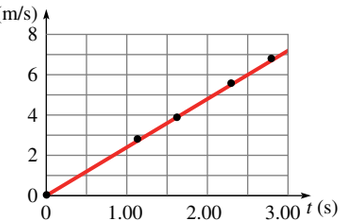
**81.** (a) 

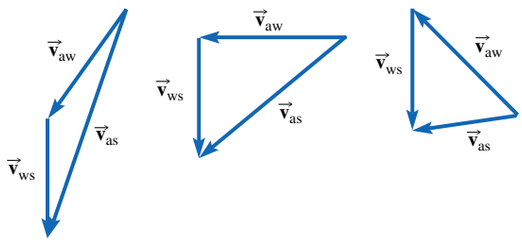

(b) yes; 2.43 m/s$^2$ (c) 14° (d) larger

**83.** (a) $v_x = v_0 \cos\theta$ and $v_y = 0$. (b) $\dfrac{v_0 \sin\theta}{g}$

**85.** (a) 28.6 cm (b) smaller (c) larger (d) $H$ = 21.3 cm; $R$ = 85.1 cm **87.** 46 m

**89.** (a) a = air; w = water; s = sailboat

Case (1): Case (2): Case (3):




(b) 1 and 2 (c) all three

**91.** (a) 98 N (b) 60° above the horizontal

**93.** (a) in front of (b) 21.4 m (c) 3.6 m (d) earlier

# Chapter 5

## Multiple Choice Questions

**1.** (b) **2.** (a) **3.** (f) **4.** (b) **5.** (a) **6.** (b) **7.** (b) **8.** (a) **9.** (e) **10.** (c)

## Problems

**1.** 17 m **3.** 0.105 rad/s **5.** 26 rad/s **7.** (a) 3.49 rad/s (b) 0.45 m/s **9.** 3800 ft **11.** (a) 31 m/s (b) 31 rad/s **13.** 3.37 cm/s$^2$ **15.** (a) $1.72 \times 10^{-2}$ rad (b) 514 m/s perpendicular to the average velocity (c) 0.00595 m/s$^2$ perpendicular to the average velocity (d) $\vec{\mathbf{a}}_c$ = 0.00595 m/s$^2$ perpendicular to the velocity, which is the same as $\vec{\mathbf{a}}_{av}$ within 3 significant figures.

**17.** (a) $\dfrac{mg}{\cos\phi}$ (b) $2\pi\sqrt{\dfrac{L\cos\phi}{g}}$ **19.** 7.9 m/s **21.** 59°

**23.** (a) 2300 N (b) 19 m/s **25.** $\tan^{-1}\dfrac{v^2}{rg}$ **27.** 130 h

**29.** $3.6 \times 10^{22}$ N **31.** 16 h **33.** (a) 13 N (b) The bob has an upward acceleration, so the net $F_y$ must be upward and greater than the weight of the bob. **35.** $g \sin\theta$

**37.** 4.0 rad/s$^2$ **39.** (a) 1.7 rad/s$^2$ (b) 0.56 rev

**41.** (a) $1.0 \times 10^5$ m/s (b) 0.080 m/s$^2$ (c) $5.0 \times 10^{10}$ m/s$^2$

**43.** 0.045 Hz **45.** (a) 518.5 N (b) 521.5 N (c) 45 m

**47.** 0.0257 m/s$^2$ **49.** 464 m/s **51.** $1.80 \times 10^6$ degrees

**53.** (a) $7.3 \times 10^{-5}$ rad/s (b) 0.02 rad (arm-length ≈ 1 m and finger-width ≈ 2 cm) (c) 5 min **55.** 200 km/s

**57.** smallest; 4.1 s **59.** $0.40\omega$ **61.** (a) 0.60 m/s (b) The dolls do not stay on the record. **63.** 1.0 rad/s

**65.** 110 μm/s **67.** (a) 90° (b) $T = \dfrac{2\pi m}{k}$ (c) $r = \dfrac{m}{k}v$

# Chapter 6

## Multiple Choice Questions

**1.** (e) **2.** (b) **3.** (b) **4.** (a) **5.** (c) **6.** (c) **7.** (c) **8.** (c) **9.** (b) **10.** (b) **11.** (f)

