atomic number, not half-life.

ANS: B PTS: 1 DIF: 2 TOP: 29.3 Radioactivity

29. An ancient building was known to have been built 3 000 years ago. Approximately what proportion of Carbon-14 atoms are yet in the building's wooden framing compared to the number which were present at the time of its construction? (half life of ^{14}C = 5 730 years)
a. 0.425
b. 0.500
c. 0.517
d. 0.696

ANS: D PTS: 1 DIF: 2 TOP: 29.3 Radioactivity

30. A pure sample of ^{226}Ra contains 2.0×10^{14} atoms of the isotope. If the half-life of $^{226}Ra = 1.6 \times 10^{3}$ years, what is the activity of this sample?
    a. 6.7×10^{9} decays/yr
    b. 8.7×10^{10} decays/yr
    c. 9.4×10^{10} decays/yr
    d. 13×10^{10} decays/yr

ANS: B PTS: 1 DIF: 2 TOP: 29.3 Radioactivity

31. A pure sample of ^{226}Ra contains 2.0×10^{14} atoms of the isotope. If the half-life of $^{226}Ra = 1.6 \times 10^{3}$ years, what is the decay rate of this sample? (1 Ci = 3.7×10^{10} decays/s)
    a. 2.7×10^{-12} Ci
    b. 3.4×10^{-10} Ci
    c. 7.4×10^{-8} Ci
    d. 9.6×10^{-6} Ci

ANS: C PTS: 1 DIF: 3 TOP: 29.3 Radioactivity

32. Tritium has a half-life of 12.3 years. How many years will elapse when the radioactivity of a tritium sample diminishes to 20% of its original value?
    a. 21 years
    b. 29 years
    c. 57 years
    d. 86 years

ANS: B PTS: 1 DIF: 2 TOP: 29.3 Radioactivity

33. Tritium has a half-life of 12.3 years. What proportion of its original radioactivity will a sample have after 9 years?
    a. 0.55
    b. 0.60
    c. 0.73
    d. 0.84

ANS: B PTS: 1 DIF: 3 TOP: 29.3 Radioactivity

34. Approximately how many radioactive atoms are present in a tritium sample with an activity of 0.4×10^{-6} Ci and a half-life of 12.3 years? (1 Ci = 3.7×10^{10} decays/s)
    a. 1.3×10^{8}
    b. 7×10^{8}
    c. 3×10^{10}
    d. 8×10^{12}

ANS: D PTS: 1 DIF: 3 TOP: 29.3 Radioactivity

35. Approximately how many half-life periods must elapse if the activity of a radioactive isotope sample is to be reduced to 0.004 of the original value?
    a. 3
    b. 6
    c. 8
    d. 60

ANS: C PTS: 1 DIF: 2 TOP: 29.3 Radioactivity

36. Over the course of 3 hours, 15% of a radioactive material decays. What is its half-life?
a. 4.1 hrs
b. 12.8 hrs
c. 24.0 hrs
d. 68.6 hrs

ANS: B PTS: 1 DIF: 3 TOP: 29.3 Radioactivity

37. 1 Bq = ________ Ci?
a. 1
b. 10^{6}
c. 2.7 ´ 10^{-11}
d. 3.7 ´ 10^{10}

ANS: C PTS: 1 DIF: 1 TOP: 29.3 Radioactivity

38. Tritium is radioactive with a half-life of 12.33 years decaying into 3He with low-energy electron emission. If we have a sample of 3.00 ´ 10^{18} tritium atoms, what is its activity in decays/second? (1 year = 3.15 ´ 10^{7} s)
a. 4.20 ´ 10^{10}/second
b. 5.35 ´ 10^{9} /second
c. 3.69 ´ 10^{8}/second
d. 6.64 ´ 10^{7}/second

ANS: B PTS: 1 DIF: 2 TOP: 29.3 Radioactivity

39. The half-life of radioactive Technetium-99 is 6.0 hours. Find the number of ^{99}Tc nuclei necessary to produce a sample of activity 1.0 µCi. (1 Ci = 3.7 ´ 10^{10} decays/second)
a. 8.0 ´ 10^{8}
b. 1.2 ´ 10^{9}
c. 2.1 ´ 10^{10}
d. 3.4 ´ 10^{11}

ANS: B PTS: 1 DIF: 2 TOP: 29.3 Radioactivity

40. The half-life of ^{18}N is 0.62 s. What is the decay constant for this isotope?
a. 0.43 s^{-1}
b. 1.1 s^{-1}
c. 1.7 ´ 10^{-11} Ci
d. The decay constant is not defined for a half-life of less than one second.

ANS: B PTS: 1 DIF: 2 TOP: 29.3 Radioactivity

41. Tritium (^{3}H) has a half-life of 12.3 years and releases 0.018 6 MeV energy per decay. What is the activity of a 1.0-gram sample of tritium? (N_A = 6.02 ´ 10^{23} mol^{-1}, 1 year = 3.16 ´ 10^{7} s, 1 MeV = 1.6 ´ 10^{-13} J, and m_t = 3.016 05 u)
a. 1.1 ´ 10^{15} Bq
b. 3.2 ´ 10^{15} Bq
c. 3.6 ´ 10^{14} Bq
d. 1.3 ´ 10^{16} Bq

ANS: C PTS: 1 DIF: 2 TOP: 29.3 Radioactivity

42. Tritium (^3H) has a half-life of 12.3 years and releases 0.018 6 MeV energy per decay. What is the rate at which energy is released for a 1.0-gram sample of tritium? (N_A = 6.02 ´ 10^{23} mol^{-1}, 1 year = 3.16 ´ 10^7 s, 1 MeV = 1.6 ´ 10^{-13} J, and m_t = 3.016 05 u)
a. 1.1 W
b. 9.6 W
c. 3.2 W
d. 0.33 W

ANS: A PTS: 1 DIF: 3 TOP: 29.3 Radioactivity

43. Uranium-238 decays to Thorium-234 by emitting which of the following?
a. beta
b. alpha
c. gamma
d. positron

ANS: B PTS: 1 DIF: 1 TOP: 29.4 The Decay Processes

44. When radium-224 emits an alpha particle, the remaining daughter nucleus is which of the following?
a. lead-213
b. actinium-215
c. radon-220
d. bismuth-215

