Answers To Topic 1

Review Questions

1. 4 **2.** 2 **3.** 4
4. 3 **5.** 3 **6.** 2
7. 1 GJ **8.** 6000 km **9.** 2
10. 3 **11.** 3 **12.** 700 nm

13. $F = \frac{mv^2}{r} = \frac{kg \cdot (m/s)^2}{m} = \frac{\frac{kg \cdot m^2}{s^2}}{m} = \frac{kg \cdot m}{s^2}$

14. $PE_s = \frac{1}{2}kx^2$

$k = \frac{2PE_s}{x^2} = \frac{kg \cdot m^2/s^2}{m^2} = \frac{kg}{s^2}$

15. 1

16. $\frac{v^2}{d} = \frac{(m/s)^2}{m} = \frac{m^2/s^2}{m} = \frac{m}{s^2}$

17. 1

18. 1.6 cm

19. $52.5\ cm\left(\frac{1\ m}{100\ cm}\right) = 0.525\ m$ or $5.25 \times 10^{-1}\ m$

20. 2 **21.** 0.4040 kg **22.** 2

23. 1 hr 15 min = 75 min, so $75\ min\left(\frac{60.\ s}{1\ min}\right) =$ $4500\ s = 4.5 \times 10^3\ s$

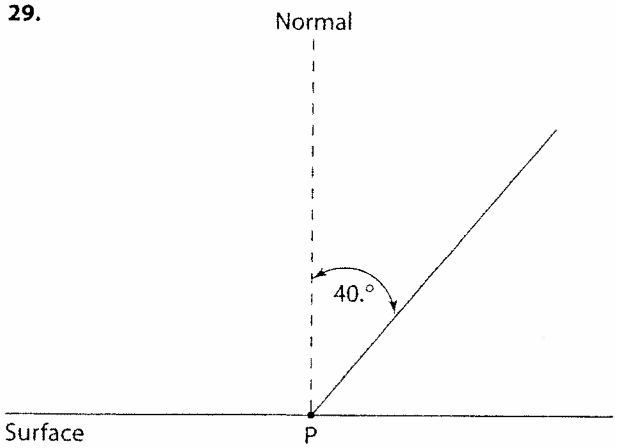
24. $18\ min\left(\frac{60.\ s}{1\ min}\right) = 1100\ s = 1.1 \times 10^3\ s$

25. 2.5 N **26.** 1.4 N

27. (a) 25° (b) $\sin\theta = \frac{opposite}{hypotenuse}$ and $c = \frac{37.\ cm}{\sin 25°} = 88\ cm$

28. (a) 25° (b) 0.42 (c) 0.91

29.



30. Using the scale in the drawing, 1.0 cm = 1.4 m, (a) 7.3 m (b) 3.6 m, or using a trigonometric function,

(a) $\sin\theta = \frac{opposite}{hypotenuse}$ and $c = \frac{6.1\ m}{\sin 60.°} = 7.0\ m$

(b) $\tan\theta = \frac{opposite}{adjacent}$ and $c = \frac{6.1\ m}{\tan 60.°} = 3.5\ m$

31. $\sin\theta = \frac{opposite}{hypotenuse}$, so $a = (50.\ m)\sin 30.° = 25\ m$

32. $\tan\theta = \frac{opposite}{adjacent}$,

so adjacent $= \frac{opposite}{\tan\theta} = \frac{35\ m}{\tan 20.°} = 96\ m$

33. 4 **34.** 3 **35.** 1
36. 4 **37.** 2 **38.** 1
39. 4 **40.** 4 **41.** 2
42. 13.3 m **43.** 0.029 kg **44.** 3
45. 2 **46.** 40.00 m

47. $A = lw = (41.6\ cm)(2.3\ cm) = 96\ cm^2$

48. $A = lw = (13.2\ m)(10.6\ m) = 140.\ m^2$

$\frac{140.\ m^2}{24\ students} = \frac{5.8\ m^2}{student}$; the answer is yes.

49. 2.1×10^{-2} m **50.** 1.5×10^3 kg **51.** 7.7×10^5 N
52. 4.98×10^2 s **53.** 3 **54.** 3
55. 1 **56.** 2 **57.** 2
58. 2 **59.** 3 **60.** 3
61. 3 **62.** 3 **63.** 3
64. 3 **65.** 2 **66.** 4
67. 3

68. $\frac{7 \times 10^2\ m/s}{1 \times 10^{-3}\ m/s} = 7 \times 10^5$

69. $\frac{1.7 \times 10^{17}\ W}{100\ W/bulb} = 1.7 \times 10^{15}$ bulbs

70. 3

71. $\frac{10^{-19}\ C}{10^{-31}\ kg} = 10^{12}\ C/kg$

72. $\frac{3.00 \times 10^8\ m/s}{3.31 \times 10^2\ m/s} = 10^6$

73. $\frac{10^{22}\ kg}{10^{24}\ kg} = 10^{-2}$

74. 1

75. Percent Error $= \frac{absolute\ error}{accepted\ value} \times 100$

$= \frac{0.25 \times 10^8\ m/s}{2.25 \times 10^8\ m/s} \times 100 = 11\%$

76. Percent Error $= \frac{absolute\ error}{accepted\ value} \times 100$

$= \frac{0.2\ m/s^2}{9.81\ m/s^2} \times 100 = 2\%$

77. Range = 4.73 min − 4.07 min = 0.66 min

x_i (min)	f_i	$x_i f_i$ (min)	$x_i - \bar{x}$ (min)	$(x_i - \bar{x})^2$ (min²)	$(x_i - \bar{x})^2 f_i$ (min²)
4.66	1	4.66	0.32	0.1024	0.1024
4.73	1	4.73	0.39	0.1521	0.1521
4.51	1	4.51	0.17	0.0289	0.0289
4.32	1	4.32	−0.02	0.0004	0.0004.
4.17	1	4.17	−0.17	0.0289	0.0289
4.15	1	4.15	−0.19	0.0361	0.0361
4.12	1	4.12	−0.22	0.0484	0.0484
4.07	1	4.07	−0.27	0.0729	0.0729
	$\Sigma f_i = 8$	$\Sigma x_i f_i = 34.73$			$\Sigma(x_i - \bar{x})^2 f_i = 0.4701$

The chart at left is for instructional purposes. Students may determine values using a scientific calculator.

101. $\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$ so opposite = hypotenuse$(\sin\theta)$ = (1.4 m)sin10.° = 0.24 m

102. $A = A_{triangle} + A_{rectangle} + A_{triangle}$

$A = \frac{1}{2}bh + bh + \frac{1}{2}bh$

$A = \frac{1}{2}(2.0\ \text{s})(10.\ \text{m/s}) + (6.0\ \text{s})(10.\ \text{m/s}) + \frac{1}{2}(2.0\ \text{s})(5\ \text{s})$

$A = 70\ \text{m}$

103. slope $= \frac{\Delta v}{\Delta t} = \frac{5.0\ \text{m/s}}{2.0\ \text{s}} = 2.5\ \text{m/s}^2$

Answers To Topic 2

Review Questions

1. 1 2. 4

3. $c^2 = a^2 + b^2$

$c = \sqrt{a^2 + b^2} = \sqrt{(15\ \text{m})^2 + (15\ \text{m})^2} = 21\ \text{m}$

4. 3 5. 1 6. 4

7. 3 8. 4

9. $a = \frac{\Delta v}{t}$

$t = \frac{\Delta v}{a} = \frac{28\ \text{m/s} - 8.0\ \text{m/s}}{2.0\ \text{m/s}^2} = 10.\ \text{s}$

10. 4 11. D 12. 1

13. 2

14. $v_f^2 = v_i^2 + 2ad = 2(3.2\ \text{m/s}^2)(40.\ \text{m})$

$v_f = 16\ \text{m/s}$

15. $a = \frac{\Delta v}{t} = \frac{25\ \text{m/s} - 10.\ \text{m/s}}{5.0\ \text{s} - 3.0\ \text{s}} = 7.5\ \text{m/s}^2$

16. 18 m/s

17. The area under the curve is equal to the distance traveled.

$A = A_{triangle} + A_{rectangle}$

$A_{triangle} = \frac{1}{2}bh = \frac{1}{2}(1.0\ \text{s})(10.\ \text{m/s}) = 5.0\ \text{m}$

