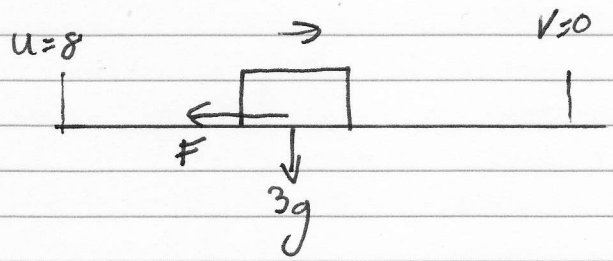
M2 – Jan 2006

(1)



(a) KE Lost $= \frac{1}{2} \times 3(8^2 - 0^2) = 96$ joules

(b) KE lost = wd v's Frict

$96 = F \times 12$

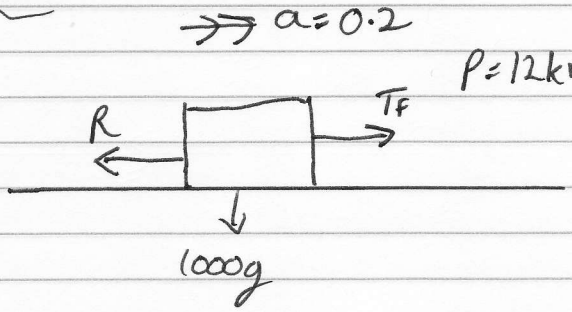
$F = 8N$

Now $F = \mu R$, $R = 3g$ $\therefore \mu = \frac{8}{3g} = 0.272$

* You would've been allowed to use UVAST + N2L For (b) *

M2 - Jan 2006

(3) (a)



$P = T_F \times V$

$\therefore T_F = \frac{12000}{15} = 800N$

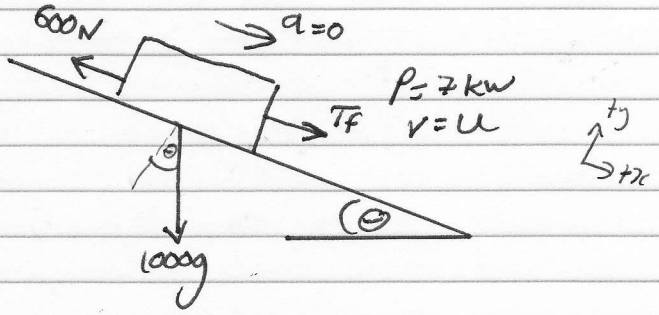
NZL: $T_F - R = 1000a$

$800 - R = 1000 \times 0.2$

$R = 800 - 200$

$R = 600\ N$ As required.

(b)



NZL: $T_F + 1000g \sin\theta - 600 = 0$

$T_f = 600 - 1000g \times \frac{1}{40}$

$T_f = 355\ N$

$P = T_f \times V$

$7000 = 355 \times u$

$u = \frac{7000}{355} = 19.7\ ms^{-1}$

M2 – JAN 2006

(5) (a) $(4m+6m+2m)\begin{pmatrix}\bar{x}\\ \bar{y}\end{pmatrix} = 4m\begin{pmatrix}0\\4\end{pmatrix} + 6m\begin{pmatrix}9\\0\end{pmatrix} + 2m\begin{pmatrix}0\\-4\end{pmatrix}$

$$12\begin{pmatrix}\bar{x}\\ \bar{y}\end{pmatrix} = \begin{pmatrix}0\\16\end{pmatrix} + \begin{pmatrix}54\\0\end{pmatrix} + \begin{pmatrix}0\\-8\end{pmatrix}$$

$$12\begin{pmatrix}\bar{x}\\ \bar{y}\end{pmatrix} = \begin{pmatrix}54\\8\end{pmatrix}$$

$$\begin{pmatrix}\bar{x}\\ \bar{y}\end{pmatrix} = \begin{pmatrix}54/12\\ 8/12\end{pmatrix} = \begin{pmatrix}4.5\\ 2/3\end{pmatrix}$$

(b) $(km+12m)\begin{pmatrix}4\\ \lambda\end{pmatrix} = km\begin{pmatrix}\frac{1}{3}\times 9\\ 0\end{pmatrix} + 12m\begin{pmatrix}4.5\\ 2/3\end{pmatrix}$

$$(k+12)\begin{pmatrix}4\\ \lambda\end{pmatrix} = \begin{pmatrix}3k\\0\end{pmatrix} + \begin{pmatrix}54\\8\end{pmatrix}$$

