1. $960\,N$

2. $2\,ms^{-2}$

3. $3\,kg$

4(a) $F = 180 - 120$

$= 60N$

$a = \frac{F}{m}$

$= \frac{60}{12}$

$= \underline{\underline{5ms^{-2}}}$

(b) $F = 9600 - 2400$

$= 7200N$

$a = \frac{F}{m}$

$= \frac{7200}{360}$

$= \underline{\underline{20ms^{-2}}}$

(c) $F = 72 - 48$

$= 24N$

$a = \frac{F}{m}$

$= \frac{24}{0.25}$

$= \underline{\underline{96ms^{-2}}}$

(d) $F = 350 - 500$

$= -150N$

$a = \frac{F}{m}$

$= \frac{-150}{300}$

$= \underline{\underline{-0.5ms^{-2}}}$

5 (a) $F = 8 - 2$

$= 6\,N$

$m = \frac{F}{a}$

$= \frac{6}{1.2}$

$= 5\,kg$

(b) $F = 480 - 400$

$= 80\,N$

$m = \frac{F}{a}$

$= \frac{80}{1.6}$

$= 50\,kg$

(c) $F = 5.2 - 5$

$= 0.2\,N$

$m = \frac{F}{a}$

$= \frac{0.2}{0.4}$

$= 0.5\,kg$

(d) $F = 1500 - 1200$

$= 300\,N$

$m = \frac{F}{a}$

$= \frac{300}{0.15}$

$= 2000\,kg$

6(a) $F = ma$
$= 2 \times 4$
$= 8N$

$8 = 48 - X$
$X = \underline{40N}$

(b) $F = ma$
$= 50 \times 0.5$
$= 25N$

$25 = 400 - X$
$X = \underline{375N}$

7(a) $F = ma$
$= 30 \times 4$
$= \underline{120N}$

(b) $F = 140 - F_F$
$120 = 140 - F_F$
$F_F = \underline{20N}$

8.

$F = 50 + 50 - 60$
$= 40N$

$a = \frac{F}{m} = \frac{40}{2000} = \underline{0.02 ms^{-2}}$

9. Force of friction = 4800N

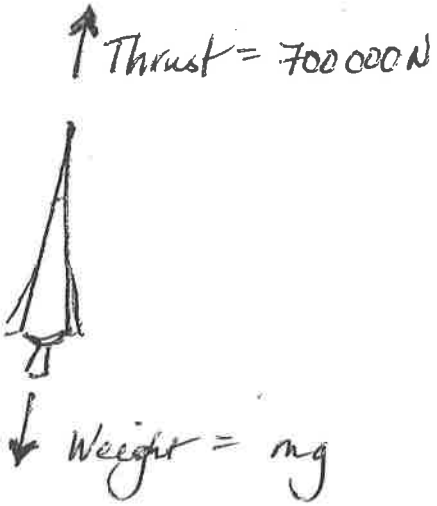
$F = 7200 - 4800 = 2400N$

$a = \frac{F}{m}$

$= \frac{2400}{1200}$

$a = \underline{2 ms^{-2}}$

10 (a) i)



$= 40000 \times 9.8$

$= 392000N$

ii) $F = 700000 - 392000$

$= 308000N$

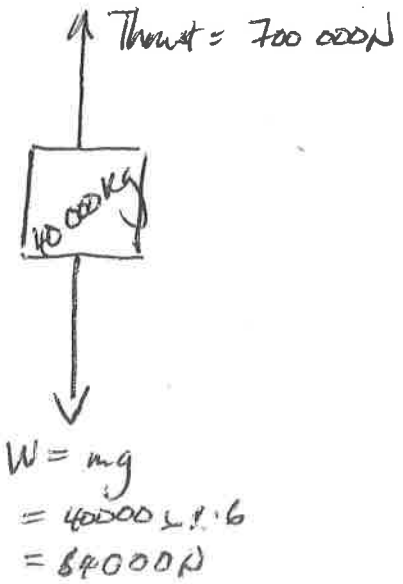
$a = \frac{F}{m}$

$= \frac{308000}{40000}$

$a = \underline{\underline{7.7 ms^{-2}}}$

(b) Acceleration increases as the unbalanced force increases. This occurs as the mass of the rocket decreases as fuel is used up, as the gravitational field strength decreases and as friction decreases since the air is less dense further from the Earth's surface.