ANS: C PTS: 1 DIF: 1 TOP: 29.4 The Decay Processes

45. Chromium-55 (54.940 8 u) emits an electron leaving a daughter nucleus of manganese-55 (54.938 0 u). How much energy is released in this reaction? (1 u = 931.5 MeV/c^2)
a. 5.59 MeV
b. 2.61 MeV
c. 1.40 MeV
d. 0.70 MeV

ANS: B PTS: 1 DIF: 2 TOP: 29.4 The Decay Processes

46. Of the main types of radiation emitted from naturally radioactive isotopes, which of the following is the most penetrating?
a. alpha
b. beta (electron)
c. gamma
d. beta (positron)

ANS: C PTS: 1 DIF: 1 TOP: 29.4 The Decay Processes

47. The beta emission process results in the daughter nucleus differing in what manner from the parent?
a. Atomic mass changes by one.
b. Atomic number changes by two.
c. Atomic number changes by one.
d. Atomic mass changes by two.

ANS: C PTS: 1 DIF: 1 TOP: 29.4 The Decay Processes

48. The alpha emission process results in the daughter nucleus differing in what manner from the parent?
a. Atomic mass increases by one.
b. Atomic number decreases by two.

c. Atomic number increases by one.
d. Atomic mass decreases by two.

ANS: B PTS: 1 DIF: 1 TOP: 29.4 The Decay Processes

49. The existence of the neutrino was postulated to account for which basic conservation laws during the beta decay process?
a. conservation of energy
b. conservation of momentum
c. Both choices a and b are valid.
d. None of the above choices are valid.

ANS: C PTS: 1 DIF: 1 TOP: 29.4 The Decay Processes

50. A radioactive isotope that emits a gamma quantum will change in what respect?
a. Atomic number increases by one.
b. Atomic number decreases by one.
c. Atomic mass number decreases by one.
d. None of the above choices are valid.

ANS: D PTS: 1 DIF: 1 TOP: 29.4 The Decay Processes

51. A radioactive isotope that emits an alpha particle will change in what respect?
a. Atomic number decreases by four.
b. Mass number decreases by four.
c. Both choices a and b are valid.
d. None of the above choices are valid.

ANS: B PTS: 1 DIF: 1 TOP: 29.4 The Decay Processes

52. What particle is emitted when ^{20}Na decays to ^{20}Ne? (atomic numbers of Na and Ne are, respectively, 11 and 10)
a. alpha
b. beta (electron)
c. beta (positron)
d. gamma quantum

ANS: C PTS: 1 DIF: 2 TOP: 29.4 The Decay Processes

53. What particle is emitted when ^{240}Pu decays to ^{236}U? (atomic numbers of Pu and U are, respectively, 94 and 92)
a. alpha
b. beta (electron)
c. beta (positron)
d. gamma quantum

ANS: A PTS: 1 DIF: 1 TOP: 29.4 The Decay Processes

54. The original nucleus and the final nucleus will be different isotopes of the same element for which decay scheme of the original nucleus?
a. alpha decay followed by two beta (electron) decays
b. two gamma decays
c. a beta (electron) decay followed by an alpha decay
d. a beta (electron) decay followed by neutron emission

ANS: A PTS: 1 DIF: 2 TOP: 29.4 The Decay Processes

55. The neutron is radioactive and can beta decay to form a proton. This can occur primarily because:
  a. the proton has less mass than a neutron.
  b. there are several hydrogen isotopes.
  c. of the binding energy of hydrogen.
  d. the neutron is neutral.

ANS: A PTS: 1 DIF: 1 TOP: 29.4 The Decay Processes

56. In the beta decay of ^{14}C, the existence of the antineutrino was required to maintain:
  a. energy conservation.
  b. charge conservation.
  c. conservation of the number of nucleons.
  d. all of the above.

ANS: A PTS: 1 DIF: 1 TOP: 29.4 The Decay Processes

57. An alpha particle (mass = 6.68×10^{-27} kg) is emitted from a radioactive nucleus with an energy of 5.00 MeV. How fast is the alpha particle moving in m/s? (1 MeV = 1.6×10^{-13} J)
  a. 2.40×10^{7} m/s
  b. 1.55×10^{7} m/s
  c. 3.70×10^{6} m/s
  d. 1.85×10^{6} m/s

ANS: B PTS: 1 DIF: 2 TOP: 29.4 The Decay Processes

58. A 1-gram sample of wood is taken from an ancient site. If the Carbon-14 activity of the sample is 12.5% that of present-day organic material, what is the age of the wood? ($T_{1/2}$ for ^{14}C is 5 730 years)
  a. 4 460 years
  b. 8 600 years
  c. 13 150 years
  d. 17 200 years

ANS: D PTS: 1 DIF: 2 TOP: 29.4 The Decay Processes

59. The neutrino is:
  a. a little neutron.
  b. another name for a positron.
  c. the particle detected in carbon dating.
  d. a particle proposed to account for “missing” energy and momentum in beta decay.

ANS: D PTS: 1 DIF: 1 TOP: 29.4 The Decay Processes

60. Each of the three naturally occurring radioactive series start with one of the following isotopes except for which one?
  a. ^{238}U
  b. ^{235}U
  c. ^{232}Th
  d. ^{237}Np

ANS: D PTS: 1 DIF: 1 TOP: 29.5 Natural Radioactivity

61. In the four radioactive series, the nuclei decay by either emitting alpha particles or beta particles until they reach the stable end product. Each decay, therefore, results in a mass number change of either 4 (for alpha decay) or 0 (for beta decay). The radium isotope ^{226}Ra is in one of these series. What is the starting isotope in the series containing ^{226}Ra?
a. ^{238}U
b. ^{235}U
c. ^{232}Th
d. ^{237}Np

ANS: A PTS: 1 DIF: 3 TOP: 29.5 Natural Radioactivity

62. The isotope ^{238}U, which starts one of the natural radioactive series, decays first by alpha decay followed by two negative beta decays. At this point, what is the resulting isotope?
a. ^{238}U
b. ^{236}U
c. ^{234}Th (Z = 90 for Th.)
d. Some other uranium isotope not given above.

