44. $\sin \theta = \frac{50.4\text{ cm}}{193.9\text{ cm}} = 0.260$

45. $\lambda = d \sin \theta = (1.67 \times 10^{-6}\text{ m})(0.260)$
$= 4.34 \times 10^{-7}\text{ m}$

46. $4.35833 \times 10^{-7}\text{ m}$

47. Percent Error $= \frac{\text{absolute error}}{\text{accepted value}} \times 100$
$= \frac{0.02 \times 10^{-7}\text{ m}}{4.358\,33 \times 10^{-7}\text{ m}} \times 100 = 0.5\%$

48. $E = \frac{hc}{\lambda} = \frac{(6.63 \times 10^{-34}\text{ J} \cdot \text{s})(3.00 \times 10^{8}\text{ m/s})}{4.34 \times 10^{-7}\text{ m}}$

$= 4.58 \times 10^{-19}\text{ J}$

49. 2.86 eV

50. f to c

51. $19.34 \times 10^{-19}\text{ J}$
or
$1.934 \times 10^{-18}\text{ J}$

52. $E = hf$

$f = \frac{E}{h}$

$f = \frac{19.34 \times 10^{-19}\text{ J}}{6.63 \times 10^{-34}\text{ J} \cdot \text{s}}$

$f = 2.92 \times 10^{15}\text{ Hz}$

or

$f = 2.92 \times 10^{15}\text{ l/s}$

53. 0.018 63 u

54. 17.3 MeV

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

$\sin\theta_2 = \frac{n_1 \sin\theta_1}{n_2} = \frac{1.00 \sin 40.°}{1.66}$

$\theta_2 = 23°$

98. See question 96.

99. $n = \frac{c}{v}$, so $v = \frac{c}{n}$ and

$v = f\lambda$, so

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

$\lambda = \frac{c}{nf} = \frac{3.00 \times 10^8 \text{ m/s}}{1.66(5.09 \times 10^{14} \text{ Hz})} = 3.55 \times 10^{-7} \text{ m}$

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

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

$\sin\theta_2 = \frac{1.00 \sin 17°}{1.46}$

$\theta_2 = 12°$ *or* $11.6°$

101. The refracted ray makes an angle of 12°(±2°) with the normal.

102. The angles are measured with a protractor.

$\theta_1 = 45°$ and $\theta_2 = 30.°$

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

$n_2 = \frac{n_1 \sin\theta_1}{\sin\theta_2} = \frac{1.33 \sin 45°}{\sin 30.°} = 1.88$

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

$v = \frac{c}{n} = \frac{3.00 \times 10^8 \text{ m/s}}{1.88} = 1.60 \times 10^8 \text{ m/s}$

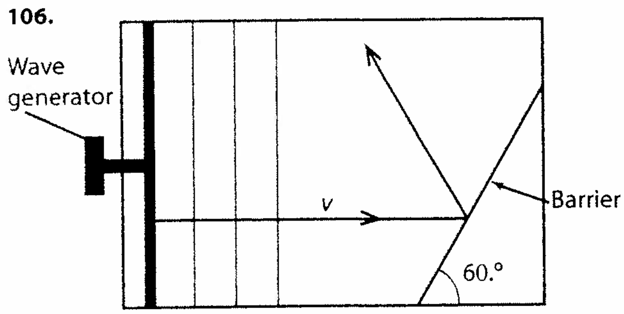
103. $T = \frac{1}{f} = \frac{1}{12 \text{ Hz}} = 0.083 \text{ s}$

104. 0.8 cm *or* 8 mm *or* 0.008 m

105. $v = f\lambda$

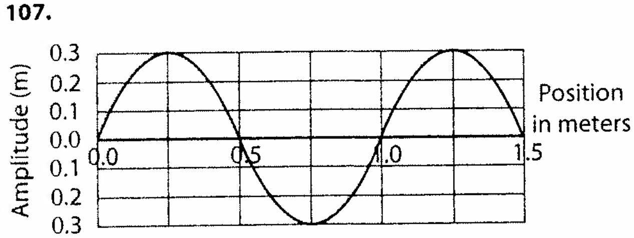
$v = (12 \text{ Hz})(0.8 \text{ cm}) = 10 \text{ cm/s}$

106.



The arrow forms an angle of 60.° ± 2° with the barrier and is directed away from the barrier, as shown.

107.



108. 0.3 m

109. 1.0 m

110. $T = \frac{1}{f}$

$f = \frac{1}{T}$

$f = \frac{1}{5.0 \text{ s}}$

$f = 0.20 \text{ Hz}$

111. $v = f\lambda$ $\qquad \bar{v} = \frac{d}{t}$

$v = (0.20 \text{ Hz})(2.0 \text{ m})$ *or* $\bar{v} = \frac{2.0 \text{ m}}{5.0 \text{ s}}$

$v = 0.40 \text{ m/s}$ $\qquad \bar{v} = 0.40 \text{ m/s}$

Answers To Topic 6

Review Questions

1. 2   2. 4   3. 3
4. 4   5. 1   6. 3
7. 4

8. $E = \frac{hc}{\lambda} = \frac{(6.63 \times 10^{-34} \text{ J·s})(3.00 \times 10^8 \text{ m/s})}{4.00 \times 10^{-7} \text{ m}}$

$= 4.97 \times 10^{-19} \text{ J}$

9. 3   10. 3   11. 3
12. 1   13. 1   14. 4
15. 3   16. 3

17. $1.26 \times 10^{-18} \text{ J}$

18. bright-line spectrum

19. 3   20. 4   21. 2
22. 1   23. 1

24. $n = 4$ to $n = 2$

25. $4.08 \times 10^{-19} \text{ J}$

26. $E = hf$

$f = \frac{E}{h} = \frac{4.08 \times 10^{-19} \text{ J}}{6.63 \times 10^{-34} \text{ J·s}} = 6.15 \times 10^{14} \text{ Hz}$

27. $E = \frac{hc}{\lambda}$

$E = \frac{(6.63 \times 10^{-34} \text{ J·s})(3.00 \times 10^8 \text{ m/s})}{6.58 \times 10^{-7} \text{ m}}$

$E = 3.02 \times 10^{-19} \text{ J}$

28. 1.89 eV

29. This value is consistent with the $n = 3$ to $n = 2$ transition of 1.89 eV.

30. $2.34 \times 10^{-18} \text{ J}$

31. $E = hf$

$f = \frac{E}{h} = \frac{2.34 \times 10^{-18} \text{ J}}{6.63 \times 10^{-34} \text{ J·s}} = 3.53 \times 10^{15} \text{ Hz}$

32. 4   33. 2

34. $E = hf$

$f = \frac{E}{h}$

$= \frac{(-1.51 \text{ eV} - (-3.40 \text{ eV}))(1.60 \times 10^{-19} \text{ J/eV})}{6.63 \times 10^{-34} \text{ J·s}}$

$= 4.56 \times 10^{14} \text{ Hz}$

35. 3   36. 4   37. 1
38. 4   39. 1   40. 3
41. 2

87. F

88. 3

89. 4

90. $n = \frac{c}{v} = \frac{3.00 \times 10^8 \text{ m/s}}{2.00 \times 10^8 \text{ m/s}} = 1.50$