(c)



$F = 700\,000 - 64000$

$= 636000N$

$a = \frac{F}{m} = \frac{636000}{40000} = \underline{\underline{15.9 ms^{-2}}}$

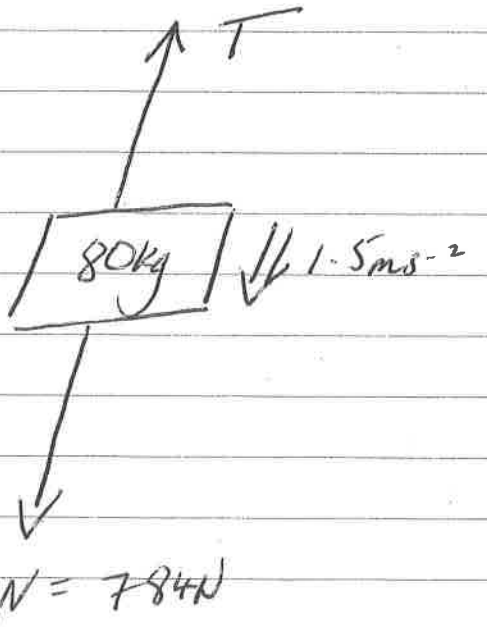
(d)

11(a)

Tension in rope = 784N
since forces are balanced when lift is stationary.

$W = mg$
$= 80 \times 9.8$
$= 784N$

(b)

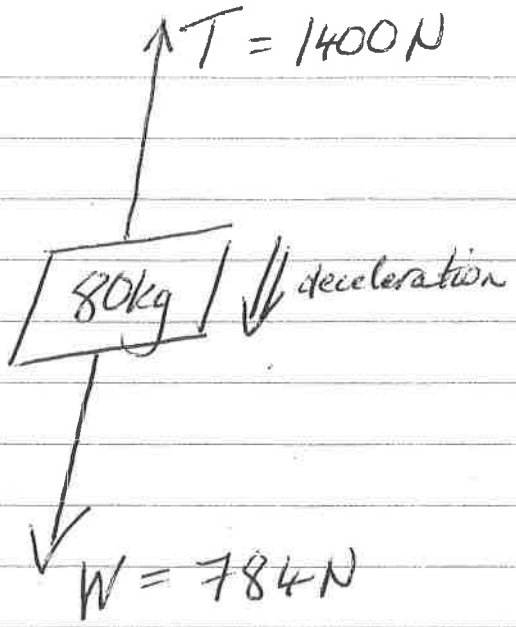


$F = ma$
$= 80 \times 1.5$
$= 120N$

$F = W - T$
$120 = 784 - T$
$T = 664N$

(c) Steady speed - therefore forces are balanced.
$W = T = 784N$.

(d)



$F = W - T$

$= 784 - 1400$

$= -616\,N$

$a = \frac{F}{m}$

$= \frac{-616}{80}$

$= -7.7\,ms^{-2}$

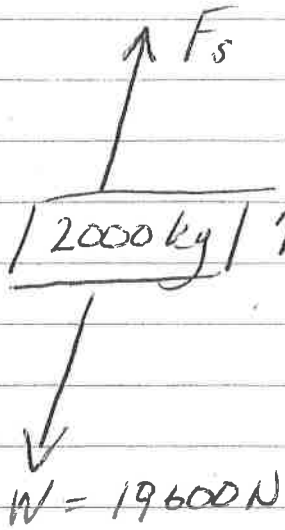
12(a)

$W = mg$

$= 2000 \times 9.8$

$= 19600N$

(b)



$F = ma$

$= 2000 \times 2$

$= 4000\ N$

$F = F_s - W$

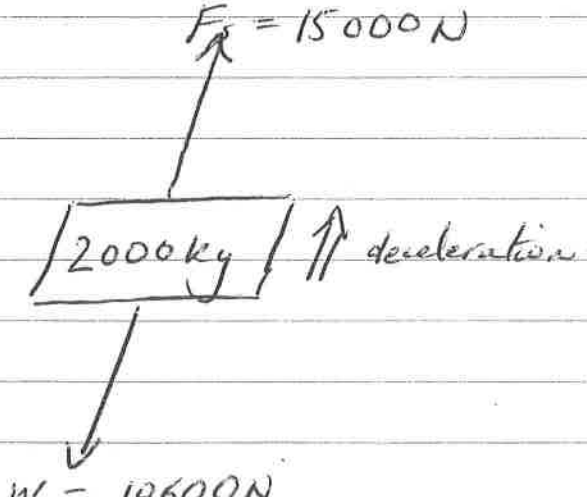
$4000 = F_s - 19600$

$F_s = 23600\ N$

(c) Steady speed - therefore forces are balanced

$W = F_s = 19600N$

(d)