ANS: D PTS: 1 DIF: 2 TOP: 29.5 Natural Radioactivity

63. Two nuclei collide, one originally at rest, in an endothermic nuclear reaction with Q = - 2.05 MeV. Which of the following describes the minimum kinetic energy needed in the reactant nuclei for the reaction is to occur?
a. equal to 2.05 MeV
b. greater than 2.05 MeV
c. less than 2.05 MeV
d. exactly half of 2.05 MeV

ANS: B PTS: 1 DIF: 1 TOP: 29.6 Nuclear Reactions

64. If the sum total mass of reactants in a nuclear reaction is greater than that of product particles, then which of the following statements best describes the conditions of the reaction?
a. reaction is exothermic
b. reaction is endothermic
c. atomic number of each reactant must be greater than 40
d. atomic number of each reactant must be less than 80

ANS: A PTS: 1 DIF: 1 TOP: 29.6 Nuclear Reactions

65. A proton is captured by an oxygen-16 atom which in turn emits a deuteron. What is the element and mass number of the product isotope?
a. nitrogen-15
b. oxygen-17
c. oxygen-15
d. fluorine-15

ANS: C PTS: 1 DIF: 2 TOP: 29.6 Nuclear Reactions

66. What is the Q-value for the reaction where the products are 0.005 0 u less than the reactants? (1 u = 931.5 MeV/c^2)
a. 8.5 MeV
b. 7.6 MeV
c. 5.2 MeV
d. 4.7 MeV

ANS: D PTS: 1 DIF: 2 TOP: 29.6 Nuclear Reactions

67. The Q of a nuclear reaction is equal to:
   a. the total charge involved.
   b. energy associated with the change in mass.
   c. energy associated with momentum conservation.
   d. the exothermic endothermy.

   ANS: B PTS: 1 DIF: 1 TOP: 29.6 Nuclear Reactions

68. In the reaction , what is the mass number and atomic number of the product designated by X?
   a. 102, 42
   b. 101, 42
   c. 102, 44
   d. not given

   ANS: A PTS: 1 DIF: 2 TOP: 29.6 Nuclear Reactions

69. What is the Q value of the reaction ? The mass of the alpha particle is 4.002 602 u, of the nitrogen is 14.003 074 u, of the oxygen is 15.994 915 u, and of the hydrogen is 2.014 102 u. (1 u = 931.5 MeV/c^2)
   a. –3.34 MeV
   b. 3.34 MeV
   c. –3.11 MeV
   d. 3.11 MeV

   ANS: C PTS: 1 DIF: 3 TOP: 29.6 Nuclear Reactions

70. The Q value of the reaction is –1.65 MeV. What is the threshold energy of this reaction? (Hint: Once the Q value is known, the relative mass numbers are precise enough to yield the result to 3 significant figures, actual masses not being needed).
   a. 1.65 MeV
   b. 1.89 MeV
   c. 1.77 MeV
   d. 1.41 MeV

   ANS: B PTS: 1 DIF: 2 TOP: 29.6 Nuclear Reactions

71. Which of the following is not a unit of radiation dose?
   a. rem
   b. roentgen
   c. rad
   d. RBE

   ANS: D PTS: 1 DIF: 1
   TOP: 29.7 Medical Applications of Radiation

72. To what is the radiation damage in biological organisms primarily due?
   a. helium introduction
   b. heating
   c. induced radioactivity
   d. ionization

   ANS: D PTS: 1 DIF: 1
   TOP: 29.7 Medical Applications of Radiation

73. Genetic radiation damage is:
   a. another name for somatic damage.

b. any radiation damage to a cell.
c. radiation damage affecting reproductive cells.
d. measured in roentgens.

ANS: C PTS: 1 DIF: 1
TOP: 29.7 Medical Applications of Radiation

74. A rad is that amount of radiation that:
a. produces 2.08 ´ 10^9 ion pairs per cm^3 in air under standard conditions.
b. deposits 8.76 ´ 10^{-3} J of energy into 1 kg of air.
c. deposits 10^{-2} J of energy into 1 kg of absorbing material.
d. is also known as a rem.

ANS: C PTS: 1 DIF: 2
TOP: 29.7 Medical Applications of Radiation

75. Sample #1 is made from an isotope with decay constant and sample #2 is made from an isotope with decay constant , where . Which of the following statements must be true?
a. The activity of sample #1 is greater than that of sample #2.
b. The activity of sample #2 is greater than that of sample #1.
c. The half-life exhibited for sample #1 is greater than that of sample #2.
d. The half-life exhibited for sample #2 is greater than that for sample #1

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Questions

76. Two different nuclei emit alpha particles, the energy released in each of these decays being the same. Which of the following has the highest resulting kinetic energy?
a. The lighter daughter nucleus.
b. The heavier daughter nucleus.
c. The alpha particle from the lighter nucleus.
d. The alpha particle from the heavier nucleus.

ANS: D PTS: 1 DIF: 2 TOP: Conceptual Questions

77. A particle is fired at a target nucleus in which a reaction that could occur has a negative Q value. Which of the following statements is true?
a. The kinetic energy of the bombarding particle can be any amount for the reaction to occur.
b. The kinetic energy of the bombarding particle must be equal to the absolute value of the Q value for the reaction to occur.
c. The kinetic energy of the bombarding particle was greater than the absolute value of the Q value if the reaction occurred.
d. The Q value has nothing to do with whether or not the reaction can occur.

ANS: C PTS: 1 DIF: 1 TOP: Conceptual Questions

78. The isotope ^{14}C cannot be used in dating old samples of which of the following?
a. charcoal from a fire
b. a bronze implement from a cave
c. a bone buried in mud
d. All of the above can be dated using ^{14}C.