## Problems

**1.** 75 J **3.** No work is done. **5.** 210 kJ **7.** 720 kJ

**9.** (a) 0.70 J (b) 0.37 m/s **11.** 0 **13.** 5.8 MJ (meteor); 0.46 MJ (car); the meteor has more than 12 times the kinetic energy of the car. **15.** 1.6 J **17.** 0 **19.** 5.2 J **21.** (a) 0 (b) 3.4 kJ (c) dissipated as heat **23.** (a) 0 (b) 2.9 J

**25.** 2 **27.** 53 kJ **29.** $v_1$ = 25 m/s; $v_2$ = 18 m/s; $v_3$ = 21 m/s

**31.** (a) –1.8 kJ (b) 7.0 m/s (c) 1100 N (d) 5.7 m/s

**33.** 1.9 m **35.** (a) $\sqrt{v^2 + 2gh}$ (b) The final speed is independent of the angle. **37.** 22.4 km/s **39.** 0.33 m

**41.** (a) $\sqrt{5g(L-d)}$ (b) $\cos^{-1}\left(\dfrac{5d}{2L} - \dfrac{3}{2}\right)$ **43.** 13 m

**45.** (a) $d\sqrt{\dfrac{k}{m}}$ (b) $d$ **47.** 2.5 kJ **51.** 150 W **53.** 60 kW

**55.** 6.2 g; the other 90% of the energy is lost as heat.

**57.** (a) 20 N (b) 6.7 m/s **59.** (a) 10 kW (b) 5.8°

**61.** –52 kJ **63.** (a) –500 J (b) 3 GW (c) 300,000 households **65.** 60.0 km/s **67.** 11.2 km/s

**69.** 43.5 km/s **71.** (a) 2.62 kW (b) 7.86 kW **73.** 6.1 m

**75.** (a) 2200 kcal/day (b) more than 0.51 lb **77.** 27 N

**79.** $5 \times 10^{24}$ J (equivalent to 50 million thermonuclear bombs)

**81.** 1.3 cm; 32 J **83.** (a) 500 m$^3$ (b) 600 kg (c) 30 kJ (d) 10 kW (e) It decreases to $\frac{1}{8}$ of its initial value; the power production of wind turbines is inconsistent, since modest changes in wind speed produce large changes in power output.

**85.** approximately 3%–5%

# Chapter 7

## Multiple Choice Questions

**1.** (c) **2.** (d) **3.** (c) **4.** (b) **5.** (d) **6.** (b) **7.** (f) **8.** (d) **9.** (a) **10.** (e) **11.** (d) **12.** (b)

## Problems

**1.** 2.0 kg·m/s to the right **3.** (a) 11 m/s (b) 1300 N

**5.** 3 kg·m/s north **7.** 20 kg·m/s in the –$x$-direction

**9.** $1.0 \times 10^2$ kg·m/s downward **11.** 320 s **13.** $6.0 \times 10^3$ N opposite the car's direction of motion **15.** (a) 750 kg·m/s upward (b) 990 N·s downward (c) 2500 N downward **17.** 1.8 m/s

**19.** $2.6 \times 10^5$ m/s **21.** 1500 kg **23.** (4.2 cm, 0)

**25.** (1.9 m, 1.4 m) **27.** (6 m/s, –4 m/s) **31.** 3.0 m/s east

**33.** 0.20 kg **35.** 43 m/s **37.** 4.8 m/s **39.** 0.066 m/s

**45.** (a) $\Delta p_{1x} = -1.00 m_1 v_0$; $\Delta p_{1y} = 0.751 m_1 v_0$ (b) $\Delta p_{2x} = m_1 v_0$; $\Delta p_{2y} = -0.751 m_1 v_0$; the momentum changes for each mass are equal and opposite. **47.** $1.73 v_{1f}$

**49.** $\left(\dfrac{v_0}{2}, -\dfrac{v_0}{2\sqrt{3}}\right)$ **51.** $5.0 \times 10^9$ kg·m/s **53.** 34 N **55.** 410 N

**57.** (a) 0.01 kg·km/h opposite the car's motion (b) 0.01 kg·km/h along the car's velocity (c) $10^5$ flies **59.** 2.8 m/s

**61.** 0.83 m/s **63.** (a) 2.5 m (b) 4.0 m **65.** $10^{-18}$ N

**67.** $\dfrac{1}{9}h$ **69.** 10 m/s **71.** (a) $\dfrac{111}{2}$ (b) 1 (c) $\dfrac{111}{2}$