

EQ. C

SOLUTIONS

Physics 101
Instr. J. OlivaEquivalent Exam

Name _____

Midterm #1

There are 30 questions.

Circle the letter of your answer on these sheets as well as fill in the bubble on the Scantron form.

$$c = 3.0 \times 10^8 \text{ m/s} \quad 1 \text{ mile} = 5280 \text{ ft} \quad 1 \text{ in} = 25.4 \text{ mm} \quad 1 \text{ m} = 3.28 \text{ ft} \quad 100 \text{ cm} = 1 \text{ m}$$

1. Which is the correct list for the three basic physical quantities ?

- a) distance, force, velocity
- ☒ b) distance, time, mass
- c) time, force, weight
- d) time, temperature, weight

2. In which list are all the items electromagnetic radiation ?

- a) sound waves, microwaves, water waves
- ☒ b) radio waves, x-rays, visible light waves
- c) x-rays, infrared waves, sound waves
- d) pressure waves, earthquake waves, gamma rays

3. How many millimeters are there in 1 mile ?

- ☒ a) 1.61×10^6
- b) 7.24×10^6
- c) 3.67×10^7
- d) 9.43×10^7

$$1 \text{ mi} \cdot \frac{5280 \text{ ft}}{1 \text{ mi}} \cdot \frac{12 \text{ in}}{1 \text{ ft}} \cdot \frac{25.4 \text{ mm}}{1 \text{ in}} = 1.61 \times 10^6 \text{ mm}$$

4. Which does NOT illustrate an energy transfer?

- a) A sound wave strikes your eardrum, causing it to move inward some small distance.
- b) A block initially at rest is then acted on by a force, causing it to acquire a nonzero velocity.
- ☒ c) A moving skateboarder rolls up a ramp. His kinetic energy decreases while his gravitational potential energy increases, keeping the total energy constant.
- d) A hot brick is placed into contact with a cold brick: the cold brick warms up.

5. How is the area of a circle changed if its radius is made one-third as large ?

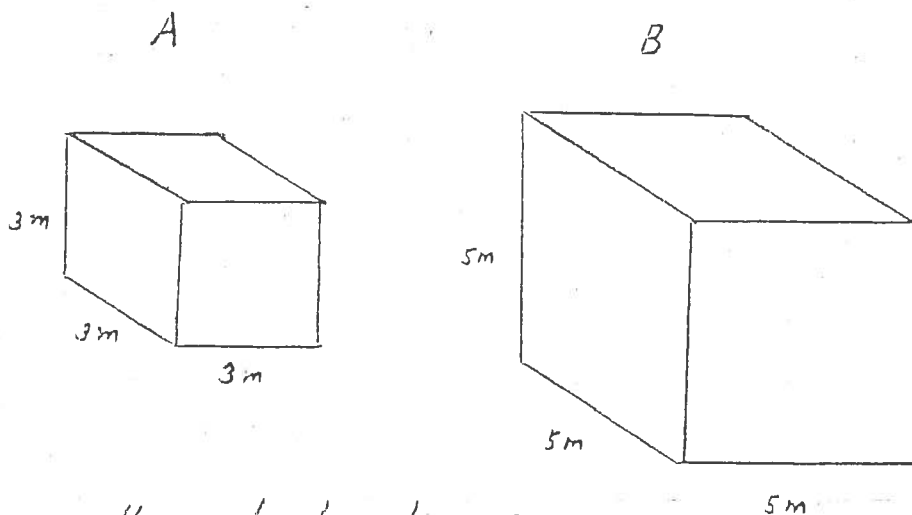
- a) 1/3 as large
- b) 1/6 " "
- ☒ c) 1/9 " "
- d) 1/12 " "

$$\frac{A_f}{A_i} = \left(\frac{r_f}{r_i} \right)^2 ; r_f = \frac{1}{3} r_i$$

$$\frac{A_f}{A_i} = \left(\frac{\frac{1}{3} r_i}{r_i} \right)^2 = \left(\frac{1}{3} \right)^2 = \frac{1}{9} \Rightarrow A_f = \frac{1}{9} A_i$$

6. Which has the larger surface-to-volume ratio? Hint: This can be solved without a calculation.

- a) A
b) B



smaller cube has larger
surface-to-volume ratio

7. A ball of mass 4 kg is dropped from a height of 30 m. What is the ball's kinetic energy when its height is 10 m? (Use $g = 10 \text{ m/s}^2$). HINT: First find the total energy at the release point.

