Additional Problems

Chapter 1 The Science of Physics

1. Mt. Waialeale in Hawaii gets 1.168×10^3 cm of rainfall per year. Express this quantity in meters.
2. An acre is equal to about 4.0469×10^3 m^2. Express this area in square kilometers.
3. A group drinks about 6.4×10^4 cm^3 of water per person per year. Express this in cubic meters.
4. The largest stone jar on the Plain of Jars in Laos has a mass of 6.0×10^3 kg. Express this mass in milligrams.
5. Half of a sample of the radioactive isotope beryllium-8 decays in 6.7×10^{-17} s. Express this time in picoseconds.

Chapter 2 Motion in One Dimension

6. The fastest airplane is the Lockheed SR-71. If an SR-71 flies 15.0 km west in 15.3 s, what is its average velocity in kilometers per hour?
7. Except for a 22.0 min rest stop, Emily drives with a constant velocity of 89.5 km/h, north. How long does the trip take if Emily's average velocity is 77.8 km/h, north?
8. A spaceship accelerates uniformly for 1220 km. How much time is required for the spaceship to increase its speed from 11.1 km/s to 11.7 km/s?
9. A polar bear initially running at 4.0 m/s accelerates uniformly for 18 s. If the bear travels 135 m in this time, what is its maximum speed?
10. A walrus accelerates from 7.0 km/h to 34.5 km/h over a distance of 95 m. What is the magnitude of the walrus's acceleration?
11. A snail can move about 4.0 m in 5.0 min. What is the average speed of the snail?
12. A crate is accelerated at 0.035 m/s^2 for 28.0 s along a conveyor belt. If the crate's initial speed is 0.76 m/s, what is its final speed?
13. A person throws a ball vertically and catches it after 5.10 s. What is the ball's initial velocity?
14. A bicyclist accelerates –0.870 m/s^2 during a 3.80 s interval. What is the change in the velocity of the bicyclist and bicycle?
15. A hockey puck slides 55.0 m in 1.25 s with a uniform acceleration. If the puck's final speed is 43.2 m/s, what was its initial speed?
16. A small rocket launched from rest travels 12.4 m upward in 2.0 s. What is the rocket's net acceleration?
17. A jet slows uniformly from 153 km/h to 0 km/h over 42.0 m. What is the jet's acceleration?
18. A softball thrown straight up at 17.5 m/s is caught 3.60 s later. How high does the ball rise?
19. A child, starting from rest, sleds down a snow-covered slope in 5.50 s. If the child's final speed is 14.0 m/s, what the length of the slope?
20. A sky diver opens her parachute and drifts down for 34.0 s with a constant velocity of 6.50 m/s. What is the sky diver's displacement?
21. In a race, a tortoise runs at 10.0 cm/s and a hare runs at 200.0 cm/s. Both start at the same time, but the hare stops to rest for 2.00 min. The tortoise wins by 20.0 cm. At what time does the tortoise cross the finish line?
22. What is the length of the race in problem 21?
23. The cable pulling an elevator upward at 12.5 m/s breaks. How long does it take for the elevator to come to rest?
24. A disk is uniformly accelerated from rest for 0.910 s over 7.19 km. What is its final speed?
25. A tiger accelerates 3.0 m/s^2 for 4.1 s to reach a final speed of 55.0 km/h. What was its initial speed in kilometers per hour?
26. A shark accelerates uniformly from 2.8 km/h to 32.0 km/h in 1.5 s. How large is its acceleration?
27. The 1903 Wright flyer was accelerated at 4.88 m/s^2 along a track that was 18.3 m long. How long did it take to accelerate the flyer from rest?
28. A drag racer starts at rest and reaches a speed of 386.0 km/h with an average acceleration of 16.5 m/s^2. How long does this acceleration take?
29. A hummingbird accelerates at –9.20 m/s^2 such that its velocity changes from +50.0 km/h to 0 km/h. What is its displacement?
30. A train backs up from an initial velocity of –4.0 m/s and an average acceleration of –0.27 m/s^2. What is the train's velocity after 17 s?
31. A cross-country skier skiing with an initial velocity of +4.42 m/s slows uniformly at –0.75 m/s^2. How long does it take the skier to stop?

32. What is the skier's displacement in problem 31?

33. A speedboat uniformly increases its speed from 25 m/s west to 35 m/s west. How long does it take the boat to travel 250 m west?

34. A ship accelerates at -7.6×10^{-2} m/s^2 so that it comes to rest at the dock 255 m away in 82.0 s. What is the ship's initial speed?

35. A student skates downhill with an average acceleration of 0.85 m/s^2. Her initial speed is 4.5 m/s, and her final speed is 10.8 m/s. How long does she take to skate down the hill?

36. A wrench dropped from a tall building is caught in a safety net when the wrench has a velocity of −49.5 m/s. How far did it fall?

37. A rocket sled comes to a complete stop from a speed of 320 km/h in 0.18 s. What is the sled's average acceleration?

38. A racehorse uniformly accelerates 7.56 m/s^2, reaching its final speed after running 19.0 m. If the horse starts at rest, what is its final speed?

39. An arrow is shot upward at a speed of 85.1 m/s. How long does the archer have to move from the launching spot before the arrow returns to Earth?

40. A handball strikes a wall with a forward speed of 13.7 m/s and bounces back with a speed of 11.5 m/s. If the ball changes velocity in 0.021 s, what is the handball's average acceleration?

41. A ball accelerates at 6.1 m/s^2 from 1.8 m/s to 9.4 m/s. How far does the ball travel?

42. A small sandbag is dropped from rest from a hovering hot-air balloon. After 2.0 s, what is the sandbag's displacement below the balloon?

43. A hippopotamus accelerates at 0.678 m/s^2 until it reaches a speed of 8.33 m/s. If the hippopotamus runs 46.3 m, what was its initial speed?

44. A ball is hit upward with a speed of 7.5 m/s. How long does the ball take to reach maximum height?

45. A surface probe on the planet Mercury falls 17.6 m downward from a ledge. If free-fall acceleration near Mercury is −3.70 m/s^2, what is the probe's velocity when it reaches the ground?

Chapter 3 Two-Dimensional Motion and Vectors

46. A plane moves 599 m northeast along a runway. If the northern component of this displacement is 89 m, how large is the eastern component?

47. Find the displacement direction in problem 46.

48. A train travels 478 km southwest along a straight stretch. If the train is displaced south by 42 km, what is the train's displacement to the west?

49. Find the displacement direction in problem 48.

50. A ship's total displacement is 7400 km at 26° south of west. If the ship sails 3200 km south, what is the western component of its journey?

51. The distance from an observer on a plain to the top of a nearby mountain is 5.3 km at 8.4° above the horizontal. How tall is the mountain?

52. A skyrocket travels 113 m at an angle of 82.4° with respect to the ground and toward the south. What is the rocket's horizontal displacement?

53. A hot-air balloon descends with a velocity of 55 km/h at an angle of 37° below the horizontal. What is the vertical velocity of the balloon?

54. A stretch of road extends 55 km at 37° north of east, then continues for 66 km due east. What is a driver's resultant displacement along this road?

55. A driver travels 4.1 km west, 17.3 km north, and finally 1.2 km at an angle of 24.6° west of north. What is the driver's displacement?

56. A tornado picks up a car and hurls it horizontally 125 m with a speed of 90.0 m/s. How long does it take the car to reach the ground?

57. A squirrel knocks a nut horizontally at a speed of 10.0 cm/s. If the nut lands at a horizontal distance of 18.6 cm, how high up is the squirrel?

58. A flare is fired at an angle of 35° to the ground at an initial speed of 250 m/s. How long does it take for the flare to reach its maximum altitude?

59. A football kicked with an initial speed of 23.1 m/s reaches a maximum height of 16.9 m. At what angle was the ball kicked?

60. A bird flies north at 58.0 km/h relative to the wind. The wind is blowing at 55.0 km/h south relative to Earth. How long will it take the bird to fly 1.4 km relative to Earth?

61. A race car moving at 286 km/h is 0.750 km behind a car moving at 252 km/h. How long will it take the faster car to catch up to the slower car?

62. A helicopter flies 165 m horizontally and then moves downward to land 45 m below. What is the helicopter's resultant displacement?

63. A toy parachute floats 13.0 m downward. If the parachute travels 9.0 m horizontally, what is the resultant displacement?

64. A billiard ball travels 2.7 m at an angle of 13° with respect to the long side of the table. What are the components of the ball's displacement?

65. A golf ball has a velocity of 1.20 m/s at 14.0° east of north. What are the velocity components?

66. A tiger leaps with an initial velocity of 55.0 km/h at an angle of 13.0° with respect to the horizontal. What are the components of the tiger's velocity?

67. A tramway extends 3.88 km up a mountain from a station 0.8 km above sea level. If the horizontal displacement is 3.45 km, how far above sea level is the mountain peak?

68. A bullet travels 850 m, ricochets, and moves another 640 m at an angle of 36° from its previous forward motion. What is the bullet's resultant displacement?

69. A bird flies 46 km at 15° south of east, then 22 km at 13° east of south, and finally 14 km at 14° west of south. What is the bird's displacement?

70. A ball is kicked with a horizontal speed of 9.37 m/s off the top of a mountain. The ball moves 85.0 m horizontally before hitting the ground. How tall is the mountain?

71. A ball is kicked with a horizontal speed of 1.50 m/s from a height of 2.50×10^2 m. What is its horizontal displacement when it hits the ground?

72. What is the velocity of the ball in problem 71 when it reaches the ground?

73. A shingle slides off a roof at a speed of 2.0 m/s and an angle of 30.0° below the horizontal. How long does it take the shingle to fall 45 m?

74. A ball is thrown with an initial speed of 10.0 m/s and an angle of 37.0° above the horizontal. What are the vertical and horizontal components of the ball's displacement after 2.5 s?