91. 3

92. $\frac{v_1}{v_2} = \frac{n_2}{n_1} = \frac{1.92}{2.42}$

93. diamond

94. 4

95. 3

96. 1

97. 1

98. B

99. 2

100. 3

101. 3

102. 3

103. 4

104. 4

105. 2

106. 3

107. green

108. 10^5 Hz

109. 2

110. 3

111. 1

112. diamond, crown glass, flint glass, Lucite™, sodium chloride, or zircon

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

$$n_2 = \frac{n_1 \sin \theta_1}{\sin \theta_2} = \frac{1.00 \sin 45°}{\sin 30.°} = 1.41$$

114. $n = \frac{c}{v}$

$$v = \frac{c}{n} = \frac{3.00 \times 10^8 \text{ m/s}}{1.5} = 2.0 \times 10^8 \text{ m/s}$$

115. The angle of refraction increases.

116. 45° (±2°)

117. 3

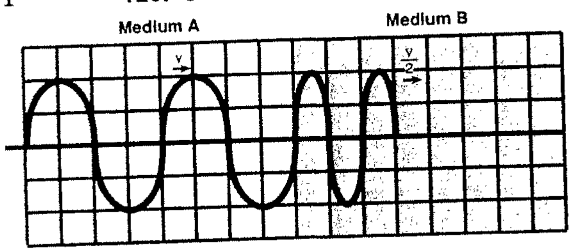
118. $n = \frac{c}{v}$

$$v = \frac{c}{n} = \frac{3.00 \times 10^8 \text{ m/s}}{1.4} = 2.1 \times 10^8 \text{ m/s}$$

119. 1

120. 3

121.



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

$$\bar{v} = \frac{2(324 \text{ m})}{0.425 \text{ s}}$$

$$\bar{v} = 1520 \text{ m/s}$$

123. $v = f\lambda$

$$\lambda = \frac{v}{f}$$

$$\lambda = \frac{1520 \text{ m/s}}{1.18 \times 10^3 \text{ Hz}}$$

$$\lambda = 1.29 \text{ m}$$

124. 8.47×10^{-4} s

125. $\frac{n_2}{n_1} = \frac{\lambda_1}{\lambda_2}$

$$\lambda_2 = \frac{n_1 \lambda_1}{n_2}$$

$$\lambda_2 = \frac{(1.00)(5.89 \times 10^{-7} \text{ m})}{2.42}$$

$$\lambda_2 = 2.43 \times 10^{-7} \text{ m}$$

126. 0°

127. The frequency of this light in diamond is the same as its frequency in air. The speed of the light in diamond is less than its speed in air.

Regents Practice Questions

1. 2

2. 2

3. 4

4. 2

5. 2

6. 1

7. 4

8. 1

9. 1

10. 3

11. 1

12. 3

13. 1

14. 1

15. 3

16. 1

17. 3

18. 1

19. 3

20. 4

21. 4

22. 1

23. 2

24. 3

25. 2

26. 1

27. 4

28. 4

29. 4

30. 1

31. 1

32. 2

33. 4

34. 4

35. 1

36. 1

37. $\frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}$

$$\lambda_2 = \frac{v_2 \lambda_1}{v_1} = \frac{(0.15 \text{ m/s})(0.50 \text{ m})}{0.30 \text{ m/s}} = 0.25 \text{ m}$$

38. 1.41

39. 4

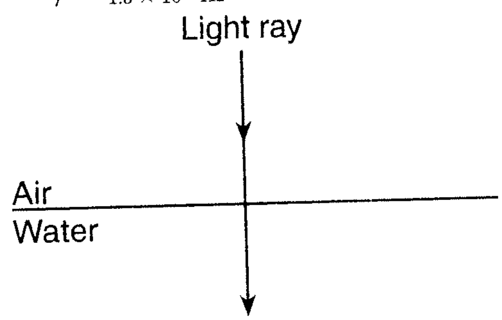
40. 1

41. 1

42. $v = f\lambda$

$$\lambda = \frac{c}{f} = \frac{3.00 \times 10^8 \text{ m/s}}{1.5 \times 10^{18} \text{ Hz}} = 2.0 \times 10^{-10} \text{ m}$$

43.

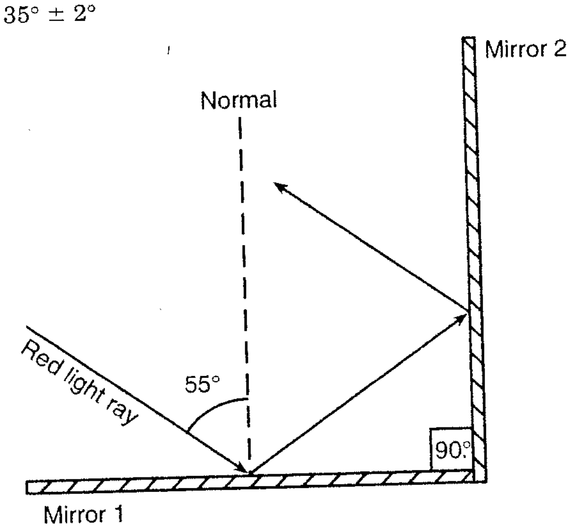


44. $\bar{v} = \frac{s}{t}$

$$t = \frac{s}{\bar{v}} = \frac{1.50 \times 10^{11} \text{ m}}{3.00 \times 10^8 \text{ m/s}} = 5.00 \times 10^2 \text{ s}$$

45. 35° ± 2°

46.



47. 1.95×10^8 m/s

48. B

49. Doppler effect

50. The observed wave frequency at B is higher than that at D.

87. $P = \frac{V^2}{R}$

$R = \frac{V^2}{P} = \frac{(120\ V)^2}{1440\ W} = 10.\ \Omega$

88. $W = Pt = (1440\ W)(10.0\ min)(60.\ s/min)$
$= 8.6 \times 10^5\ J$

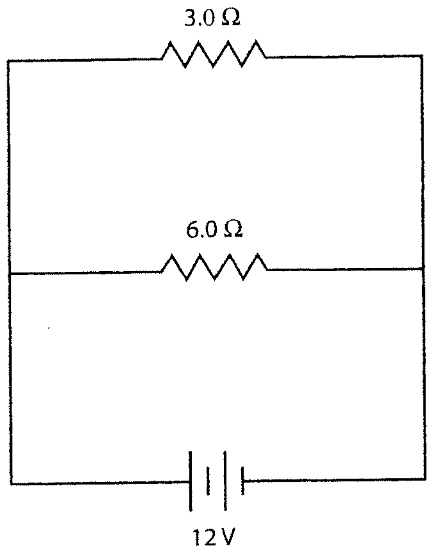
89. $P = VI$

$I = \frac{P}{V} = \frac{1440\ W}{120\ V} = 12\ A$

Because the broiler draws 12 A of current, 3 A additional current can be drawn before the fuse blows.

90. Although the potential drop across the broiler would remain the same, most of the current would go through the short circuit having negligible resistance. Because power is directly proportional to both potential difference and current, the power output of the broiler would decrease.

91.



