X is the supporting force from the other ladder. There is no Y component as the vectors in the Y direction already sum to zero.

Taking moments around B we get:

$R(l \sin \theta) = \mu R(l \cos \theta) + W\left(\frac{l}{2} \sin \theta\right)$

$\ldots$ multiply by $\frac{2}{l \cos \theta}$ and let $W = R$

$\Rightarrow 2R \tan \theta = 2\mu R + R \tan \theta$

$\ldots$ divide by R

$\Rightarrow 2 \tan \theta = 2\mu + \tan \theta$

$\Rightarrow 2\mu = \tan \theta$

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

This is the minimum value of θ that will prevent slipping from occurring.

$\Rightarrow \mu \geq \frac{1}{2} \tan \theta$

Q. 14. (i) Let x equal the distance from P to where the block touches the rod.

$\sin \alpha = \frac{0.8y}{x}$ $\quad \ldots \tan \alpha = \frac{4}{3}$

$\Rightarrow \sin \alpha = \frac{4}{5}$

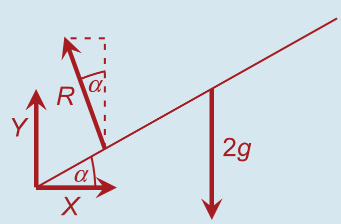
$\Rightarrow \frac{4}{5} = \frac{0.8y}{x}$

$\ldots$ multiply both sides by $5x$

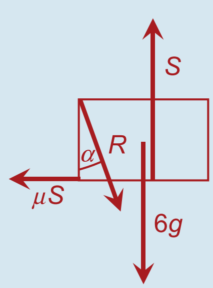
$\Rightarrow 4x = 4y$

$\Rightarrow x = y$

(ii) **Rod**



Block



(iii) Firstly, examine the diagram of the rod. Taking moments around the hinge we get:

$2g(3 \cos \alpha) = R(1)$ $\quad \ldots \cos \alpha = \frac{3}{5}$

$\Rightarrow R = \frac{18}{5}g$

Now, examine the diagram of the block:

① $S = R \cos \alpha + 6g$

$\Rightarrow S = \left(\frac{18}{5}g\right)\left(\frac{3}{5}\right) + 6g$

$\Rightarrow S = \frac{204}{25}g$

② $\mu S = R \sin \alpha$

$\Rightarrow \mu\left(\frac{204}{25}g\right) = \left(\frac{18}{5}g\right)\left(\frac{4}{5}\right)$

$\ldots$ multiply by $\frac{25}{g}$

$\Rightarrow 204\mu = 72$

$\Rightarrow \mu = \frac{72}{204} = \frac{6}{17}$

(iv) Looking at the diagram of the rod:

$X = R \sin \alpha$

$= \left(\frac{18}{5}g\right)\left(\frac{4}{5}\right)$

$= 28.224$

$Y + R \cos \alpha = 2g$

$\Rightarrow Y = 2g - R \cos \alpha$

$= 2g - \left(\frac{18}{5}g\right)\left(\frac{3}{5}\right)$

$= -1.568$

$\ldots$ i.e. 1.568 N downwards

$\Rightarrow$ Reaction at hinge

$= 28.224\vec{i} - 1.568\vec{j}$ N

Magnitude

$= \sqrt{(28.224)^2 + (1.568)^2}$

$= 28$ N