Exercise 11.1

Q1 $W = Fs = (10)(30) = 300$ J

Q2 $W = Fs = (400)(30) = 12\,000$ J

Q3 $W = Fs \Rightarrow s = \frac{W}{F} = \frac{20\,000}{340} = 58.82$ m

Q4 $W = mg = (100)(9.8) = 980$ N
$W = Fs = (980)(60) = 58\,800$ J

Q5 $W = Fs = (20)(9.8)(1) = 196$ J

Q6 $W = Fs = (60)(9.8)(8) = 4704$ J

Q7 $u = 0, v = 30, t = 10, a = ?, s = ?$

Find a: $v = u + at$
$30 = 0 + a(10)$
$\Rightarrow a = 3\ \text{m s}^{-2}$

Find s: $s = ut + \frac{1}{2}at^2$
$s = \frac{1}{2}(3)(10^2)$
$s = 150$ m

$F = ma \Rightarrow F = (800)(3) = 2400$ N
$W = Fs = (2400)(150) = 360\,000$ J

Q8 $u = 0$
$v = 80\ \text{km h}^{-1} = \frac{80\,000}{(60)(60)}\ \text{m s}^{-1} = 22.22\ \text{m s}^{-1}$

$t = 20, a = ?, s = ?$
Find a:
$v = u + at \Rightarrow 22.22 = a(20) \Rightarrow a = 1.11\ \text{m s}^{-2}$
Find F:
$F = ma \Rightarrow F = (1000)(1.11) = 1110$ N
Find s:
$s = ut + \frac{1}{2}at^2 \Rightarrow s = \frac{1}{2}(1.11)(20)^2 \Rightarrow s = 222$ m

Find W:
$W = Fs = (1110)(222) = 246\,420$ J

The answer is 246 914 J if you retain all decimal places throughout the calculation.

Q9 Let h = Vertical height
$\text{Sin } 40° = \frac{h}{10} \Rightarrow h = 10 \text{ Sin } 40°$

$W = Fs = (105)(9.8)\ 10 \text{ Sin } 40° = 6614.28$ J
If ladder was vertical:
$W = Fs = (105)(9.8)(10) = 10\,290$ J

Exercise 11.2

Q1 $E_k = \frac{1}{2}mv^2 = \left(\frac{1}{2}\right)(20)(12)^2 = 1440$ J

Q2 $E_k = \frac{1}{2}(1000)(28)^2 = 392\,000$ J

Q3 $E_k = \frac{1}{2}(9.1\times10^{-31})(1.5\times10^{7})^2$

$= 1.024\times10^{-16}$ J

Q4 $E_k = \frac{1}{2}mv^2 \Rightarrow m = \frac{2E_k}{v^2}$

$= \frac{(2)(160\,000)}{(20)^2} = 800$ kg

Q5 $E_k = \frac{1}{2}mv^2 \Rightarrow v = \sqrt{\frac{2E_k}{m}}$

$= \sqrt{\frac{(2)(4000)}{200}} = 6.32$ m s^{-1}

Q6 (i) $\frac{1}{2}(4\times10^{-3})(400)^2 = 320$ J

(ii) $\frac{1}{2}(800)(28)^2 = 313\,600$ J

(iii) $\frac{1}{2}(10\,000)\left(\frac{100\,000}{(60)(60)}\right)^2 = 3.9\times10^{6}$ J

(iv) $\frac{1}{2}(30\times10^{-3})\left(\frac{150\,000}{(60)(60)}\right)^2 = 26$ J

Q7 (i) $\frac{1}{2}(20)(3)^2 = 90$ J

(ii) $\frac{1}{2}(20)(30)^2 = 9000$ J

(iii) Change in $E_k = 9000 - 90 = 8910$ J

(iv) Work done = change in E_k

= Force × distance

$\therefore 8910 = (12)\,s \Rightarrow s = 742.5$ m

(v) From above: 8910 J

Q8 Work done on bullet = loss in E_k

$= (0.5)(4\times10^{-3})(200)^2 = 80$ J

$W = Fs \Rightarrow F = \frac{W}{s} = \frac{80}{0.5} = 160$ N

Work done $= Fs = (160)(0.25)$

$= 40$ J = loss in E_k

Remaining $E_k = 80$ J $- 40$ J $= 40$ J

$\therefore 40 = \frac{1}{2}(4\times10^{-3})v^2 \Rightarrow v = 141.4$ m s^{-1}

Q9 $E_k = \frac{1}{2}mv^2$

Double speed to $2v$

$E_k = \frac{1}{2}m(2v)^2 = 4(\frac{1}{2}mv^2)$

$\Rightarrow E_k$ has quadrupled.