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

$I = \frac{V}{R} = \frac{12\ V}{6.0\ \Omega} = 2.0\ A$

93. 12 V

94. $P = \frac{V^2}{R}$ and $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$

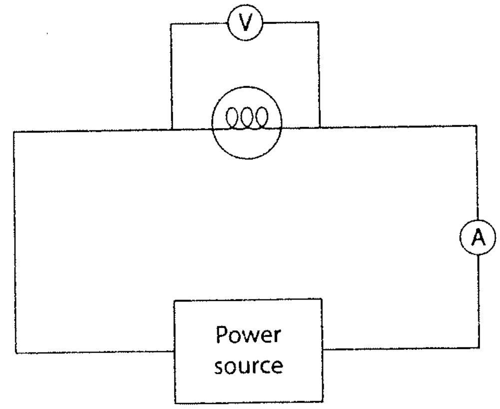
$\frac{1}{R_{eq}} = \frac{1}{3.0\ \Omega} + \frac{1}{6.0\ \Omega} = \frac{2+1}{6.0\ \Omega}$

$P = \frac{(12\ V)^2}{2.0\ \Omega} = 72\ W$

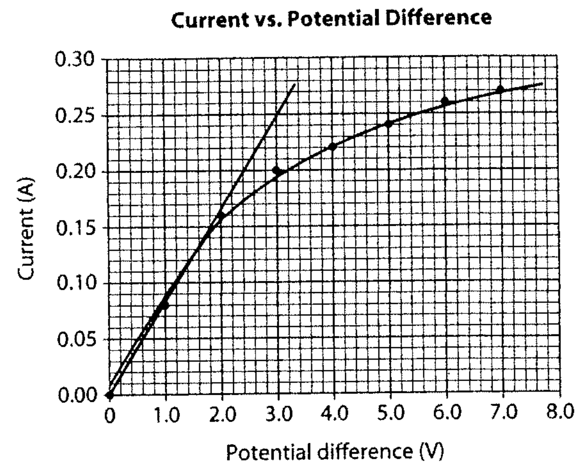
95. Adding an additional 2.0-ohm resistor to the circuit would not change the amount of current drawn by the 6.0-ohm resistor. Only the main line current would increase, as a result of the additional resistor.

96. When connected in parallel, the equivalent resistance is less than the value of either resistor. When connected in series, the equivalent resistance is greater than the value of either resistor.

97.



98.



99. slope $= \frac{\Delta I}{\Delta V} = \frac{0.21\ A - 0.18\ A}{3.4\ V - 2.6\ V} = 0.038\ \frac{1}{\Omega}$

100. The slope is the reciprocal of the resistance or $\frac{1}{R}$.

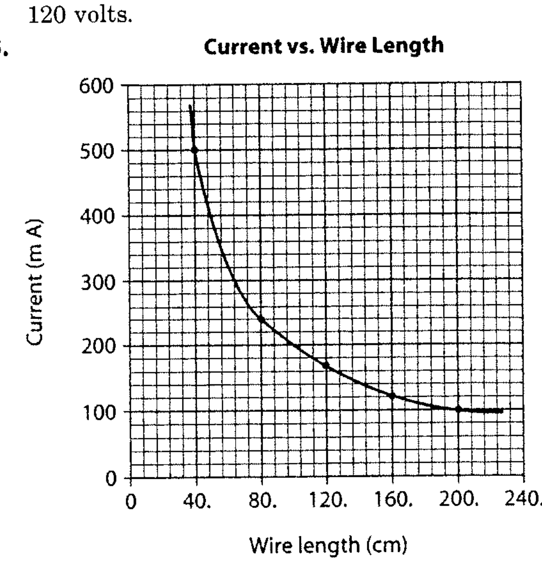
101. The lamp does not obey Ohm's law because the filament gets hot.

102. See answer to question 98.

103. $P = IV = (7.0\ V)(0.27\ A) = 1.9\ W$

104. The bulb is not operating at the standard 120 volts.

105.



106. The current in the wire is inversely proportional to the wire's length.

107. Ω

75. 120 V

76. $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{10.\ \Omega} + \frac{1}{15\ \Omega} = \frac{3+2}{30.\ \Omega} = \frac{1}{6.0\ \Omega}$ and

$R_{eq} = 6.0\ \Omega$

77. 12 V

78. $I = \frac{V}{R} = \frac{12\ \text{V}}{10.\ \Omega} = 1.2\ \text{A}$

79. The current in ammeter A_1 is greater than the current in ammeter A_2.

80. If another resistor is added to the circuit in parallel, the equivalent resistance decreases and the total current in the circuit increases.

81. $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_2} = \frac{1}{R_{eq}} - \frac{1}{R_1} = \frac{1}{6.0\ \Omega} - \frac{1}{10.\ \Omega} = \frac{5-3}{30.\ \Omega} = \frac{1}{15\ \Omega}$

$R_2 = 15\ \Omega$

82. $I = \frac{V}{R} = \frac{30.\ \text{V}}{6.0\ \Omega} = 5.0\ \text{A}$

83. $P = \frac{V^2}{R} = \frac{(30.\ \text{V})^2}{10.\ \Omega} = 90.\ \text{W}$

84. The potential difference across the source is equal to the potential difference across R_2, 30. volts.

85. If the resistance of R_2 is increased, the potential difference across it remains 30. volts, but the current through it decreases.

86. 4	**87.** 4	**88.** 3
89. 3	**90.** 2	**91.** 1
92. 3	**93.** 3	**94.** 4

95. $P = \frac{V^2}{R}$

$R = \frac{V^2}{P} = \frac{(120\ \text{V})^2}{4800\ \text{W}} = 3.0\ \Omega$

96. $W = Pt = (4800\ \text{W})(10.0\ \text{s}) = 4.8 \times 10^4\ \text{J}$

97. $P = IV$ and $I = \frac{q}{t}$

$P = \frac{qV}{t}$

$q = \frac{Pt}{V} = \frac{(15\ \text{W})(60.\ \text{s})}{12\ \text{V}} = 75\ \text{C}$

98. 2	**99.** 2	**100.** 2
101. 4	**102.** 1	**103.** 4

104. at least one is a magnet *or* one is a magnet

105. 3

106. S ◁▶ N

107. 1	**108.** A	**109.** C
110. 3	**111.** 4	**112.** 1

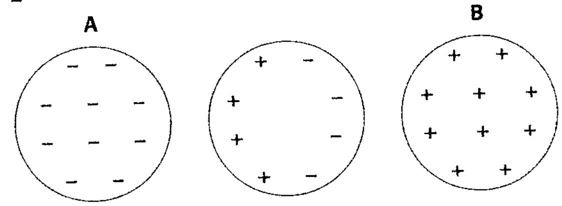
Regents Practice Questions

Part A

1. 3	**2.** 3	**3.** 2
4. 2	**5.** 4	**6.** 2
7. 2	**8.** 4	**9.** 4
10. 3	**11.** 3	**12.** 1
13. 4	**14.** 1	**15.** 3
16. 2	**17.** 3	**18.** 2
19. 1	**20.** 2	**21.** 1
22. 2	**23.** 3	**24.** 3
25. 2	**26.** 3	**27.** 4
28. 1	**29.** 2	**30.** 2

31. 4	**32.** 3	**33.** 4
34. 4	**35.** 2	**36.** 4
37. 2	**38.** 1	**39.** 1
40. 3	**41.** 4	**42.** 3
43. 2	**44.** 2	

45.



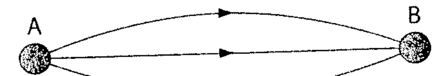
46. $-1.0 \times 10^{-2}\ \text{N}$

47. $\frac{e}{m} = \frac{1.60 \times 10^{-19}\ \text{C}}{9.11 \times 10^{-31}\ \text{kg}} = 1.76 \times 10^{11}\ \text{C/kg}$

48. $q/4$

49.

50.