$A_{rectangle} = bh = (2.0\ \text{s})(10.\ \text{m/s}) = 20.\ \text{m}$

$A = 25\ \text{m}$

18. AB 19. 3

20. $\bar{v} = \frac{d}{t} = \frac{3.0\ \text{m} - 2.0\ \text{m}}{2.0\ \text{s} - 1.0\ \text{s}} = 1.0\ \text{m/s}$

21. 3 22. 3 23. 3

24. C 25. B 26. C

27. A 28. 2 29. 2

30. 4 31. 4 32. 3 m

33. 2 s to 3 s 34. 1 35. 3 s to 4 s

36. 4 37. 3 38. 2

39. $v_f = v_i + at = (9.81\ \text{m/s}^2)(3.00\ \text{s}) = 29.4\ \text{m/s}$

40. 1 41. 3 42. 1

43. 4 44. 1 45. 3

46. 2 47. 2 48. 3

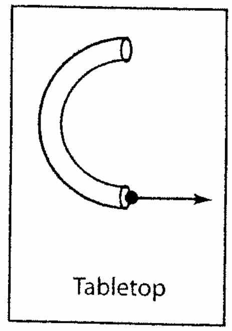
49. 1 50. 2

51. $A_y = A \sin\theta = (300.\ \text{N})(\sin 60.°) = 260\ \text{N}$

52. 2 53. 4 54. 4

55. 1 56. 2

57.



58. 3 59. 3 60. 4

61. 4 62. 2

63. $a = \frac{F_{net}}{m} = \frac{10.0\ \text{N}}{20.0\ \text{kg}} = 0.500\ \text{m/s}^2$

64. 3 65. 1 66. 4

67. 4 68. 40. N 69. 4

70. For every action force there is an equal but opposite reaction force.

71. 2 72. 3 73. 2

74. 3 75. 1

76. 2 77. B

78. Both arrows take the same amount of time to strike the plane.

79. $d = v_i t + \frac{1}{2}at^2$

$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(45\ \text{m})}{9.81\ \text{m/s}^2}} = 3.0\ \text{s}$

80. 3 81. 3

82. 2 83. 1

84. $A_x = A\cos\theta = (150.\ \text{m/s})(\cos 30.°) = 130.\ \text{m/s}$

85. 1 86. 1

87. $a_{horizontal} + 0.0\ \text{m/s}^2$ and $a_{vertical} = 9.81\ \text{m/s}^2$

88. $a = \frac{v^2}{r} = \frac{(6.0\ \text{m/s})^2}{3.0\ \text{m}} = 12\ \text{m/s}^2$, directed toward the center of curvature

89. $F = \frac{mv^2}{r} = \frac{(2.0\ \text{kg})(6.0\ \text{m/s})^2}{3.0\ \text{m}} = 24\ \text{N}$

90. 2 91. 1 92. 4

93. 3 94. D 95. A

96. 3 97. 2 98. 1

99. 3 100. S 101. Q

102. 1 103. 3 104. 3

105. $\frac{F}{9}$ 106. 4 107. 3

108. B

109. $g = \frac{F_g}{m}$

$F_g = mg = (5.00\ \text{kg})(9.81\ \text{m/s}^2) = 49.1\ \text{N}$

110. 4

111. acceleration due to gravity or gravitational field strength

112. $g = \frac{F_g}{m} = \frac{96\ \text{N}}{60.\ \text{kg}} = 1.6\ \text{m/s}^2$

113. 4 114. 2 115. 3

116. 3 117. 2 118. 1

119. 2 120. A and D

the stone is traveling in the opposite direction so its velocity is −20. m/s, or 20. m/s downward.

67. In a 6.0-second time interval, the stone rises for 2.0 seconds as determined in question 62, and falls for 4.0 seconds, assuming the cliff is high enough so that the stone does not hit the ground before 4.0 seconds has elapsed.

$v_f = v_i = at = 0.0 \text{ m/s} + (-9.81 \text{ m/s}^2)(4.0 \text{ s})$

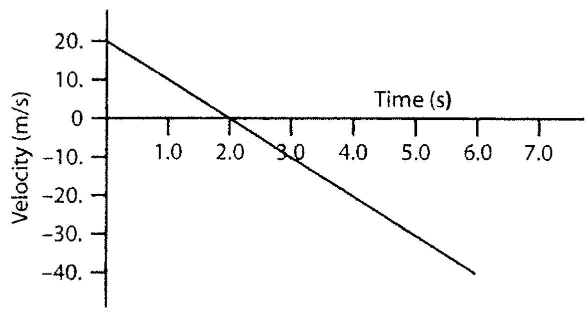
$= 39 \text{ m/s downward, or } -39 \text{ m/s}$

68. $d = \frac{1}{2}at^2$ (from rest)

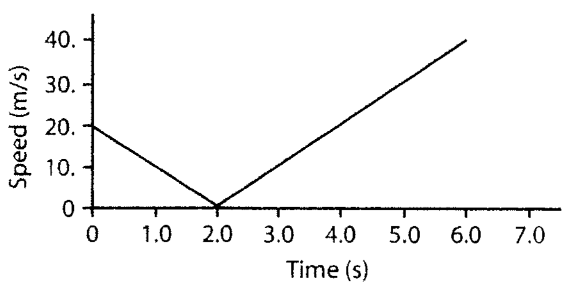
$d = \frac{1}{2}(-9.81 \text{ m/s}^2)(4.0 \text{ s})^2 = -78 \text{ m}$

The stone falls 78 meters downward from its highest point, or 58 meters below the position of the student.

69.



70.



71. $a = \frac{\Delta v}{t} = \frac{40. \text{ m/s}}{20. \text{ s}} = 2.0 \text{ m/s}^2$

72. The area under the curve is equal to the distance traveled.

$A = A_{\text{triangle}} + A_{\text{rectangle}}$

$A_{\text{triangle}} = \frac{1}{2}bh = \frac{1}{2}(20. \text{ s})(40. \text{ m/s}) = 400 \text{ m}$

$A_{\text{rectangle}} = bh = (2.0 \text{ s})(40. \text{ m/s}) = 800. \text{ m}$

$A = 1200 \text{ m}$

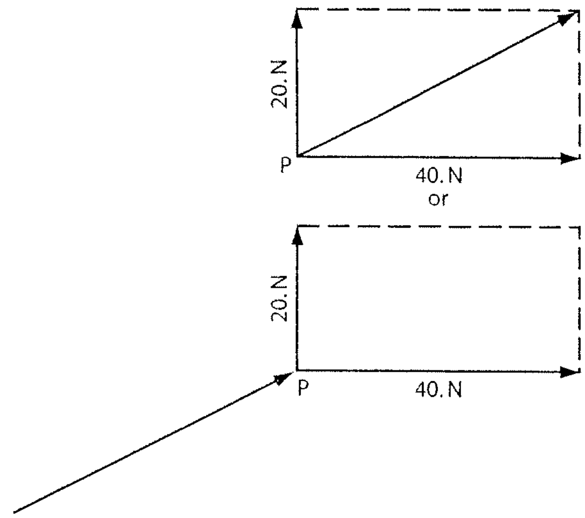
73. 20. m/s

74. decelerating to rest

75. BC

76. 5.0 N ± 0.2 N

77.



78. 45 N ± 2 N

79. 27° ± 2°

80. $a = \frac{F_{\text{net}}}{m} = \frac{45 \text{ N}}{10. \text{ kg}} = 4.5 \text{ m/s}^2$

81. $c^2 = a^2 + b^2$

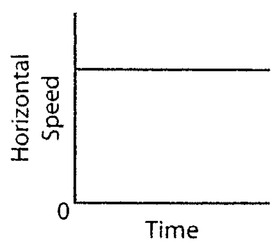
$c = \sqrt{a^2 + b^2} = \sqrt{(9.0 \text{ m/s})^2 + (9.0 \text{ m/s})^2} = 13 \text{ m/s}$

82. $\bar{v} = \frac{d}{t}$

$d = \bar{v}t = (9.0 \text{ m/s})(1.84 \text{ s}) = 17 \text{ m}$

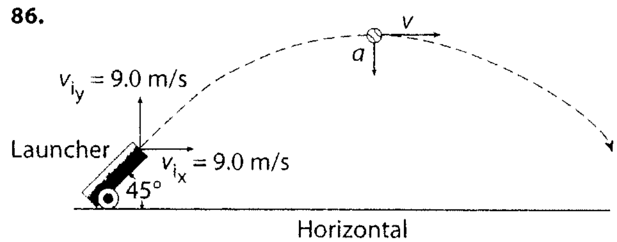
83. The vertical acceleration is a constant, -9.81 m/s^2.