$F = F_s - W$

$= 15000 - 19600$

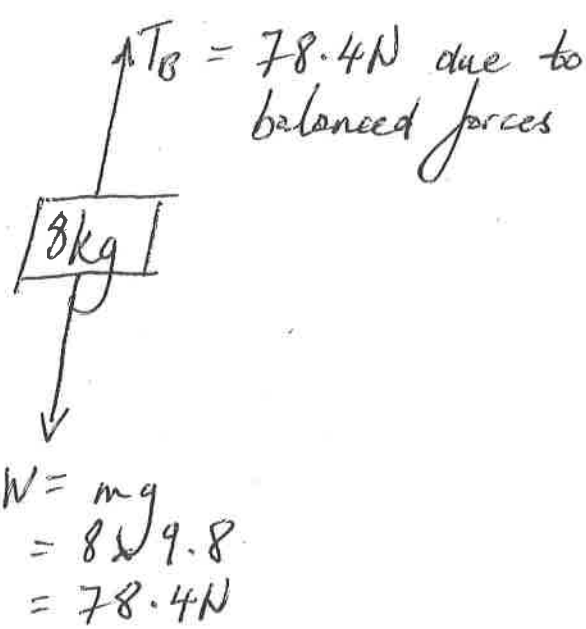
$= -4600$

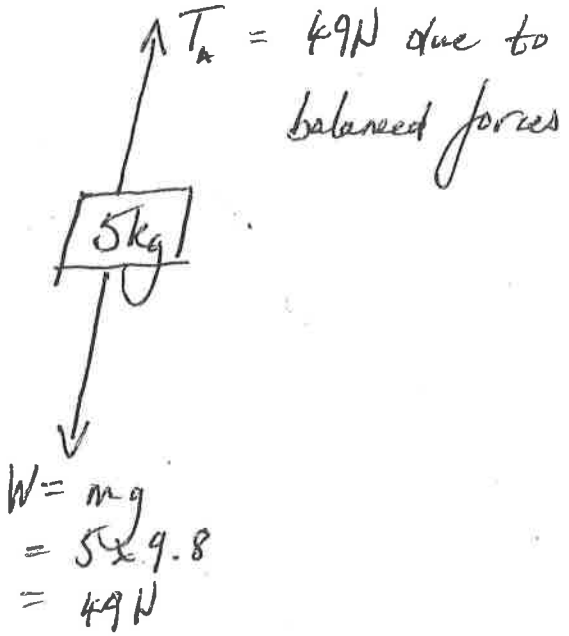
$a = \frac{F}{m}$

$= \frac{-4600}{2000}$

$= -2.3ms^{-2}$

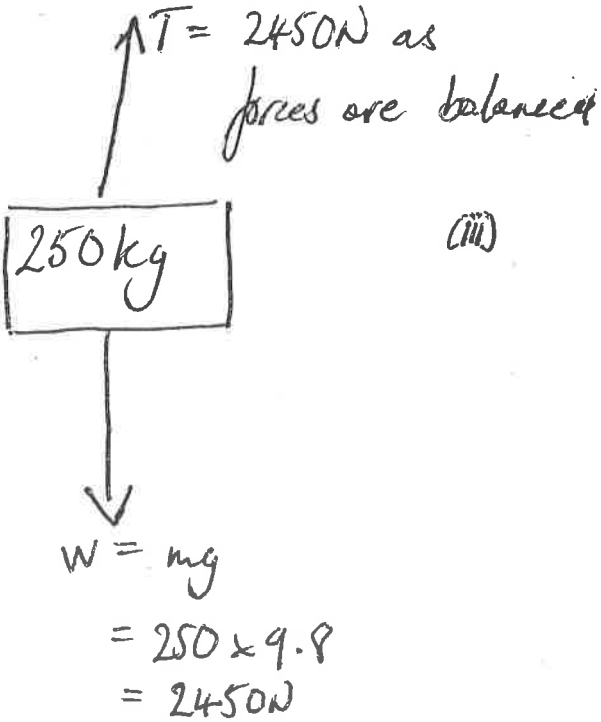
13(a)





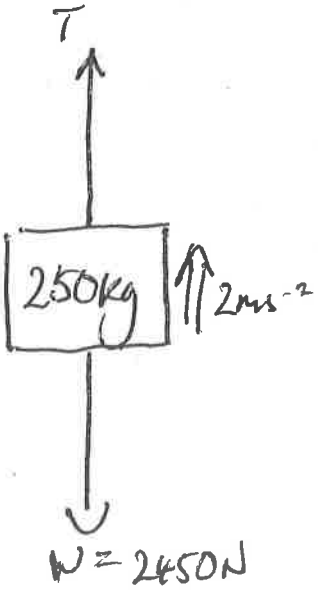
(b) Tension is zero as both masses fall at the same rate.