75. A rocket moves north at 55.0 km/h with respect to the air. It encounters a wind from 17.0° north of west at 40.0 km/h with respect to Earth. What is the rocket's velocity with respect to Earth?

76. How far to the north and west does the rocket in problem 75 travel after 15.0 min?

77. A cable car travels 2.00×10^2 m on level ground, then 3.00×10^2 m at an incline of 3.0°, and then 2.00×10^2 m at an incline of 8.8°. What is the final displacement of the cable car?

78. A hurricane moves 790 km at 18° north of west, then due west for 150 km, then north for 470 km, and finally 15° east of north for 240 km. What is the hurricane's resultant displacement?

79. What is the range of an arrow shot horizontally at 85.3 m/s from 1.50 m above the ground?

80. A drop of water in a fountain takes 0.50 s to travel 1.5 m horizontally. The water is projected upward at an angle of 33°. What is the drop's initial speed?

81. A golf ball is hit up a 41.0° ramp to travel 4.46 m horizontally and 0.35 m below the edge of the ramp. What is the ball's initial speed?

82. A flare is fired with a velocity of 87 km/h west from a car traveling 145 km/h north. With respect to Earth, what is the flare's resultant displacement 0.45 s after being launched?

83. A sailboat travels south at 12.0 km/h with respect to the water against a current 15.0° south of east at 4.0 km/h. What is the boat's velocity?

Chapter 4 Forces and the Laws of Motion

84. A boat exerts a 9.5×10^4 N force 15.0° north of west on a barge. Another exerts a 7.5×10^4 N force north. What direction is the barge moved?

85. A shopper exerts a force on a cart of 76 N at an angle of 40.0° below the horizontal. How much force pushes the cart in the forward direction?

86. How much force pushes the cart in problem 85 against the floor?

87. What are the magnitudes of the largest and smallest net forces that can be produced by combining a force of 6.0 N and a force of 8.0 N?

88. A buoyant force of 790 N lifts a 214 kg sinking boat. What is the boat's net acceleration?

89. A house is lifted by a net force of 2850 N and moves from rest to an upward speed of 15 cm/s in 5.0 s. What is the mass of the house?

90. An 8.0 kg bag is lifted 20.0 cm in 0.50 s. If it is initially at rest, what is the net force on the bag?

91. A 90.0 kg skier glides at constant speed down a 17.0° slope. Find the frictional force on the skier.

92. A snowboarder slides down a 5.0° slope at a constant speed. What is the coefficient of kinetic friction between the snow and the board?

93. A 2.00 kg block is in equilibrium on a 36.0° incline. What is the normal force on the block?

94. A 1.8×10^3 kg car is parked on a hill on a 15.0° incline. A 1.25×10^4 N frictional force holds the car in place. Find the coefficient of static friction.

95. The coefficient of kinetic friction between a jar slid across a table and the table is 0.20. What is the magnitude of the jar's acceleration?

96. A force of 5.0 N to the left causes a 1.35 kg book to have a net acceleration of 0.76 m/s^2 to the left. What is the frictional force on the book?

97. A child pulls a toy by exerting a force of 15.0 N at an angle of 55.0° with respect to the floor. What are the components of the force?

98. A car is pulled by three forces: 600.0 N to the north, 750.0 N to the east, and 675 N at 30.0° south of east. What direction does the car move?

99. Suppose a catcher exerts a force of −65.0 N to stop a baseball with a mass of 0.145 kg. What is the ball's net acceleration as it is being caught?

100. A 2.0 kg fish pulled upward by a fisherman rises 1.9 m in 2.4 s, starting from rest. What is the net force on the fish during this interval?

101. An 18.0 N force pulls a cart against a 15.0 N frictional force. The speed of the cart increases 1.0 m/s every 5.0 s. What is the cart's mass?

102. A 47 kg sled carries a 33 kg load. The coefficient of kinetic friction between the sled and snow is 0.075. What is the magnitude of the frictional force on the sled as it moves up a hill with a 15° incline?

103. Ice blocks slide with an acceleration of 1.22 m/s^2 down a chute at an angle of 12.0° below the horizontal. What is the coefficient of kinetic friction between the ice and chute?

104. A 1760 N force pulls a 266 kg load up a 17° incline. What is the coefficient of static friction between the load and the incline?

105. A 4.26×10^7 N force pulls a ship at a constant speed along a dry dock. The coefficient of kinetic friction between the ship and dry dock is 0.25. Find the normal force exerted on the ship.

106. If the incline of the dry dock in problem 105 is 10.0°, what is the ship's mass?

107. A 65.0 kg skier is pulled up an 18.0° slope by a force of 2.50×10^2 N. If the net acceleration uphill is 0.44 m/s^2, what is the frictional force between the skis and the snow?

108. Four forces are acting on a hot-air balloon: $\mathbf{F_1}$ = 2280.0 N up, $\mathbf{F_2}$ = 2250.0 N down, $\mathbf{F_3}$ = 85.0 N west, and $\mathbf{F_4}$ = 12.0 N east. What is the direction of the net external force on the balloon?

109. A traffic signal is supported by two cables, each of which makes an angle of 40.0° with the vertical. If each cable can exert a maximum force of 7.50×10^2 N, what is the largest weight they can support?

110. A certain cable of an elevator is designed to exert a force of 4.5×10^4 N. If the maximum acceleration that a loaded car can withstand is 3.5 m/s^2, what is the combined mass of the car and its contents?

111. A frictional force of 2400 N keeps a crate of machine parts from sliding down a ramp with an incline of 30.0°. The coefficient of static friction between the box and the ramp is 0.20. What is the normal force of the ramp on the box?

112. Find the mass of the crate in problem 111.

113. A 5.1×10^2 kg bundle of bricks is pulled up a ramp at an incline of 14° to a construction site. The force needed to move the bricks up the ramp is 4.1×10^3 N. What is the coefficient of static friction between the bricks and the ramp?

Chapter 5 Work and Energy

114. If 2.13×10^6 J of work must be done on a roller-coaster car to move it 3.00×10^2 m, how large is the net force acting on the car?

115. A force of 715 N is applied to a roller-coaster car to push it horizontally. If 2.72×10^4 J of work is done on the car, how far has it been pushed?

116. In 0.181 s, through a distance of 8.05 m, a test pilot's speed decreases from 88.9 m/s to 0 m/s. If the pilot's mass is 70.0 kg, how much work is done against his body?

117. What is the kinetic energy of a disk with a mass of 0.20 g and a speed of 15.8 km/s?

118. A 9.00×10^2 kg walrus is swimming at a speed of 35.0 km/h. What is its kinetic energy?

119. A golf ball with a mass of 47.0 g has a kinetic energy of 1433 J. What is the ball's speed?

120. A turtle, swimming at 9.78 m/s, has a kinetic energy of 6.08×10^4 J. What is the turtle's mass?

121. A 50.0 kg parachutist is falling at a speed of 47.00 m/s when her parachute opens. Her speed upon landing is 5.00 m/s. How much work is done by the air to reduce the parachutist's speed?

122. An 1100 kg car accelerates from 48.0 km/h to 59.0 km/h over 100.0 m. What was the magnitude of the net force acting on it?

123. What is the gravitational potential energy of a 64.0 kg person at 5334 m above sea level?

124. A spring has a force constant of 550 N/m. What is the elastic potential energy stored in the spring when the spring is compressed 1.2 cm?

125. What is the kinetic energy of a 0.500 g raindrop that falls 0.250 km? Ignore air resistance.

126. A 50.0 g projectile is fired upward at 3.00×10^2 m/s and lands at 89.0 m/s. How much mechanical energy is lost to air resistance?

127. How long does it take for 4.5×10^6 J of work to be done by a 380.3 kW engine?

128. A ship's engine has a power output of 13.0 MW. How much work can it do in 15.0 min?

129. A catcher picks up a baseball from the ground with a net upward force of 7.25×10^{-2} N so that 4.35×10^{-2} J of net work is done. How far is the ball lifted?

130. A crane does 1.31×10^3 J of net work when lifting cement 76.2 m. How large is the net force doing this work?

131. A girl exerts a force of 35.0 N at an angle of 20.0° to the horizontal to move a wagon 15.0 m along a level path. What is the net work done on it if a frictional force of 24.0 N is present?

132. The *Queen Mary* had a mass of 7.5×10^7 kg and a top cruising speed of 57 km/h. What was the kinetic energy of the ship at that speed?

133. How fast is a 55.0 kg sky diver falling when her kinetic energy is 7.81×10^4 J?

134. A hockey puck with an initial speed of 8.0 m/s coasts 45 m to a stop. If the force of friction on the puck is 0.12 N, what is the puck's mass?

135. How far does a 1.30×10^4 kg jet travel if it is slowed from 2.40×10^2 km/h to 0 km/h by an acceleration of -30.8 m/s^2?

136. An automobile is raised 7.0 m, resulting in an increase in gravitational potential energy of 6.6×10^4 J. What is the automobile's mass?

137. A spring in a pogo stick has a force constant of 1.5×10^4 N/m. How far is the spring compressed when its elastic potential energy is 120 J?

138. A 100.0 g arrow is pulled back 30.0 cm against a bowstring. The bowstring's force constant is 1250 N/m. What speed will the arrow leave the bow?

139. A ball falls 3.0 m down a vertical pipe, the end of which bends horizontally. How fast does the ball leave the pipe if no energy is lost to friction?

140. A spacecraft's engines do 1.4×10^{13} J of work in 8.5 min. What is the power output of these engines?

141. A runner exerts a force of 334 N against the ground while using 2100 W of power. How long does it take him to run a distance of 50.0 m?

142. A high-speed boat has four 300.0 kW motors. How much work is done in 25 s by the motors?

143. A 92 N force pushes an 18 kg box of books, initially at rest, 7.6 m across a floor. The coefficient of kinetic friction between the floor and the box is 0.35. What is the final kinetic energy of the box of books?