ANS: B PTS: 1 DIF: 1 TOP: Conceptual Questions

79. Which of the following is not true for both the photon and the neutrino.
a. Both are uncharged.
b. Both have spin .

c. Both can carry different amounts of momentum.
d. Choose this answer if all of the above are true.

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Questions

CHAPTER 30—Nuclear Energy and Elementary Particles

MULTIPLE CHOICE

1. Nuclear fission was first observed by:
   a. Hahn and Strassman.
   b. Meitner and Frisch.
   c. Einstein and Fermi.
   d. Dirac and Heisenberg.

   ANS: A PTS: 1 DIF: 1 TOP: 30.1 Nuclear Fission

2. The average mass per nucleon is greatest in which of the following elements?
   a. hydrogen
   b. iron
   c. uranium
   d. krypton

   ANS: A PTS: 1 DIF: 1 TOP: 30.1 Nuclear Fission

3. A capture by a target nucleus of uranium-235 is most apt to occur for which type of “bullet” particle?
   a. low velocity alpha particle
   b. low velocity proton
   c. high velocity neutron
   d. low velocity neutron

   ANS: D PTS: 1 DIF: 1 TOP: 30.1 Nuclear Fission

4. In order to be useful in sustaining a reaction, the neutrons in a fission reactor must be:
   a. released from the reactor.
   b. warmed to a higher temperature.
   c. accelerated.
   d. decelerated.

   ANS: D PTS: 1 DIF: 1 TOP: 30.1 Nuclear Fission

5. In a nuclear reactor which uses the fission process, which of the following is the most likely result in the event of a cooling system failure followed by a nuclear accident?
   a. proliferation of plutonium fuel
   b. accumulation of critical mass of fissionable material
   c. spread of radioactive material into the environment
   d. reduction of ozone in upper atmosphere

   ANS: C PTS: 1 DIF: 1 TOP: 30.1 Nuclear Fission

6. Assume that (i) the energy released per fission event of ^{235}U is 208 MeV, and (ii) 30% of the nuclear energy released in a power plant is ultimately converted to usable electrical energy. Approximately how many fission events will occur in one second in order to provide the one GW electrical power output of a typical power plant? (1 eV = 1.6 ´ 10^{-19} J)
   a. 2 ´ 10^{16} fission/s
   b. 1 ´ 10^{20} fission/s
   c. 3 ´ 10^{24} fission/s
   d. 2 ´ 10^{27} fission/s

ANS: B PTS: 1 DIF: 2 TOP: 30.1 Nuclear Fission

7. What characteristic is preferred in the elements contained in moderator materials when used in a nuclear fission reactor?
   a. low atomic mass
   b. metallic
   c. non-metallic
   d. high atomic mass

ANS: A PTS: 1 DIF: 1 TOP: 30.1 Nuclear Fission

8. The water surrounding the fuel rods in a nuclear fission reactor serves what purpose(s)?
   a. coolant
   b. moderator
   c. Both choices above are valid.
   d. None of the choices above are valid.

ANS: C PTS: 1 DIF: 1 TOP: 30.1 Nuclear Fission

9. The K-ratio in a uranium fuel reactor is defined as the average number of neutrons from each fission event that will cause another event. In a well-functioning reactor, it is desired that the K-ratio have what value?
   a. zero
   b. 0.5
   c. 1.0
   d. 2.0

ANS: C PTS: 1 DIF: 1 TOP: 30.1 Nuclear Fission

10. In a fission reaction, a ^{235}U nucleus captures a neutron. This results in the creation of the products ^{141}Ba and ^{92}Kr along with how many neutrons?
   a. 1
   b. 2
   c. 3
   d. 5

ANS: C PTS: 1 DIF: 2 TOP: 30.1 Nuclear Fission

11. In a fission reaction, a ^{235}U nucleus captures a neutron. What energy is released if the products are ^{139}I, ^{95}Y and two neutrons? (atomic masses: ^{235}U, 235.043 9; ^{139}I, 138.935 0; ^{95}Y, 94.913 4; neutron, 1.008 67; and 1 u = 931.5 MeV/c^2)
   a. 123 MeV
   b. 174 MeV
   c. 199 MeV
   d. 218 MeV

ANS: B PTS: 1 DIF: 2 TOP: 30.1 Nuclear Fission

12. In a nuclear fission process involving the use of ^{239}Pu fuel, if the approximate average binding energy per nucleon in the product fragments is 8.5 MeV while that of the fuel atom is 7.7 MeV, what approximate net energy is released per fission?
   a. 190 MeV
   b. 240 MeV
   c. 2 000 MeV
   d. 3 800 MeV

ANS: A PTS: 1 DIF: 2 TOP: 30.1 Nuclear Fission

13. Which of the following will not influence the rate at which nuclear reactions will occur in a nuclear power plant where the fuel elements are a mixture of ^{235}U and ^{238}U?
    a. the presence of moderating material
    b. the presence of control rods
    c. the percentage of ^{235}U relative to ^{238}U
    d. the percentage of the energy that is used to produce electricity

    ANS: D PTS: 1 DIF: 1 TOP: 30.1 Nuclear Fission

14. Which of the following can only occur if the reproduction constant, *K*, exceeds 1?
    a. nuclear meltdown at a nuclear power plant
    b. explosive release of radioactivity and steam from a nuclear power plant
    c. the explosion of a nuclear bomb
    d. All of the above require that *K* exceed 1.