14(a) (i)



(ii) T = 2450 as forces are balanced.

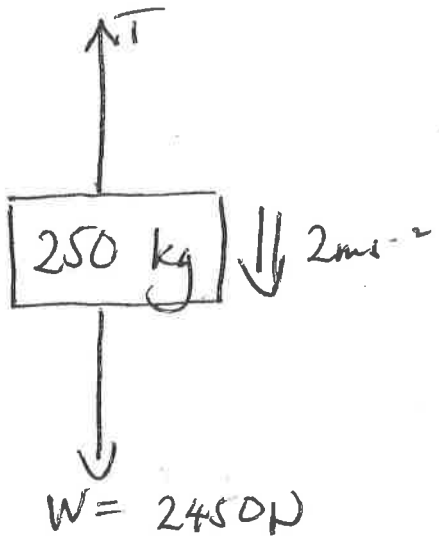
(iii)



F = ma
= 250 × 2
= 500N

F = T − W
500 = T − 2450
T = 2950N

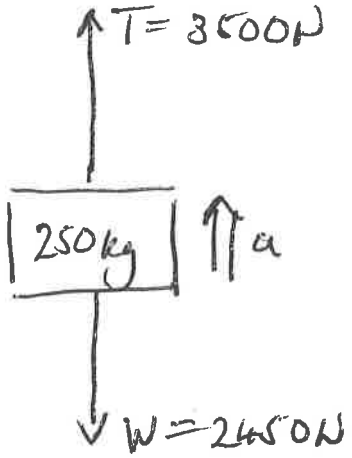
14(a) (iv)



$F = ma$
$= 250 \times 2$
$= 500N$

$F = W - T$
$500 = 2450 - T$
$T = 1950N$

(b)

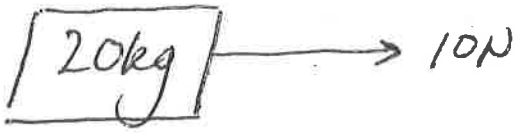


$F = T - W$
$= 3500 - 2450$
$= 1050N$

$a = \frac{F}{m}$
$= \frac{1050}{250}$
$= 4.2 ms^{-2}$

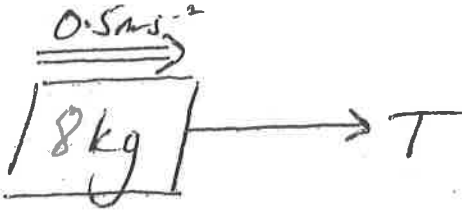
(c) If the mass was smaller the weight would decrease resulting in a greater unbalanced force which causes the acceleration to increase.

15(a)



$$a = \frac{F}{m} = \frac{10}{20} = \underline{0.5\,ms^{-2}}$$

(b)



$$T = ma$$
$$= 8 \times 0.5$$
$$= \underline{4N}$$

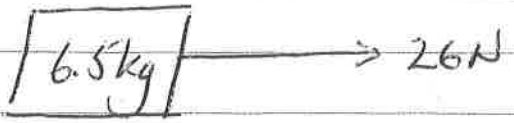
16(a)

$$a = \frac{F}{m} = \frac{24}{3} = \underline{8\,ms^{-2}}$$

(b)

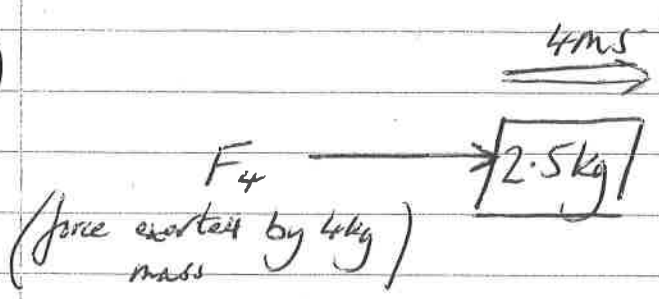
$$T = ma$$
$$= 2 \times 8$$
$$= \underline{16\,N}$$

17(a)



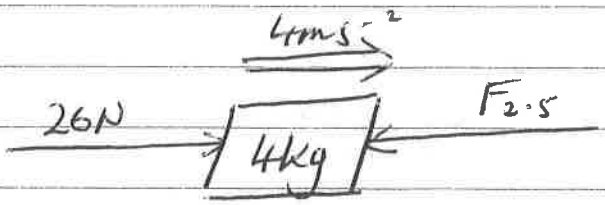
$$a = \frac{F}{m} = \frac{26}{6.5} = \underline{\underline{4\,ms^{-2}}}$$