$4k+48 = 3k+54$

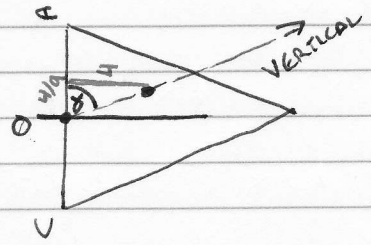
$k = 6$ as required

(c) $(6+12)\lambda = 8$

$18\lambda = 8$

$\lambda = \frac{8}{18} = \frac{4}{9}$

(d)

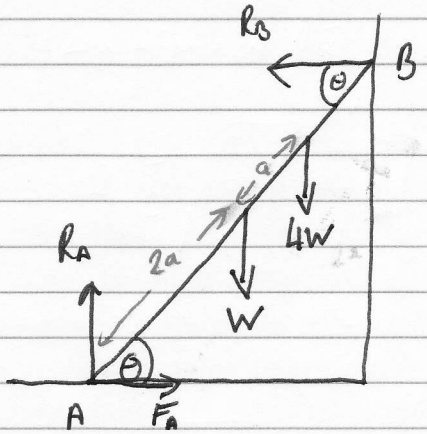


$\tan\alpha = \frac{4}{(4/9)}$

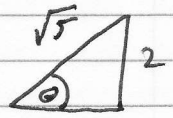
$\alpha = 83.7°$.

M2 – JAN 2006

(6)



$\tan\theta = \frac{2}{1}$



$\therefore \cos\theta = \frac{1}{\sqrt{5}} \quad \sin\theta = \frac{2}{\sqrt{5}}$

(a) System in limiting equilibrium $\therefore F_A = \mu R_A$ — (1)

$\Sigma F_x: \quad F_A - R_B = 0$ — (2)

$\Sigma F_y: \quad R_A - W - 4W = 0$ — (3)

$\Sigma G_A: \quad 4a \times R_B \sin\theta - 2a \times W\cos\theta - 3a \times 4W\cos\theta = 0$

$4R_B \times \frac{2}{\sqrt{5}} - 2W \times \frac{1}{\sqrt{5}} - 12W \times \frac{1}{\sqrt{5}} = 0$

$\times\sqrt{5}$

$8R_B - 14W = 0$

$R_B = \frac{14W}{8}$

in (2) $F_A = R_B = \frac{14W}{8}$

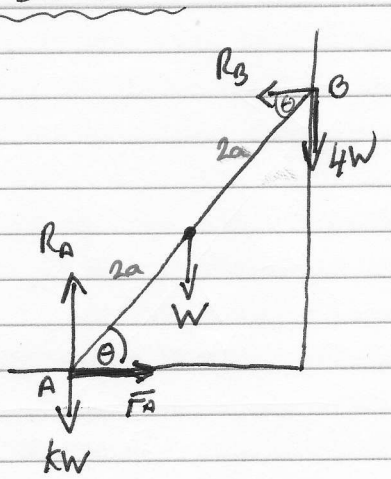
From (3) $R_A = 5W$

in (1) $\frac{14W}{8} = \mu 5W$

$\mu = \frac{14}{40} = 0.35$

M2 - JAN 2006

(6)(b)



(a) System is in equilibrium $\therefore F_A \leq \mu R_A$ — (1)

ΣF_x: $F_A = R_B$ — (2)

ΣF_y: $R_A = kW + W + 4W = W(k+5)$ — (3)

ΣG_A: $4aR_B \sin\theta - 2aW\cos\theta - 4a \times 4W\cos\theta = 0$

$\div 2a$

$$2R_B \times \frac{2}{\sqrt{5}} - W \times \frac{1}{\sqrt{5}} - 8W \times \frac{1}{\sqrt{5}} = 0$$

$\times \sqrt{5}$ $\quad 4R_B - W - 8W = 0$

$$R_B = \frac{9W}{4}$$

$\therefore F_A = \frac{9W}{4}$

sub (1) $\quad \frac{9W}{4} \leq 0.35W(k+5)$

$$\frac{9W}{4} \leq 0.35Wk + 1.75W$$

$$9 \leq 1.4k + 7$$

$$2 \leq 1.4k$$

$$\frac{2}{1.4} \leq k$$

$$\frac{10}{7} \leq k$$

$$\therefore k \geq \frac{10}{7}$$