144. A guardrail can be bent by 5.00 cm and then restore its shape. What is its force constant if struck by a car with 1.09×10^4 J of kinetic energy?

145. A 25.0 kg trunk strikes the ground with a speed of 12.5 m/s. If no energy is lost from air resistance, what is the height from which the trunk fell?

146. Sliding a 5.0 kg stone up a frictionless ramp with a 25.0° incline increases its gravitational potential energy by 2.4×10^2 J. How long is the ramp?

147. A constant 4.00×10^2 N force moves a 2.00×10^2 kg iceboat 0.90 km. Frictional force is negligible, and the boat starts at rest. Find the boat's final speed.

148. A 50.0 kg circus clown jumps from a platform into a net 1.00 m above the ground. The net is stretched 0.65 m and has a force constant of 3.4×10^4 N/m. What is the height of the platform?

Chapter 6 Momentum and Collisions

149. If a 50.0 kg cheetah, initially at rest, runs 274 m north in 8.65 s, what is its momentum?

150. If a 1.46×10^5 kg whale has a momentum of 9.73×10^5 kg•m/s to the south, what is its velocity?

151. A star has a momentum of 8.62×10^{36} kg•m/s and a speed of 255 km/s. What is its mass?

152. A 5.00 g projectile has a velocity of 255 m/s right. Find the force to stop this projectile in 1.45 s.

153. How long does it take a 0.17 kg hockey puck to decrease its speed by 9.0 m/s if the coefficient of kinetic friction is 0.050?

154. A 705 kg race car driven by a 65 kg driver moves with a velocity of 382 km/h right. Find the force to bring the car and driver to a stop in 12.0 s.

155. Find the stopping distance in problem 154.

156. A 50.0 g shell fired from a 3.00 kg rifle has a speed of 400.0 m/s. With what velocity does the rifle recoil in the opposite direction?

157. A twig at rest in a pond moves with a speed of 0.40 cm/s opposite a 2.5 g snail, which has a speed of 1.2 cm/s. What is the mass of the twig?

158. A 25.0 kg sled holding a 42.0 kg child has a speed of 3.50 m/s. They collide with and pick up a snowman, initially at rest. The resulting speed of the snowman, sled, and child is 2.90 m/s. What is the snowman's mass?

159. An 8500 kg railway car moves right at 4.5 m/s, and a 9800 kg railway car moves left at 3.9 m/s. The cars collide and stick together. What is the final velocity of the system?

160. What is the change in kinetic energy for the two railway cars in problem 159?

161. A 55 g clay ball moving at 1.5 m/s collides with a 55 g clay ball at rest. By what percentage does the kinetic energy change after the inelastic collision?

162. A 45 g golf ball collides elastically with an identical ball at rest and stops. If the second ball's final speed is 3.0 m/s, what was the first ball's initial speed?

163. A 5.00×10^2 kg racehorse gallops with a momentum of 8.22×10^3 kg•m/s to the west. What is the horse's velocity?

164. A 3.0×10^7 kg ship collides elastically with a 2.5×10^7 kg ship moving north at 4.0 km/h. After the collision, the first ship moves north at 3.1 km/h and the second ship moves south at 6.9 km/h. Find the unknown velocity.

165. A high-speed train has a mass of 7.10×10^5 kg and moves at a speed of 270.0 km/h. What is the magnitude of the train's momentum?

166. A bird with a speed of 50.0 km/h has a momentum of magnitude of 0.278 kg•m/s. What is the bird's mass?

167. A 75 N force pulls a child and sled initially at rest down a snowy hill. If the combined mass of the sled and child is 55 kg, what is their speed after 7.5 s?

168. A student exerts a net force of −1.5 N over a period of 0.25 s to bring a falling 60.0 g egg to a stop. What is the egg's initial speed?

169. A 1.1×10^3 kg walrus starts swimming east from rest and reaches a velocity of 9.7 m/s in 19 s. What is the net force acting on the walrus?

170. A 12.0 kg wagon at rest is pulled by a 15.0 N force at an angle of 20.0° above the horizontal. If an 11.0 N frictional force resists the forward force, how long will the wagon take to reach a speed of 4.50 m/s?

171. A 42 g meteoroid moving forward at 7.82×10^3 m/s collides with a spacecraft. What force is needed to stop the meteoroid in 1.0×10^{-6} s?

172. A 455 kg polar bear slides for 12.2 s across the ice. If the coefficient of kinetic friction between the bear and the ice is 0.071, what is the change in the bear's momentum as it comes to a stop?

173. How far does the bear in problem 172 slide?

174. How long will it take a -1.26×10^4 N force to stop a 2.30×10^3 kg truck moving at a speed of 22.2 m/s?

175. A 63 kg skater at rest catches a sandbag moving north at 5.4 m/s. The skater and bag then move north at 1.5 m/s. Find the sandbag's mass.

176. A 1.36×10^4 kg barge is loaded with 8.4×10^3 kg of coal. What was the unloaded barge's speed if the loaded barge has a speed of 1.3 m/s?

177. A 1292 kg automobile moves east at 88.0 km/h. If all forces remain constant, what is the car's velocity if its mass is reduced to 1255 kg?

178. A 68 kg student steps into a 68 kg boat at rest, causing both to move west at a speed of 0.85 m/s. What was the student's initial velocity?

179. A 1400 kg automobile, heading north at 45 km/h, collides inelastically with a 2500 kg truck traveling east at 33 km/h. What is the vehicles' final velocity?

180. An artist throws 1.3 kg of paint onto a 4.5 kg canvas at rest. The paint-covered canvas slides backward at 0.83 m/s. What is the change in the kinetic energy of the paint and canvas?

181. Find the change in kinetic energy if a 0.650 kg fish leaping to the right at 15.0 m/s collides inelastically with a 0.950 kg fish leaping to the left at 13.5 m/s.

182. A 10.0 kg cart moving at 6.0 m/s hits a 2.5 kg cart moving at 3.0 m/s in the opposite direction. Find the carts' final speed after an inelastic collision.

183. A ball, thrown right 6.00 m/s, hits a 1.25 kg panel at rest, then bounces back at 4.90 m/s. The panel moves right at 1.09 m/s. Find the ball's mass.

184. A 2150 kg car, moving east at 10.0 m/s, collides and joins with a 3250 kg car. The cars move east together at 5.22 m/s. What is the 3250 kg car's initial velocity?

185. Find the change in kinetic energy in problem 184.

186. A 15.0 g toy car moving to the right at 20.0 cm/s collides elastically with a 20.0 g toy car moving left at 30.0 cm/s. The 15.0 g car then moves left at 37.1 cm/s. Find the 20.0 g car's final velocity.

187. A remora swimming right at 5.0 m/s attaches to a 150.0 kg shark moving left at 7.00 m/s. Both move left at 6.25 m/s. Find the remora's mass.

188. A 6.5×10^{12} kg comet, moving at 420 m/s, catches up to and collides inelastically with a 1.50×10^{13} kg comet moving at 250 m/s. Find the change in the comets' kinetic energy.

189. A 7.00 kg ball moves east at 2.00 m/s, collides with a 7.00 kg ball at rest, and then moves 30.0° north of east at 1.73 m/s. What is the second ball's final velocity?

190. A 2.0 kg block moving at 8.0 m/s on a frictionless surface collides elastically with a block at rest. The first block moves in the same direction at 2.0 m/s. What is the second block's mass?

Chapter 7 Circular Motion and Gravitation

191. A pebble that is 3.81 m from the eye of a tornado has a tangential speed of 124 m/s. What is the magnitude of the pebble's centripetal acceleration?

192. A race car speeds along a curve with a tangential speed of 75.0 m/s. The centripetal acceleration on the car is 22.0 m/s^2. Find the radius of the curve.

193. A subject in a large centrifuge has a radius of 8.9 m and a centripetal acceleration of 20g ($g = 9.81\ m/s^2$). What is the tangential speed of the subject?

194. A 1250 kg automobile with a tangential speed of 48.0 km/h follows a circular road that has a radius of 35.0 m. How large is the centripetal force?

195. A rock in a sling is 0.40 m from the axis of rotation and has a tangential speed of 6.0 m/s. What is the rock's mass if the centripetal force is 8.00×10^2 N?

196. A 7.55×10^{13} kg comet orbits the sun with a speed of 0.173 km/s. If the centripetal force on the comet is 505 N, how far is it from the sun?

197. A 2.05×10^8 kg asteroid has an orbit with a 7378 km radius. The centripetal force on the asteroid is 3.00×10^9 N. Find the asteroid's tangential speed.

198. Find the gravitational force between a 0.500 kg mass and a 2.50×10^{12} kg mountain that is 10.0 km away.

199. The gravitational force between Ganymede and Jupiter is 1.636×10^{22} N. Jupiter's mass is 1.90×10^{27} kg, and the distance between the two bodies is 1.071×10^6 km. What is Ganymede's mass?

200. At the sun's surface, the gravitational force on 1.00 kg is 274 N. The sun's mass is 1.99×10^{30} kg. If the sun is assumed spherical, what is the sun's radius?

201. At the surface of a red giant star, the gravitational force on 1.00 kg is only 2.19×10^{-3} N. If its mass equals 3.98×10^{31} kg, what is the star's radius?

202. Uranus has a mass of 8.6×10^{25} kg. The mean distance between the centers of the planet and its moon Miranda is 1.3×10^5 km. If the orbit is circular, what is Miranda's period in hours?

203. What is the tangential speed in problem 202?

204. The rod connected halfway along the 0.660 m radius of a wheel exerts a 2.27×10^5 N force. How large is the maximum torque?

205. A golfer exerts a torque of 0.46 N•m on a golf club. If the club exerts a force of 0.53 N on a stationary golf ball, what is the length of the club?

