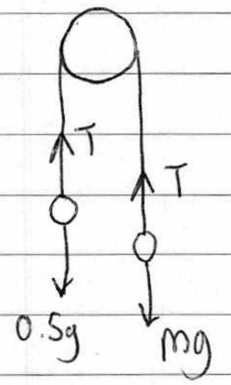
M1 : DYNAMICS

1a)

$S = 3.15$
$u = 0$
$v =$
$a = a$
$t = 1.5$

$S = ut + \frac{1}{2}at^2$
$3.15 = \frac{1}{2}(a)(1.5)^2$
$3.15 = \frac{9}{8}a$
$a = 2.8 \ ms^{-2}$

b)



$a = 2.8 \ ms^{-2}$

$F = ma$
$0.5g - T = 0.5(2.8)$
$0.5(9.8) - 0.5(2.8) = T$
$T = 3.5 \ N$

c)
$F = ma$
$T - mg = ma$
$3.5 - mg = m(2.8)$
$3.5 = mg + m(2.8)$
$3.5 = 12.6m$
$m = \frac{3.5}{12.6} = \frac{5}{18}$

d) Tension is the same throughout the string

e) original motion

$s = 3.15$

$u = 0$

$v = ?$

$a = 2.8$

$t = 1.5$

$v = u + at$

$= 2.8 \times 1.5$

$= 4.2 \, ms^{-1}$

Q. After P reaches the ground.

$s =$

$u = -4.2$

$v = 0$

$a = -9.8$

$t =$

$v = u + at$

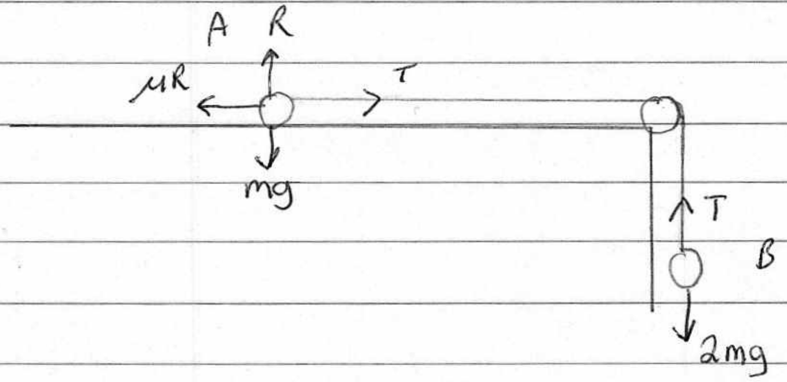
$0 = -4.2 + (-9.8)t$

$4.2 = 9.8t$

$t = \frac{4.2}{9.8} = \frac{3}{7}$

$\frac{3}{7} \times 2 = \frac{6}{7}$ seconds

2a)



A : Resolving vertically

$R = mg$

Motion of B : $F = ma$

$2mg - T = 2m\left(\frac{4}{9}g\right)$ ①

Motion of A $F = ma$

$T - \mu(mg) = m\left(\frac{4}{9}g\right)$ ②

① $2mg - 2m\left(\frac{4}{9}g\right) = T$

$m\left(2g - \frac{8}{9}g\right) = T$

$m\left(\frac{10}{9}g\right) = T$ $T = \frac{10\,mg}{9}$

$m = \frac{T}{\frac{10}{9}g} = \frac{9T}{98}$

b)

② $T - \mu\left(\frac{9T}{98}\right)(g) = \frac{9T}{98}\left(\frac{4}{9}g\right)$