84.



85. As the ball rises the vertical component of its velocity decreases and the horizontal component of its velocity remains the same.

86.



87. See question 86.

88. 0.0 N

89. $F = \frac{mv^2}{r} = \frac{(1.00 \times 10^3 \text{ kg})(20.0 \text{ m/s})^2}{100. \text{ m}}$

$= 4.00 \times 10^3$ N directed toward the center of curvature

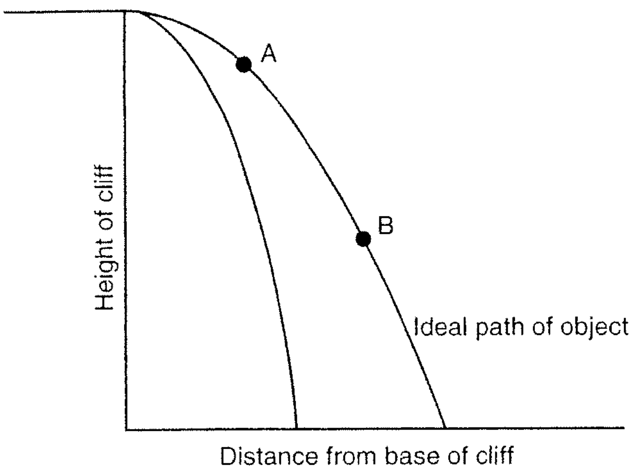
90. $\bar{v} = \frac{d}{t}$

$d = \bar{v}t = (20.0 \text{ m/s})(20.0 \text{ s}) = 400. \text{ m}$

91. The magnitude of the car's centripetal acceleration from D to A is twice as great as the magnitude of its centripetal acceleration from B to C.

92. Because the car is moving at constant speed, the magnitude of its momentum is always the same.

120.



121. 0.5 m/s

122. $\bar{v} = \frac{d}{t} = \frac{60.\text{ km}}{4.0\text{ h}} = 15$ km/h

123. 1 **124.** 1 **125.** 2

126. 4 **127.** 4 **128.** 3

129. 4 **130.** 50.0 N

131. 2 **132.** 1

133. Block *A* has a mass of 1 kilogram and block *B* has a mass of 2 kilograms.

134. $A_x = A\cos\theta = (100.\text{ N})(\cos 30.°) = 86.6$ N

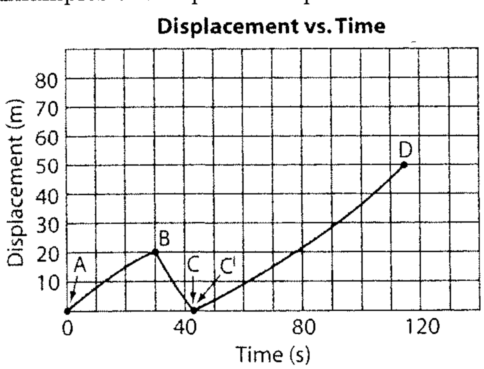
In equilibrium $F_{net} = 0$

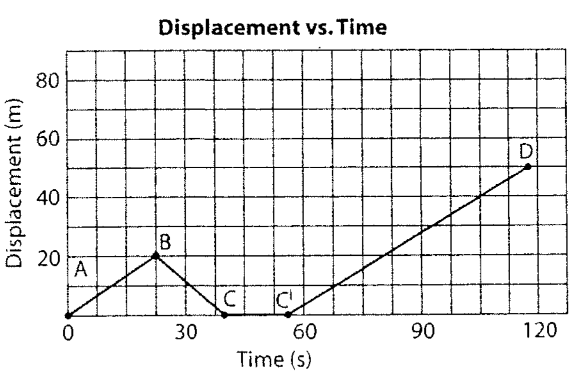
$F_{net} = F_x + F_f = 0$ and $F_f = 86.6$ N (magnitude)

135. 2 **136.** 1 **137.** 75 m

138. 6.0 m/s² **139.** 3 **140.** 1

141. Examples of acceptable responses:





142. See question 141.

143. Range: 0.50 s to 1.00 s

144. 0.7615 s and 0.76 s

145. $\sigma = 0.11$ s

146. 32

147. 80.%

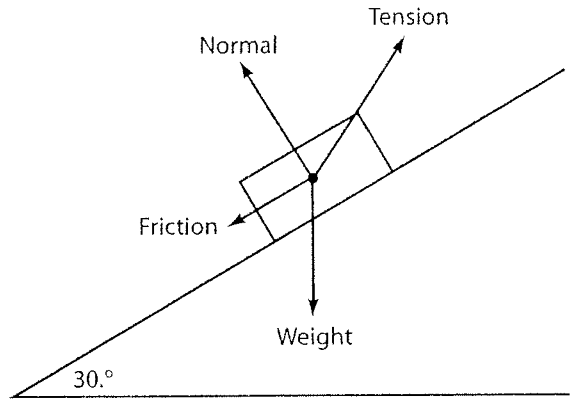
148. $d = \frac{1}{2}at^2$ (from rest)

$a = \frac{2d}{t^2} = \frac{2(2.848\text{ m})}{(0.7615\text{ s})^2} = 9.823\text{ m/s}^2$

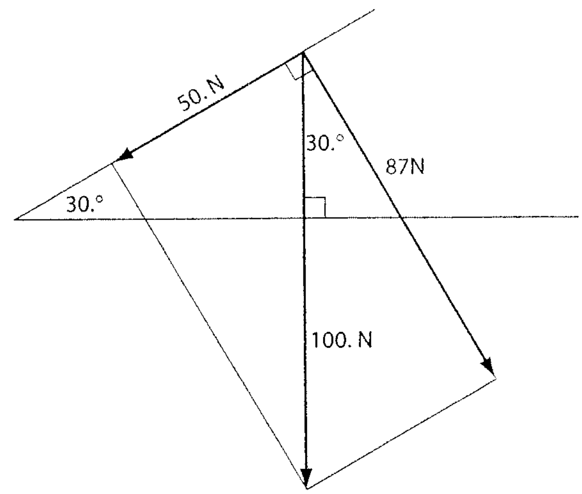
149. Percent Error $= \frac{\text{absolute error}}{\text{accepted value}} \times 100$

$= \frac{0.01\text{ m/s}^2}{9.81\text{ m/s}^2} \times 100 = 0.1\%$

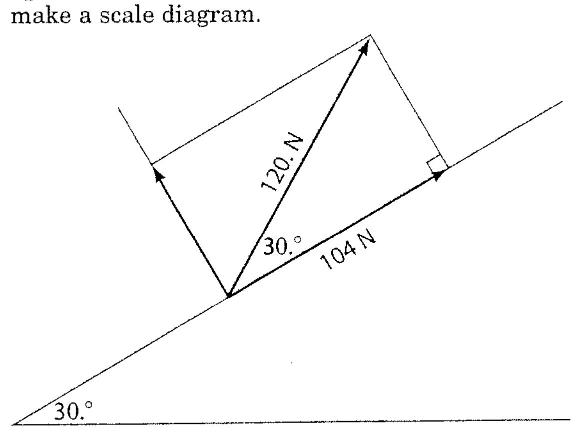
150.



151. $F_{g_{parallel}} = F_g \sin\theta = (100.\text{ N})(\sin 30.°) = 50.0$ N, or make a scale diagram.



152. $F_x = F\cos\theta = (120.\text{ N})(\cos 30.°) = 104$ N, or make a scale diagram.



153. $a = \frac{F_{net}}{m}$ and $g = \frac{F_g}{m}$

$F_{net} = 104\text{ N} - 50.\text{ N} - 10.\text{ N} = 44$ N

$m = \frac{F_g}{g} = \frac{100.\text{ N}}{9.81\text{ m/s}^2} = 10.2$ kg

$a = \frac{44\text{ N}}{10.2\text{ kg}} = 4.3\text{ m/s}^2$ up the incline

172. All of the washers could be collectively massed using the triple-beam balance. Dividing by the number of washers would yield the average mass of a washer. It is the weight of the suspended washers that provides the centripetal force acting on the moving rubber stopper. Substituting the mass in kilograms of the appropriate number of washers into the formula $F_g = mg$ yields the value of the centripetal force.