206. What is the orbital radius of the Martian moon Deimos if it orbits 6.42×10^{23} kg Mars in 30.3 h?

207. A 4.00×10^2 N•m torque is produced applying a force 1.60 m from the fulcrum and at an angle of 80.0° to the lever. How large is the force?

208. A customer 11 m from the center of a revolving restaurant has a speed of 1.92×10^{-2} m/s. How large a centripetal acceleration acts on the customer?

209. A toy train on a circular track has a tangential speed of 0.35 m/s and a centripetal acceleration of 0.29 m/s^2. What is the radius of the track?

210. A person against the inner wall of a hollow cylinder with a 150 m radius feels a centripetal acceleration of 9.81 m/s^2. Find the cylinder's tangential speed.

211. The tangential speed of 0.20 kg toy carts is 5.6 m/s when they are 0.25 m from a turning shaft. How large is the centripetal force on the carts?

212. A 1250 kg car on a curve with a 35.0 m radius has a centripetal force from friction and gravity of 8.07×10^3 N. What is the car's tangential speed?

213. Two wrestlers, 2.50×10^{-2} m apart, exert a 2.77×10^{-3} N gravitational force on each other. One has a mass of 157 kg. What is the other's mass?

214. A 1.81×10^5 kg blue whale is 1.5 m from a 2.04×10^4 kg whale shark. What is the gravitational force between them?

215. Triton's orbit around Neptune has a radius of 3.56×10^5 km. Neptune's mass is 1.03×10^{26} kg. What is Triton's period?

216. Find the tangential speed in problem 215.

217. A moon orbits a 1.0×10^{26} kg planet in 365 days. What is the radius of the moon's orbit?

218. What force is required to produce a 1.4 N•m torque when applied to a door at a 60.0° angle and 0.40 m from the hinge?

219. What is the maximum torque that the force in problem 218 can exert?

220. A worker hanging 65.0° from the vane of a windmill exerts an 8.25×10^3 N•m torque. If the worker weighs 587 N, what is the vane's length?

Chapter 8 Fluid Mechanics

221. A cube of volume 1.00 m^3 floats in gasoline, which has a density of 675 kg/m^3. How large a buoyant force acts on the cube?

222. A cube 10.0 cm on each side has a density of 2.053×10^4 kg/m^3. Its apparent weight in fresh water is 192 N. Find the buoyant force.

223. A 1.47×10^6 kg steel hull has a base that is 2.50×10^3 m^2 in area. If it is placed in sea water ($\rho = 1.025 \times 10^3$ kg/m^3), how deep does the hull sink?

224. What size force will open a door of area 1.54 m^2 if the net pressure on the door is 1.013×10^3 Pa?

225. Gas at a pressure of 1.50×10^6 Pa exerts a force of 1.22×10^4 N on the upper surface of a piston. What is the piston's upper surface area?

226. In a barometer, the mercury column's weight equals the force from air pressure on the mercury's surface. Mercury's density is 13.6×10^3 kg/m^3. What is the air's pressure if the column is 760 mm high?

227. A cube of osmium with a volume of 166 cm^3 is placed in fresh water. The cube's apparent weight is 35.0 N. What is the density of osmium?

228. A block of ebony with a volume of 2.5×10^{-3} m^3 is placed in fresh water. If the apparent weight of the block is 7.4 N, what is the density of ebony?

229. One piston of a hydraulic lift holds 1.40×10^3 kg. The other holds an ice block ($\rho = 917$ kg/m^3) that is 0.076 m thick. Find the first piston's area.

230. A hydraulic-lift piston raises a 4.45×10^4 N weight by 448 m. How large is the force on the other piston if it is pushed 8.00 m downward?

231. A platinum flute with a density of 21.5 g/cm^3 is submerged in fresh water. If its apparent weight is 40.2 N, what is the flute's mass?

Chapter 9 Heat

232. Surface temperature on Mercury ranges from 463 K during the day to 93 K at night. Express this temperature range in degrees Celsius.

233. Solve problem 233 for degrees Fahrenheit.

234. The temperature in Fort Assiniboine, Montana, went from –5°F to +37°F on January 19, 1892. Calculate this change in temperature in kelvins.

235. An acorn falls 9.5 m, absorbing 0.85 of its initial potential energy. If 1200 J/kg will raise the acorn's temperature 1.0°C, what is its temperature increase?

236. A bicyclist on level ground brakes from 13.4 m/s to 0 m/s. What is the cyclist's and bicycle's mass if the increase in internal energy is 5836 J?

237. A 61.4 kg roller skater on level ground brakes from 20.5 m/s to 0 m/s. What is the total change in the internal energy of the system?

238. A 0.225 kg tin can ($c_p = 2.2 \times 10^3$ J/kg•°C) is cooled in water, to which it transfers 3.9×10^4 J of energy. By how much does the can's temperature change?

239. What mass of bismuth ($c_p = 121$ J/kg•°C) increases temperature by 5.0°C when 25 J are added by heat?

240. Placing a 0.250 kg pot in 1.00 kg of water raises the water's temperature 1.00°C. The pot's temperature drops 17.5°C. Find the pot's specific heat capacity.

241. Lavas at Kilauea in Hawaii have temperatures of 2192°F. Express this quantity in degrees Celsius.

242. The present temperature of the background radiation in the universe is 2.7 K. What is this temperature in degrees Celsius?

243. The human body cannot survive at a temperature of 42°C for very long. Express this quantity in kelvins.

244. Two sticks rubbed together gain 2.15×10^4 J from kinetic energy and lose 33 percent of it to the air. How much does the sticks' internal energy change?

245. A stone falls 561.7 m. When the stone lands, the internal energy of the ground and the stone increases by 105 J. What is the stone's mass?

246. A 2.5 kg block of ice at 0.0°C slows on a level floor from 5.7 m/s to 0 m/s. If 3.3×10^5 J cause 1.0 kg of ice to melt, how much of the ice melts?

247. Placing a 3.0 kg skillet in 5.0 kg of water raises the water's temperature 2.25°C and lowers the skillet's temperature 29.6°C. Find the skillet's specific heat.

248. Air has a specific heat of 1.0×10^3 J/kg•°C. If air's temperature increases 55°C when 45×10^6 J are added to it by heat, what is the air's mass?

249. A 0.23 kg tantalum part has a specific heat capacity of 140 J/kg•°C. By how much does the part's temperature change if it gives up 3.0×10^4 J as heat?

Chapter 10 Thermodynamics

250. A volume of air increases 0.227 m^3 at a net pressure of 2.07×10^7 Pa. How much work is done on the air?

251. The air in a hot-air balloon does 3.29×10^6 J of work, increasing the balloon's volume by 2190 m^3. What is the net pressure in the balloon?

252. Filling a fire extinguisher with nitrogen gas at a net pressure of 25.0 kPa requires 472.5 J of work on the gas. Find the change in the gas's volume.

253. The internal energy of air in a closed car rises 873 J. How much heat energy is transferred to the air?

254. A system's initial internal energy increases from 39 J to 163 J. If 114 J of heat are added to the system, how much work is done on the system?

255. A gas does 623 J of work on its surroundings when 867 J are added to the gas as heat. What is the change in the internal energy of the gas?

256. An engine with an efficiency of 0.29 takes in 693 J as heat. How much work does the engine do?

257. An engine with an efficiency of 0.19 does 998 J of work. How much energy is taken in by heat?

258. Find the efficiency of an engine that receives 571 J as heat and loses 463 J as heat per cycle.

259. A 5.4×10^{-4} m^3 increase in steam's volume does 1.3 J of work on a piston. What is the pressure?

260. A pressure of 655 kPa does 393 J of work inflating a bike tire. Find the change in volume.

261. An engine's internal energy changes from 8093 J to 2.0920×10^4 J. If 6932 J are added as heat, how much work is done on or by the system?

262. Steam expands from a geyser to do 192 kJ of work. If the system's internal energy increases by 786 kJ, how much energy is transferred as heat?

263. If 632 kJ are added to a boiler and 102 kJ of work are done as steam escapes from a safety valve, what is the net change in the system's internal energy?

264. A power plant with an efficiency of 0.35 percent requires 7.37×10^8 J of energy as heat. How much work is done by the power plant?

265. An engine with an efficiency of 0.11 does 1150 J of work. How much energy is taken in as heat?

266. A test engine performs 128 J of work and receives 581 J of energy as heat. What is the engine's efficiency?

Chapter 11 Vibrations and Waves

267. A scale with a spring constant of 420 N/m is compressed 4.3 cm. What is the spring force?

268. A 669 N weight attached to a giant spring stretches it 6.5 cm. What is the spring constant?

269. An archer applies a force of 52 N on a bowstring with a spring constant of 490 N/m. What is the bowstring's displacement?

270. On Mercury, a pendulum 1.14 m long would have a 3.55 s period. Calculate a_g for Mercury.

271. Find the length of a pendulum that oscillates with a frequency of 2.5 Hz.

272. Calculate the period of a 6.200 m long pendulum in Oslo, Norway, where $a_g = 9.819$ m/s^2.

273. Find the pendulum's frequency in problem 272.

274. A 24 kg child jumps on a trampoline with a spring constant of 364 N/m. What is the oscillation period?

275. A 32 N weight oscillates with a 0.42 s period when on a spring scale. Find the spring constant.

276. Find the mass of a ball that oscillates at a period of 0.079 s on a spring with a constant of 63 N/m.

277. A dolphin hears a 280 kHz sound with a wavelength of 0.51 cm. What is the wave's speed?

278. If a sound wave with a frequency of 20.0 Hz has a speed of 331 m/s, what is its wavelength?

279. A sound wave has a speed of 2.42×10^4 m/s and a wavelength of 1.1 m. Find the wave's frequency.

280. An elastic string with a spring constant of 65 N/m is stretched 15 cm and released. What is the spring force exerted by the string?