    ANS: C PTS: 1 DIF: 1 TOP: 30.1 Nuclear Fission

15. Calculate the energy (in kW·h) given off if one kg of plutonium-239 undergoes complete fission. The energy released per fission is 200 MeV. (1 MeV = 1.6×10^{-13} J)
    a. 1.2×10^{5} kW·h
    b. 7.7×10^{6} kW·h
    c. 11×10^{6} kW·h
    d. 22×10^{6} kW·h

    ANS: D PTS: 1 DIF: 2 TOP: 30.1 Nuclear Fission

16. When uranium fissions into two medium-mass nuclei, the product nuclei tend to have an excess of neutrons when compared to stable nuclei. What type of radioactive decay would one expect from these product nuclei?
    a. meson decay
    b. negative beta decay
    c. positive beta decay
    d. proton decay

    ANS: B PTS: 1 DIF: 2 TOP: 30.1 Nuclear Fission

17. Where is the largest untapped source of uranium?
    a. Canada
    b. Siberia
    c. Africa
    d. none of the above

    ANS: D PTS: 1 DIF: 1 TOP: 30.1 Nuclear Fission

18. A plasma can be contained in a “magnetic bottle” because it has which of the following properties?
    a. high temperature
    b. liquid in form
    c. made of charged particles
    d. made of light elements

    ANS: C PTS: 1 DIF: 1 TOP: 30.2 Nuclear Fusion

19. The advantage of a fusion reactor when compared to a fission reactor is which of the following?

a. The fuel is cheaper.
b. There is less radioactive waste material.
c. Both choices above are valid.
d. None of the above choices are valid.

ANS: C PTS: 1 DIF: 1 TOP: 30.2 Nuclear Fusion

20. If a self-sustained controlled fusion reaction is to operate, a condition which must be met is that the fuel material be subjected to which of the following condition(s)?
a. confined for sufficient time period
b. have sufficiently high density
c. be at sufficiently high temperature
d. All of the above choices are valid.

ANS: D PTS: 1 DIF: 1 TOP: 30.2 Nuclear Fusion

21. When comparing product nuclei to reactant nuclei in an exothermal nuclear fusion process, which has the greater binding energy per nucleon?
a. greater in product nuclei
b. greater in reactant nuclei
c. equal in both product and reactant nuclei
d. None of the above choices are valid.

ANS: A PTS: 1 DIF: 1 TOP: 30.2 Nuclear Fusion

22. In a nuclear fusion reactor, the Lawson criterion prescribes the necessary conditions, as related to density and confinement time of the plasma fuel, in order that the process produces a net power output. If the fuel density were doubled, by what factor would the required confinement time change?
a. 0.25
b. 0.50
c. 1.4
d. 2.0

ANS: B PTS: 1 DIF: 1 TOP: 30.2 Nuclear Fusion

23. Calculate the energy released in the following fusion reaction where reactants are ^{6}Li and a neutron; products are ^{4}He and ^{3}H. (atomic masses: ^{6}Li, 6.015 12; neutron, 1.008 67; ^{4}He, 4.002 60; ^{3}H, 3.016 031; also 1 u = 931.5 MeV/c^2)
a. 2.95 MeV
b. 4.81 MeV
c. 8.63 MeV
d. 17.2 MeV

ANS: B PTS: 1 DIF: 2 TOP: 30.2 Nuclear Fusion

24. In a fusion reactor, the high temperature of the order of 10^8 K is required in order that what condition is met?
a. melt down the hydrogen fuel
b. strip the hydrogen atoms of their electrons
c. break the protons into their elementary particle sub-parts
d. overcome Coulomb repelling forces between protons

ANS: D PTS: 1 DIF: 1 TOP: 30.2 Nuclear Fusion

25. The formation of a star requires the consideration of the effects of gravity and the energy from nuclear reactions and a star will form only when both the temperature and density are sufficiently high. In the birth of a star:
    a. gravity produces the initial required high temperature and density.
    b. nuclear reactions produce the initial high temperature.
    c. nuclear reactions produce the initial required high density.
    d. nuclear reactions produce the initial required high temperature and density.

    ANS: A PTS: 1 DIF: 1 TOP: 30.2 Nuclear Fusion

26. The reason that a thermonuclear fusion reaction cannot be maintained in the oceans of the earth is because:
    a. the temperature is not high enough.
    b. the density is not high enough.
    c. there is insufficient deuterium in the ocean.
    d. the deuterium in the ocean is not radioactive.

    ANS: A PTS: 1 DIF: 1 TOP: 30.2 Nuclear Fusion

27. One in 6 500 water molecules contains a deuterium atom. If all the deuterium could be extracted from 1 m^3 of water and then reacted, how much energy could be obtained? (Each D-D fusion liberates 3.65 MeV of energy, 1 MeV = 1.6×10^{-13} J, $\rho_{water} = 10^3$ kg/m^3, one mole of water has a mass of 18 g, and $N_A = 6.02 \times 10^{23}$)
    a. 8.0×10^{10} J
    b. 9.6×10^{10} J
    c. 4.8×10^{11} J
    d. 1.5×10^{12} J

    ANS: D PTS: 1 DIF: 2 TOP: 30.2 Nuclear Fusion

28. How much kinetic energy must a deuterium ion (charge = 1.6×10^{-19} C) have to approach within 1.0×10^{-14} m of another deuterium ion? ($k_e = 8.99 \times 10^9$ N·m^2/C^2 and 1 keV = 1.6×10^{-16} J)
    a. 30 keV
    b. 50 keV
    c. 70 keV
    d. 140 keV

    ANS: D PTS: 1 DIF: 2 TOP: 30.2 Nuclear Fusion

29. How fast is an ion of deuterium moving, assuming rms speed, if it is in a plasma with a temperature of 100×10^6 K? ($k_B = 1.38 \times 10^{-23}$ J/K and $m_D = 2 \times 1.66 \times 10^{-27}$ kg)
    a. 1.12×10^6 m/s
    b. 0.93×10^5 m/s
    c. 0.46×10^5 m/s
    d. 2.32×10^4 m/s

    ANS: A PTS: 1 DIF: 3 TOP: 30.2 Nuclear Fusion

30. In the proton-proton cycle, the eventual product is:
    a. heavy hydrogen.
    b. tritium.
    c. helium-3.
    d. helium-4.

    ANS: D PTS: 1 DIF: 1 TOP: 30.2 Nuclear Fusion

31. Assuming the Lawson criterion for the deuterium-tritium interaction,, what is the minimum plasma ion density at 10^8 K?
   a. $10^6/cm^3$
   b. $10^{22}/cm^3$
   c. $10^{-6}/cm^3$
   d. More information is needed.