173. $F_c = \frac{mv^2}{r}$

$\bar{v} = \frac{d}{t} = \frac{2\pi r}{T}$

substituting

$F_c = \frac{m\left(\frac{2\pi r}{T}\right)^2}{r}$

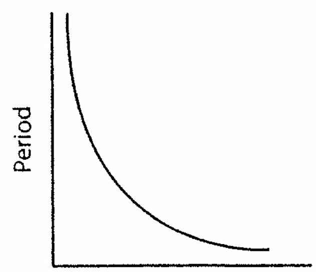
$F_c = \frac{4\pi^2 mr}{T^2}$

174. a pair of goggles for each student and a meter stick to measure the radius

175. It is difficult to note exactly one revolution for a rapidly moving object. Significant error can be introduced in starting and stopping the watch due to human reaction time. It is preferable to spread that error over thirty revolutions to minimize its effects.

176. Constant quantities: mass of stopper, radius of curvature. Column headings might be Number of Washers, Magnitude of Centripetal Force (N), Time for Thirty Revolutions (s), and Period of Revolution(s).

177.



178. They did not determine (a) the relationship between the magnitude of the centripetal force and the mass of a moving object or (b) the relationship between the magnitude of the centripetal force and the radius of curvature of the path of a moving object.

179. $F_f = \mu F_N \quad F_N = mg \quad F_c = \frac{mv^2}{r}$ [1]

$\mu = \frac{v^2}{rg}$ [1]

$\mu = \frac{(20.\ \text{m/s})^2}{(80.\ \text{m})(9.81\ \text{m/s}^2)}$ [1]

$\mu = 0.51$ [1]

or

$F_c = ma_c \quad a_c = \frac{v^2}{r}$

$F_c = \frac{mv^2}{r} = \frac{(1600\ \text{kg})(20.\ \text{m/s}^2)}{80.\ \text{m}} = 8.0 \times 10^3\ \text{N}$ [1]

$F_N = mg = (1600\ \text{kg})(9.81\ \text{m/s}^2) = 1.6 \times 10^4\ \text{N}$ [1]

$F_f = F_c$ [1]

$F_f = \mu F_N \quad \mu = \frac{F_f}{F_N} = \frac{8.0 \times 10^3\ \text{N}}{1.6 \times 10^4\ \text{N}} = 0.50$ [1]

180. Changing the mass of the car would have no effect on the maximum speed at which it could round the curve.

Answers To Topic 3

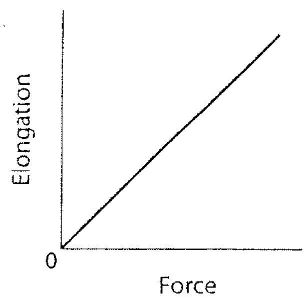
Review Questions

1. 4 2. 2 3. 2
4. 80. N 5. 3 6. 100. J
7. 4 8. 3
9. $W = Fd$ and $\bar{v} = \frac{d}{t}$, therefore
$W = F\bar{v}t = (20.0\ \text{N})(4.0\ \text{m/s})(6.0\ \text{s}) = 480\ \text{J}$
10. 0 N
11. $W = Fd = (8.0\ \text{N})(3.0\ \text{m}) = 24\ \text{J}$
12. 4.0 m
13. 3 14. 3 15. 4
16. 20. m/s 17. 3 18. 3
19. $1.2 \times 10^3\ W$ 20. 3
21. $P = \frac{Fd}{t}$ and $t = \frac{Fd}{P} = \frac{(5.0 \times 10^2\ \text{N})(5.0\ \text{m})}{250\ \text{W}} = 10.\ \text{s}$
22. 4
23. $P = \frac{W}{t} = \frac{Fd}{t} = \frac{(500.\ \text{N})(18\ \text{m})}{50.0\ \text{s}} = 180\ \text{W}$
24. 1
25. $P = F\bar{v}$

$\bar{v} = \frac{P}{F} = \frac{2.00 \times 10^3\ \text{W}}{4.0 \times 10^2\ \text{N}} = 5.0\ \text{m/s}$

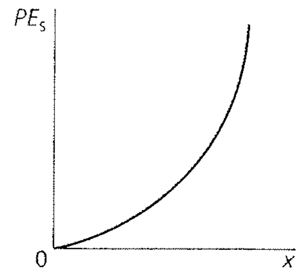
26. 2 27. 4 28. 3
29. 2 30. 4 31. 3
31. 3 32. 2
33. $\Delta PE = mg\Delta h = (5.00\ \text{kg})(9.81\ \text{m/s}^2)(2.00\ \text{m}) = 98.1\ \text{J}$
34. 1 35. 4 36. 2
37. 3 38. 4
39. $F = kx = (25\ \text{N/m})(0.25\ \text{m}) = 6.3\ \text{N}$
40. 4 41. 4 42. 4
43. 4
44. 12.7 cm = 0.127 m
45. 1 46. 2 47. 3
48. 3 49. 3
50. $PE_s = \frac{1}{2}kx^2 = \frac{1}{2}(120\ \text{N/m})(0.20\ \text{m})^2 = 0.024\ \text{J}$
51. 2 52. 4 53. 1
54. 1
55. slope $= k = \frac{\Delta F}{\Delta x} = \frac{24\ \text{N}}{0.40\ \text{m}} = 60.\ \text{N/m}$

41.

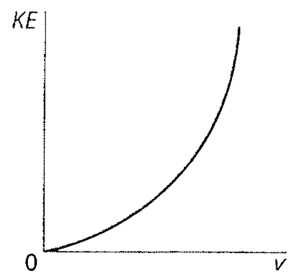


42. the length of the spring before any weight was added

43.



44.



45. $k = \frac{\Delta F}{\Delta x} = \frac{0.50\ \text{N}}{0.20\ \text{m}} = 2.5\ \text{N/m}$

46. $PE_s = \frac{1}{2}kx^2 = \frac{1}{2}(2.5\ \text{N/m})(0.20\ \text{m})^2 = 5.0 \times 10^{-2}\ \text{J}.$

47. 0.050 J

48. 2

49. $\bar{v} = \frac{d}{t}$

$d = \bar{v}t = (1\ \text{m/s})(3\ \text{s}) = 3\ \text{m}$

50. 0.0 N

51. $p = mv = (2.0\ \text{kg})(4\ \text{m/s}) = 8\ \text{kg} \cdot \text{m/s}$

52. $KE = \frac{1}{2}mv^2 = \frac{1}{2}(2.0\ \text{kg})(4.0\ \text{m/s})^2 = 16\ \text{J}$

53. $\overline{BC}$ or $\overline{DE}$

54. 0.0 J

55. $P = \frac{W}{t}$

$W = Pt = (10.0\ \text{W})(2.0\ \text{s}) = 20.\ \text{J}$

56. 6.0 N

57. $a = \frac{F}{m} = \frac{6.0\ \text{N}}{3.0\ \text{kg}} = 2.0\ \text{m/s}^2$

58. $\Delta PE = mg\Delta h = (3.0\ \text{kg})(9.81\ \text{m/s}^2)(4.0\ \text{m}) = 120\ \text{J}$

59. 3

60. $PE_1 + KE_1 = PE_3 + KE_3$

$PE_1 = KE_3 = \frac{1}{2}mv^2 = \frac{1}{2}(2.00\ \text{kg})(6.00\ \text{m/s})^2 = 36.0\ \text{J}$

61. A

62. $a = \frac{v^2}{r} = \frac{(6.00\ \text{m/s})^2}{10.0\ \text{m}} = 3.6\ \text{m/s}^2$

63. The sum of the kinetic and potential energies of the bob at position 1 is equal to the sum of the kinetic and potential energies of the bob at position 2.

64. $(8.0\ \text{cm})(3.0\ \text{m/cm}) = 24\ \text{m}$

65. $\Delta PE = mg\Delta h = (650\ \text{kg})(9.81\ \text{m/s}^2)(24\ \text{m}) = 1.5 \times 10^5\ \text{J}$

66. The kinetic energy of the car at the top of the second hill is less than the kinetic energy of the car at the top of the third hill.