281. The spring in a seat compresses 7.2 cm under a 620 N weight. What is the spring constant?

282. A 3.0 kg mass is hung from a spring with a spring constant of 36 N/m. Find the displacement.

283. Calculate the period of a 2.500 m long pendulum in Quito, Ecuador, where $a_g = 9.780$ m/s^2.

284. How long is a pendulum with a frequency of 0.50 Hz?

285. A tractor seat supported by a spring with a spring constant of 2.03×10^3 N/m oscillates at a frequency of 0.79 Hz. What is the mass on the spring?

286. An 87 N tree branch oscillates with a period of 0.64 s. What is the branch's spring constant?

287. What is the oscillation period for an 8.2 kg baby in a seat that has a spring constant of 221 N/m?

288. An organ creates a sound with a speed of 331 m/s and a wavelength of 10.6 m. Find the frequency.

289. What is the speed of an earthquake s-wave with a 2.3×10^4 m wavelength and a 0.065 Hz frequency?

Chapter 12 Sound

290. What is the distance from a sound with 5.88×10^{-5} W power if its intensity is 3.9×10^{-6} W/m^2?

291. Sound waves from a stereo have a power output of 3.5 W at 0.50 m. What is the sound's intensity?

292. What is a vacuum cleaner's power output if the sound's intensity 1.5 m away is 4.5×10^{-4} W/m^2?

293. Waves travel at 499 m/s on a 0.850 m long cello string. Find the string's fundamental frequency.

294. A mandolin string's first harmonic is 392 Hz. How long is the string if the wave speed on it is 329 m/s?

295. A 1.53 m long pipe that is closed on one end has a seventh harmonic frequency of 466.2 Hz. What is the speed of the waves in the pipe?

296. A pipe open at both ends has a fundamental frequency of 125 Hz. If the pipe is 1.32 m long, what is the speed of the waves in the pipe?

297. Traffic has a power output of 1.57×10^{-3} W. At what distance is the intensity 5.20×10^{-3} W/m^2?

298. If a mosquito's buzzing has an intensity of 9.3×10^{-8} W/m^2 at a distance of 0.21 m, how much sound power does the mosquito generate?

299. A note from a flute (a pipe with a closed end) has a first harmonic of 392.0 Hz. How long is the flute if the sound's speed is 331 m/s?

300. An organ pipe open at both ends has a first harmonic of 370.0 Hz when the speed of sound is 331 m/s. What is the length of this pipe?

Chapter 13 Light and Reflection

301. A 7.6270×10^8 Hz radio wave has a wavelength of 39.296 cm. What is this wave's speed?

302. An X ray's wavelength is 3.2 nm. Using the speed of light in a vacuum, calculate the frequency of the X ray.

303. What is the wavelength of ultraviolet light with a frequency of 9.5×10^{14} Hz?

304. A concave mirror has a focal length of 17 cm. Where must a 2.7 cm tall coin be placed for its image to appear 23 cm in front of the mirror's surface?

305. How tall is the coin's image in problem 304?

306. A concave mirror's focal length is 9.50 cm. A 3.0 cm tall pin appears to be 15.5 cm in front of the mirror. How far from the mirror is the pin?

307. How tall is the pin's image in problem 306?

308. A convex mirror's magnification is 0.11. Suppose you are 1.75 m tall. How tall is your image?

309. How far in front of the mirror in problem 308 are you if your image is 42 cm behind the mirror?

310. A mirror's focal length is −12 cm. What is the object distance if an image forms 9.00 cm behind the surface of the mirror?

311. What is the magnification in problem 310?

312. A metal bowl is like a concave spherical mirror. You are 35 cm in front of the bowl and see an image at 42 cm. What is the bowl's focal length?

313. For problem 312, find the bowl's radius of curvature.

314. A concave spherical mirror on a dressing table has a focal length of 60.0 cm. If someone sits 35.0 cm in front of it, where is the image?

315. What is the magnification in problem 314?

316. An image appears 5.2 cm behind the surface of a convex mirror when the object is 17 cm in front of the mirror. What is the mirror's focal length?

317. If the object in problem 316 is 3.2 cm tall, how tall is its image?

318. In order for someone to observe an object, the wavelength of the light must be smaller than the object. The Bohr radius of a hydrogen atom is $5.291\,770 \times 10^{-11}$ m. What is the lowest frequency that can be used to locate a hydrogen atom?

319. Meteorologists use Doppler radar to watch the movement of storms. If a weather station uses electromagnetic waves with a frequency of 2.85×10^{9} Hz, what is the wavelength of the radiation?

320. PCS cellular phones have antennas that use radio frequencies from 1800–2000 MHz. What range of wavelengths corresponds to these frequencies?

321. Suppose you have a mirror with a focal length of 32.0 cm. Where would you place your right hand so that you appear to be shaking hands with yourself?

322. A car's headlamp is made of a light bulb in front of a concave spherical mirror. If the bulb is 5.0 cm in front of the mirror, what is the radius of the mirror?

323. Suppose you are 19 cm in front of the bell of your friend's trumpet and you see your image at 14 cm. If the trumpet's bell is a concave mirror, what would be its focal length?

324. A soup ladle is like a spherical convex mirror with a focal length of 27 cm. If you are 43 cm in front of the ladle, where does the image appear?

325. What is the magnification in problem 324?

326. Just after you dry a spoon, you look into the convex part of the spoon. If the spoon has a focal length of −8.2 cm and you are 18 cm in front of the spoon, where does the image appear?

327. The base of a lamp is made of a convex spherical mirror with a focal length of −39 cm. Where does the image appear when you are 16 cm from the base?

328. Consider the lamp and location in problem 327. If your nose is 6.0 cm long, how long does the image appear?

329. How fast does microwave radiation that has a frequency of $1.173\,06 \times 10^{11}$ Hz and a wavelength of 2.5556 mm travel?

330. Suppose the microwaves in your microwave oven have a frequency of 2.5×10^{10} Hz. What is the wavelength of these microwaves?

331. You place an electric heater 3.00 m in front of a concave spherical mirror that has a focal length of 30.0 cm. Where would your hand feel warmest?

332. You see an image of your hand as you reach for a doorknob with a focal length of 6.3 cm. How far from the doorknob is your hand when the image appears at 5.1 cm behind the doorknob?

333. What is the magnification of the image in problem 332?

Chapter 14 Refraction

334. A ray of light in air enters an amethyst crystal ($n = 1.553$). If the angle of refraction is 35°, what is the angle of incidence?

335. Light passes from air at an angle of incidence of 59.2° into a nephrite jade vase ($n = 1.61$). Determine the angle of refraction in the jade.

336. Light entering a pearl travels at a speed of 1.97×10^{8} m/s. What is the pearl's index of refraction?

337. An object in front of a diverging lens of focal length 13.0 cm forms an image with a magnification of +5.00. How far from the lens is the object placed?

338. An object with a height of 18 cm is placed in front of a converging lens. The image height is −9.0 cm. What is the magnification of the lens?

339. If the focal length of the lens in problem 338 is 6.0 cm, how far in front of the lens is the object?

340. Where does the image appear in problem 339?

341. The critical angle for light traveling from a green tourmaline gemstone into air is 37.8°. What is tourmaline's index of refraction?

342. Find the critical angle for light traveling from ruby ($n = 1.766$) into air.

343. Find the critical angle for light traveling from emerald ($n = 1.576$) into air.

344. Malachite has two indices of refraction: $n_1 = 1.91$ and $n_2 = 1.66$. A ray of light in air enters malachite at an incident angle of 35.2°. Calculate both of the angles of refraction.

345. A ray of light in air enters a serpentine figurine ($n = 1.555$). If the angle of refraction is 33°, what is the angle of incidence?

346. The critical angle for light traveling from an aquamarine gemstone into air is 39.18°. What is the index of refraction for aquamarine?

347. A 15 cm tall object is placed 44 cm in front of a diverging lens. A virtual image appears 14 cm in front of the lens. What is the lens's focal length?

348. What is the image height in problem 347?

349. A lighthouse converging lens has a focal length of 4 m. What is the image distance for an object placed 4 m in front of the lens?

350. What is the magnification in problem 349?

351. Light moves from olivine ($n = 1.670$) into onyx. If the critical angle for olivine is 62.85°, what is the index of refraction for onyx?

352. When light in air enters an opal mounted on a ring, the light travels at a speed of 2.07×10^8 m/s. What is opal's index of refraction?

353. When light in air enters albite, it travels at a velocity of 1.95×10^8 m/s. What is albite's index of refraction?

354. A searchlight is constructed by placing a 500 W bulb 0.5 m in front of a converging lens. The focal length of the lens is 0.5 m. What is the image distance?

355. A microscope slide is placed in front of a converging lens with a focal length of 3.6 cm. The lens forms a real image of the slide 15.2 cm behind the lens. How far is the lens from the slide?

356. Where must an object be placed to form an image 12 cm in front of a diverging lens with a focal length of 44 cm?

357. The critical angle for light traveling from almandine garnet into air ranges from 33.1° to 35.3°. Calculate the range of almandine garnet's index of refraction.

358. Light moves from a clear andalusite ($n = 1.64$) crystal into ivory. If the critical angle for andalusite is 69.9°, what is the index of refraction for ivory?

Chapter 15 Interference and Diffraction

359. Light with a 587.5 nm wavelength passes through two slits. A second-order bright fringe forms 0.130° from the center. Find the slit separation.

360. Light passing through two slits with a separation of 8.04×10^{-6} m forms a third bright fringe 13.1° from the center. Find the wavelength.

361. Two slits are separated by 0.0220 cm. Find the angle at which a first-order bright fringe is observed for light with a wavelength of 527 nm.

362. For 546.1 nm light, the first-order maximum for a diffraction grating forms at 75.76°. How many lines per centimeter are on the grating?

363. Infrared light passes through a diffraction grating of 3600 lines/cm. The angle of the third-order maximum is 76.54°. What is the wavelength?