   ANS: D PTS: 1 DIF: 1 TOP: 30.2 Nuclear Fusion

32. Which particle in the free state is least stable?
   a. electron
   b. photon
   c. neutron
   d. proton

   ANS: C PTS: 1 DIF: 1
   TOP: 30.3 Elementary Particles and the Fundamental Forces

33. What is meant by a particle being elementary?
   a. It is too small to see.
   b. It is subatomic.
   c. It is not composed of other particles.
   d. It has no charge.

   ANS: C PTS: 1 DIF: 1
   TOP: 30.3 Elementary Particles and the Fundamental Forces

34. Which of the following particles is (are) considered to be elementary?
   a. the neutron
   b. the meson
   c. the electron
   d. All of the above.

   ANS: C PTS: 1 DIF: 1
   TOP: 30.3 Elementary Particles and the Fundamental Forces

35. Which of the following forces is the weakest?
   a. strong nuclear
   b. weak nuclear
   c. electromagnetic
   d. gravitational

   ANS: D PTS: 1 DIF: 1
   TOP: 30.3 Elementary Particles and the Fundamental Forces

36. Which force can act over distances comparable to the distance between planets?
   a. only gravitational
   b. only electrical
   c. only magnetic
   d. All of the above.

   ANS: D PTS: 1 DIF: 1
   TOP: 30.3 Elementary Particles and the Fundamental Forces

37. Which of the following particles has not been observed experimentally?

a. photon
b. graviton
c. antiproton
d. Z^0 boson

ANS: B PTS: 1 DIF: 1
TOP: 30.3 Elementary Particles and the Fundamental Forces

38. The weak force that acts between an electron and a quark is caused by the exchange of:
a. photons.
b. gluons.
c. gravitons.
d. W^+, W^-, or Z^0 bosons.

ANS: D PTS: 1 DIF: 1
TOP: 30.3 Elementary Particles and the Fundamental Forces

39. Theoretical physicists have had the least success in combining which force with the electromagnetic force?
a. strong nuclear force
b. weak nuclear force
c. gravitational force
d. electrical Coulomb force

ANS: C PTS: 1 DIF: 1
TOP: 30.3 Elementary Particles and the Fundamental Forces

40. Theoretical physicists have had the greatest success in combining which force with the electromagnetic force?
a. strong nuclear force
b. weak nuclear force
c. gravitational force
d. the force caused by the exchange of gluons

ANS: B PTS: 1 DIF: 1
TOP: 30.3 Elementary Particles and the Fundamental Forces

41. The Dirac theory predicted that a positron would be:
a. a negative electron in a negative energy state.
b. a particle with same mass as an electron but with opposite charge.
c. a particle with negative mass.
d. All of the above.

ANS: B PTS: 1 DIF: 1
TOP: 30.4 Positrons and Other Antiparticles

42. A positron and an electron differ in:
a. charge.
b. mass.
c. spin.
d. energy.

ANS: A PTS: 1 DIF: 1
TOP: 30.4 Positrons and Other Antiparticles

43. The size and sign of the charge on an electron is the same as that for:

a. a positron.
b. an antiproton.
c. an antineutron.
d. an antineutrino.

ANS: B PTS: 1 DIF: 1
TOP: 30.4 Positrons and Other Antiparticles

44. The medical diagnostic technique PET stands for:
a. proton energizing test.
b. phosphorus electron tracing.
c. precision electronic tracking.
d. positron emission tomography.

ANS: D PTS: 1 DIF: 1
TOP: 30.4 Positrons and Other Antiparticles

45. Which particle was the last to be discovered?
a. electron
b. neutrino
c. neutron
d. proton

ANS: B PTS: 1 DIF: 1
TOP: 30.4 Positrons and Other Antiparticles

46. Calculate the range of the force that might be produced by the virtual exchange of a proton. Assume $\Delta E \cdot \Delta t = h/2\pi$. ($m_p = 1.67 \times 10^{-27}$ kg, $c = 3.00 \times 10^{8}$ m/s, and $h/2\pi = 1.05 \times 10^{-34}$ J$\cdot$s)
a. 6.7×10^{-25} m
b. 2.1×10^{-16} m
c. 6.0×10^{-8} m
d. 1.5×10^{-15} m

ANS: B PTS: 1 DIF: 2
TOP: 30.4 Positrons and Other Antiparticles

47. The virtual exchange of photons can produce:
a. a repulsive force.
b. an attractive force.
c. either a repulsive or an attractive force.
d. neither a repulsive nor an attractive force.

ANS: C PTS: 1 DIF: 1
TOP: 30.4 Positrons and Other Antiparticles

48. The pion (m_π = 140 MeV/c^2) is thought to be the particle exchanged in the nuclear force. What is the maximum range of this particle if its "time of existence" is as long as can be allowed by the uncertainty principle $\Delta E \cdot \Delta t = h/2\pi$? ($h/2\pi = 1.05 \times 10^{-34}$ J$\cdot$s, $c = 3.00 \times 10^{8}$ m/s, and 1 eV = 1.6×10^{-19} J)
a. 1.2×10^{-15} m
b. 1.4×10^{-15} m
c. 2.0×10^{-15} m
d. 7.5×10^{-15} m

ANS: B PTS: 1 DIF: 3

TOP: 30.4 Positrons and Other Antiparticles

49. The attractive force between protons and neutrons in the nucleus is brought about by the exchange of a virtual pi-meson (m_{π} = 140 MeV/c^2). Estimate the longest time a π can exist in accordance with the uncertainty principle $\Delta E \cdot \Delta t = h/2\pi$. ($h/2\pi = 1.05 \times 10^{-34}$ J·s, 1 eV = 1.6×10^{-19} C)
a. 3.3×10^{-18} s
b. 2.4×10^{-21} s
c. 4.7×10^{-24} s
d. 6.9×10^{-27} s

ANS: C PTS: 1 DIF: 3
TOP: 30.4 Positrons and Other Antiparticles

50. "MeV/c^2" is a unit for:
a. energy.
b. mass.
c. momentum.
d. nuclear force.