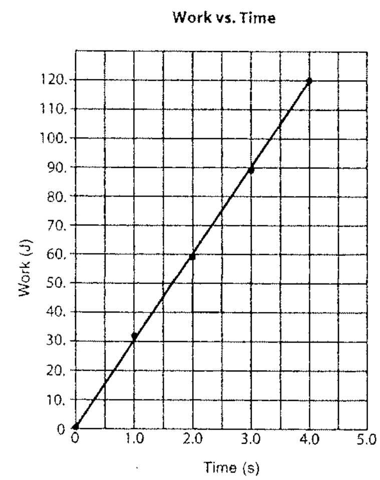
67. $\Delta PE = mg\Delta h = (6.00\ \text{kg})(9.81\ \text{m/s}^2)(55.0\ \text{m}) = 3240\ \text{J}$

68. $KE = \frac{1}{2}mv^2 = \frac{1}{2}(6.00\ \text{kg})(30.0\ \text{m/s})^2 = 2700\ \text{J}$

69. 540 J

70. The "lost" energy was converted into heat because work was done against friction.

71.



72. slope $= \frac{\Delta W}{\Delta t} = \frac{120.\ \text{J} - 60.\ \text{J}}{4.0\ \text{s} - 2.0\ \text{s}} = 30.\ \text{W}$

73. The slope represents the power developed.

74. 2.5 s

75. The work that must be done to stop a moving object is equal to the kinetic energy of the object.

Kinetic energy is given by the formula $KE = \frac{1}{2}mv^2$, so if two objects have the same initial velocity v, the more massive object has the greater kinetic energy. Thus, it requires more work to stop the ferry boat.

76. If no outside work is done on a pendulum, such as giving it a push while swinging, the pendulum cannot possess more energy at any point in its swing than at its point of release. At the instant the bob is released, it has no kinetic energy. All of its energy is potential energy, $PE = mgh$, where h is the height of the bob above the lowest point of its swing. When the bob swings through one cycle and returns to the student, the maximum energy the bob can have is mgh. Thus, the ideal pendulum would return to the tip of the student's nose. In reality, some energy is converted to work done against friction. As a result, the bob rises to some height less than its height at the time of its release.

77. The power developed by the teacher is found by determining the time rate of doing work.

$P = \frac{W}{t} = \frac{Fd}{t} = \frac{(700.\ \text{N})(6.0\ \text{m})}{7.0\ \text{s}} = 600\ \text{W}.$

The teacher develops the same power as the power consumed when six 100-watt light bulbs are turned on.

101. $KE = \frac{1}{2}mv^2$

$KE = \frac{1}{2}(6000.\ \text{kg})\ (1.0\ \text{m/s})^2$

$KE = 3000\ \text{J}$ *or* $3.0 \times 10^3\ \text{J}$

102. The KE of the combined carts after the collision is less than the KE of the carts before the collision.

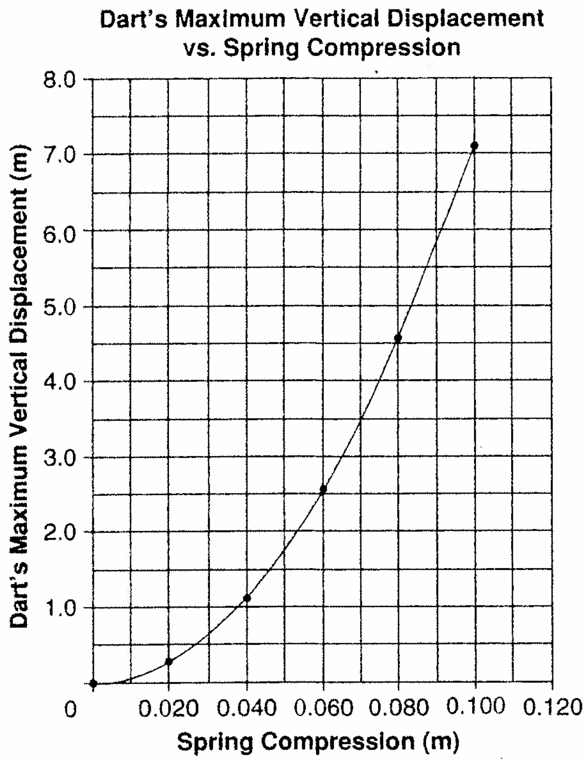
$KE_{before} > KE_{after}$

103. — B, because the mass has the greatest speed
— B, because the total potential energy is least
— B, the speed at A and C is zero

104. — A, because it is the highest point of travel

105. — C, because the spring is stretched the maximum amount
— C, because the KE and gravitational PE are a minimum

106 and 107.



108. $PE_s = \frac{1}{2}kx^2$

$PE_s = \frac{1}{2}(140\ \text{N/m})(0.070\ \text{m})^2$

$PE_s = 0.34\ \text{J}$

109. 5.6 N

Answers To Topic 4

Review Questions

1. 3
2. 2
3. proton +e
   electron −e
   neutron 0e
4. 1
5. 3
6. 3
7. 1
8. 1
9. 3
10. $+2\mu C$
11. 2
12. 1
13. 4
14. 1
15. 1
16. 4
17. $F_e = \frac{kq_1q_2}{r^2}$

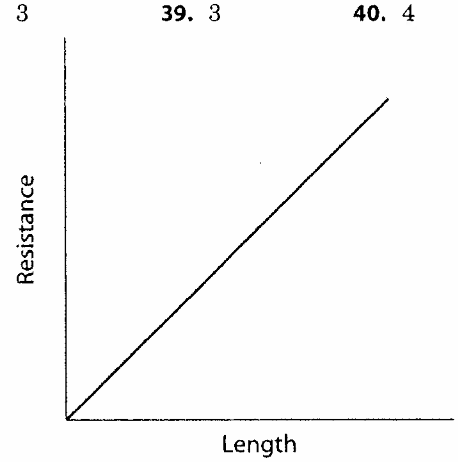
$= \frac{(8.99 \times 10^9\ \text{N}\cdot\text{m}^2/\text{C}^2)(3.0 \times 10^{-7}\ \text{C})(4.0 \times 10^{-7}\ \text{C})}{(2.0 \times 10^{-2}\ \text{m})^2}$

$= 2.7\ \text{N}$

18. 4
19. 1
20. 2
21. 2
22. 2
23. 3
24. $V = \frac{W}{q} = \frac{6.0\ \text{J}}{2.0\ \text{C}} = 3.0\ \text{V}$
25. 4
26. $V = \frac{W}{q} = \frac{4.0\ \text{J}}{2.0\ \text{C}} = 2.0\ \text{V}$
27. 200. eV
28. potential difference
29. $I = \frac{q}{t} = \frac{20.0\ \text{C}}{4.0\ \text{s}} = 5.0\ \text{A}$
30. 3
31. 1
32. 1
33. 1
34. 3
35. $I = \frac{V}{R}$ and $I = \frac{q}{t}$

$V = IR = \frac{qR}{t} = \frac{(40.\ \text{C})(20.\ \Omega)}{5.0\ \text{s}} = 160\ \text{V}$

36. 10 Ω
37. $I = \frac{V}{R} = \frac{12\ \text{V}}{4.0\ \Omega} = 3.0\ \text{A}$
38. 3
39. 3
40. 4
41.



