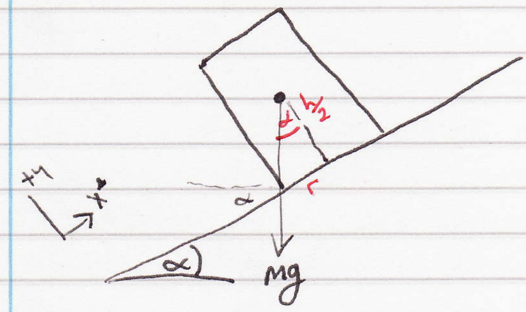
Ex5D

(1)



On point of toppling when $\tan\alpha = \frac{r}{\frac{h}{2}} = \frac{2r}{h}$

On point of sliding $F - Mg\sin\alpha = 0$

$F = \mu R_n$

$R_n - Mg\cos\alpha = 0$

$F = Mg\sin\alpha$

$Mg\sin\alpha = \mu Mg\cos\alpha$

$\mu = \tan\alpha$

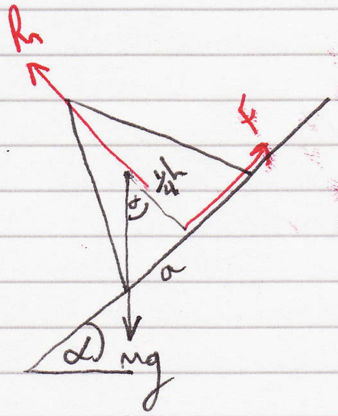
$\therefore$ on point of sliding when $\mu = \tan\alpha$

on point of toppling when $\tan\alpha = \frac{2r}{h}$

$\therefore$ if $\mu \geq \tan\alpha$ cylinder will not slide

$\therefore$ $\mu > \frac{2r}{h}$, cylinder will topple because sliding will not occur, but com will cross outside base.

(2)



On point of toppling $\tan\alpha = \frac{a}{\frac{1}{4}h} = \frac{4a}{h}$

On point of slipping: $F - Mg\sin\alpha = 0$

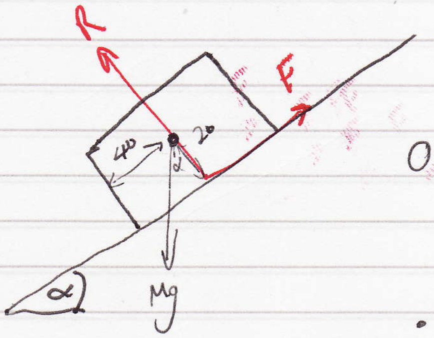
$R_n - Mg\cos\alpha = 0$

$\mu = \frac{F}{R_n} = \frac{Mg\sin\alpha}{Mg\cos\alpha} = \tan\alpha$

Now if on point of toppling + slipping

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

3 (a)



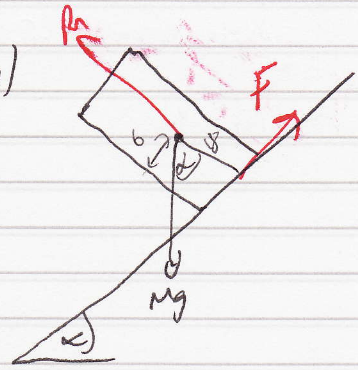
On point of toppling $\tan\alpha = \frac{40}{20}$, $\alpha = 63.4^\circ$

On point of slipping $\mu = \tan\alpha$

$\alpha = \tan^{-1}(0.5) = 26.6^\circ$

$\therefore$ slips first

(b)



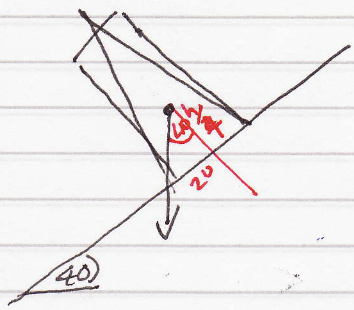
On point of toppling $\tan\alpha = \frac{6}{18}$, $\alpha = 18.4^\circ$

On point of slipping $\mu = \tan\alpha$

$0.5 = \tan\alpha$, $\alpha = 26.6^\circ$

$\therefore$ topples 1st.

4

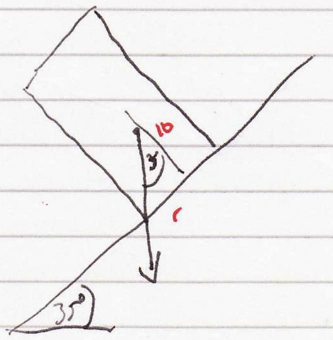


$\tan 40 = \frac{20}{h/4}$

$\tan 40 = \frac{80}{h}$

$h = \frac{80}{\tan 40} = 95.3$ cm.