ANS: B PTS: 1 DIF: 1
TOP: 30.4 Positrons and Other Antiparticles

51. Which of these particles has the most mass?
a. pion
b. muon
c. electron
d. positron

ANS: A PTS: 1 DIF: 2
TOP: 30.5 Classification of Particles

52. According to present theories, there is a neutrino for all the following particles except:
a. the neutral pion.
b. the electron.
c. the muon.
d. the tau lepton.

ANS: A PTS: 1 DIF: 1
TOP: 30.5 Classification of Particles

53. Which of the following is not true of electron neutrinos?
a. They are spinless.
b. They are chargeless.
c. They are massless (or nearly so).
d. They are leptons.

ANS: A PTS: 1 DIF: 1
TOP: 30.5 Classification of Particles

54. In the decay of the muon into an electron, a neutrino, and an antineutrino, the antineutrino is a(n) ________ antineutrino.
a. electron
b. muon
c. tau
d. gluon

ANS: A PTS: 1 DIF: 2
TOP: 30.5 Classification of Particles

55. Which of the following is not a meson?
a. the muon
b. the pion
c. the kaon
d. All of the above are mesons.

ANS: A PTS: 1 DIF: 1
TOP: 30.5 Classification of Particles

56. If protons have a half-life of 10^{31} years, what fraction of the original protons have decayed during the 10^{10} year existence of the universe?
a. 10/31
b. 21/31
c. 5×10^{-7}
d. less than any of the above values

ANS: D PTS: 1 DIF: 2 TOP: 30.6 Conservation Laws

57. A neutron and a proton have the same:
a. charge.
b. half-life.
c. mass.
d. baryon number.

ANS: D PTS: 1 DIF: 1 TOP: 30.6 Conservation Laws

58. What quantity is conserved in the following reaction?
a. baryon number
b. charge
c. lepton number
d. All of the above.

ANS: D PTS: 1 DIF: 2 TOP: 30.6 Conservation Laws

59. What quantity is conserved in the following reaction?
a. baryon number
b. charge
c. lepton number
d. All of the above.

ANS: D PTS: 1 DIF: 2 TOP: 30.6 Conservation Laws

60. A photon hits an electron, and an antiproton is created. Some uncharged particles must have left the collision. These may be:
a. neutron and neutrino.
b. neutron and antineutrino.
c. photon and neutrino.
d. photon and antineutrino.

ANS: A PTS: 1 DIF: 2 TOP: 30.6 Conservation Laws

61. A negative muon decays to form an electron and a mu neutrino and one additional particle. The other particle must be a(n):
    a. positron.
    b. antineutrino.
    c. neutrino.
    d. photon.

ANS: B PTS: 1 DIF: 2 TOP: 30.6 Conservation Laws

62. If a negative muon decays to form an electron-antineutrino pair and one other particle, the other particle may be a(n):
    a. positron.
    b. antineutrino.
    c. mu neutrino.
    d. electron.

ANS: C PTS: 1 DIF: 2 TOP: 30.6 Conservation Laws

63. If a photon produces an electron-positron pair and one other particle, the other particle may be a(n):
    a. muon.
    b. antineutrino.
    c. neutrino.
    d. photon.

ANS: D PTS: 1 DIF: 2 TOP: 30.6 Conservation Laws

64. Which of the following particle reactions cannot occur?
    a.
    b.
    c.
    d.

ANS: A PTS: 1 DIF: 2 TOP: 30.6 Conservation Laws

65. Which of the following particle reactions can occur?
    a.
    b.
    c.
    d.

ANS: A PTS: 1 DIF: 2 TOP: 30.6 Conservation Laws

66. Which of the following decays violates conservation of lepton number?
    a.
    b.
    c.
    d.

ANS: D PTS: 1 DIF: 2 TOP: 30.6 Conservation Laws

67. A proton and antiproton each with total energy 400 GeV collide head-on. What is the total energy (particles + energy) released?
    a. 800 GeV
    b. 400 GeV
    c. zero
    d. 1 600 GeV

ANS: A PTS: 1 DIF: 1 TOP: 30.6 Conservation Laws

68. Which of the following is not conserved?
a. lepton number
b. baryon number
c. meson number
d. energy

ANS: C PTS: 1 DIF: 1 TOP: 30.6 Conservation Laws

69. Experimentally, strange particles can be produced in abundance, but they decay relatively slowly. This occurs because strangeness:
a. is conserved in both their production and decay.
b. is conserved in their production but not in their decay.
c. is conserved in their decay but not in their production.
d. is not conserved in either their production or their decay.

ANS: B PTS: 1 DIF: 2 TOP: 30.6 Conservation Laws

70. The strangeness of an anti-proton is:
a. +1.
b. 0.
c. –1.
d. –2.

ANS: B PTS: 1 DIF: 1 TOP: 30.6 Conservation Laws

71. The S^+, S^0, and S^- all have strangeness of (-1). The collision of a proton and a neutron to produce a S^0 and an anti-S^- cannot occur because it does not conserve:
a. strangeness.
b. charge.
c. baryon number.
d. All of the above.

ANS: C PTS: 1 DIF: 2 TOP: 30.6 Conservation Laws

72. The S^+, S^0, and S^- all have strangeness of (-1). The collision of an anti-proton and a neutron may produce which of the following particles?
a. S^- and S^0
b. S^+ and anti-S^0
c. anti-S^+ and S^0
d. anti-S^- and S^0

ANS: C PTS: 1 DIF: 2 TOP: 30.6 Conservation Laws

73. If a K^0 meson at rest decays in 0.90 ´ 10^{-10} s, how far will a K^0 meson moving at 0.96 *c* travel through a bubble chamber? (*c* = 3.00 ´ 10^8 m/s)
a. 9.3 cm
b. 1.1 cm
c. 53 cm
d. 42 cm

ANS: A PTS: 1 DIF: 3 TOP: 30.6 Conservation Laws

74. Which of the following particles is made of two or more smaller particles?

a. electron
b. photon
c. proton
d. None of the above.

ANS: C PTS: 1 DIF: 2 TOP: 30.8 Quarks and Color

75. According to the standard model, a quark and its antiquark may have the same:
a. spin.
b. baryon number.
c. charge.
d. All of the above may be the same.