42. 4 Ω
43. 2
44. 1
45. $R = \frac{\rho L}{A}$

$\rho = \frac{RA}{L} = \frac{(0.35\ \Omega)(2.00 \times 10^{-6}\ \text{m}^2)}{5.00\ \text{m}}$

$= 14 \times 10^{-8}\ \Omega\cdot\text{m}$

46. 4
47. 1
48. 2
49. 2
50. 3
51. 2
52. 1
53. 70 V
54. 1.0 A
55. 2
56. 4
57. 2
58. 3
59. 4
60. 4
61. 2
62. 3 A
63. 33 A
64. 3
65. 3
66. 4
67. 2
68. 3
69. 2
70. 4
71. 1
72. 60. Ω
73. $I = \frac{V}{R} = \frac{120\ \text{V}}{60.\ \Omega} = 2.0\ \text{A}$
74. $I = I_1 + I_2 = 2.0\ \text{A} + 2.0\ \text{A} = 4.0\ \text{A}$

55. The electron would travel a parabolic path toward the positive plate.

56. The magnitude of the electric field strength at points B and A is the same.

57. $V = \frac{W}{q}$

$W = Vq = (10.0\text{ V})(-1.60 \times 10^{-19}\text{ C})$
$= -1.60 \times 10^{-18}\text{ J}$

58. 1.87×10^{6} m/s

59. 3

60. B

61. D

62. A

63. $R = \frac{V}{I} = \frac{1.5\text{ V}}{2.0\text{ A}} = 0.75\ \Omega$

64. $P = VI = (1.5\text{ V})(2.0\text{ A}) = 3.0\text{ W}$

65. 120 V

66. $I = \frac{V}{R} = \frac{120\text{ V}}{20.\ \Omega} = 6.0\text{ A}$

67. $P = I^2R = (4.0\text{ A})^2(30.\ \Omega) = 480\text{ W}$

68. $R = \frac{V}{I}$

$V = IR = (0.50\text{ A})(5.0\ \Omega) = 2.5\text{ V}$

69. $W = VIt = (15\text{ V})(0.50\text{ A})(10.0\text{ min})(60\text{ s/min})$
$= 4.5 \times 10^{3}\text{ J}$

70. 10.0 Ω

71. The 5.0-ohm resistor dissipates less power than the 15.0-ohm resistor.

72. Removing the 5.0-ohm resistor from the circuit increases the potential drop across resistor R and increases the current through the ammeter.

73. 8.0 Ω

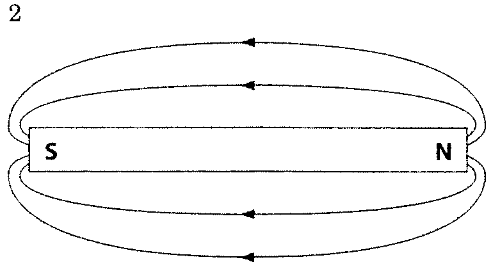
74. $R = \frac{V}{I}$

$I = \frac{V}{R} = \frac{24\text{ V}}{20.\ \Omega} = 1.2\text{ A}$

75. 24 Ω

76. 2

77.

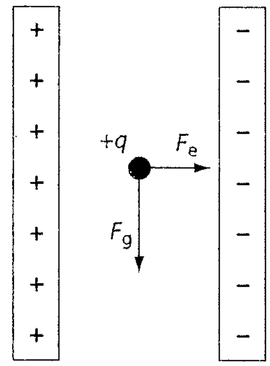


78. A series circuit provides only one current path. Typical electrical devices used in a kitchen include one or more lights, a refrigerator, and a toaster. If these devices were connected in a series circuit, all of the devices would have to be turned on for the refrigerator to operate. If one device was not receiving electricity, none of the other devices would either.

79. Standard incandescent light bulbs are designed to be operated in parallel at 120 volts. The power developed is given by the formula $P = \frac{V^2}{R}$, so power is inversely proportional to resistance. Therefore, the 150-watt bulb has less resistance than the 60-watt bulb. Resistance, $R = \frac{\rho L}{A}$, is directly proportional to length and inversely proportional to cross-sectional area. Thus, a filament of low resistance is relatively thick and short.

80. An electron located between two oppositely charged metal plates experiences an upward electric force that accelerates the electron upward if the upper plate is positively charged and the upward force, exerted by the electric field, is greater than the downward force exerted by the gravitational field.

81.



82. $KE = \frac{1}{2}mv^2$ and $V = \frac{W}{q}$

The maximum speed corresponds to the maximum kinetic energy, which equals the work done on the electron by the field.

$\frac{1}{2}mv^2 = Vq$, but $m = m_e$ and $q = e$

$\frac{1}{2}m_e v^2 = Ve$

$v = \sqrt{\frac{2Ve}{m_e}}$

83. The maximum speed of a proton would be less than that of an electron. Although both particles have the same magnitude of charge e, the proton is more massive than the electron. The maximum speed is inversely proportional to the square root of mass. (See problem 82.)

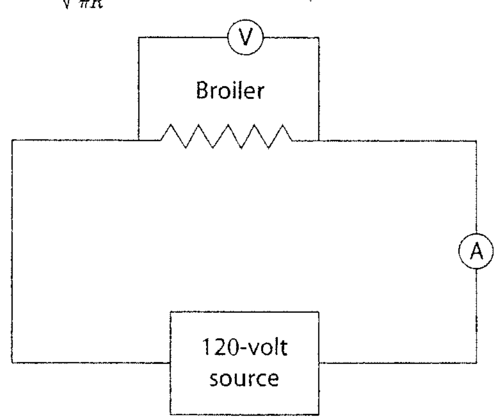
84. $\frac{V}{A} = \frac{\frac{J}{C}}{\frac{C}{s}} = \frac{J \cdot s}{C^2} = \frac{\frac{kg \cdot m^2}{s^2} \cdot s}{C^2} = \frac{\frac{kg \cdot m^2}{s}}{(A \cdot s)^2} = \frac{kg \cdot m^2}{A^2 \cdot s^3}$

85. $R = \frac{\rho L}{A}$ and $A = \pi r^2$

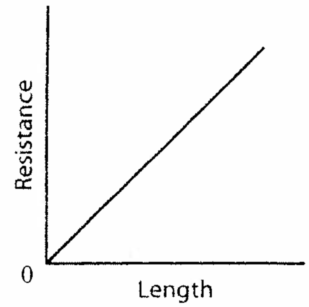
$R = \frac{\rho L}{\pi r^2}; r^2 = \frac{\rho L}{\pi R}$

$r = \sqrt{\frac{\rho L}{\pi R}}$

86.



108.

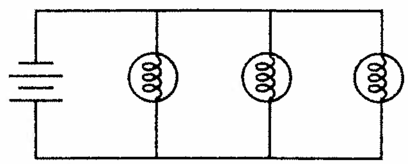


109. $R = \frac{\rho L}{A}$ and $A = \pi r^2$ and $r = d/2$

$$\rho = \frac{RA}{L} = \frac{R\pi r^2}{L} = \frac{(20.\ \Omega)\pi(1.59 \times 10^{-4}\ \text{m})^2}{2.00\ \text{m}}$$

$$= 79 \times 10^{-8}\ \Omega \cdot \text{m}$$

110.



111. 40.1 V

112. $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{89\ \Omega} + \frac{1}{365\ \Omega} + \frac{1}{143\ \Omega}$

$R_{eq} = 48\ \Omega$ *or* $47.7\ \Omega$

or

$I = I_1 + I_2 + I_3 = 0.45\,A + 0.11\,A + 0.28\,A = 0.84\,A$

$R = \frac{V}{I} = \frac{40.1\ V}{0.84\ A} = 48\ \Omega$ *or* $47.7\ \Omega$

113. 40.1 V

114. 0.11 A

115. The sphere is attracted to both rods.

116. The sphere is repelled by the positive rod (only).

Answers To Topic 5

Review Questions

1. 4 **2.** 4 **3.** 3
4. 3 **5.** 1 **6.** 1
7. T = 0.50 s **8.** 4 **9.** 3
10. 4 **11.** frequency **12.** 1
13. 1 **14.** 3 **15.** 1
16. 2 **17.** B **18.** 2 m
19. 2.0 m

20. $v = f\lambda$ and $f = \frac{1}{T}$

$v = \frac{\lambda}{T} = 8.0\ \text{m}/5.0\ \text{s} = 1.6\ \text{m/s}$

21. 170 m **22.** 1 **23.** A and C
24. A and B *or* C and D
25. A and B *or* C and D
26. 2
27. 2

28. $v = f\lambda$

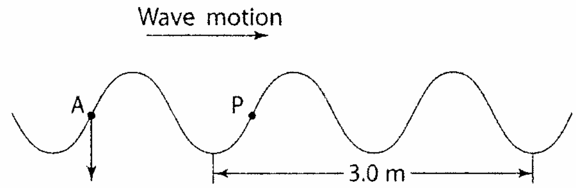
$\lambda = \frac{v}{f} = \frac{331\ \text{m/s}}{250\ \text{Hz}} = 1.3\ \text{m}$