(b)



$$F_4 = ma$$
$$= 2.5 \times 4$$
$$= \underline{\underline{10\,N}}$$

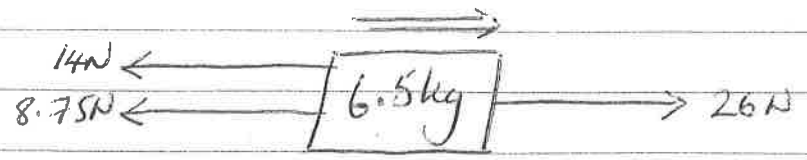
(c)



$$F = ma$$
$$= 4 \times 4$$
$$= 16N$$

$$F = 26 - F_{2.5}$$
$$16 = 26 - F_{2.5}$$
$$\underline{\underline{F_{2.5} = 10N}}$$

18(a)



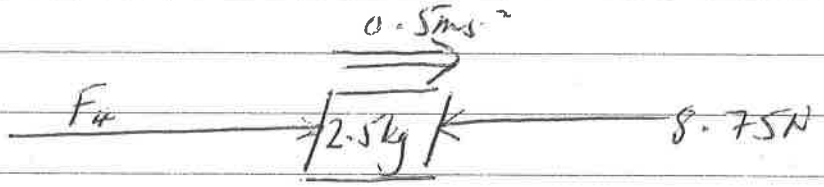
$$F = 26 - 14 - 8.75$$
$$= 3.25N$$

$$a = \frac{F}{m}$$

$$= \frac{3.25}{6.5}$$

$$= 0.5 ms^{-2}$$

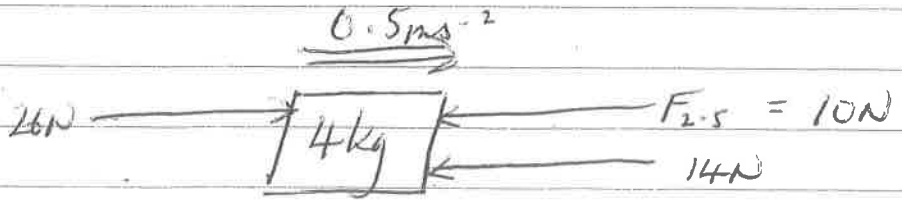
(b)



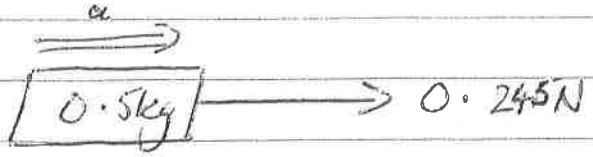
$$F = ma$$
$$= 2.5 \times 0.5$$
$$= 1.25N$$

$$F = F_4 - 8.75$$
$$1.25 = F_4 - 8.75$$
$$F_4 = 10N$$

(c)



19 (a)

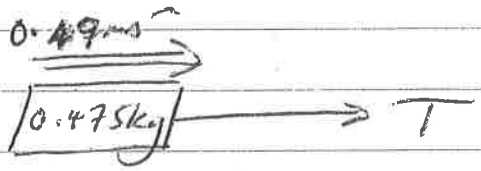


$$a = \frac{F}{m}$$

$$= \frac{0.245}{0.5}$$

$$= 0.49 ms^{-2}$$

(b)



$$T = ma$$
$$= 0.475 \times 0.49$$
$$= 0.233N$$
$$= 0.23N$$

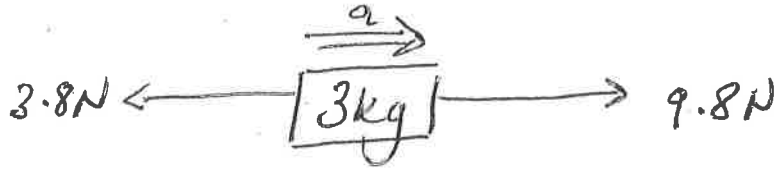
(c) $u = 0 ms^{-1}$

$s = 0.5m$

$a = 0.49 ms^{-2}$

$$s = ut + \frac{1}{2}at^2$$
$$0.5 = 0 + \frac{1}{2} \times 0.49 \times t^2$$
$$0.5 = 0.245 t^2$$
$$t^2 = 2.04$$
$$t = 1.43s$$

