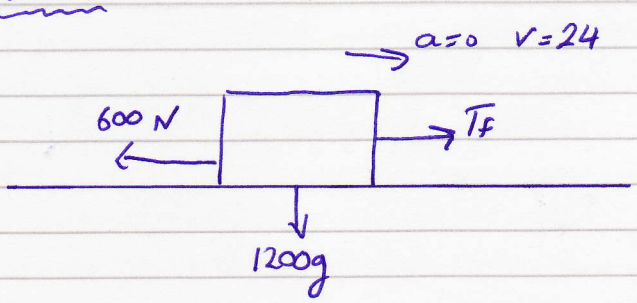
# M2 JUNE 2006

Q2

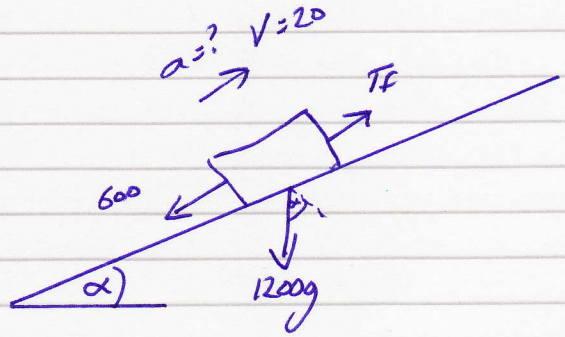



(a) $a=0 \therefore$ N2L $T_F - 600 = 0$

$T_F = 600$

Power $= T_F \times V = 600 \times 24 = 14400 = 14.4\text{kW}$

(b)




N2L: $T_F - 600 - 1200g\sin\alpha = 1200a$

$P = T_F \times V$

$30\,000 = T_F \times 20$

$T_F = 1500\text{N}$

hence $1500 - 600 - 1200g \times \frac{1}{28} = 1200a$

$1200a = 480$

$a = 0.4\ \text{ms}^{-2}$

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Q4 (a) Rods are uniform ∴ centres of mass act @ centre of each rod

Take A as origin

$$(M+M+M+M+6M+2M)\begin{pmatrix}\bar{x}\\ \bar{y}\end{pmatrix} = M\begin{pmatrix}0\\ a\end{pmatrix} + M\begin{pmatrix}1.5a\\ 0\end{pmatrix} + M\begin{pmatrix}1.5a\\ 2a\end{pmatrix} + M\begin{pmatrix}3a\\ a\end{pmatrix} + 6M\begin{pmatrix}3a\\ 2a\end{pmatrix} + 2M\begin{pmatrix}3a\\ 0\end{pmatrix}$$

$$12M\begin{pmatrix}\bar{x}\\ \bar{y}\end{pmatrix} = \begin{pmatrix}30Ma\\ 16Ma\end{pmatrix}$$

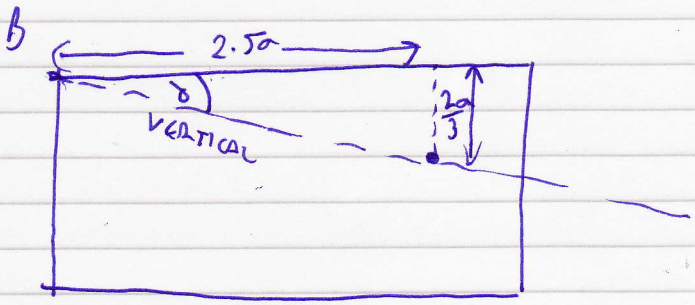
$$\begin{pmatrix}\bar{x}\\ \bar{y}\end{pmatrix} = \begin{pmatrix}30/12\\ 16/12\end{pmatrix}$$

$$\begin{pmatrix}\bar{x}\\ \bar{y}\end{pmatrix} = \begin{pmatrix}2.5a\\ 1.3a\end{pmatrix}$$