29. $\bar{v} = \frac{d}{t}$

$d = \bar{v}t = (331\ \text{m/s})(3.00\ \text{s}) = 993\ \text{m}$

30. longitudinal

31. and **32.**



33. $\lambda = \frac{3.0\ \text{m}}{2} = 1.5\ \text{m}$

$v = f\lambda = (40.\ \text{Hz})(1.5\ \text{m}) = 60.\ \text{m/s}$

34. $T = \frac{1}{f} = \frac{1}{40.\ \text{Hz}} = 0.025\ \text{s}$

35. 0.080 s

36. $f = \frac{1}{T} = \frac{1}{0.080\ \text{s}} = 13\ \text{Hz}$

37. $v = \lambda f = (4.0\ \text{m})\left(\frac{1}{2.5\ \text{s}}\right) = 1.6\ \text{m/s}$

38. $\bar{v} = \frac{s}{t}$

$t = \frac{s}{\bar{v}} = \frac{50.\ \text{m}}{1.6\ \text{m/s}} = 31\ \text{s}$

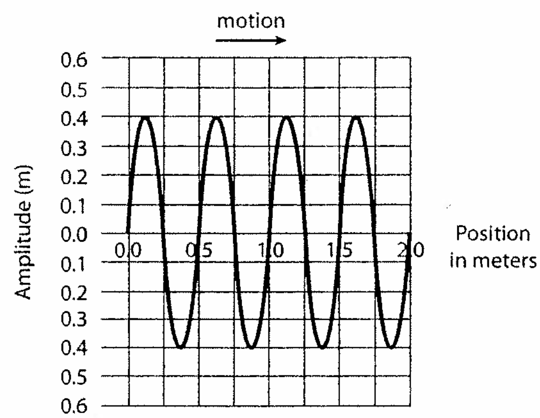
39. 6.4 m

40. $v = \frac{\lambda}{T}$

41. 1

42. 4

43.



44. 150 waves
45. 1 **46.** 3 **47.** 1
48. Doppler effect
49. 3 **50.** 1 **51.** 2
52. 3 **53.** 2 **54.** 1
55. 180° **56.** 2 **57.** A and C
58. 3 **59.** D **60.** 1
61. 3 **62.** 2 **63.** 4
64. 4.0 m **65.** 3
66. diffraction and interference
67. 2 **68.** 3 **69.** 3
70. 4 **71.** 4 **72.** 3

73. $v = f\lambda$

$\lambda = \frac{v}{f} = \frac{3.00 \times 10^8\ \text{m/s}}{5.3 \times 10^{14}\ \text{Hz}}$

$= 5.7 \times 10^{-7}\ \text{m}\left(\frac{1\ \text{nm}}{10^{-9}\ \text{m}}\right) = 570\ \text{nm}$

74. 2 **75.** 1 **76.** B
77. 2 **78.** C **79.** 2
80. 0°
81. 1 **82.** 2 **83.** 2
84. 2 **85.** 1 **86.** 3

51. The wavelength observed at D increases.
52. 0.2 m
53. 2.0 m
54. 1.5 cycles
55. 2.5 Hz
56. $v = f\lambda = (2.5\ \text{Hz})(2.0\ \text{m}) = 5.0\ \text{m/s}$
57. A and G, *or* C and I, *or* D and J
58. down, towards the bottom of the page
59. $n = \frac{c}{v}$

$v = \frac{c}{n} = \frac{3.00 \times 10^8\ \text{m/s}}{1.33} = 2.26 \times 10^8\ \text{m/s}$

60. $n_1 \sin \theta_1 = n_2 \sin \theta_2$

$\sin \theta_1 = \frac{n_2 \sin \theta_2}{n_1} = \frac{1.00 \sin 45°}{1.33}$

$\theta_1 = 32°$

61. B
62. The speed of light in water is greater than the speed of light in medium X.
63. 1.33
64. $v = f\lambda$ and $n = \frac{c}{v}$

$\lambda = \frac{v}{f}$ and $v = \frac{c}{n}$

$\lambda = \frac{c}{fn} = \frac{3.00 \times 10^8\ \text{m/s}}{(5.09 \times 10^{14}\ \text{Hz})(1.33)} = 4.43 \times 10^{-7}\ \text{m}$

65. $v = f\lambda$

$f = \frac{c}{\lambda} = \frac{3.00 \times 10^8\ \text{m/s}}{4.00 \times 10^{-7}\ \text{m}} = 7.50 \times 10^{14}\ \text{Hz}$

66. violet
67. $\frac{n_2}{n_1} = \frac{\lambda_1}{\lambda_2}$

$\lambda_2 = \frac{n_1 \lambda_1}{n_2} = \frac{1.00(4.00 \times 10^{-7}\ \text{m})}{1.50} = 2.67 \times 10^{-7}\ \text{m}$

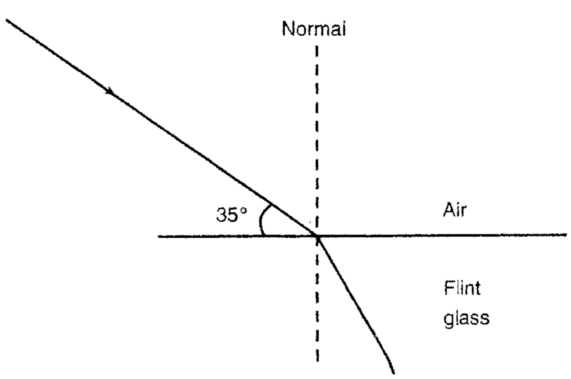
68. The measure of angle A is equal to the measure of angle B.
69. The angle of refraction would increase.
70. 55° (±2°)
71. $n_1 \sin \theta_1 = n_2 \sin \theta_2$

$\sin \theta_2 = \frac{n_1 \sin \theta_1}{n_2}$

$\sin \theta_2 = \frac{(1.00)(\sin 55°)}{1.66}$

$\theta_2 = 29.6°$ *or* 30.°

72. 30.° (±2°)
73.



74. $v = f\lambda$

$\lambda = \frac{v}{f} = \frac{1.5 \times 10^3\ \text{m/s}}{5.0 \times 10^3\ \text{Hz}} = 0.30\ \text{m}$

75. $\bar{v} = \frac{d}{t}$

$d = \bar{v}t = (1.5 \times 10^3\ \text{m/s})(2.0\ \text{s}) = 3.0 \times 10^3\ \text{m}$

76. reflection
77. $\bar{v} = \frac{d}{t}$

$t = \frac{d}{\bar{v}} = \frac{20.\ \text{m}}{340\ \text{m/s}} = 0.059\ \text{s}$

78. $v = f\lambda$

$\lambda = \frac{v}{f} = \frac{340\ \text{m/s}}{10^3\ \text{Hz}} = 0.34\ \text{m}$

79. 1λ
80. The frequency of the sound observed at point P increases.
81. 22 m
82. The fire engine produces a sound of constant frequency, or pitch. As the engine approaches you, the distance between successive wave fronts that reach you is decreased. Because the speed of sound is constant, a decrease in wavelength produces an observed increase in frequency or pitch.
83. angle of incidence = 45° (±2°)

angle of refraction = 26° (±2°)

84. The angle of reflection in material X is 64° (±2°).
85. longitudinal
86. resonance
87. range = 0.163 m − 0.149 m = 0.014 m
88. 0.038 m
89. 2
90. $\lambda = 4\ell + 1.6d = 4(0.163\ \text{m}) + 1.6(0.032\ \text{m})$

$= 0.703\ \text{m}$

91. $v = 331\sqrt{1 + \frac{T_C}{273}} = 331\ \text{m/s}\sqrt{1 + \frac{21.5}{273}}$

$= 344\ \text{m/s}$

92. $\text{Percent Error} = \frac{\text{absolute error}}{\text{accepted value}} \times 100$

$= \frac{6\ \text{m/s}}{343\ \text{m/s}} \times 100 = 2\%$

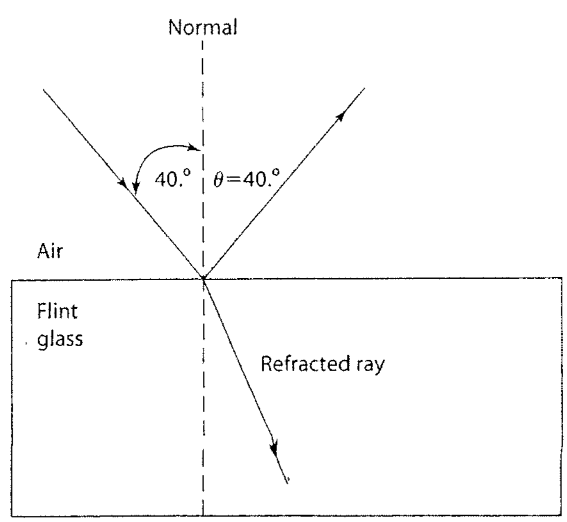
93. $3.75 \times 10^{12}\ \text{W}$
94. $\text{Heat} = (0.75)(3.75 \times 10^{12}\ \text{W})(1.5 \times 10^{-3}\ \text{s})$

$= 4.2 \times 10^9\ \text{J}$

95. $\bar{v} = \frac{d}{t}$

$t = \frac{d}{\bar{v}} = \frac{3.0 \times 10^4\ \text{m}}{3.31 \times 10^2\ \text{m/s}} = 91\ \text{s}$

96.