Q10 $\frac{1}{2}m_1v_1^2 = \frac{1}{2}m_2v_2^2$

$m_1(4v_2)^2 = m_2v_2^2$

$\therefore \frac{m_1}{m_2} = \frac{1}{16} \Rightarrow m_1 : m_2 = 1 : 16$

Exercise 11.3

Q1 $E_P = mgh = (20)(9.8)(600)$
$= 117\,600$ J

Q2 $E_P = mgh \therefore 4000 = (4)(9.8)h$
$\therefore 4000 = 39.2h$

$h = \frac{4000}{39.2} = 102$ m

Q3 $E_P = mgh = (3)(9.8)(60)$
$= E_K = 1764$ J

$1764 = \frac{1}{2}(3)v^2 \Rightarrow v = 34.3$ m s^{-1}

Q4 Loss in kinetic energy = gain in potential energy.

$\frac{1}{2}(m)(100)^2 = m(9.8)(h)$

$h = 510.2$ m

Q5 $E_P = mgh = (100)(9.8)(50) = 49\,000$ J
E_P at 30 m = $(100)(9.8)(30) = 29\,400$ J
Kinetic Energy = Loss in potential energy
$= 19\,600$ J

Q6 Loss in E_P = Gain in E_k

$m(9.8)(0.5) = \frac{1}{2}mv^2$

$v = \sqrt{(2)(9.8)(0.5)} = 3.13$ m s^{-1}

Q7 Loss in Potential Energy = Gain in Kinetic energy

$mg(2 - 2\cos 40°) = \frac{1}{2}mv^2$

$v = \sqrt{4g(1 - \cos 40°)} = 3.028$ m s^{-1}

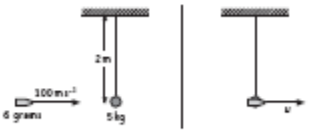
Q8 $(10)(30) + 0 = 25v \Rightarrow v = 12$ m s^{-1}

Initial $E_k = \frac{1}{2}(10)(30)^2 = 4500$ J

Final $E_k = \frac{1}{2}(25)12^2 = 1800$ J

Loss in $E_k = 2700$ J

Q9



Conservation of momentum:

$\Rightarrow \left(\frac{6}{1000}\right)(100) = 5.006u \Rightarrow u = 0.1199$ m s^{-1}

Gain in E_P = Loss in E_k

$(5.006)(9.8)h = \frac{1}{2}(5.006)(0.1199)^2$

$\Rightarrow h = 0.073$ cm

Exercise 11.4

Q1 $P = \frac{W}{t} = \frac{600\,000}{12} = 50$ kw

Q2 $P = \frac{E}{t} = \frac{18\,000}{(30)(60)} = 10$ W

Q3 $P = \frac{E}{t} = \frac{60\,000}{60} = 1000$ W

Q4 $P = \frac{W}{t} = \frac{2 \times 10^7}{(2)(60)(60)} = 2778$ W

Q5 $E = Pt = (60)(5)(60)(60) = 1.08 \times 10^6$ J

Q6 $E = Pt = (130 \times 10^3)(5)(60) = 3.9 \times 10^7$ J

Q7 $P = \frac{W}{t} = \frac{(50)(9.8)(50)}{12} = 2042$ W

Q8 $P = \frac{W}{t} = \frac{(50)(9.8)(2)(25)}{60} = 408$ W

Q9 $P = \frac{W}{t} = \frac{(40)(9.8)(50)(0.16)}{40} = 78.4$ W

Q10 $t = \frac{W}{P} = \frac{1 \times 10^6}{77 \times 10^3} = 12.987$ s

Q11 $W = Pt = (1000)(60)(60) = 3.6$ MJ

Exercise 11.5

Q1 % efficiency $= \frac{P_o}{P_i} \times 100 = \frac{4000}{5000} \times 100 = 80\%$

Q2 Power out $= \frac{\text{Work}}{\text{Time}} = \frac{mgh}{t} = \frac{(2000)(9.8)(20)}{10}$

$= 39\,200$ W

% efficiency $= \frac{P_o}{P_i} \times 100 = \frac{39\,200}{60\,000} \times 100$

$= 65.3\%$

Q3 25% of input power = 130 kW

75% of power becomes heat $\therefore$ amount converted to heat $= \left(\frac{130}{25}\right) 75$ kW $= 390$ kW