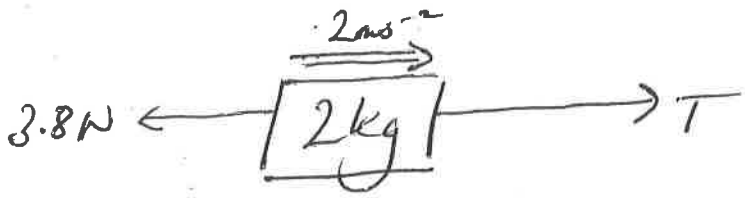
20. (a)



$$F = 9.8 - 3.8$$
$$= 6N$$

$$a = \frac{F}{m} = \frac{6}{3} = \underline{2 ms^{-2}}$$

(b)



$$F = ma$$
$$= 2 \times 2$$
$$= 4N$$

$$F = T - 3.8$$
$$4 = T - 3.8$$
$$T = \underline{7.8N}$$

22. (a) $\sin 50 = \frac{F_y}{48}$ $\qquad \cos 50 = \frac{F_x}{48}$

$F_y = 48 \sin 50$ $\qquad F_x = 48 \cos 50$

$= 36.8\,N$ $\qquad = 30.9\,N$

(b) $\sin 50 = \frac{F_y}{1200}$ $\qquad \cos 50 = \frac{F_x}{1200}$

$F_y = 1200 \sin 50$ $\qquad F_x = 1200 \cos 50$

$= 919.3\,N$ $\qquad = 771.3\,N$

23. (a) Horizontal Force $= 50 \cos 30°$

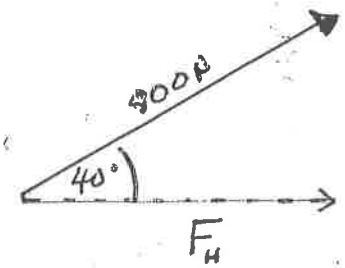
$= 43.3\,N$

(b) To increase the effective force the gardener should decrease the angle at which he applies the 50N.

24. Force parallel $= 500 \cos 45°$

$= 353.6\,N$

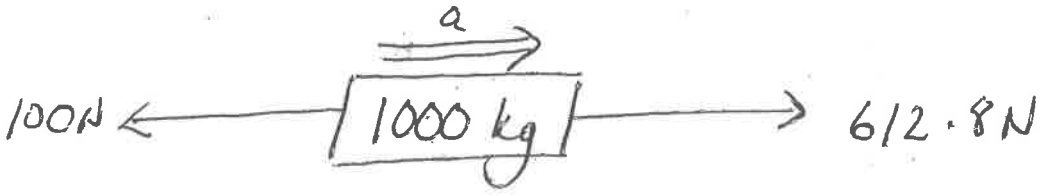
25.



$\cos 40 = \frac{F_H}{800}$

$F_H = 800 \cos 40$

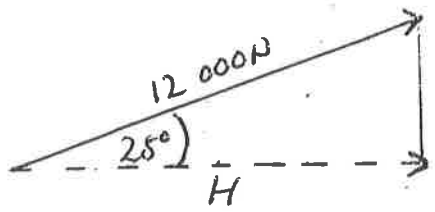
$= 612.8\,N$



$F = 612.8 - 100 = 512.8\,N$

$a = \frac{F}{m} = \frac{512.8}{1000} = 0.51\,ms^{-2}$

26.



$\cos 25 = \frac{H}{12\,000}$

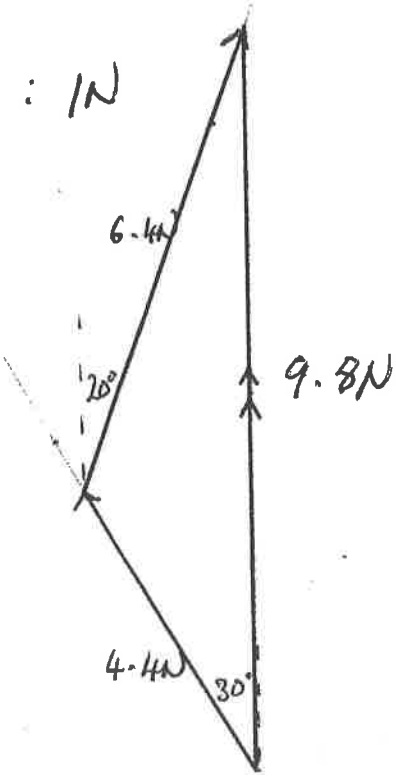
$H = 12\,000 \cos 25$

$= 10\,876\ N$

Resultant Force $= 2 \times 10876$

$= \underline{21\,752\ N}$

27. 1cm : 1N

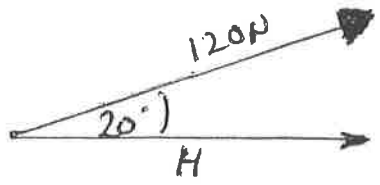


$m = \frac{W}{g}$

$= \frac{9.8}{9.8}$

$= \underline{1kg}$

28 (a)



$\cos 20 = \frac{H}{120}$

$H = 120 \cos 20$

$= 112.8N$

Forward force on mass $= 2 \times 112.8$

$= 225.6N$

Force of friction $= 225.6N$ since forces are balanced.

