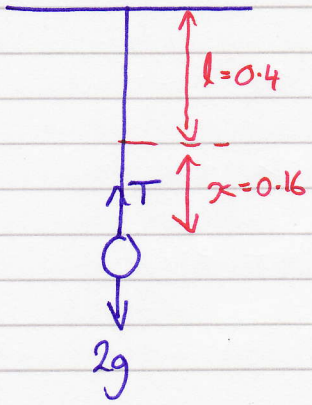
M3 – Jan 08

① (a)



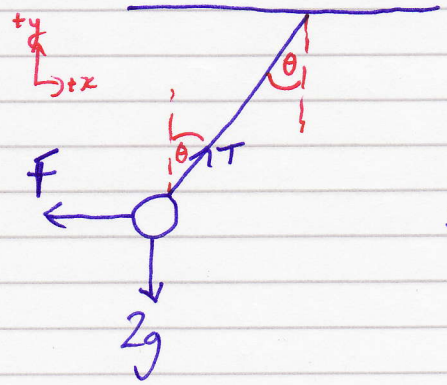
$$T = \frac{\lambda x}{l}$$

$$T - 2g = 0 \quad \therefore \quad T = 2g$$

$$2g = \frac{\lambda \times 0.16}{0.4}$$

$$\lambda = 49 \text{ N}$$

(b)



$$T = \frac{49 \times 0.32}{0.4} = 39.2\text{N}$$

Σf_x: $T\sin\theta - F = 0$

Σf_y: $T\cos\theta - 2g = 0$

$$39.2\cos\theta = 2g$$

$$\cos\theta = \frac{2g}{39.2}$$

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

$$\theta = 60^\circ$$

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Q3 (a) $\left(\frac{1}{3}\pi(2r)^2 2h - \frac{\pi}{3}(r)^2 h\right)\bar{y} = \frac{1}{3}\pi(2r)^2 2h\left(\frac{1}{4}\times 2h\right) - \frac{1}{3}\pi r^2 h\left(h+\frac{1}{4}h\right)$

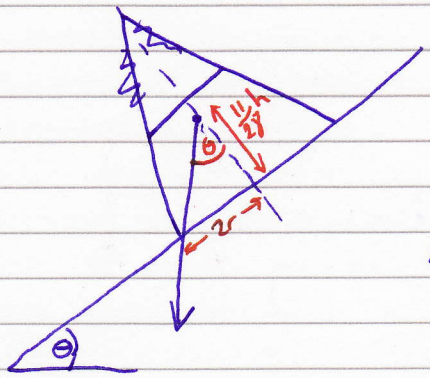
$\left(\frac{8}{3}\pi r^2 h - \frac{1}{3}\pi r^2 h\right)\bar{y} = \frac{4}{3}\pi r^2 h^2 - \frac{1}{3}\pi r^2 h^2 - \frac{1}{12}\pi r^2 h^2$

$\frac{7}{3}\pi r^2 h\,\bar{y} = \frac{11}{12}\pi r^2 h^2$

$\bar{y} = \frac{33\pi r^2 h^2}{84\pi r^2 h}$

$\bar{y} = \frac{11}{28}h$ As required

(b)



On point of toppling when c.o.m passes through circumference of base

$\therefore \tan\theta = \frac{2r}{\frac{11}{28}h}$

but $2r = h$

$\therefore \tan\theta = \frac{h}{\frac{11}{28}h} = \frac{28}{11}$

$\theta = 68.6°$

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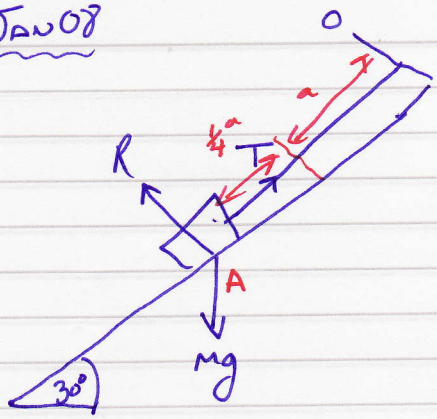
(4) (a)



In equilb $T = \frac{\lambda x}{l}$

$T = \frac{2mg}{a} \cdot \frac{1}{4}a$

$T = \frac{mg}{2}$

Not necessary

gain in EPE = loss in KE + loss in PE

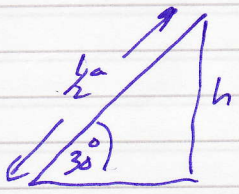
$$\text{gain in EPE} = \frac{\lambda}{2a}\left(\frac{1}{2}a + \frac{1}{4}a\right)^2 - \frac{\lambda}{2a}\left(\frac{1}{4}a\right)^2$$

$$= \frac{2mg}{2a}\left(\frac{9a^2}{16}\right) - \frac{2mg}{2a}\left(\frac{a^2}{16}\right)$$

$$= \frac{mga}{2}$$

$$\text{loss in KE} = \frac{1}{2}mv^2$$

$$\text{loss in PE} = mg \cdot \frac{1}{4}a$$



$\frac{h}{\frac{1}{2}a} = \sin 30$

$h = \frac{1}{4}a$

∴ Consv of energy eq^n

$$\frac{mga}{2} = \frac{1}{2}mv^2 + \frac{mga}{4}$$

$$\frac{1}{2}mv^2 = \frac{mga}{4}$$

$$v^2 = \frac{ga}{2}$$

$$\therefore v = \sqrt{\frac{ga}{2}}$$

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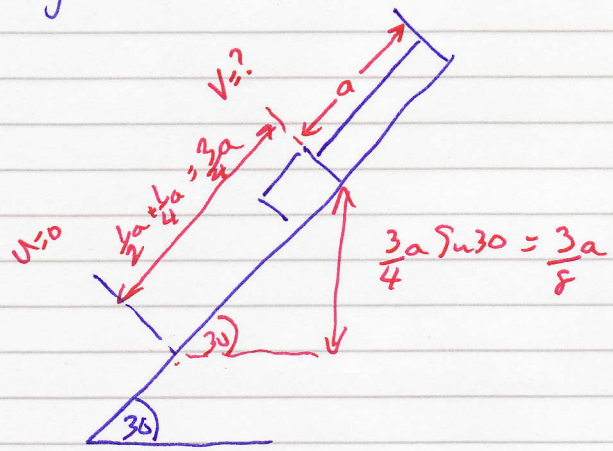
Q4(b) When string becomes slack



loss in EPE = gain in KE + gain in PE

$$\frac{2mg}{2a}\left(\frac{3}{4}a\right)^2 = \frac{1}{2}mV^2 + mg \times \frac{3}{8}a$$

$$\frac{9}{16}mga = \frac{1}{2}mV^2 + \frac{3}{8}mga$$

$$\frac{1}{2}V^2 = \frac{3}{16}ga$$

$$V^2 = \frac{3}{8}ga$$

$$V = \sqrt{\frac{3ga}{8}}$$