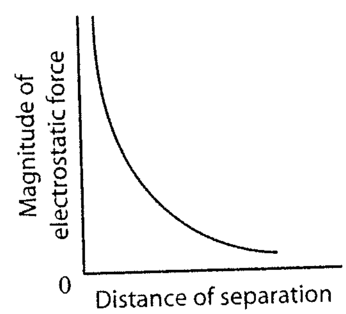


51. $F_e = \frac{kq_1q_2}{r^2}$

$= \frac{(8.99 \times 10^9\ \text{N}\cdot\text{m}^2/\text{C}^2)(2.4 \times 10^{-6}\ \text{C})(2.4 \times 10^{-6}\ \text{C})}{(0.50\ \text{m})^2}$

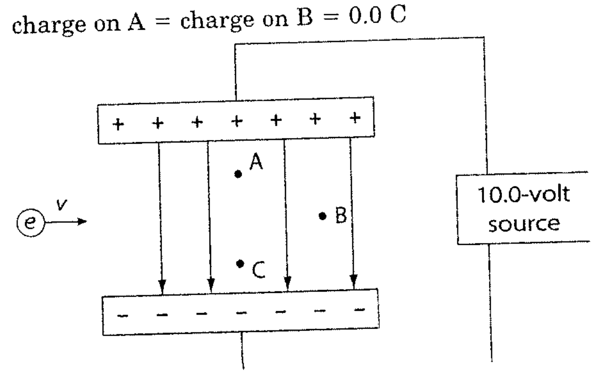
$= 0.21\ \text{N}$

52.



53. charge on A = charge on B = 0.0 C

54.



78. $1.00\text{ kW}\cdot\text{h} = \frac{1.00\times10^3\text{ J}}{\text{s}}\cdot\text{h}$

$= \frac{1.00\times10^3\text{ J}}{\text{s}}\cdot 1\text{ h}\left(\frac{60\text{ min}}{1\text{ h}}\right)\left(\frac{60\text{ s}}{1\text{ min}}\right)$

$= 3.6\times10^5\text{ J}$

79. $PE_i + KE_i = PE_{top} + KE_{top}$

$mgh + 0 = mg(2r) + \frac{1}{2}m\nu_{top}^2$

$gh = g(2r) + \frac{1}{2}\nu_{top}^2$

And if the car just makes it around the top of the loop, the normal force of the track on the car is zero. Gravity provides the centripetal force.

$F_g = F_c$

$mg = \frac{m\nu^2}{r}$

$\nu^2 = gr$

Substituting,

$gh = g(2r) + \frac{1}{2}gr$

$h = \frac{5r}{2}$

80. During the collision momentum is conserved.

$p_i = p_f$

$m_B\nu_{B_i} = (m_B + m_W)\nu_f$

$\nu_f = \frac{m_B\nu_{B_i}}{m_B + m_W}$

Mechanical energy is conserved after the collision.

$E_i = E_f$

$PE_{BW_i} + KE_{BW_i} = PE_{BW_f} + KE_{BW_f}$

$\frac{1}{2}(m_B + m_W)\nu_f^2 = (m_B + m_W)gh$

$h = \frac{v_f^2}{2g} = \frac{\left(\frac{m_Bv_{B_i}}{m_B + m_w}\right)^2}{2g}$

81. $T = 2\pi\sqrt{\frac{m}{k}}$

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

$k = \frac{m}{\left(\frac{T}{2\pi}\right)^2}$ and

$PE_s = \frac{1}{2}kx^2 = \frac{mx^2}{2\left(\frac{T}{2\pi}\right)^2} = \frac{2\pi^2mx^2}{T^2}$ or $2m\left(\frac{\pi x}{T}\right)^2$

82. $PE_s = KE$

$\frac{1}{2}kx^2 = \frac{1}{2}mv^2$ *or* $\frac{1}{2}kx^2 = \frac{1}{2}mv^2$

$k = \frac{mv^2}{x^2}$ $\quad k = \frac{mv^2}{x^2}$

83. $KE = \frac{1}{2}mv^2$ and $p = mv$

$v = \sqrt{\frac{2KE}{m}}$ and $p = m\sqrt{\frac{2KE}{m}} = \sqrt{2mKE}$

84. $PE = mgh$

85. $PE_B + KE_B = PE_A + KE_A$

$\frac{1}{2}mv_B^2 = mgh$

$v_B = \sqrt{2gh}$

86. $PE_B + KE_B = PE_C + KE_C + PE_S$

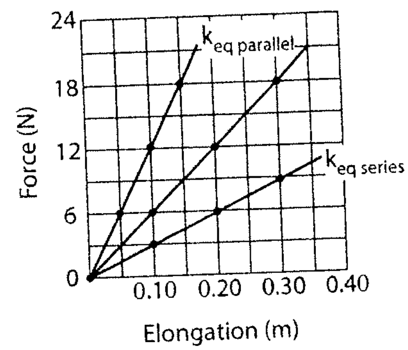
$\frac{1}{2}mv_B^2 = mg(-y) + \frac{1}{2}ky^2$

$mv_B^2 = 2mg(-y) + ky^2$

87. $ky^2 = mv_B^2 + 2mgy$

$k = \frac{m}{y^2}(v_B^2 + 2gy)$

88. **Force vs. Elongation**



89. See question 88.

90. $PE_B + KE_B = PE_A + KE_A$

$\frac{1}{2}m\nu_B^2 = mg\ell$

$\nu_B = \sqrt{2g\ell}$

91. $PE = mgh = mg(2r) = 2mgr$

92. $PE_C + KE_C = PE_B + KE_B$

$2mgr + \frac{1}{2}m\nu_C^2 = 0 + \frac{1}{2}m\nu_B^2$

but $\frac{1}{2}m\nu_B^2 = mg\ell$

so

$2mgr + \frac{1}{2}m\nu_C^2 = mg\ell$

$\frac{1}{2}m\nu_C^2 = mg\ell - 2mgr$

$\nu_C^2 = 2g\ell - 4gr$

$\nu_C = \sqrt{2g(\ell - 2r)}$

93. 1.2×10^4 N *or* 11,800 N

94. $F_f = \mu F_N$

$F_f = (0.67)(12{,}000\text{ N})$

$F_f = 8{,}000$ N *or* 8,040 N

95. $W = Fd$

$W = (8{,}000\text{ N})(16\text{ m})$

$W = 1.3\times10^5$ J *or* 128,000 J

96. $W = KE = \frac{1}{2}m\nu^2$ $\quad a = \frac{F_{net}}{m}$

$\nu = \sqrt{\frac{2KE}{m}}$ $\quad a = 6.7\text{ m/s}^2$

$\nu_f^2 = \nu_i^2 + 2ad$

$\nu = \sqrt{\frac{2(1.3\times10^5\text{ J})}{1.2\times10^3\text{ kg}}}$ *or* $\nu_i = \sqrt{\nu_f^2 - 2ad}$