	$h(\text{m})$	$KE(\text{J})$	$GPE(\text{J})$	$E(\text{J})$
a) 1000 J				
b) 800	30	0 ($v=0$)	$4 \cdot 10 \cdot 30 = 1200$	1200
c) 600				
d) 400	10	[?]	$4 \cdot 10 \cdot 10 = 400$	1200

at $h = 10$:

$$KE + 400 = 1200 \Rightarrow KE = 800 \text{ J}$$

8. In convection, internal energy is transferred by....

- a) molecular collisions
b) flow of matter
c) electromagnetic waves
d) chemical reactions taking place at the boundaries

$$\begin{cases} KE = \frac{1}{2}mv^2 \\ GPE = mgh \\ E = KE + GPE \end{cases} \leftarrow \begin{cases} \text{same,} \\ \text{LCE} \end{cases}$$

9. Which statement concerning electromagnetic waves is TRUE?

- a) An electromagnetic wave is just a type of sound wave.
b) Electromagnetic waves cannot travel through any solid substance (like glass).
c) They can travel through the vacuum of space.
d) In vacuum, they travel at different speeds, depending on their wavelengths.

10. How does the volume of a sphere change if its radius is made 3.7 times larger?

- a) 50.7 times larger
b) 34.2 " "
c) 11.1 " "
d) 3.7 " "

$$\frac{V_f}{V_i} = \left(\frac{r_f}{r_i}\right)^3 ; r_f = 3.7 r_i$$

$$\frac{V_f}{V_i} = \left(\frac{3.7 r_i}{r_i}\right)^3 = (3.7)^3 = 50.7 \Rightarrow V_f = 50.7 V_i$$

11. Which illustrates heat conduction ?

- (a) A hot iron block is placed into contact with a cold iron block: internal kinetic energy flows from the hot to the cold block by means of molecular collisions.
- b) A flame heats up air which then flows upward, carrying energy.
- c) The sun sends infrared ("heat") waves to the earth.
- d) None of the above.

12. What is the order of magnitude of the number: $200 \times 32,000$? Hint: First multiply this out.

- a) 10^5
- (b) 10^6
- c) 10^7
- d) 10^8

$$200 \times 32000 = 6,400,000$$

$$= 6.4 \times 10^6$$

13. Which statement concerning work is FALSE ?

- (a) A weightlifter holds a barbell at a steady height above his head: work is being done.
- b) Energy represents the amount of work done.
- c) Doing work on an object involves exerting a force through a distance.
- d) A moving steel block strikes a nail in a tree, pushing the nail further into the tree: work is done on the nail.

14. An electromagnetic wave passes an observer. He measures a time of 2×10^{-9} sec. for one wavelength to cross his location. Find the distance between adjacent peaks of the wave.

- a) 0.7 m
- (b) 0.6
- c) 0.5
- d) 0.4

$$c = \lambda f \Rightarrow \lambda = \frac{c}{f}$$

$$f = \frac{1}{T} = \frac{1}{2 \times 10^{-9} \text{ s}} = 5 \times 10^8 \frac{\text{cycles}}{\text{s}} ; \lambda = \frac{3.0 \times 10^8 \text{ m/s}}{5 \times 10^8 \text{ cycles/s}}$$

$$\lambda = 0.6 \text{ m}$$

15. Which statement concerning density is TRUE ?

- a) Two samples of aluminum of the same size and shape can have different densities.
- b) Aluminum and iron have the same density.
- c) A small marble of iron has a smaller density than a large block of iron.
- (d) A styrofoam object always has a lower density than an iron object, regardless of the size or shape of the objects.

16. What is the surface-to-volume ratio of a cube of edge length 3.5 ?

- a) 1.71
- b) 1.32
- c) 1.05
- d) 0.85

$$SVR = \frac{ TSA }{ V } ; TSA = 6L^2 = 6(3.5)^2 = 73.5$$

$$V = L^3 = (3.5)^3 = 42.9$$

$$SVR = \frac{ 73.5 }{ 42.9 } = 1.71$$

17. Why do you feel colder in water at 70°F than in air at 70°F ?

- a) The water is actually colder than the air since it is a liquid.
- b) Your body temperature reduces to 70°F in both environments.
- c) Water and air can never have the same temperature.
- d) Water is a much better conductor of heat than air and so your body loses heat more readily in water.

18. Energy

- a) is the same as force.
- b) has nothing to do with work.
- c) is an amount of work done.
- d) is not carried by electromagnetic waves.