ANS: A PTS: 1 DIF: 2 TOP: 30.8 Quarks and Color

76. According to the standard model, there are some cases in which a quark and its anti-quark have the same:
a. charge.
b. baryon number.
c. strangeness.
d. All of the above are always different.

ANS: C PTS: 1 DIF: 2 TOP: 30.8 Quarks and Color

77. If two quarks in an anti-proton have the color anti-red and anti-blue, the third quark must have the color:
a. red.
b. blue.
c. anti-purple.
d. anti-green.

ANS: D PTS: 1 DIF: 2 TOP: 30.8 Quarks and Color

78. The spin of all quarks is:
a. 0.
b. 1/2.
c. 1.
d. 1/3 or 2/3.

ANS: B PTS: 1 DIF: 2 TOP: 30.8 Quarks and Color

79. The charge of some quarks or anti-quarks is:
a. 0.
b. 1/2 (1.6 ´ 10^{-19}) C.
c. 1/3 (1.6 ´ 10^{-19}) C.
d. 1 (1.6 ´ 10^{-19}) C.

ANS: C PTS: 1 DIF: 1 TOP: 30.8 Quarks and Color

80. The following reaction can occur by the strong interaction: p^0 + n ® K^+ + S^-. If the quark composition of the n is (udd), the p^0 is and the composition of the K^+ is , what is the quark composition of the S^-?
a. dds
b. uds
c. sss
d.

ANS: A PTS: 1 DIF: 3 TOP: 30.8 Quarks and Color

81. Mesons are composed of ________ quarks, and baryons are composed of ________ quarks.
a. two, two
b. two, three
c. three, two
d. three, three

ANS: B PTS: 1 DIF: 2 TOP: 30.8 Quarks and Color

82. Mesons are always composed of:
a. two quarks, one being classified as a quark and the other as an antiquark.
b. a quark of one color and an antiquark of the anticolor.
c. an up or down quark and a down or up antiquark.
d. Two of the above choices are correct.

ANS: D PTS: 1 DIF: 2 TOP: 30.8 Quarks and Color

83. The weak force is mediated by:
a. the W^+ boson.
b. the W^- boson.
c. the Z^0 boson.
d. All of the above.

ANS: D PTS: 1 DIF: 1
TOP: 30.9 Electroweak Theory and the Standard Model

84. The particle thought responsible for particle masses is:
a. the graviton.
b. the gluon.
c. the particle.
d. the Higgs boson.

ANS: D PTS: 1 DIF: 1
TOP: 30.9 Electroweak Theory and the Standard Model

85. The cosmic background radiation appears compatible with a blackbody source at what temperature?
a. 0.000 3 K
b. 0.03 K
c. 3 K
d. 300 K

ANS: C PTS: 1 DIF: 1
TOP: 30.10 The Cosmic Connection

86. The Big Bang occurred:
a. about 15 to 20 billion years ago.
b. about 5 to 7 thousand years ago.
c. about 4 to 6 billion years ago.
d. infinitely far in the past.

ANS: A PTS: 1 DIF: 1
TOP: 30.10 The Cosmic Connection

87. The microwave background radiation:
a. represents the leftover glow from the Big Bang.

b. was discovered by Penzias and Wilson.
c. had its slight non-uniformity measured by COBE.
d. All of the above.

ANS: D PTS: 1 DIF: 1
TOP: 30.10 The Cosmic Connection

88. The stars farther than 20 000 LY from the center of the Milky Way are traveling too fast to be bound to the galaxy by the observed mass of the galaxy. Which of the following are currently being investigated as possible explanations of this?
a. neutrino mass
b. WIMPs
c. Newtonian dynamics are not quite correct.
d. all of the above

ANS: D PTS: 1 DIF: 1
TOP: 30.11 Unanswered Questions in Cosmology

89. What is the particle referred to as a WIMP?
a. the result of a neutrino oscillation
b. a hypothetical particle left over from the Big Bang
c. a hypothetical particle in the MOND theory
d. none of the above

ANS: B PTS: 1 DIF: 1
TOP: 30.11 Unanswered Questions in Cosmology

90. What is the “cosmological constant?”
a. The universe has existed forever and on the average (over billions of cubic light years) does not change.
b. This is the ratio between “dark energy” and “dark matter.”
c. This is a quantity also referred to as “quintessence.”
d. This is a self-admitted blunder in his theory of general relativity by Einstein, that might not be a blunder after all..

ANS: D PTS: 1 DIF: 1
TOP: 30.11 Unanswered Questions in Cosmology

91. When considering the law of conservation of lepton number for a reaction, how many different lepton numbers must be checked?
a. 1
b. 2
c. 3
d. 6

ANS: C PTS: 1 DIF: 2 TOP: Conceptual Questions

92. If the lifetime of a particle is roughly inversely proportional to the relative strength of the force involved, then for the strong, electromagnetic, and weak forces, arrange the forces according to their resulting lifetimes ranging from shortest to longest lifetimes.
a. strong, electromagnetic, weak
b. weak, electromagnetic, strong
c. weak, strong, electromagnetic
d. strong, weak, electromagnetic

ANS: A PTS: 1 DIF: 2 TOP: Conceptual Questions

93. The law of conservation of strangeness tells us that strangeness is not conserved for which of the following interactions?
a. strong
b. electromagnetic
c. weak
d. All three of the above interactions conserve strangeness.

ANS: C PTS: 1 DIF: 1 TOP: Conceptual Questions

94. Which, if any, is an elementary particle?
a. the proton
b. the particle
c. the muon
d. All three are not elementary particles.

ANS: C PTS: 1 DIF: 1 TOP: Conceptual Questions

95. Baryons are composed of 3 quarks. If all 3-quark compositions of particles could happen, what would be the highest possible charge for such a particle?
a. 1 e
b. 2 e
c. 3 e
d. There is no upper limit, though the charge is usually less than 3 e.

ANS: B PTS: 1 DIF: 2 TOP: Conceptual Questions