$\nu_i = \sqrt{0 - 2(-6.7\text{ m/s}^2)(16\text{ m})}$

$\nu = 15$ m/s $\quad \nu_i = 14.6$ m/s

97. $p_{before} = p_{after}$

or

$m_{before}v_{before} = m_{after}v_{after}$

$(50.\text{ kg})(6.0\text{ m/s}) = (60.\text{ kg})\,v_{after}$

$v_{after} = (50.\text{ kg})(6.0\text{ m/s})/(60.\text{ kg})$

$v_{after} = 5.0$ m/s

98. $KE = \frac{1}{2}m\nu^2$

$KE = \frac{1}{2}(60.\text{ kg})(5.0\text{ m/s})^2$

$KE = 750$ J

99. 750 J

100. $p_{before} = p_{after}$

$m_1\nu_{1i} + m_2\nu_{2i} = (m_1 + m_2)\nu_f$

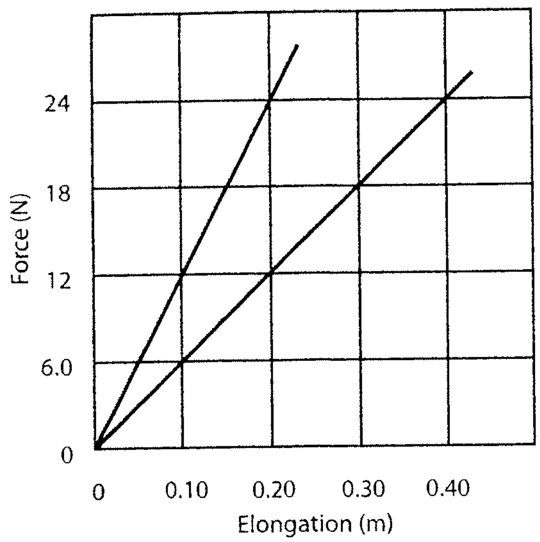
$(1000.\text{ kg})(6.0\text{ m/s}) + (5000.\text{ kg})(0.0\text{ m/s}) = (1000.\text{ kg} + 5000.\text{ kg})\,\nu_f$

$6000\text{ kg}\cdot\text{m/s} = (6000.\text{ kg})\,\nu_f$

$\nu_f = 1.0$ m/s

56. Example of Acceptable Response

Force vs. Elongation



57. 4 **58.** 3

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

$v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(96\text{ J})}{3.0\text{ kg}}} = 8.0\text{ m/s}$

60. 1 **61.** 2 **62.** 12 J

63. 1 **64.** 3 **65.** 3

66. 4 **67.** 1 **68.** 2

69. 2

70. $PE_A + KE_A = PE_B + KE_B$

$PE_A = KE_B$

$mgh = KE_B$

$h = \frac{KE_B}{mg} = \frac{1962\text{ J}}{(20.0\text{ kg})(9.81\text{ m/s}^2)} = 10.0\text{ m}$

71. 3

72. $PE_A + KE_A = PE_B + KE_B$

$KE_B = PE_A = mgh = F_g h = (600\text{ N})(0.5\text{ m}) = 300\text{ J}$

73. 3 **74.** 4 **75.** 2

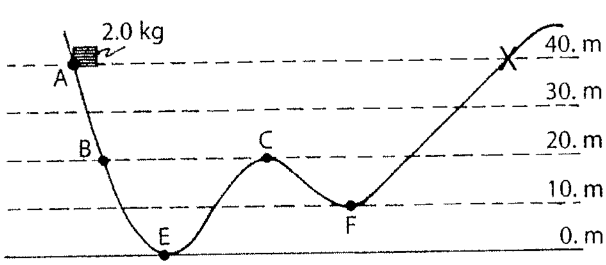
76. 2 **77.** 3 **78.** 3

79. 19.6 J **80.** 2 **81.** 3

82. $\Delta PE = mg\Delta h = (2.0\text{ kg})(9.81\text{ m/s}^2)(40.\text{m}) = 780\text{ J}$

83. 2

84.



85. 4 **86.** 3

87. $KE = \frac{1}{2}mv^2 = \frac{1}{2}(10.0\text{ kg})(10.0\text{ m/s})^2 = 500.\text{ J}$

88. $F = ma = \frac{m\Delta v}{t} = \frac{(10.0\text{ kg})(10.0\text{ m/s})}{4.0\text{ s}} = 25\text{ N}$

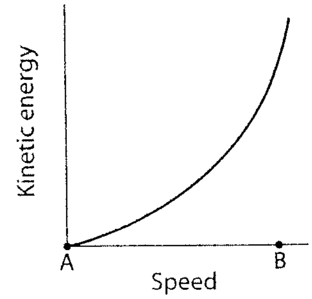
89. $\bar{v} = \frac{d}{t}$

$d = \bar{v}t = (5.00\text{ m/s})(4.0\text{ s}) = 20.\text{ m}$

90. $J = \Delta p = m\Delta v = (10.0\text{ kg})(-10.0\text{ m/s}) = 100.\text{ N}\cdot\text{s}$

91. 2 **92.** 3

93.



94. $PE_A + KE_A = PE_B + KE_B$

$PE_A = KE_B$

$mgh = \frac{1}{2}mv^2$

$h = \frac{v^2}{2g} = \frac{(10.0\text{ m/s})^2}{2(9.81\text{ m/s}^2)} = 5.10\text{ m}$

95. $F_c = \frac{mv^2}{r} = \frac{(1.00\text{ kg})(10.0\text{ m/s})^2}{10.0\text{ m}} = 10.0\text{ N}$

96. 2 **97.** 2

98. $PE_A + KE_A = PE_B + KE_B + W$

$PE_A = PE_B + F_f d$

$F_f = \frac{PE_A - PE_B}{d} = \frac{mgh_A - mgh_B}{d} = \frac{mg(h_A - h_B)}{d}$

$F_f = \frac{(4.00 \times 10^{-2}\text{ kg})(9.81\text{ m/s}^2)(0.80\text{ m} - 0.50\text{ m})}{3.60\text{ m}}$

$= 3.3 \times 10^{-2}\text{ N}$

99. $W = Fd$ and $F = F_f = \mu F_N = \mu mg$

$W = \mu mgd = (0.67)(1.00 \times 10^3\text{ kg})(9.81\text{ m/s}^2)(250\text{ m}) = 1.6 \times 10^6\text{ J}$

100. 491 J **101.** 109 J **102.** 1

103. 3 **104.** 1

Regents Practice Questions

1. 3 **2.** 2 **3.** 3

4. 1 **5.** 3 **6.** 2

7. 4 **8.** 1 **9.** 2

10. 2 **11.** 3 **12.** 4

13. 3 **14.** 4 **15.** 4

16. 3 **17.** 3 **18.** 2

19. 4 **20.** 2 **21.** 4

22. 1 **23.** 1 **24.** 2

25. 1 **26.** 2 **27.** 2

28. 3 **29.** 1 **30.** 3

31. 4 **32.** 2 **33.** 4

34. 1 **35.** 1

36. $W = Fd$ and $F_x = F\cos\theta$

$W = (F\cos\theta)(d) = (120\text{ N})(\cos 37°)(10.\text{ m}) = 960\text{ J}$

37. $W = \Delta PE = mg\Delta h = (20.\text{ N})(3.0\text{ m}) = 60.\text{ J}$

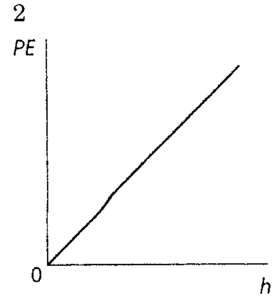
38. $W = Fd$ and $d = vt$

$d = (4.0\text{ m/s})(6.0\text{ s}) = 24\text{ m}$

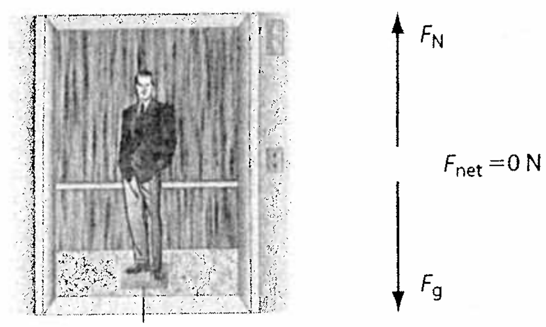
$W = (20.\text{ N})(24\text{ m}) = 480\text{ J}$

39. 2

40.