364. A diffraction grating with 1950 lines/cm is used to examine light with a wavelength of 497.3 nm. Find the angle of the first-order maximum.

365. At what angle does the second-order maximum in problem 364 appear?

366. Light passes through two slits separated by 3.92×10^{-6} m to form a second-order bright fringe at an angle of 13.1°. What is the light's wavelength?

367. Light with a wavelength of 430.8 nm shines on two slits that are 0.163 mm apart. What is the angle at which a second dark fringe is observed?

368. Light of wavelength 656.3 nm passes through two slits. The fourth-order dark fringe is 0.548° from the central maximum. Find the slit separation.

369. The first-order maximum for light with a wavelength of 447.1 nm is found at 40.25°. How many lines per centimeter does the grating have?

370. Light through a diffraction grating of 9550 lines/cm forms a second-order maximum at 54.58°. What is the wavelength of the light?

Chapter 16 Electric Forces and Fields

371. Charges of −5.3 μC and +5.3 μC are separated by 4.2 cm. Find the electric force between them.

372. A dog's fur is combed, and the comb gains a charge of 8.0 nC. Find the electric force between the fur and comb when they are 2.0 cm apart.

373. Two equal charges are separated by 6.5×10^{-11} m. If the magnitude of the electric force between the charges is 9.92×10^{-4} N, what is the value of q?

374. Two point charges of −13.0 μC and −16.0 μC exert repulsive forces on each other of 12.5 N. What is the distance between the two charges?

375. Three equal point charges of 4.00 nC lie 4.00 m apart on a line. Calculate the magnitude and direction of the net force on the middle charge.

376. A proton is at each corner of a square with sides 1.52×10^{-9} m long. Calculate the resultant force vector on the proton at the upper right corner.

377. Three 2.0 nC charges are located at coordinates (0 m, 0 m), (1.0 m, 0 m), and (1.0 m, 2.0 m). Find the resultant force on the first charge.

378. Charges of 7.2 nC and 6.7 nC are 32 cm apart. Find the equilibrium position for a −3.0 nC charge.

379. A −12.0 μC charge is between two 6.0 μC charges, 5.0 cm away from each. What electric force keeps the central charge in equilibrium?

380. A 9.0 N/C electric field is directed along the *x*-axis. Find the electric force vector on a −6.0 C charge.

381. What charge experiences an electric force of 6.43×10^{-9} N in an electric field of 4.0×10^{3} N/C?

382. A 5.00 μC charge is 0.500 m above a 15.0 μC charge. Calculate the electric field at a point 1.00 m above the 15.0 mC charge.

383. Two static point charges of 99.9 μC and 33.3 μC exert repulsive forces on each other of 87.3 N. What is the distance between the two charges?

384. Two particles are separated by 9.30×10^{-11} m. If the magnitude of the electric force between the charges is 2.66×10^{-8} N, what is the value of q?

385. A −23.4 nC charge is 0.500 m below a 4.65 nC charge and 1.00 m below a 0.299 nC charge. Find the resultant force vector on the −23.4 nC charge.

386. Three point charges are on the corners of a triangle: $q_1 = -9.00$ nC is at the origin; $q_2 = -8.00$ nC is at $x = 2.00$ m; and $q_3 = 7.00$ nC is at $y = 3.00$ m. Find the magnitude and direction of the resultant force on q_1.

387. Charges of −2.50 nC and −7.50 nC are 20.0 cm apart. Find a 5.0 nC charge's equilibrium position.

388. A −4.6 C charge is in equilibrium with a −2.3 C charge 2.0 m to the right, and an unknown charge 4.0 m to the right. What is the unknown charge?

389. Find the electric force vector on a 5.0 nC charge in a 1500 N/C electric field directed along the *y*-axis.

390. What electric charge experiences an 8.42×10^{-9} N electric force in an electric field of 1663 N/C?

391. Two 3.00 μC charges lie 2.00 m apart on the *x*-axis. Find the resultant electric field vector at a point 0.250 m on the *y*-axis, above the charge on the left.

392. Two electrons are 2.00×10^{-10} m and 3.00×10^{-10} m, respectively, from a point. Where with respect to that point must a proton be placed so that the resultant electric field strength is zero?

393. A −7.0 C charge is in equilibrium with a 49 C charge 18 m to the right and an unknown charge 25 m to the right. What is the unknown charge?

394. Suppose two pions are separated by 8.3×10^{-10} m. If the magnitude of the electric force between the charges is 3.34×10^{-10} N, what is the value of q?

395. Suppose two muons having equal but opposite charge are separated by 6.4×10^{-8} m. If the magnitude of the electric force between the charges is 5.62×10^{-14} N, what is the value of q?

396. Consider four electrons at the corners of a square. Each side of the square is 3.02×10^{-5} m. Find the magnitude and direction of the resultant force on q_3 if it is at the origin.

397. A charge of 5.5 nC and a charge of 11 nC are separated by 88 cm. Find the equilibrium position for a −22 nC charge.

398. Three charges are on the *y*-axis. At the origin is a charge, $q_1 = 72$ C; an unknown charge, q_2, is at $y = 15$ mm. A third charge, $q_3 = -8.0$ C, is placed at $y = -9.0$ mm so that it is in electrostatic equilibrium with q_1 and q_2. What is the charge on q_2?

Chapter 17 Electrical Energy and Current

399. A helium-filled balloon with a 14.5 nC charge rises 290 m above Earth's surface. By how much does the electrical potential energy change if Earth's electric field is −105 N/C?

400. A charged airplane rises 7.3 km in a 3.4×10^{5} N/C electric field. The electrical potential energy changes by -1.39×10^{11} J. What is the charge on the plane?

401. Earth's radius is 6.4×10^6 m. What is Earth's capacitance if it is regarded as a conducting sphere?

402. A 0.50 pF capacitor is connected across a 1.5 V battery. How much charge can this capacitor store?

403. A 76 C charge passes through a wire's cross-sectional area in 19 s. Find the current in the wire.

404. The current in a telephone is 1.4 A. How long does 98 C of charge take to pass a point in the wire?

405. What is a television's total resistance if it is plugged into a 120 V outlet and carries 0.75 A of current?

406. A motor with a resistance of 12.2 Ω is plugged into a 120.0 V outlet. What is the current in the motor?

407. The potential difference across a motor with a 0.30 Ω resistance is 720 V. How much power is used?

408. What is a microwave oven's resistance if it uses 1750 W of power at a voltage of 120.0 V?

409. A 64 nC charge moves 0.95 m with an electrical potential energy change of -3.88×10^{-5} J. What is the electric field strength?

410. A −14 nC charge travels through a 156 N/C electric field with a change of 2.1×10^{-6} J in the electrical potential energy. How far does the charge travel?

411. A 5.0×10^{-5} F polyester capacitor stores 6.0×10^{-4} C. Find the potential difference across the capacitor.

412. Some ceramic capacitors can store 3×10^{-2} C with a potential difference of 30 kV across them. What is the capacitance of such a capacitor?

413. The area of the plates in a 4550 pF parallel-plate capacitor is 6.4×10^{-3} m^2. Find the plate separation.

414. A television receiver contains a 14 μF capacitor charged across a potential difference of 1.5×10^4 V. How much charge does this capacitor store?

415. A photocopier uses 9.3 A in 15 s. How much charge passes a point in the copier's circuit in this time?

416. A 114 μC charge passes through a gold wire's cross-sectional area in 0.36 s. What is the current?

417. If the current in a blender is 7.8 A, how long do 56 C of charge take to pass a point in the circuit?

418. A computer uses 3.0 A in 2.0 min. How much charge passes a point in the circuit in this time?

419. A battery-powered lantern has a resistance of 6.4 Ω. What potential difference is provided by the battery if the total current is 0.75 A?

420. The potential difference across an electric eel is 650 V. How much current would an electric eel deliver to a body with a resistance of 1.0×10^2 Ω?

421. If a garbage-disposal motor has a resistance of 25.0 Ω and carries a current of 4.66 A, what is the potential difference across the motor's terminals?

422. A medium-sized oscillating fan draws 545 mA of current when the potential difference across its motor is 120 V. How large is the fan's resistance?

423. A generator produces a 2.5×10^4 V potential difference across power lines that carry 20.0 A of current. How much power is generated?

424. A computer with a resistance of 91.0 Ω uses 230.0 W of power. Find the current in the computer.

425. A laser uses 6.0×10^{13} W of power. What is the potential difference across the laser's circuit if the current in the circuit is 8.0×10^6 A?

426. A blender with a 75 Ω resistance uses 350 W of power. What is the current in the blender's circuit?

Chapter 18 Circuits and Circuit Elements

427. A theater has 25 surround-sound speakers wired in series. Each speaker has a resistance of 12.0 Ω. What is the equivalent resistance?

428. In case of an emergency, a corridor on an airplane has 57 lights wired in series. Each light bulb has a resistance of 2.00 Ω. Find the equivalent resistance.

429. Four resistors with resistances of 39 Ω, 82 Ω, 12 Ω, and 42 Ω are connected in parallel across a 3.0 V potential difference. Find the equivalent resistance.

430. Four resistors with resistances of 33 Ω, 39 Ω, 47 Ω, and 68 Ω are connected in parallel across a 1.5 V potential difference. Find the equivalent resistance.

431. A 16 Ω resistor is connected in series with another resistor across a 12 V battery. The current in the circuit is 0.42 A. Find the unknown resistance.

432. A 24 Ω resistor is connected in series with another resistor across a 3.0 V battery. The current in the circuit is 62 mA. Find the unknown resistance.

433. A 3.3 Ω resistor and another resistor are connected in parallel across a 3.0 V battery. The current in the circuit is 1.41 A. Find the unknown resistance.

