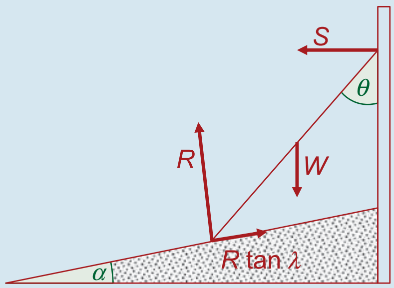
Q. 10.



Let the length of the ladder be $2l$.

We must firstly resolve R and $R \tan \lambda$ into horizontal and vertical components:

The horizontal component of R is $R \sin \alpha$.

The vertical component of R is $R \cos \alpha$.

The horizontal component of $R \tan \lambda$ is $R \tan \lambda \cos \alpha$.

The vertical component of $R \tan \lambda$ is $R \tan \lambda \sin \alpha$

(1) $S + R \sin \alpha = R \tan \lambda \cos \alpha$

$$\Rightarrow R = \frac{S}{\tan \lambda \cos \alpha - \sin \alpha}$$

(2) $W = R \cos \alpha + R \tan \lambda \sin \alpha$

$\Rightarrow W = R(\tan \lambda \sin \alpha + \cos \alpha)$

(3) $W(l \sin \theta) = S(2l \cos \theta)$

$\Rightarrow S = \frac{1}{2}W \tan \theta$ … as required

(2) $W = \left(\frac{S}{\tan \lambda \cos \alpha - \sin \alpha}\right)(\tan \lambda \sin \alpha + \cos \alpha)$

$\Rightarrow W = \frac{1}{2}W \tan \theta \left(\frac{\tan \lambda \sin \alpha + \cos \alpha}{\tan \lambda \cos \alpha - \sin \alpha}\right)$ … divide top and bottom by $\cos \alpha$

$\Rightarrow 1 = \frac{1}{2} \tan \theta \left(\frac{\tan \lambda \tan \alpha + 1}{\tan \lambda - \tan \alpha}\right)$

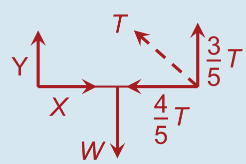
$\Rightarrow \tan \theta(\tan \lambda \tan \alpha + 1) = 2(\tan \lambda - \tan \alpha)$

$\Rightarrow \tan \theta = 2\left(\frac{\tan \lambda - \tan \alpha}{1 + \tan \lambda \tan \alpha}\right)$

$\Rightarrow \tan \theta = 2 \tan(\lambda - \alpha)$ … as required.

Exercise 8I

Q. 1. Here is a diagram of the forces acting on the rod PQ:



(1) $Y = \frac{3}{5}T = W$ … **Equation 1**

(2) $X + \frac{4}{5}T = W$ … **Equation 2**

(3) Take moments about P

$W(2) = \frac{3}{5}T(4)$ … **Equation 2**

Equation 3: $5W = 6T$

$\Rightarrow T = \frac{5}{6}W$