42. $E = mc^2 = (2.50 \times 10^{-3}\text{ kg})(3.00 \times 10^8\text{ m/s})^2$
$= 2.25 \times 10^{14}\text{ J}$

43. 3

44. $E = mc^2$

$$m = \frac{E}{c^2} = \frac{9.90 \times 10^{-13}\text{ J}}{(3.00 \times 10^8\text{ m/s})^2} = 1.10 \times 10^{-29}\text{ kg}$$

45. 1 46. 1

47. 10^{-3} pm 48. 10^{-9} nm 49. 10^{36}

50. 2

51. The mass of the neutron is greater than the mass of the proton.

52. The charge on the electron antineutrino is zero *or* neutral.

53. 2 54. 3 55. +1e

56. 0e 57. 1 58. 3

59. 1.67×10^{-27} kg

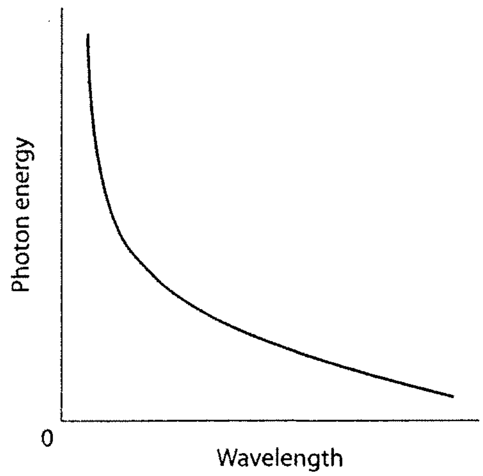
Regents Practice Questions

1. 2 2. 1 3. 3
4. 4 5. 3 6. 1
7. 4 8. 1 9. 3
10. 2 11. 3 12. 2
13. 2 14. 1

15. $\overline{uud}$

16. $E = hf = (6.63 \times 10^{-34}\text{ J}\cdot\text{s})(5.00 \times 10^{15}\text{ Hz})$
$= 3.32 \times 10^{-18}\text{ J}$

17.



18. $v = f\lambda$

$$\lambda = \frac{v}{f} = \frac{3.00 \times 10^8\text{ m/s}}{1.00 \times 10^{18}\text{ Hz}} = 3.00 \times 10^{-10}\text{ m}$$

19. $\Delta E_{photon} = \frac{hc}{\lambda_f} - \frac{hc}{\lambda_i} = hc\left(\frac{1}{\lambda_f - \lambda_i}\right)$

The energy gained by the electron equals the energy lost by the photon.

20. $E_{\text{photon}} = E_i - E_f = -5.74\text{ eV} - (-3.71\text{ eV})$
$= 2.03\text{ eV}$

21. 3.25×10^{-19} J

22. $E = hf$

$$f = \frac{E}{h} = \frac{3.25 \times 10^{-19}\text{ J}}{6.63 \times 10^{-34}\text{ J}\cdot\text{s}} = 4.90 \times 10^{14}\text{ Hz}$$

23. Nothing would happen because it is not enough energy to excite the electron to level *b*.

24. 2

25. c^2, the speed of light in a vacuum squared

26. 4

27. $h = 6.63 \times 10^{-34}\text{ J}\cdot\text{s}$

In fundamental units, 1 joule $= \frac{1\text{ kilogram}\cdot\text{meter}^2}{\text{second}^2}$,
so 1 joule · second $= \frac{1\text{ kilogram}\cdot\text{meter}^2}{\text{second}^2} \times$ second
$= \frac{1\text{ kilogram}\cdot\text{meter}^2}{\text{second}}$

28. $(1.0087\text{ u})(9.31 \times 10^2\text{ MeV/u}) = 9.39 \times 10^2\text{ MeV}$

29. $\Delta m = 3.0170\text{ u} - [1.0073\text{ u} + 2(1.0087\text{ u})]$
$= 0.0077\text{ u}$

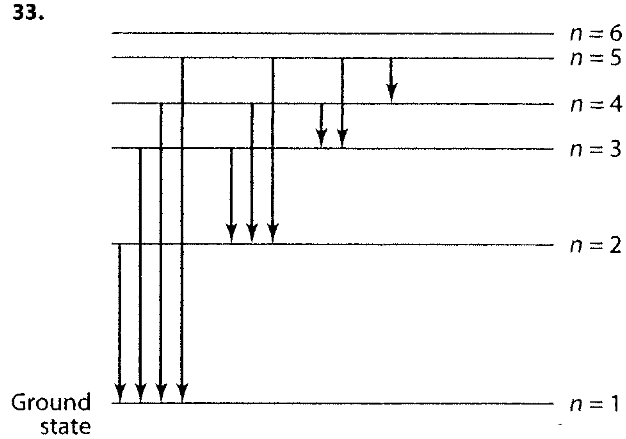
30. $\underline{-1}$ e → $\underline{-1}$ e + $\underline{0}$ e + $\underline{0}$ e

31. 4

32. $E = mc^2$

$$m = \frac{E}{c^2}$$
$$= \frac{(9.31 \times 10^2\text{ MeV})(10^6\text{ eV/MeV})(1.60 \times 10^{-19}\text{ J/eV})}{(3.00 \times 10^8\text{ m/s})^2}$$
$= 1.66 \times 10^{-27}$ kg

33.



34. $\lambda = \frac{h}{mv}$

$$\lambda = \frac{6.63 \times 10^{-34}\text{ J}\cdot\text{s}}{(6.7 \times 10^{-27}\text{ kg})(2.0 \times 10^6\text{ m/s})}$$

$\lambda = 4.9 \times 10^{-14}$ m

35. The wavelength of the particle is of the same order of magnitude of gamma rays.

36. $r_n = \frac{n^2h^2}{4\pi^2m_eke^2}$

$$= \frac{1^2(6.63 \times 10^{-34}\text{ J}\cdot\text{s})^2}{4\pi^2(9.11 \times 10^{-31}\text{ kg})(8.99 \times 10^9\text{ N}\cdot\text{m}^2/\text{C}^2)(1.60 \times 10^{-19}\text{ C})^2}$$

$= 5.31 \times 10^{-11}$ m

37. 5.31×10^{-2} nm

38. $$\frac{r_{n=4}}{r_{n=2}} = \frac{\frac{4^2h^2}{4\pi^2m_eke^2}}{\frac{2^2h^2}{4\pi^2m_eke^2}} = \frac{4^2}{2^2} = \frac{16}{4} = \frac{4}{1}$$

39. $E = mc^2 = 2(9.11 \times 10^{-31}\text{ kg})(3.00 \times 10^8\text{ m/s})^2$
$= 1.64 \times 10^{-13}\text{ J}$

40. 5.13×10^5 eV

41. $E = hf$

$$f = \frac{E}{h} = \frac{\frac{1}{2}(1.64 \times 10^{-13}\text{ J})}{6.63 \times 10^{-34}\text{ J}\cdot\text{s}} = 1.24 \times 10^{20}\text{ Hz}$$

42. gamma ray *or* X-ray

43. $d = 1.67 \times 10^{-6}$ m