$T - \mu\left(\frac{9}{10}T\right) = \frac{2}{5}T$

$1 - \frac{9}{10}\mu = \frac{2}{5}$

$\frac{3}{5} = \frac{9}{10}\mu$

$\mu = \frac{2}{3}$

c) original motion: $s = h$

$u = 0$

$v = ?$

$a = \frac{4}{9}g$

$t =$

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

$v^2 = (0)^2 + 2\left(\frac{4}{9}g\right)h$

$v^2 = \frac{8}{9}gh$

$v = \sqrt{\frac{8}{9}gh}$

After B hits the ground

$$F = ma$$

$$-\frac{2}{3}mg = ma$$

$$a = -\frac{2}{3}g$$

$s = \frac{1}{3}h$

$u = \sqrt{\frac{8}{9}gh}$

$v = ?$

$a = -\frac{2}{3}g$

$t = $

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

$$v^2 = \frac{8}{9}gh + 2\left(\frac{-2}{3}g\right)\left(\frac{1}{3}h\right)$$

$$= \frac{8}{9}gh - \frac{4}{9}gh$$

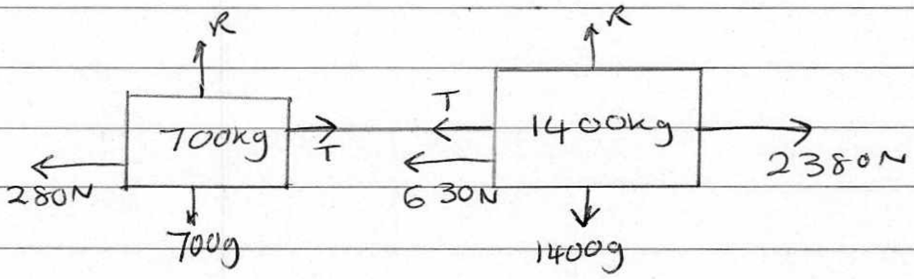
$$= \frac{4}{9}gh$$

$$v = \sqrt{\frac{4}{9}gh}$$

$$= \frac{2}{3}\sqrt{gh} \quad ms^{-1}$$

d) The tension is the same for A and B

3a)



whole system : $F = ma$

$$2380 - 630 - 280 = 2100a$$

$$1470 = 2100a$$

$$a = \frac{7}{10} \; ms^{-2}$$

3b) Trailer:

$$F = ma$$

$$T - 280 = 700\left(\frac{7}{10}\right)$$

$$T = 490 + 280$$

$$= \underline{\underline{770\ N}}$$

c) Car (after rope has broken)

$$F = ma$$

$$2380 - 630 = 1400a$$

$$1750 = 1400a$$

$$a = 5/4\ ms^{-2}$$

$s = ?$

$u = 12$

$v =$

$a = 5/4$

$t = 4$

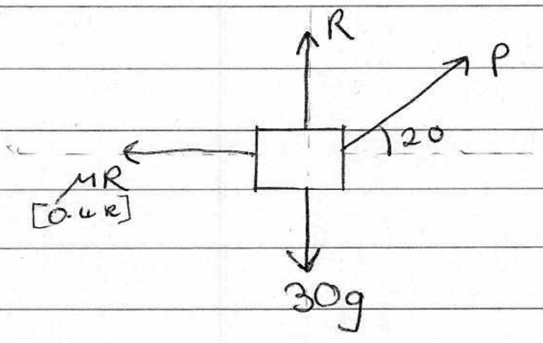
$$s = ut + \tfrac{1}{2}at^2$$

$$= 12(4) + \tfrac{1}{2}\left(\tfrac{5}{4}\right)(4)^2$$

$$= \underline{\underline{58m}}$$

d) ~~tension~~ acceleration is the same for the car and trailer

4a



Resolving vertically:

$$R + P\sin 20 = 30g$$
$$R = 30g - P\sin 20$$

Resolving Horizontally:

