Chapter 7

Problems & Exercises

1.

$3.00 \text{ J} = 7.17 \times 10^{-4} \text{ kcal}$

3.

(a) 5.92×10^{5} J

(b) -5.88×10^{5} J

(c) The net force is zero.

5.

3.14×10^{3} J

7.

(a) -700 J

(b) 0

(c) 700 J

(d) 38.6 N

(e) 0

9.

1/250

11.

1.1×10^{10} J

13.

2.8×10^{3} N

15.

102 N

16.

(a) 1.96×10^{16} J

(b) The ratio of gravitational potential energy in the lake to the energy stored in the bomb is 0.52. That is, the energy stored in the lake is approximately half that in a 9-megaton fusion bomb.

18.

(a) 1.8 J

(b) 8.6 J

20.

$v_f = \sqrt{2\text{gh} + {v_0}^2} = \sqrt{2(9.80\text{ m/s}^2)(-0.180\text{ m}) + (2.00\text{ m/s})^2} = 0.687\text{ m/s}$

22.

7.81×10^5 N/m

24.

9.46 m/s

26.

4×10^4 molecules

27.

Equating ΔPE_g and ΔKE, we obtain $v = \sqrt{2\text{gh} + {v_0}^2} = \sqrt{2(9.80\text{ m/s}^2)(20.0\text{ m}) + (15.0\text{ m/s})^2} = 24.8\text{ m/s}$

29.

(a) 25×10^6 years

(b) This is much, much longer than human time scales.

30.

2×10^{-10}

32.

(a) 40

(b) 8 million

34.

$149

36.

(a) 208 W

(b) 141 s

38.

(a) 3.20 s

(b) 4.04 s

40.

(a) 9.46×10^7 J

(b) 2.54 y

42.

Identify knowns: $m = 950$ kg, slope angle $\theta = 2.00$, $v = 3.00\ m/s,\ f = 600$ N

Identify unknowns: power P of the car, force F that car applies to road

Solve for unknown:

$P = \frac{W}{t} = \frac{\text{Fd}}{t} = F\left(\frac{d}{t}\right) = \text{Fv},$

where F is parallel to the incline and must oppose the resistive forces and the force of gravity:

$F = f + w = 600\text{ N} + \text{mg sin }\theta$

Insert this into the expression for power and solve:

$$\begin{aligned} P &= (f{+}\text{mg sin }\theta)v \\ &= \left[600\text{ N} + (950\text{ kg})\left(9.80\text{ m/s}^2\right)\sin 2º\right](30.0\text{ m/s}) \\ &= 2.77 \times 10^4\text{ W} \end{aligned}$$

About 28 kW (or about 37 hp) is reasonable for a car to climb a gentle incline.

44.

(a) 9.5 min

(b) 69 flights of stairs

46.

641 W, 0.860 hp

48.

31 g

50.

14.3%

52.

(a) 3.21×10^4 N

(b) 2.35×10^3 N

(c) Ratio of net force to weight of person is 41.0 in part (a); 3.00 in part (b)

54.

(a) 108 kJ

(b) 599 W

56.

(a) 144 J

(b) 288 W

58.

(a) 2.50×10^{12} J

(b) 2.52%

(c) 1.4×10^{4} kg (14 metric tons)

60.

(a) 294 N

(b) 118 J

(c) 49.0 W

62.

(a) 0.500 m/s^2

(b) 62.5 N

(c) Assuming the acceleration of the swimmer decreases linearly with time over the 5.00 s interval, the frictional force must therefore be increasing linearly with time, since $f = F - \text{ma}$. If the acceleration decreases linearly with time, the velocity will contain a term dependent on time squared (t^2). Therefore, the water resistance will not depend linearly on the velocity.

64.

(a) $16.1 \times 10^{3}\ N$

(b) $3.22 \times 10^{5}\ J$

(c) 5.66 m/s

(d) 4.00 kJ

66.

(a) 4.65×10^{3} kcal

(b) 38.8 kcal/min

(c) This power output is higher than the highest value on Table 7.5, which is about 35 kcal/min (corresponding to 2415 watts) for sprinting.

(d) It would be impossible to maintain this power output for 2 hours (imagine sprinting for 2 hours!).

69.

(a) 4.32 m/s

(b) $3.47 \times 10^3\ N$

(c) 8.93 kW

70.

(a) Box A has the greatest speed since it has the greatest work done; work equals change in kinetic energy and thus fastest speed.

(b) i. Yes, this equation is consistent. An increased force or distance increases the work done, and thus increases the change in kinesthetic energy. ii. No, this equation does not make sense.

(c)