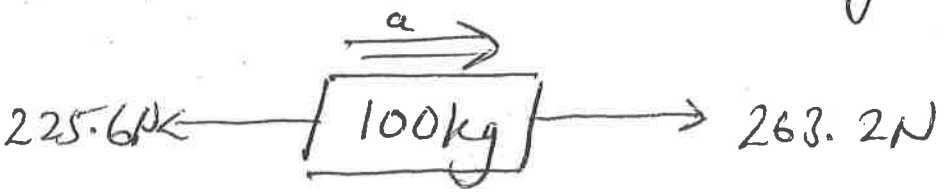
(b) $\cos 20 = \frac{H}{140}$

$H = 140 \cos 20$

$= 131.6N$

Forward force $= 2 \times 131.6$

$= 263.2N$



$F = 263.2 - 225.6$

$= 37.6N$

$a = \frac{F}{m} = \frac{37.6}{100} = 0.38 ms^{-2}$

29. (a) $F_s = mg \sin\theta$

$= 12 \times 9.8 \sin 25$

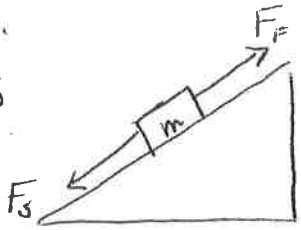
$= 49.7N$

(b) $F_p = mg \cos\theta$

$= 12 \times 9.8 \cos 25$

$= 106.6N$

30. Stationary $\Rightarrow$ Balanced Forces



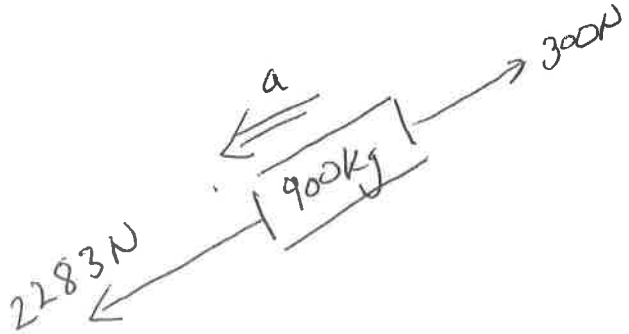
$$\therefore F_F = F_S$$
$$= m g \sin\theta$$
$$70 = 12 \times 9.8 \sin\theta$$
$$70 = 117.6 \sin\theta$$
$$\sin\theta = 70 / 117.6$$
$$\underline{\theta = 36.7^\circ}$$

31. Stationary $\Rightarrow$ Balanced Forces

$$\therefore F_F = F_S$$
$$= m g \sin\theta$$
$$= 2 \times 9.8 \sin 30$$
$$= \underline{9.8N}$$

32.(a) $F_S = m g \sin\theta$
$$= 900 \times 9.8 \sin 15^\circ$$
$$= \underline{2283N}$$

(b)



$F = F_S - F_F$
$= 2283 - 300$
$= 1983N$

$$a = \frac{F}{m} = \frac{1983}{900}$$
$$= \underline{2.2 ms^{-2}}$$

32. cont.

(c) $s = 50m$
$a = 2.2 ms^{-2}$
$u = 0 ms^{-1}$
$v = ?$

$v^2 = u^2 + 2as$
$= 0 + 2 \times 2.2 \times 50$
$= 220$
$v = 14.8 ms^{-1}$

33. $F_s = mg\sin\theta$
$= 4 \times 9.8 \sin 20$
$= 13.4N$

$F_F = 8N$

$F_u = F_s - F_F$
$= 13.4 - 8$
$= 5.4N$

$a = \frac{F}{m}$

$= \frac{5.4}{4}$
$= 1.35 ms^{-2}$

34(a) $a = g\sin\theta$
$= 9.8 \sin 5$
$= 0.85 ms^{-2}$

(b) The same ($0.85 ms^{-2}$)

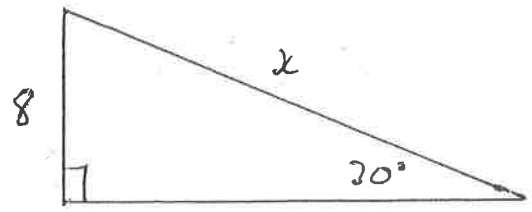
(35) a) $F_s = mg\sin\theta$

$= 20 \times 9.8 \sin 30$

$= \underline{98\,N}$

b) $a = \frac{F}{m} = \frac{98}{20} = \underline{4.9\,ms^{-2}}$

c)