$$P\cos 20 = 0.4R$$
$$\frac{5}{2}P\cos 20 = R$$

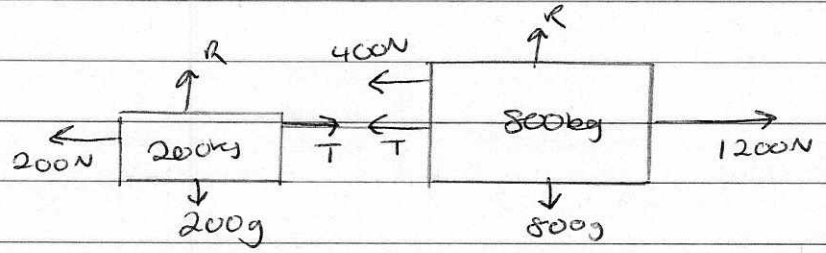
$$30g - P\sin 20 = \frac{5}{2}P\cos 20$$
$$30g = \frac{5}{2}P\cos 20 + P\sin 20$$
$$30g = P\left(\frac{5}{2}\cos 20 + \sin 20\right)$$
$$P = \frac{30g}{\frac{5}{2}\cos 20 + \sin 20}$$
$$= 109\ N\ (3sf)$$

b/ Resolving vertically

$$R + 150\sin 20 = 30g$$
$$R = 242.6969785$$

$$F = ma$$
$$150\cos 20 - 0.4(243) = 30a$$
$$a = 1.46\ ms^{-2}\ (3sf)$$

5a)



whole system

$F = ma$

$1200 - 400 - 200 = 1000a$

$600 = 1000a$

$a = \frac{3}{5}\ ms^{-2}$

b) Trailer.

$F = ma$

$T - 200 = 200(\frac{3}{5})$

$T = 320\ N$

c) Trailer:

$F = ma$

$-200 - 100 = 200a$

$-300 = 200a$

$a = -1.5\ ms^{-2}$

Car

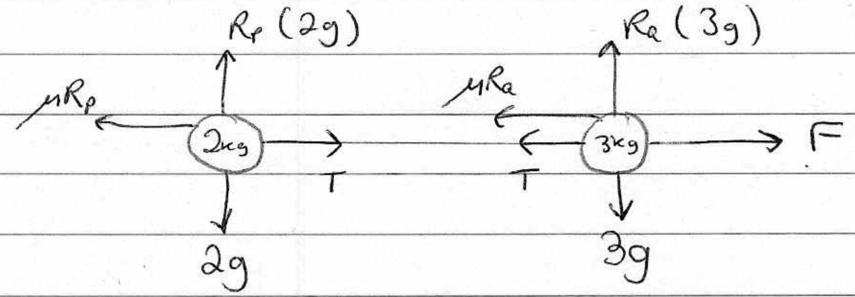
$F = ma$

$100 - 400 - F = 800(-1.5)$

$-300 - F = -1200$

$F = 900\ N$

6a)



~~whole system~~

~~F = ma~~

~~F~~

$s = 6$
$u = 0$
$v =$
$a = ?$
$t = 3$

$$s = ut + \tfrac{1}{2}at^2$$
$$6 = \tfrac{1}{2}a(3)^2$$
$$\underline{\underline{a = \tfrac{4}{3}\ ms^{-2}}}$$

b) whole system

$$F = ma$$
$$F - \mu R_Q - \mu R_P = 5\left(\tfrac{4}{3}\right)$$

~~F~~

$$30 - 3g\mu - 2g\mu = \frac{20}{3}$$
$$30 - 5g\mu = 20/3$$
$$\mu = \frac{30 - 20/3}{5g}$$
$$\underline{\underline{\mu = \frac{10}{21}}}$$

c) P: $T - 2g\left(\frac{10}{21}\right) = 2\left(\frac{4}{3}\right)$

$$\underline{\underline{T = 12}}$$

d) Tension is the same for both Q and P (acceleration is the same)

e) ~~s =~~ original motion

~~t =~~

$s = 6$

$u = 0$

$v = ?$

$a = 4/3$

$t = 3$

$v = u + at$

$= \underline{\underline{4\ ms^{-1}}}$

$s =$

$u = 4$

~~a =~~ $v = 0$

$a = \frac{-10}{21}g$

$t =$

$F = ma$

$-\frac{10}{21}(3g) = 3a$

$a = \frac{-10}{21}g$

$v = u + at$

$0 = 4 - \frac{10}{21}g\,t$

$t = \frac{4}{\frac{10}{21}g}$

$= \underline{\underline{\frac{6}{7}\ s}}$