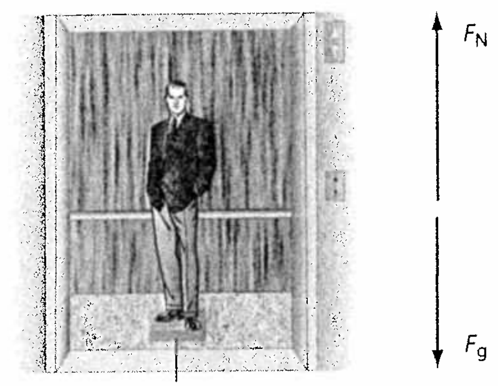


154.



155. $F_{net} = 0 \text{ N}$

156.



157. The reading on the scale when the elevator is accelerating upward is greater than when the elevator is stationary.

158. $\bar{v}_x = \frac{d_x}{t}$ and $t = \frac{t_1 + t_2 + t_3}{3}$

$= \frac{0.453 \text{ s} + 0.347 \text{ s} + 0.390 \text{ s}}{3} = 0.397 \text{ s}$

$\bar{v}_x = \frac{1.00 \text{ m}}{0.397 \text{ s}} = 2.52 \text{ m/s}$

159. $d = \frac{1}{2}at^2$ from rest

$t = \sqrt{\frac{2d_y}{a_y}} = \sqrt{\frac{2(0.926 \text{ m})}{9.81 \text{ m/s}^2}} = 0.434 \text{ s}$

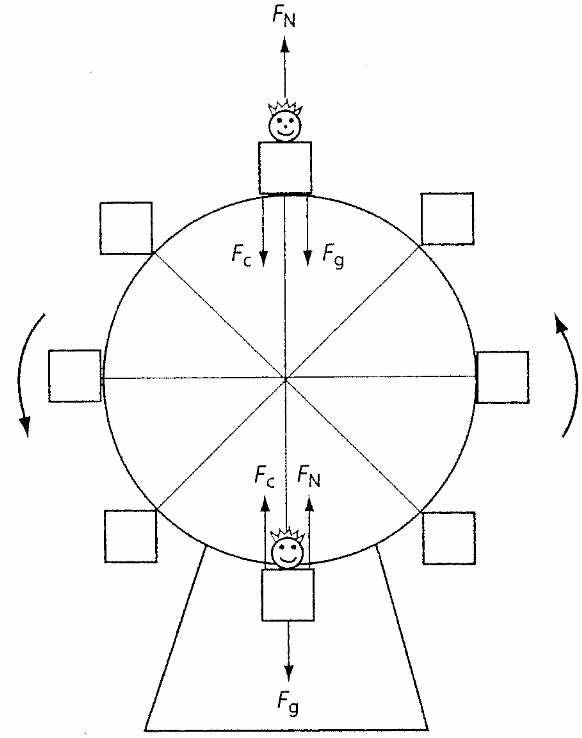
160. $\bar{v}_x = \frac{d_x}{t}$

$d_x = \bar{v}_x t = (2.52 \text{ m/s})(0.434 \text{ s}) = 1.09 \text{ m}$

161. Although the time was recorded to the nearest thousandth of a second, the broad range in the values indicates that more data should have been taken. The calculated horizontal speed of the car represents an average over an interval; the car was actually traveling slower when it was projected from the edge of the tabletop.

162. (a) The car would have a greater initial potential energy and, consequently, a greater final kinetic energy and horizontal speed. (b) Releasing the car from a greater height on the elevated track would have no effect on the time required for the car to hit the floor once it left the tabletop. The time of fall depends only on the height of the tabletop. (c) With the greater horizontal speed noted in (a), the car would travel a greater horizontal distance after it was projected from the tabletop.

163.



164. See question 163.

165. $F_{net} = F_c = F_N - F_g$

166. $F_{net} = -F_c = F_N - F_g$

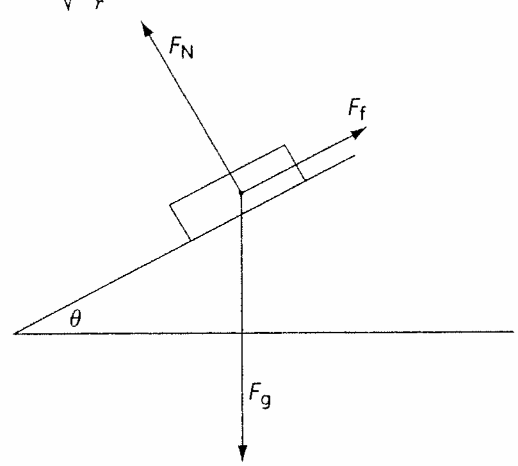
167. $F_c = F_g$

$\frac{mv^2}{r} = \frac{Gm_1m_2}{r^2}$

$\frac{v^2}{r} = \frac{Gm_E}{r^2}$

$v = \sqrt{\frac{Gm_E}{r}}$

168.



169. $F_\parallel = F_g \sin\theta$

$F_\perp = F_g \cos\theta$

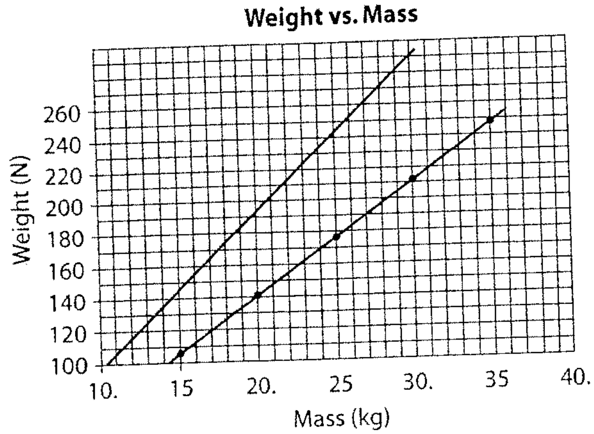
170. $F_f = \mu F_N$

$\mu = \frac{F_g \sin\theta}{F_g \cos\theta} = \tan\theta$

171. Julia is correct. Average speed, a scalar quantity, is total distance traveled divided by time of travel. Velocity is a vector quantity. As an object moves in a circular path, its velocity continually changes due to a change in direction of travel, although the object may be moving at a constant speed.

93. The magnitude of the centripetal acceleration is the same because it is not dependent on mass.

94.



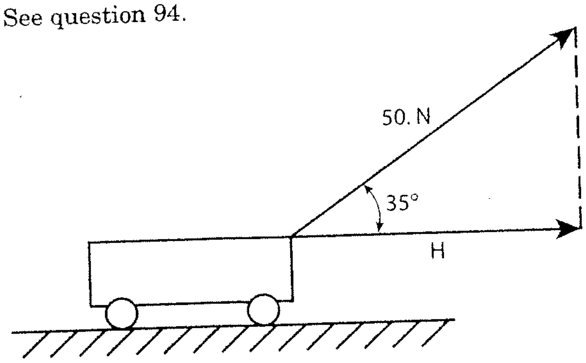
95. See question 94.