$\sin 30 = \frac{8}{x}$

$x = 8/\sin 30 = 16$

$a = 4.9\,ms^{-2}$

$u = 0\,ms^{-1}$

$s = 16\,m$

$v = ?$

$v^2 = u^2 + 2as$

$v^2 = 0 + 2 \times 4.9 \times 16$

$v = \underline{12.5\,ms^{-1}}$

d) $E_p = mgh$

$= 20 \times 9.8 \times 8$

$= \underline{1568\,J}$

(35) e) $E_K = E_P$

$= 1568\ J$

f) $E_K = \frac{1}{2} m v^2$

$1568 = \frac{1}{2} \times 20 \times v^2$

$1568 = 10 v^2$

$v = 12.5\ ms^{-1}$

(36) a) $E_P = mgh$

$= 0.2 \times 9.8 \times 4$

$= 7.84\ J$

$E_P = mgh$

$= 0.2 \times 9.8 \times 2$

$= 3.92\ J$

Total Loss = $3.92\ J$

b) $E_K = E_P$

$\frac{1}{2} m v^2 = 7.84$

$\frac{1}{2} \times 0.2 \times v^2 = 7.84$

$0.1 v^2 = 7.84$

$v^2 = 78.4$

$v = 8.9\ ms^{-1}$

c) $E_K = E_P$

$\frac{1}{2} m v^2 = 3.92$

$\frac{1}{2} \times 0.2 \times v^2 = 3.92$

$0.1 v^2 = 3.92$

$v = 6.3\ ms^{-1}$

(37) a) $E_p = mgh$
$= 20 \times 9.8 \times 50$
$= 9800\ J$

$E_k = \frac{1}{2} m v^2$
$= \frac{1}{2} \times 20 \times 900$
$= 9000\ J$

800 J of energy is lost.

b) 'lost' energy is changed to heat and sound as a result of air resistance.

(38) $E_p = mgh$
$= 2 \times 9.8 \times 25$
$= 490\ J$

$E_{lost} = 100\ J$

$E_k = 390\ J$
$E_k = \frac{1}{2} m v^2$
$390 = \frac{1}{2} \times 2 \times v^2$
$v = 19.7\ ms^{-1}$

(39) $v = 0\ cms^{-1}$
$u = 60\ cms^{-1}$
$a = g \sin\theta$
$= 9.8 \sin 2°$
$= 0.34\ ms^{-2}$
$s = ?$

$v^2 = u^2 + 2as$
$0 = (0.6)^2 + 2 \times -0.34 \times s$
$0 = 0.36 + (-0.68s)$
$0.68s = 0.36$
$s = 0.53m$

(40) a) $W = mg$
$= 50 \times 9.8$
$= 490N$

(40) cont.

b) $E_w = F d$
$= 490 \times 20$
$= \underline{9800\ J}$

c) $t = \frac{E}{P}$
$= \frac{9800}{2500}$
$= \underline{3.9\ s}$

(41) $E_w = F d$
$= 30\,000 \times 2000$
$= 6 \times 10^7\ J$

$t = \frac{s}{v}$
$= \frac{2000}{10}$
$= 200\ s$

$P = \frac{E}{t}$
$= \frac{6 \times 10^7}{200}$
$= \underline{3 \times 10^5\ W}$

(42) a) $v^2 = u^2 + 2as$
$0 = 900 + 2a \times 0.03$
$0 = 900 + 0.06a$
$-0.06a = 900$
$a = -15\,000\ ms^{-2}$

$F = m a$
$= 0.022 \times 15000$
$= \underline{330\ N}$

(42) cont.

b) $v = u + at$

$0 = 30 - 15000t$

$15000t = 30$

$t = \underline{2 \times 10^{-3} s}$

(43) a) (i) $E_p = E_k$

$mgh = \frac{1}{2} m v^2$

$m \times 9.8 \times 3.15 = \frac{1}{2} m v^2$

$30.87 = \frac{1}{2} v^2$

$v^2 = 61.74$

$v = \underline{7.86 ms^{-1}}$

(ii) $E_p = E_k$

$mgh = \frac{1}{2} m v^2$

$m \times 9.8 \times 1.75 = \frac{1}{2} m v^2$

$17.15 = \frac{1}{2} v^2$

$v^2 = 34.3$

$v = \underline{5.86 ms^{-1}}$

b)(i) Mean Height = $\underline{1.74m}$

(ii) Random error = $\frac{\text{max.} - \text{min.}}{\text{no.}}$

$= \frac{1.78 - 1.71}{6}$

$= \underline{0.01}$