19. What is the velocity of an object of mass 20 kg and with a kinetic energy of 1000 J ?

- a) 30 m/s
- b) 20
- c) 10
- d) 5

$$KE = \frac{1}{2} m v^2$$

$$2 KE = m v^2$$

$$\frac{2 KE}{m} = v^2$$

$$v = \sqrt{\frac{2 KE}{m}}$$

$$v = \sqrt{\frac{2 \cdot 1000}{20}} = \sqrt{100} = 10$$

20. A typical scaling question is:

- a) If you triple the edge of a cube, how does the volume of the cube change ?
- b) What is the (total) energy E, given values for KE and GPE ?
- c) What is the volume of a sphere ?
- d) What is the wavelength of an electromagnetic wave of a certain frequency ?

21. Which statement concerning the electromagnetic spectrum is TRUE ?

- a) Gamma rays are "heat" waves and they are just a part of sunlight: they are not in the spectrum.
- b) Ultraviolet rays have the longest wavelength in the spectrum.
- c) Microwaves have the smallest wavelength in the spectrum (careful!).
- d) X-rays are not in the spectrum
- ☒ e) Red visible light and violet visible light are in the spectrum.

22. Which is CORRECT ?

- a) If quantity A is a "measure of" quantity B, when B increases, A decreases.
- ☒ b) The weight of an object (on the surface of the Earth) is a measure of the number of molecules in the object.
- c) The volume of a cube is not a measure of its edge length.
- d) None of the above is correct.

23. Which statement concerning solids is TRUE ?

- a) In a crystalline solid, the molecules are in a random pattern and oscillate
- b) In an amorphous solid, the molecules are in a repeating, regular, geometric pattern and do not move at all
- c) In a crystalline solid, the molecules are not "close-packed"
- ☒ d) In an amorphous solid, the molecules are in a random pattern and are vibrating

24. A substance has a "large" specific heat. Which is TRUE ?

- a) If a "large" amount of heat is added to it, there will be no increase in temperature whatsoever.
- ☒ b) A "large" amount of heat has to be added to 1 gm of this substance to increase its temperature by 1°C.
- c) Iron is an example of such a substance.
- d) If a "small" amount of heat is added to 1 gm of this substance, the temperature will increase by 1°C.

25. Which statement concerning temperature is FALSE ?

- a) The higher the temperature, the more rapid is the motion of the molecules.
- ☒ b) As the temperature is increased, the kinetic energy of each molecule of a substance decreases, while the potential energy of each molecule increases.
- c) On the Kelvin scale, 100 degrees separate the freezing point of water from the boiling point of water.
- d) At absolute zero, the system is at its lowest possible temperature.

26. Compared to a giant iceberg, a cup of hot coffee has

- a) a higher temperature, but less internal kinetic energy.
- b) more internal kinetic energy and higher temperature.
- c) a greater specific heat and more internal kinetic energy.
- d) - None of the above.

27. Which statement concerning the atom is TRUE?

- a) The nucleus contains protons and electrons.
- b) Most of the atom's mass is in the electron cloud.
- c) The radius of the nucleus is much smaller than the radius of the electron cloud.
- d) In an atom, there are about 10 times as many electrons in the large electron cloud as there are protons in the small nucleus.

28. Which statement is TRUE ?

- a) In a gas the molecules are close-packed and "slide" around each other.
- b) In a liquid the molecules are in a regular, geometric pattern and vibrate.
- c) In a gas the molecules have a motion which is vibrational in nature.
- d) In a liquid, the molecules are in a random pattern and slide past each other.

29. Absolute zero

- a) occurs at -273 degrees on the absolute (Kelvin) scale.
- b) is the highest temperature that a solid can have before it liquefies into the liquid state.
- c) occurs at minus one million degrees on the Centigrade scale.
- d) is the lowest temperature which a system can theoretically reach.
- e) has nothing to do with temperature.

30. Water has a specific heat of 1 cal/gm°C. If 20 cal of heat is added to 5 gm of water, by how much does the temperature of the water increase ?

- a) 4 °C
- b) 6
- c) 2
- d) 8

$$\text{add 1 cal to 1gm water} \Rightarrow T \uparrow 1^\circ\text{C}$$

$$\text{" 20 cal " 1gm " } \Rightarrow T \uparrow 20^\circ\text{C}$$

$$\text{" 20 cal " 5gm " } \Rightarrow T \uparrow \frac{20}{5} = 4^\circ\text{C}$$

$$\text{or: } Q = mc\Delta T$$

$$\Rightarrow \Delta T = \frac{Q}{mc}$$

$$\Delta T = \frac{20 \text{ cal}}{5 \text{ gm} (1 \text{ cal/gm}^\circ\text{C})} = 4^\circ\text{C}$$