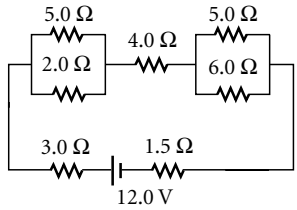
434. A 56 Ω resistor and another resistor are connected in parallel across a 12 V battery. The current in the circuit is 3.21 A. Find the unknown resistance.

435. Three bulbs with resistances of 56 Ω, 82 Ω, and 24 Ω are wired in series. If the voltage across the circuit is 9.0 V, what is the current in the circuit?

436. Three bulbs with resistances of 96 Ω, 48 Ω, and 29 Ω are wired in series. What is the current through the bulbs if the voltage across them is 115 V?

437. A refrigerator ($R_1 = 75\ \Omega$) wired in parallel with an oven ($R_2 = 91\ \Omega$) is plugged into a 120 V outlet. What is the current in the circuit of each appliance?

438. A computer ($R_1 = 82\ \Omega$) and printer ($R_2 = 24\ \Omega$) are wired in parallel across a 120 V potential difference. Find the current in each machine's circuit.

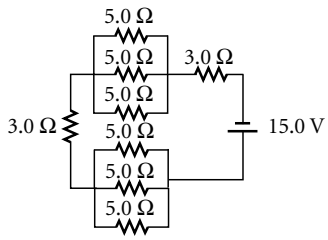


439. For the figure above, what is the equivalent resistance of the circuit?

440. For the figure above, find the current in the circuit.

441. For the figure above, what is the potential difference across the 6.0 Ω resistor?

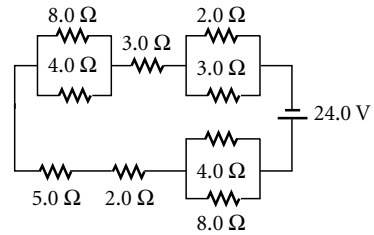
442. For the figure above, what is the current through the 6.0 Ω resistor?



443. For the figure above, calculate the equivalent resistance of the circuit.

444. For the figure above, what is the total current in the circuit?

445. For the figure above, what is the current in the 3.0 Ω resistors?



446. For the figure above, calculate the equivalent resistance of the circuit.

447. For the figure above, what is the total current in the circuit?

448. For the figure above, what is the current in either of the 8.0 Ω resistors?

Chapter 19 Magnetism

449. A proton moves at right angles to a magnetic field of 0.8 T. If the proton's speed is 3.0×10^7 m/s, how large is the magnetic force exerted on the proton?

450. A weak magnetic field exerts a 1.9×10^{-22} N force on an electron moving 3.9×10^6 m/s perpendicular to the field. What is the magnetic field strength?

451. A 5.0×10^{-5} T magnetic field exerts a 6.1×10^{-17} N force on a 1.60×10^{-19} C charge, which moves at a right angle to the field. What is the charge's speed?

452. A 14 A current passes through a 2 m wire. A 3.6×10^{-4} T magnetic field is at right angles to the wire. What is the magnetic force on the wire?

453. A 1.0 m printer cable is perpendicular to a 1.3×10^{-4} T magnetic field. What current must the cable carry to experience a 9.1×10^{-5} N magnetic force?

454. A wire perpendicular to a 4.6×10^{-4} T magnetic field experiences a 2.9×10^{-3} N magnetic force. How long is the wire if it carries a 10.0 A current?

455. A 12 m wire carries a 12 A current. What magnetic field causes a 7.3×10^{-2} N magnetic force to act on the wire when it is perpendicular to the field?

456. A magnetic force of 3.7×10^{-13} N is exerted on an electron moving at 7.8×10^6 m/s perpendicular to a sunspot. How large is the sunspot's magnetic field?

457. An electron moves with a speed of 2.2×10^6 m/s at right angles through a 1.1×10^{-2} T magnetic field. How large is the magnetic force on the electron?

458. A pulsar's magnetic field is 1×10^{-8} T. How fast does an electron move perpendicular to this field so that a 3.2×10^{-22} N magnetic force acts on the charge?

459. A levitation device designed to suspend 75 kg uses 10.0 m of wire and a 4.8×10^{-4} T magnetic field, perpendicular to the wire. What current is needed?

460. A power line carries 1.5×10^3 A for 15 km. Earth's magnetic field is 2.3×10^{-5} T at a 45° angle to the power line. What is the magnetic force on the line?

Chapter 20 Electromagnetic Induction

461. A coil with 540 turns and a 0.016 m^2 area is rotated exactly from 0° to 90.0° in 0.050 s. How strong must a magnetic field be to induce an emf of 3.0 V?

462. A 550-turn coil with an area of 5.0×10^{-5} m^2 is in a magnetic field that decreases by 2.5×10^{-4} T in 2.1×10^{-5} s. What is the induced emf in the coil?

463. A 246-turn coil has a 0.40 m^2 area in a magnetic field that increases from 0.237 T to 0.320 T. What time interval is needed to induce an emf of −9.1 V?

464. A 9.5 V emf is induced in a coil that rotates from 0.0° to 90.0° in a 1.25×10^{-2} T magnetic field for 25 ms. The coil's area is 250 cm^2. How many turns of wire are in the coil?

465. A generator provides a rms emf of 320 V across 100 Ω. What is the maximum emf?

466. Find the rms current in the circuit in problem 465.

467. Some wind turbines can provide an rms current of 1.3 A. What is the maximum ac current?

468. A transformer has 1400 turns on the primary and 140 turns on the secondary. What is the voltage across the primary if secondary voltage is 6.9 kV?

469. A transformer has 140 turns on the primary and 840 turns on the secondary. What is the voltage across the secondary if the primary voltage is 5.6 kV?

470. A step-down transformer converts a 3.6 kV voltage to 1.8 kV. If the primary (input) coil has 58 turns, how many turns does the secondary have?

471. A step-up transformer converts a 4.9 kV voltage to 49 kV. If the secondary (output) coil has 480 turns, how many turns does the primary have?

472. A 320-turn coil rotates from 0° to 90.0° in a 0.046 T magnetic field in 0.25 s, which induces an average emf of 4.0 V. What is the area of the coil?

473. A 180-turn coil with a 5.0×10^{-5} m^2 area is in a magnetic field that decreases by 5.2×10^{-4} T in 1.9×10^{-5} s. What is the induced current if the coil's resistance is 1.0×10^2 W?

474. A generator provides a maximum ac current of 1.2 A and a maximum output emf of 211 V. Calculate the rms potential difference.

475. Calculate the rms current for problem 474.

476. A generator can provide a maximum output emf of 170 V. Calculate the rms potential difference.

477. A step-down transformer converts 240 V across the primary to 5.0 V across the secondary. What is the step-down ratio ($N_1:N_2$)?

Chapter 21 Atomic Physics

478. Determine the energy of a photon of green light with a wavelength of 527 nm.

479. Calculate the de Broglie wavelength of an electron with a velocity of 2.19×10^6 m/s.

480. Calculate the frequency of ultraviolet (UV) light having a photon energy of 20.7 eV.

481. X-ray radiation can have an energy of 12.4 MeV. To what wavelength does this correspond?

482. Light of wavelength 240 nm shines on a potassium surface. Potassium has a work function of 2.3 eV. What is the maximum kinetic energy of the photoelectrons?

483. Manganese has a work function of 4.1 eV. What is the wavelength of the photon that will just have the threshold energy for manganese?

484. What is the speed of a proton with a de Broglie wavelength of 2.64×10^{-14} m?

485. A cheetah can run as fast as 28 m/s. If the cheetah has a de Broglie wavelength of 8.97×10^{-37} m, what is the cheetah's mass?

486. What is the energy of a photon of blue light with a wavelength of 430.8 nm?

487. Calculate the frequency of infrared (IR) light with a photon energy of 1.78 eV.

488. Calculate the wavelength of a radio wave that has a photon energy of 3.1×10^{-6} eV.

489. Light of frequency 6.5×10^{14} Hz illuminates a lithium surface. The ejected photoelectrons are found to have a maximum kinetic energy of 0.20 eV. Find the threshold frequency of this metal.

490. Light of wavelength 519 nm shines on a rubidium surface. Rubidium has a work function of 2.16 eV. What is the maximum kinetic energy of the photoelectrons?

491. The smallest known virus moves across a Petri dish at 5.6×10^{-6} m/s. If the de Broglie wavelength of the virus is 2.96×10^{-8} m, what is the virus's mass?

492. The threshold frequency of platinum is 1.36×10^{15} Hz. What is the work function of platinum?

493. The ship *Queen Elizabeth II* has a mass of 7.6×10^{7} kg. Calculate the de Broglie wavelength if this ship sails at 35 m/s.

494. Cobalt has a work function of 5.0 eV. What is the wavelength of the photon that will just have the threshold energy for cobalt?

495. Light of frequency 9.89×10^{14} Hz illuminates a calcium surface. The ejected photoelectrons are found to have a maximum kinetic energy of 0.90 eV. Find the threshold frequency of this metal.

496. What is the speed of a neutron with a de Broglie wavelength of 5.6×10^{-14} m?

Chapter 22 Subatomic Physics

497. Calculate the binding energy of ${}^{39}_{19}\text{K}$.

498. Determine the difference in the binding energy of ${}^{107}_{47}\text{Ag}$ and ${}^{63}_{29}\text{Cu}$.

499. Find the mass defect of ${}^{58}_{28}\text{Ni}$.

500. Complete this radioactive-decay formula: ${}^{212}_{84}\text{Po} \longrightarrow \text{?} + {}^{4}_{2}\text{He}$.

501. Complete this radioactive-decay formula: ${}^{16}_{7}\text{N} \longrightarrow \text{?} + {}^{0}_{-1}e + \overline{\nu}$.

502. Complete this radioactive-decay formula: ${}^{147}_{62}\text{Sm} \longrightarrow {}^{143}_{60}\text{Nd} + \text{?}$.