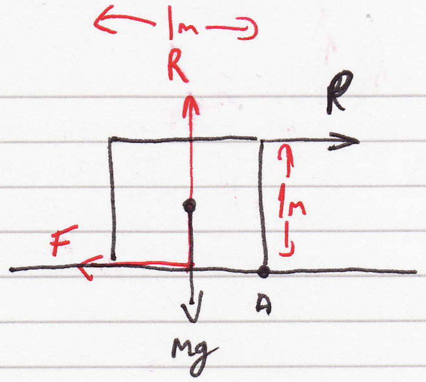
5



$\tan 35 = \frac{r}{10}$

$r = 10\tan 35 = 7.00.$

(6)



(a) On point of toppling: $\curvearrowleft_A$ $1 \times P - 0.5 \times Mg = 0$

$$P = 0.5 \times 150 \times 9.8 = 735\,N.$$

(b) On point of sliding: $P - F = 0$

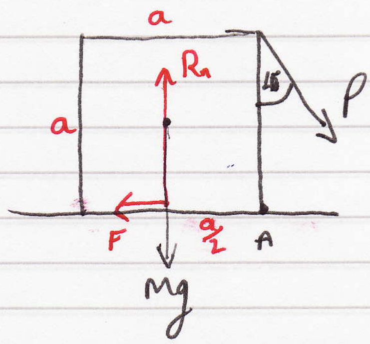
$F = 0.4R$

$R = Mg$

$P = 0.4 \times 150 \times 9.8 = 588\,N$

(c) $P_{slide} < P_{topple}$ $\therefore$ slides 1st.

(7).



(a) On point of toppling: $\curvearrowleft_A$ $P\sin 45 \times a - Mg \times \frac{a}{2} = 0$

$$\frac{P}{\sqrt{2}} - \frac{Mg}{2} = 0$$

$$P = \frac{Mg\sqrt{2}}{2}$$

(b) On point of sliding: $P\sin 45 - F = 0$

$R - Mg - P\cos 45 = 0$

$F = \mu R$

7 (b) contd:

$$F = P\sin 45$$
$$R = mg + P\cos 45$$

$$F = \mu R$$

$$\frac{P}{\sqrt{2}} = \mu\left(mg + \frac{P}{\sqrt{2}}\right)$$

$$\frac{P}{\sqrt{2}} = \mu mg + \frac{\mu P}{\sqrt{2}}$$

$$P\left(\frac{1}{\sqrt{2}} - \frac{\mu}{\sqrt{2}}\right) = \mu mg$$

$$P(1-\mu) = \sqrt{2}\mu mg$$

$$P = \frac{\sqrt{2}\mu mg}{1-\mu}$$

(c) if tilt occurs b4 sliding, $P_{tilt} < P_{slide}$

$$\frac{\cancel{mg}\sqrt{2}}{2} < \frac{\sqrt{2}\mu \cancel{mg}}{1-\mu}$$

$$\cancel{\sqrt{2}}(1-\mu) < 2\cancel{\sqrt{2}}\mu$$

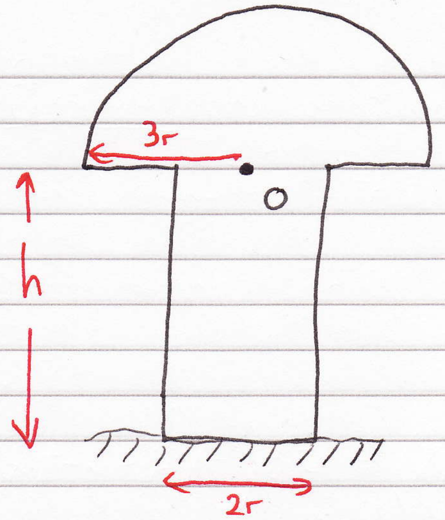
$$1-\mu < 2\mu$$

$$1 < 3\mu$$

$$\frac{1}{3} < \mu$$

$$\therefore \mu > \frac{1}{3}.$$

⑧



Com @ O $\therefore$ $\bar{y} = h$

(measured from table)

(a) $$\left(\cancel{\pi}r^2h + \frac{2}{3}\cancel{\pi}(3r)^3\right)\cancel{\rho}h = \left(\cancel{\pi}r^2h\right)\cancel{\rho}\left(\frac{h}{2}\right) + \left(\frac{2}{3}\cancel{\pi}(3r)^3\right)\cancel{\rho}\left(h + \frac{3}{8}(3r)\right)$$

$$r^2h^2 + 18r^3h = \frac{r^2h^2}{2} + 18r^3h + \frac{81}{4}r^4$$

$\div r^2$

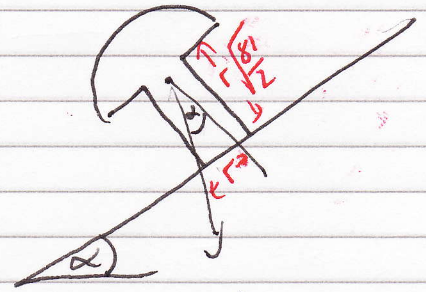
$$h^2 + \cancel{18rh} = \frac{h^2}{2} + \cancel{18rh} + \frac{81}{4}r^2$$

$$\frac{h^2}{2} = \frac{81r^2}{4}$$

$$h^2 = \frac{81r^2}{2}$$

$$h = r\sqrt{\frac{81}{2}}$$ As required.

(b)



$$\tan\alpha = \frac{\cancel{r}}{\cancel{r}\sqrt{\frac{81}{2}}}$$

$\alpha = 8.9^\circ = 9^\circ$ to nearest degree.