M1 – June 10th 2003

(1) i) $s = 5t^2 - \frac{1}{2}t^3$

$v = \frac{ds}{dt} = \boxed{10t - \frac{3}{2}t^2}$

$a = \frac{dv}{dt} = \boxed{10 - 3t}$

ii) When $a = 4\ ms^{-2}$ $\quad 4 = 10 - 3t$

so $3t = 6$

$t = 2$ s

Then $v = 10 \times 2 - \frac{3}{2} \times 2^2 = 20 - 6 = \boxed{14\ ms^{-1}}$

(2) i) $3 \times 0.15 - 2 \times 0.12 = 0.45 - 0.24 = \underline{0.21\ Ns}$

ii) Loss of mom resp. – $0.21 = 0.12 \times b$

so $b = \frac{0.21}{0.12} = \boxed{1.75}$

(iii) If both directions are reversed then, supposing a is new speed of A, we have:–

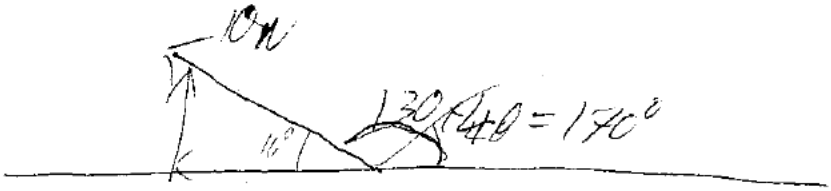
$0.21 = 0.12b - 0.15a$

so $b = \frac{0.21 + 0.15a}{0.12}$

& as $a \geq 0$, this gives $b \geq \frac{0.21}{0.12} = 1.75$

(3) (i) Need to resolve perp to PQ, the two 8N forces cancel out.

This we only need to worry about the 10N force.



(a) Parallel to $\vec{PQ}$ = ~~10~~ 10 − 10 cos 10

= −9.85 N to 2 dp ✗

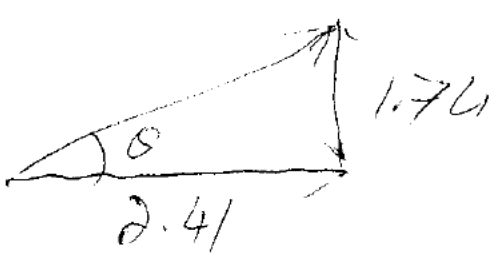
(b) Perpend to $\vec{PQ}$ = 10 sin 10 = 1.74N ✓

(ii) Also Parallel to $\vec{PQ}$ there is 2 × (8 cos 40)

= 12.26

So a) = 12.26 − 9.85 = 2.41N

(ii)



$\sqrt{2.41^2 + 1.74^2} = \sqrt{5.79 + 3.03}$

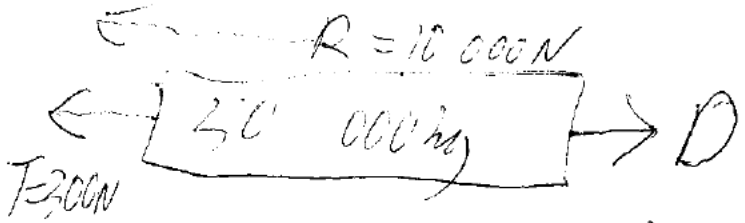
= 2.97

(iii) $\theta = \tan^{-1}\left(\frac{1.74}{2.41}\right) = 35.8°$

$F=ma$ gives $2800-T=10\,000\times 0.25$

So $2800-2500=300N=T$

(iii)



$F=ma$ again gives

$10300-D=50\,000\times 0.25$

So $10300-12500=D$

$D=-2200N$

Breaking Force ~~$T=300N$~~ ~~Driving force~~.

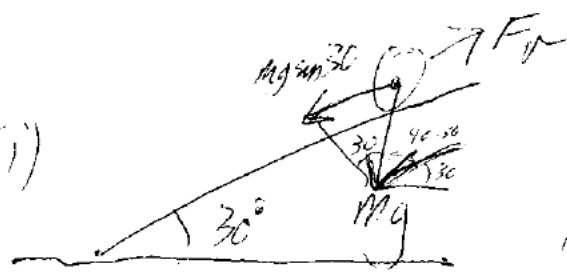
(6)(i) $u=4 \quad t=2 \quad v=9$

$v=u+at$ gives $a=\frac{9-4}{2}=2.5ms^{-2}$

(ii) $v^2=u^2+2as$ gives $s=\frac{9^2-4^2}{2\times 2.5}=\frac{81-16}{5}$

$=\frac{65}{5}=13m$

(iii)



$F=ma$ gives:-

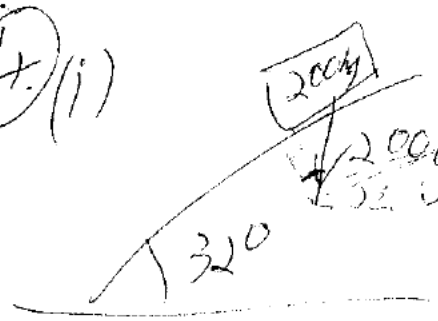
$\frac{mg}{2}-F_r=m\times 2.5$

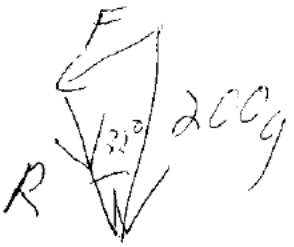
$4.9m-2.5m=F_r$

$2.4m=F_r$ $\quad 4.9\frac{1}{2}M$

(iv) $\mu R=F_r=2.4\mu$, $R=mg\cos 30=8.4.9m$, so $\mu=\frac{2.4}{8.49}=0.28$

4. (i)





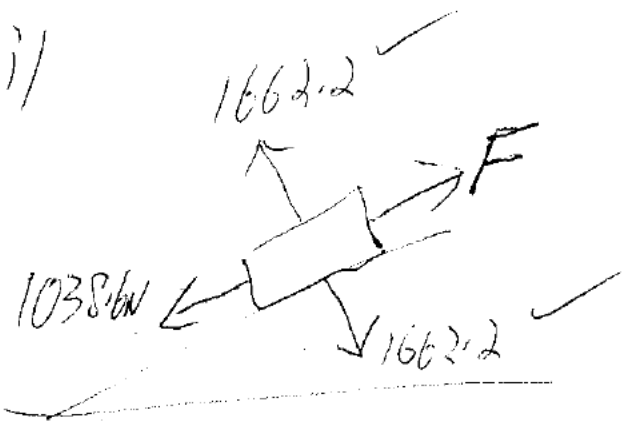
$F = 200g \sin 32 = \boxed{1038.6\,N}$

(ii) $R = 200g \cos 32 = 1662.2\,N$

$F = \mu R$, so $\mu = \frac{1038.6}{1662.2}$

$\mu = \boxed{0.625}$

(iii)



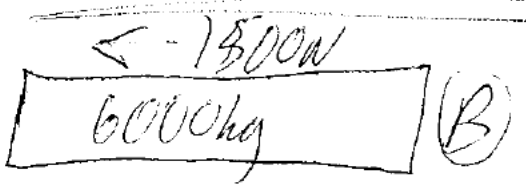
In limit ~~$F = \mu$~~

$F - 1038.6 = \mu R$

$= 1038.6$

So $\boxed{F = 2077.2\,N}$

5. (i)



As $F = ma$, $a = \frac{F}{m} = \frac{1500}{6000} = 0.25$

(ii)