96. See question 94.

97. $g = \frac{F_g}{m} = \frac{170.\text{ N}}{24\text{ kg}} = 7.1\text{ m/s}^2$

98. See question 94.

99.



100. See question 99.

101. 41 N ± 3 N

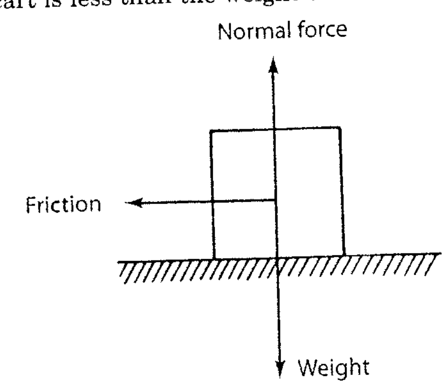
102. 41 N ± 3 N

103. $F_f = \mu F_N$

$F_N = \frac{F_f}{\mu} = \frac{41\text{ N}}{0.68} = 60.\text{ N}$

104. The magnitude of the normal force acting on the cart is less than the weight of the cart.

105.



106. $a = \frac{F_{net}}{m}$ and $g = \frac{F_g}{m}$, so $m = \frac{F_g}{g}$

$a = \frac{F_{net}g}{F_g} = \frac{(2.4\text{ N})(9.81\text{ m/s}^2)}{4.2\text{ N}} = 5.6\text{ m/s}^2$

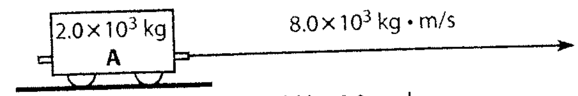
107. $F_f = \mu F_N$

$\mu = \frac{F_f}{F_N} = \frac{2.4\text{ N}}{4.2\text{ N}} = 0.57$

108. $p = mv = (2.00 \times 10^3\text{ kg})(4.0\text{ m/s})$

$= 8.0 \times 10^3\text{ kg} \cdot \text{m/s}$

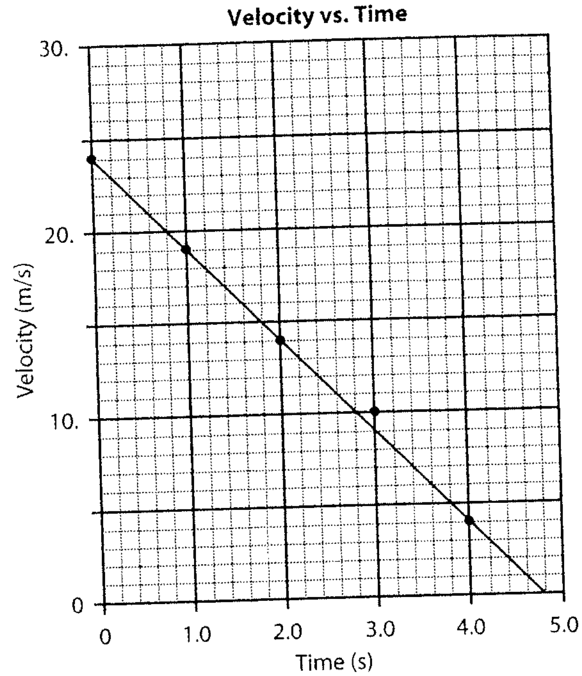
109.



The vector should be 8.0 cm long.

110. Momentum is conserved. The initial momentum of the system was $8.0 \times 10^3\text{ kg} \cdot \text{m/s} + (-6.0 \times 10^3\text{ kg} \cdot \text{m/s}) = +2.0 \times 10^3\text{ kg} \cdot \text{m/s}$, so the final momentum of the system is $+2.0 \times 10^3\text{ kg} \cdot \text{m/s}$.

111.



112. See question 111.

113. $a = \frac{\Delta v}{t} = \frac{1\text{ m/s} - 21\text{ m/s}}{4.6\text{ s} - 0.6\text{ s}} = -5.0\text{ m/s}^2\ (\pm 0.3\text{ m/s}^2)$

114. $A_{triangle} = \frac{1}{2}bh = \frac{1}{2}(4.8\text{ s})(24\text{ m/s}) = 58\text{ m}$

115. $\Delta p = m\Delta v = (1500\text{ kg})(-24.0\text{ m/s})$

$= -3.6 \times 10^4\text{ kg} \cdot \text{m/s}$

116. $F_{net}t = \Delta p$

$F = \frac{\Delta p}{t} = \frac{-3.6 \times 10^4\text{ kg} \cdot \text{m/s}}{4.8\text{ s}} = -7.5 \times 10^3\text{ N}$

117. The impulse is equal to the change in momentum.

118. The magnitude of the horizontal component of the object's velocity is the same at points *A* and *B*.

119. The magnitude of the vertical component of the object's velocity at point *A* is less than it is at point *B*.

121. $F_f = \mu F_N$
$F_f = (0.30)(25\text{ N})$
$F_f = 7.5\text{ N}$

122. 2.5 N

123. The crate is accelerating because a net force is acting on it.

124. 1　　125. 2

126. $F_f = \mu F_N$
$F_f = (.15)(10.\text{ kg})(9.81\text{ m/s}^2)$
$F_f = 15\text{ N}$ *or* 14.7 N

127. 10. N

128. $g = \frac{F_g}{m}$
$F_g = mg = (5.0\text{ kg})(9.81\text{ m/s}^2) = 49\text{ N}$

129. The normal force is equal in magnitude to the cart's weight, but opposite in direction.

130. $F_f = \mu F_N$
$\mu = \frac{F_f}{F_N} = \frac{10.\text{ N}}{49\text{ N}} = 0.20$

131. $F_f = \mu F_N$
$F_N = \frac{F_f}{\mu} = \frac{5.2\text{ N}}{0.30} = 17\text{ N}$; in this case, the weight equals the normal force.

132. 3	133. 1	134. 2
135. 3	136. 4	137. 3

138. $J = F_{net}t$
$F_{net} = \frac{J}{t} = \frac{6.0\text{ N}\cdot\text{s}}{3.0\text{ s}} = 2.0\text{ N east}$

139. 2　　140. 3 s to 4 s

141. $+3\text{ N}\cdot\text{s}$　　142. 1

143. $J = \Delta p = m\Delta v$
$\Delta v = \frac{J}{m} = \frac{30.0\text{ N}\cdot\text{s}}{5.00\text{ kg}} = 6.00\text{ m/s}$
Therefore, the final speed of the mass could be 94 m/s or 106 m/s.

