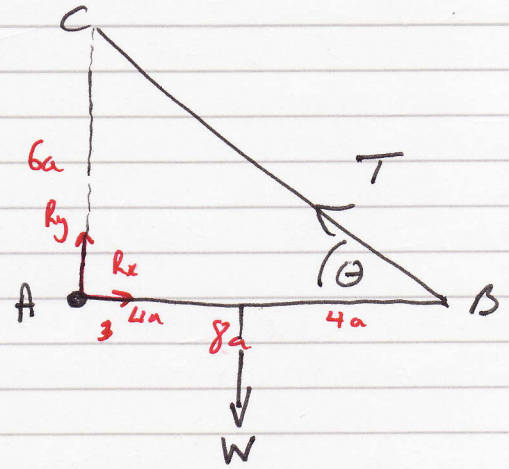
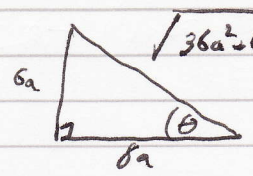
M2 JAN 2007

Q1





$\sin\theta = \frac{6a}{10a} = \frac{3}{5}$

$\cos\theta = \frac{8a}{10a} = \frac{4}{5}$

(a) $\sum G_A$: $8a \times T\sin\theta - 4aW = 0$

$8a \times T \times \frac{3}{5} = 4aW$

$T = \frac{20}{24}W$

$T = \frac{5}{6}W$ As required.

(b) $\sum F_x$: $R_x - T\cos\theta = 0$

$R_x = T\cos\theta = \frac{5}{6}W \times \frac{4}{5} = \frac{2}{3}W$ N

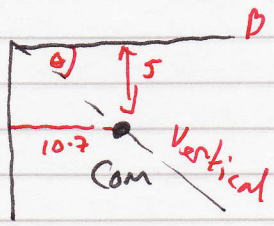
Q2 (a) $(200 - 9\pi)M\begin{pmatrix}\bar{x}\\ \bar{y}\end{pmatrix} = 200M\begin{pmatrix}10\\5\end{pmatrix} - 9\pi M\begin{pmatrix}6\\5\end{pmatrix}$

$(200 - 9\pi)\begin{pmatrix}\bar{x}\\ \bar{y}\end{pmatrix} = \begin{pmatrix}2000 - 54\pi\\ 5(200 - 9\pi)\end{pmatrix}$

$\begin{pmatrix}\bar{x}\\ \bar{y}\end{pmatrix} = \begin{pmatrix}(2000 - 54\pi)/(200 - 9\pi)\\ 5\end{pmatrix}$

$\begin{pmatrix}\bar{x}\\ \bar{y}\end{pmatrix} = \begin{pmatrix}10.7\\5\end{pmatrix}$

(b)



$\tan\theta = \frac{5}{10.7}$

$\theta = 25^\circ$

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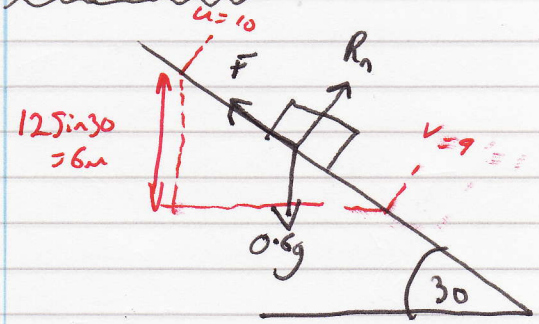
Q3



(a) loss in KE $= \frac{1}{2} \times 0.6 \times (10^2 - 9^2) = 5.7$ joules

loss in PE $= 0.6 \times 9.8 \times 6 = 35.28$ joules

$\therefore$ total loss in energy $= 35.28 + 5.7 =$ 40.98 joules

(b) wd v's friction = energy loss

$F \times 12 = 40.98$

$F = \frac{40.98}{12} = 3.415$

Now $F = \mu R$ $\quad R = 0.6g \cos 30 = 0.3\sqrt{3}g$

$\therefore \mu = \frac{3.415}{0.3\sqrt{3}g} =$ 0.671.

* you could have got away with using UVAST formulae & NZL here because question doesn't insist that you use energy considerations *

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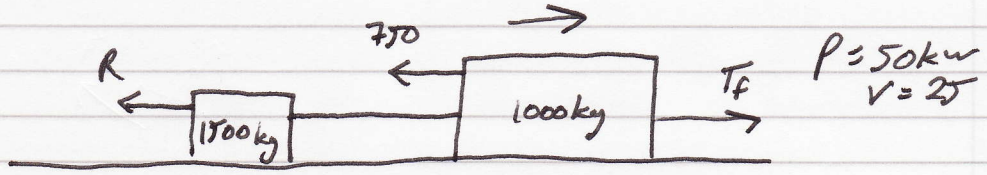
Q5



(a) $P = T_f \times V$

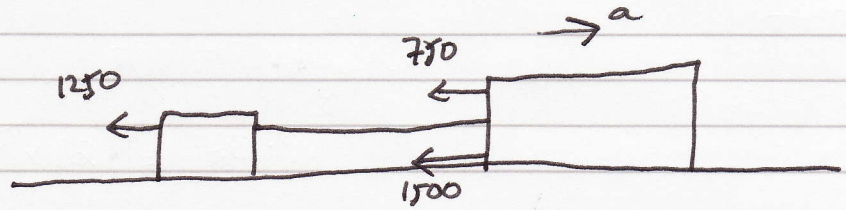
$50000 = T_f \times 25$

$T_f = \frac{50000}{25} = 2000\ N$

No accel $\therefore$ $2000 - 750 - R = 0$

$R = 1250\ N$ As required

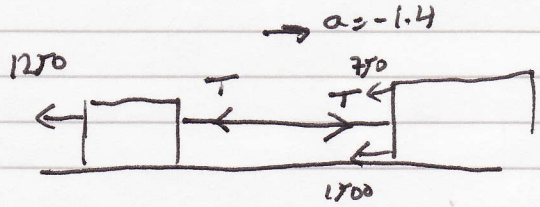
(b)



$-750 - 1500 - 1250 = 2500\,a$

$a = -\frac{3500}{2500} = -1.4\ ms^{-2}$

(c)



Consider trailer:

$-T - 1250 = 1500 \times -1.4$

$-T - 1250 = -2100$

$T = 2100 - 1250 = 850\ N$

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Q5 contd

(d) dist travelled in bringing car to rest: $u = 25$, $v = 0$, $a = -1.4$, $s = ?$

$$v^2 = u^2 + 2as$$
$$0^2 = 25^2 + 2 \times 1.4 \times s$$
$$s = \frac{625}{2.8} = 223.2 \text{ m}$$

$$Wd = F \times s = 1500 \times 223.2 = 334821 = 335 \text{ kJ}.$$

(e) Make resistances proportional to speed.