∴ (i) com from AB is $2.5a$

(ii) " " AD is $4/3\,a$

(b)




$$\tan\alpha = \frac{\frac{2}{3}a}{2.5a}$$

$$\alpha = 14.9^\circ$$

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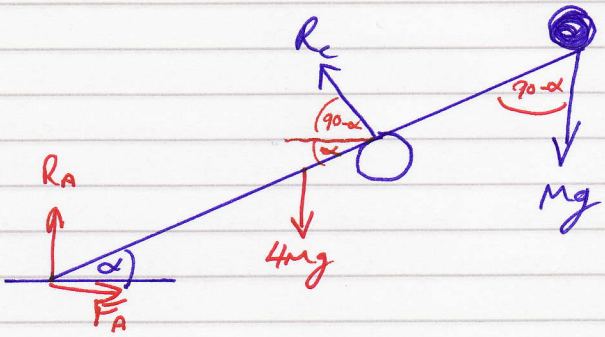
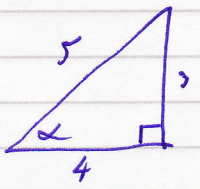
Q6




$\tan\alpha = \frac{3}{4}$

$\cos\alpha = \frac{4}{5}$

$\sin\alpha = \frac{3}{5}$

(a) $\Sigma G_A$: $-4Mg\cos\alpha \times 2a + R_C \times 3a - Mg\cos\alpha \times 4a = 0$

$-8Mg \times \frac{4}{5} + 3R_C - 4Mg \times \frac{4}{5} = 0$

$\times 5$

$-32Mg + 15R_C - 16Mg = 0$

$15R_C = 48Mg$

$R_C = \frac{48}{15}Mg = \frac{16}{5}Mg$ As Required

(b) $\Sigma F_x$: $F_A - R_C\cos(90-\alpha) = 0$

$F_A = R_C\sin\alpha$

$= \frac{16}{5}Mg \times \frac{3}{5}$

$= \frac{48}{25}Mg$

$\Sigma F_y$: $R_A + R_C\sin(90-\alpha) - 4Mg - Mg = 0$

$R_A + \frac{16}{5}Mg \times \frac{4}{5} = 5Mg$

$R_A = 5Mg - \frac{64}{25}Mg$

$R_A = \frac{61}{25}Mg$

(c) No friction acting at peg

Now if plank is in equilibrium $F \leq \mu R$

$\frac{48}{25}Mg \leq \mu \times \frac{61}{25}Mg$ $\quad \frac{48}{61} \leq \mu$ $\quad \therefore \mu \geq \frac{48}{61}$

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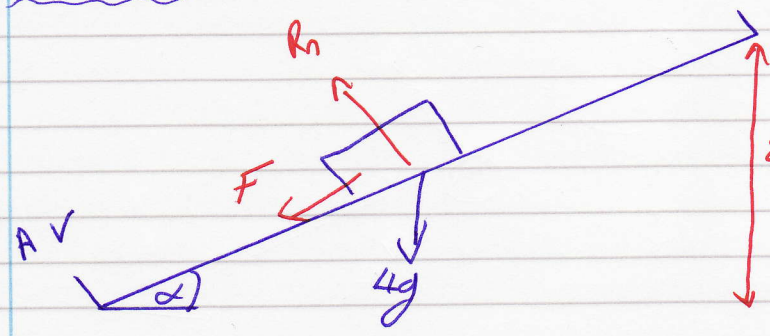
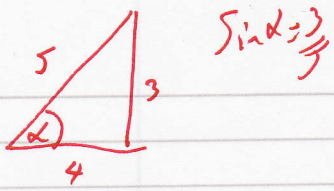
Q7




$2.5 \sin\alpha = 2.5 \times \frac{3}{5} = 1.5$

(a) $F = \mu R_n$

$R_n = 4g\cos\alpha = 4g \times \frac{4}{5} = 31.36$

$F = \frac{2}{7} \times 31.36 = 8.96\,N$

WD v's Frict $= 8.96 \times 2.5 =$ **22.4 joules**

(b) Loss in KE = gain in PE + wd v's resistances

$\frac{1}{2} \times 4(v^2 - 0^2) = 1.5 \times 4g + 22.4$

$2v^2 = 81.2$

$v = 6.4\,ms^{-1}$

(c) Now Loss in PE = gain in KE + wd v's res

$1.5 \times 4g = \frac{1}{2} \times 4(v^2 - 0^2) + 22.4$

$58.8 = 2v^2 + 22.4$

$v = 4.3\,ms^{-1}$