144. 2

145. $p_{before} = p_{after}$
$m_a v_{a_i} = m_b v_{b_i} = p_{after}$
$(2.0\text{ kg})(6.0\text{ m/s}) + (3.0\text{ kg})v_{b_i} = 0\text{ kg}\cdot\text{m/s}$
$(3.0\text{ kg})v_{b_i} = -12\text{ kg}\cdot\text{m/s}$
$v_{b_i} = -4.0\text{ m/s}$

146. $p_{before} = p_{after}$
$m_a v_{a_i} + m_b v_{b_i} = (m_a + m_b)v_f$
$(0.180\text{ kg})(0.80\text{ m/s}) + (0.100\text{ kg})(0.0\text{ m/s}) = (0.180\text{ kg} + 0.100\text{ kg})v_f$
$v_f = 0.51\text{ m/s}$ to the right

147. 1

Regents Practice Questions

1. 2	2. 3	3. 1
4. 4	5. 3	6. 1
7. 4	8. 3	9. 2
10. 2	11. 4	12. 3
13. 1	14. 3	15. 3
16. 1	17. 1	18. 2
19. 3	20. 2	21. 2
22. 3	23. 3	24. 3
25. 4	26. 1	27. 4
28. 2	29. 2	30. 1

31. 4	32. 3	33. 1
34. 1	35. 1	36. 3
37. 1	38. 4	39. 2
40. 4	41. 4	42. 3
43. 3	44. 2	45. 3
46. 4	47. 3	48. 2
49. 4	50. 3	51. 3

52. 3

53. 30.° ± 2°

54. 140 m ± 20 m

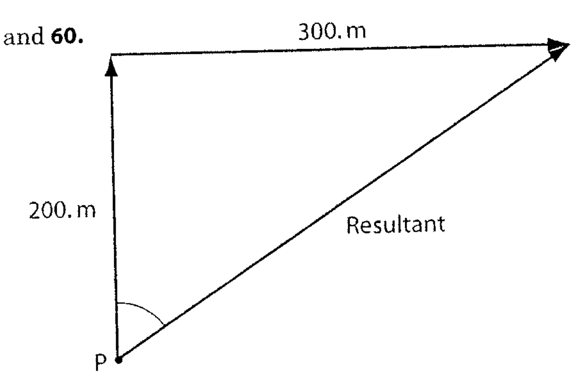
55. 240 m

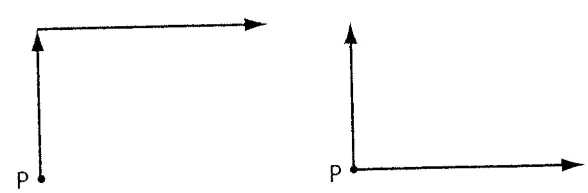
56. $d = v_i t + \frac{1}{2}at^2$
$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(240\text{ m})}{9.81\text{ m/s}^2}} = 7.0\text{ s}$

57. $v_f = v_i = at = (9.81\text{ m/s}^2)(7.0\text{ s}) = 69\text{ m/s}$ or
$v_f = \sqrt{v_i^2 + 2ad} = \sqrt{2(9.81\text{ m/s}^2)(240\text{ m})} = 69\text{ m/s}$

58. 1

59. and 60.





correct vector sequence　　incorrect vector sequence

61. 361 m ± 15 m

62. 56° ± 2°

63. $v_f = v_i + at$
$t = \frac{v_f - v_i}{a} = \frac{0.0\text{ m/s} - 20.\text{ m/s}}{9.81\text{ m/s}^2} = 2.0\text{ s}$

64. Because the stone averages 10. m/s while it is moving upwards,
$d = \bar{v}t = (10.\text{ m/s})(2.0\text{ s}) = 20.\text{ m}$ or
$d = v_i t + \frac{1}{2}at^2$
$= (20.\text{ m/s})(2.0\text{ s}) + \frac{1}{2}(-9.81\text{ m/s}^2)(2.0\text{ s})^2$
$= 40.\text{ m} - 20.\text{ m} = 20.\text{ m}$

65. The time it takes for the stone to fall to the level of the student equals its time of rise, 2.0 seconds, because neglecting air resistance the force of gravity on the stone is constant.

66. The speed of the stone at the time it returns to the level of the student is 20. m/s because the force of gravity acting on the stone is constant. However,

78. $\bar{x} = \frac{34.73 \text{ min}}{8} = 4.34$ min

79. $\sigma = \sqrt{\frac{0.4701 \text{ min}^2}{8}} = 0.24$ min

80. Range = 96°F − 63°F = 33 °F. The chart below is for instructional purposes. Students may determine values using a scientific calculator.

x_i (°F)	f_i	$x_i f_i$ (°F)	$x_i - \bar{x}$ (°F)	$(x_i - \bar{x})^2$ (°F)^2	$(x_i - \bar{x})^2 f_i$ (°F)^2
63	5	315	−16	256	1280.
70.	3	210.	−9	81	243
78	4	312	−1	1	4
79	3	237	0	0	0
80.	6	480.	1	1	6
84	4	336	5	25	100.
96	5	480.	17	289	1445
	$\Sigma f_i = 30.$	$\Sigma x_i f_i = 2370.$			$\Sigma(x_i - \bar{x})^2 f_i = 3078$

81. $\bar{x} = \frac{2370. \text{ °F}}{30.} = 79.0\text{°F}$

82. $\sigma = \sqrt{\frac{3078 \text{ °F}^2}{30.}} = 10.1$ °F

83. Range = 26 cm − 18 cm = 8 cm. The chart below is for instructional purposes. Students may determine values using a scientific calculator.

x_i (cm)	f_i	$x_i f_i$ (cm)	$x_i - \bar{x}$ (cm)	$(x_i - \bar{x})^2$ (cm^2)	$(x_i - \bar{x})^2 f_i$ (cm^2)
18	6	108	−3	9	54
19	4	76	−2	4	16
20.	4	80.	−1	1	4
21	3	63	0	0	0
24	5	120.	3	9	45
26	3	782	5	25	75
	$\Sigma f_i = 25$	$\Sigma x_i f_i = 525$			$\Sigma(x_i - \bar{x})^2 f_i = 194$

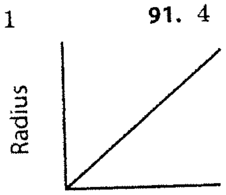
84. $\bar{x} = \frac{525 \text{ cm}}{25} = 21.0$ cm

85. $\sigma = \sqrt{\frac{194 \text{ cm}^2}{25}} = 2.8$ cm

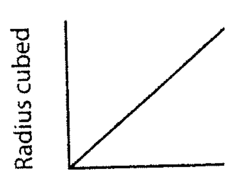
86. Nonlinear horizontal scale, skipped 300 on vertical scale, (m) as a unit not labeled on the vertical axis, dependent variable should be first in the title.

87. 4
88. 3
89. 3
90. 1
91. 4

92.



93.



94. (a) $F = \frac{mv^2}{r}$

$Fr = mv^2$

$r = \frac{mv^2}{F}$

(b) $A = \pi r^2$

$r^2 = \frac{A}{\pi}$

$r = \sqrt{\frac{A}{\pi}}$

(c) $C = 2\pi r$

$r = \frac{C}{2\pi}$

(d) $F = G\frac{m_1 m_2}{r^2}$

$Fr^2 = Gm_1m_2$

$r = \sqrt{\frac{Gm_1m_2}{F}}$

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

$d = \bar{v}t$

(b) $P = \frac{Fd}{t}$

$Pt = Fd$

$d = \frac{Pt}{F}$

(c) $v_f^2 = v_i^2 + 2ad$

$2ad = v_f^2 - v_i^2$

$d = \frac{v_f^2 - v_i^2}{2a}$

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

97. (a) $RI = V$

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

$W = VIt$

(b) $I = \frac{W}{Vt}$

$P = I^2R$

(c) $I^2 = \frac{P}{R}$

$I = \sqrt{\frac{P}{R}}$

98. $3.335\,640\,95 \times 10^{-9}$ s

99. 2

100. 10.°

96. (a) $KE = \frac{1}{2}mv^2$

$2\,KE = mv^2$

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

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

(b) $p = mv$

$v = \frac{p}{m}$

(c) $n = \frac{c}{v}$

$v = \frac{c}{n}$