503. A 3.29×10^{-3} g sample of a pure radioactive substance is found after 30.0 s to have only 8.22×10^{-4} g left undecayed. What is the half-life of the substance?

504. The half-life of ${}^{48}_{24}\text{Cr}$ is 21.6 h. A chromium-48 sample contains 6.5×10^{6} nuclei. Calculate the activity of the sample in mCi.

505. How long will it take a sample of lead-212 (which has a half-life of 10.64 h) to decay to one-eighth its original strength?

506. Compute the binding energy of ${}^{120}_{50}\text{Sn}$.

507. Calculate the difference in the binding energy of ${}^{12}_{6}\text{C}$ and ${}^{16}_{8}\text{O}$.

508. What is the mass defect of ${}^{64}_{30}\text{Zn}$?

509. Complete this radioactive-decay formula: $\text{?} \longrightarrow {}^{131}_{54}\text{Xe} + {}^{0}_{-1}e + \overline{\nu}$.

510. Complete this radioactive-decay formula: ${}^{160}_{74}\text{W} \longrightarrow {}^{156}_{72}\text{Hf} + \text{?}$.

511. Complete this radioactive-decay formula: $\text{?} \longrightarrow {}^{107}_{52}\text{Te} + {}^{4}_{2}\text{He}$.

512. A 4.14×10^{-4} g sample of a pure radioactive substance is found after 1.25 days to have only 2.07×10^{-4} g left undecayed. What is the substance's half-life?

513. How long will it take a sample of cadmium-109 with a half-life of 462 days to decay to one-fourth its original strength?

514. The half-life of ${}^{55}_{26}\text{Fe}$ is 2.7 years. What is the decay constant for the isotope?

APPENDIX I

Additional Problems

1. 11.68 m

3. 6.4×10^{-2} m^3

5. 6.7×10^{-5} ps

7. 2.80 h = 2 h, 48 min

9. 4.0×10^{1} km/h

11. 48 m/h

13. +25.0 m/s = 25.0 m/s, upward

15. 44.8 m/s

17. -21.5 m/s^2 = 21.5 m/s^2, backward

19. 38.5 m

21. 126 s

23. 1.27 s

25. 11 km/h

27. 2.74 s

29. 10.5 m, forward

31. 5.9 s

33. 8.3 s

35. 7.4 s

37. -490 m/s^2 = 490 m/s^2, backward

39. 17.3 s

41. 7.0 m

43. 2.6 m/s

45. -11.4 m/s = 11.4 m/s, downward

47. 8.5° north of east

49. 5.0° south of west

51. 770 m

53. -33 km/h = 33 km/h, downward

55. 18.9 km, 76° north of west

57. 17.0 m

59. 52.0°

61. 79 s

63. 15.8 m, 55° below the horizontal

65. 0.290 m/s, east; 1.16 m/s, north

67. 2.6 km

69. 66 km, 46° south of east
71. 10.7 m
73. 3.0 s
75. 76.9 km/h, 60.1° west of north
77. 7.0×10^2 m, 3.8° above the horizontal
79. 47.2 m
81. 6.36 m/s
83. 13.6 km/h, 73° south of east
85. 58 N
87. 14.0 N; 2.0 N
89. 9.5×10^4 kg
91. 258 N, up the slope
93. 15.9 N
95. 2.0 m/s^2
97. $F_x = 8.60$ N; $F_y = 12.3$ N
99. -448 $m/s^2 = 448$ m/s^2, backward
101. 15 kg
103. 0.085
105. 1.7×10^8 N
107. 24 N, downhill
109. 1.150×10^3 N
111. 1.2×10^4 N
113. 0.60
115. 38.0 m
117. 2.5×10^4 J
119. 247 m/s
121. -5.46×10^4 J
123. 3.35×10^6 J
125. 1.23 J
127. 12 s
129. 0.600 m
131. 133 J
133. 53.3 m/s
135. 72.2 m
137. 0.13 m = 13 cm
139. 7.7 m/s
141. 8.0 s
143. 230 J
145. 7.96 m
147. 6.0×10^1 m/s
149. 1.58×10^3 kg•m/s, north
151. 3.38×10^{31} kg
153. 18 s
155. 637 m, to the right
157. 7.5 g
159. 0.0 m/s
161. -5.0×10^1 percent
163. 16.4 m/s, west
165. 5.33×10^7 kg•m/s
167. 1.0×10^1 m/s
169. 560 N, east
171. -3.3×10^8 N = 3.3×10^8 N, backward
173. 52 m
175. 24 kg
177. 90.6 km/h, east
179. 26 km/h, 37° north of east
181. −157 J
183. 0.125 kg
185. -4.1×10^4 J
187. 9.8 kg
189. 1.0 m/s, 60° south of east
191. 4.04×10^3 m/s^2
193. 42 m/s
195. 8.9 kg
197. 1.04×10^4 m/s = 10.4 km/s
199. 1.48×10^{23} kg
201. 1.10×10^{12} m
203. 6.6×10^3 m/s = 6.6 km/s
205. 0.87 m
207. 254 N
209. 0.42 m = 42 cm
211. 25 N
213. 165 kg
215. 5.09×10^5 s = 141 h
217. 5.5×10^9 m = 5.5×10^6 km
219. 1.6 N•m
221. 6.62×10^3 N
223. 0.574 m
225. 8.13×10^{-3} m^2
227. 2.25×10^4 kg/m^3
229. 2.0×10^1 m^2
231. 4.30 kg
233. 374°F to −292°F
235. 6.6×10^{-2}°C
237. 1.29×10^4 J
239. 4.1×10^{-2} kg
241. 1.200×10^3°C
243. 315 K
245. 1.91×10^{-2} kg = 19.1 g
247. 530 J/kg•°C
249. −930°C
251. 1.50×10^3 Pa = 1.50 kPa
253. 873 J
255. 244 J
257. 5.3×10^3 J
259. 2.4×10^3 Pa = 2.4 kPa
261. 5895 J
263. 5.30×10^2 kJ = 5.30×10^5 J
265. 1.0×10^4 J
267. −18 N
269. −0.11 m = −11 cm
271. 4.0×10^{-2} m = 4.0 cm
273. 0.2003 Hz
275. 730 N/m
277. 1.4×10^3 m/s
279. 2.2×10^4 Hz
281. 8.6×10^3 N/m
283. 3.177 s
285. 82 kg
287. 1.2 s
289. 1.5×10^3 m/s
291. 1.1 W/m^2
293. 294 Hz
295. 408 m/s
297. 0.155 m
299. 0.211 m = 21.1 cm
301. 2.9971×10^8 m/s
303. 3.2×10^{-7} m = 320 nm
305. −0.96 cm
307. −1.9 cm
309. 3.8 m
311. 0.25
313. 38 cm

315. 2.40
317. 0.98 cm
319. 10.5 cm
321. 64.0 cm in front of the mirror
323. 8.3 cm
325. 0.40
327. −11 cm
329. 2.9979×10^{8} m/s
331. 33.3 cm
333. 0.19
335. 32.2°
337. −10.4 cm
339. 18 cm
341. 1.63
343. 39.38°
345. 58°
347. −21 cm
349. ∞
351. 1.486
353. 1.54
355. 4.8 cm
357. 1.73 to 1.83
359. 5.18×10^{-4} m = 0.518 mm
361. 0.137°
363. 9.0×10^{-7} m = 9.0×10^{2} nm
365. 11.2°
367. 0.227°
369. 1.445×10^{4} lines/cm
371. 140 N attractive
373. 2.2×10^{-17} C
375. 0.00 N
377. 4.0×10^{-8} N, 9.3° below the negative x-axis
379. 260 N from either charge
381. 1.6×10^{-12} C
383. 0.585 m = 58.5 cm
385. 3.97×10^{-6} N, upward
387. 0.073 m = 7.3 cm
389. 7.5×10^{-6} N, along the $+y$-axis
391. 4.40×10^{5} N/C, 89.1° above the $-x$-axis
393. −7.4 C
395. 1.6×10^{-19} C
397. 36 cm
399. 4.4×10^{-4} J
401. 7.1×10^{-4} F
403. 4.0 A
405. 160 Ω
407. 1.7×10^{6} W = 1.7 MW
409. 6.4×10^{2} N/C
411. 12 V
413. 1.2×10^{-5} m
415. 1.4×10^{2} C
417. 7.2 s
419. 4.8 V
421. 116 V
423. 5.0×10^{5} W = 0.50 MW
425. 7.5×10^{6} V
427. 3.00×10^{2} Ω
429. 6.0 Ω
431. 13 Ω
433. 6.0 Ω
435. 0.056 A = 56 mA
437. 1.6 A (refrigerator); 1.3 A (oven)
439. 12.6 Ω
441. 2.6 V
443. 9.4 Ω
445. 1.6 A
447. 1.45 A
449. 4×10^{-12} N
451. 7.6×10^{6} m/s
453. 0.70 A
455. 5.1×10^{-4} T
457. 3.9×10^{-15} N
459. 1.5×10^{5} A
461. 1.7×10^{-2} T
463. 0.90 s
465. 450 V
467. 1.8 A
469. 3.4×10^{4} V = 34 kV
471. 48 turns
473. 2.5×10^{-3} A = 2.5 mA
475. 0.85 A
477. 48:1
479. 3.32×10^{-10} m
481. 1.00×10^{-13} m
483. 3.0×10^{-7} m
485. 26 kg
487. 4.30×10^{14} Hz
489. 6.0×10^{14} Hz
491. 4.0×10^{-21} kg
493. 2.5×10^{-43} m
495. 7.72×10^{14} Hz
497. 333.73 MeV
499. 0.543 705 u
501. ${}^{16}_{8}\mathrm{O}$
503. 15.0 s
505. 31.92 h
507. 35.46 MeV
509. ${}^{131}_{53}\mathrm{I}$
511. ${}^{111}_{54}\mathrm{Xe}$
513. 924 days