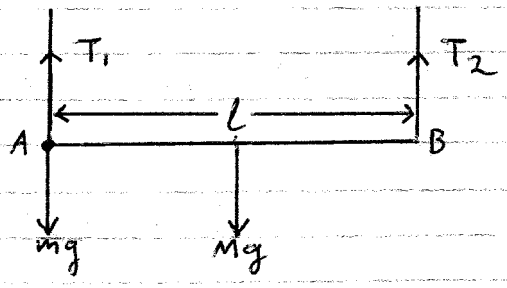
Mechanics Examples Sheet 2 – Solutions

1. Take moments about A so as to exclude the force and tension acting at that point:



$$Mg\frac{l}{2} = T_2 l \Rightarrow T_2 = \frac{1}{2}Mg$$

Take moments about B:

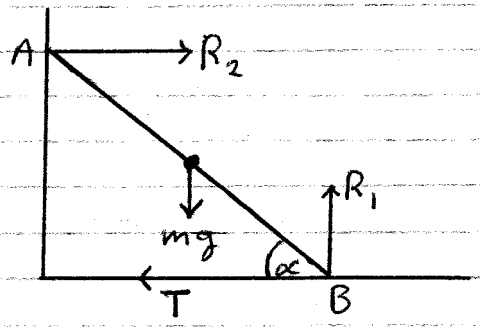
$$Mg\frac{l}{2} + mgl = T_1 l \Rightarrow T_1 = \frac{1}{2}(M+2m)g$$

Alternatively, one can resolves forces vertically:

$$T_1 + T_2 = mg + Mg$$

and the result follows for T_1 with T_2 known or vice versa.

2. Let the length of the ladder be l. Take moments about B so as to exclude the reaction and tension acting at that point:



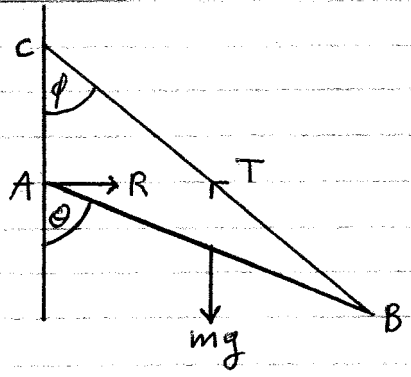
$$R_2 l \sin\alpha = mg\frac{l}{2}\cos\alpha$$

$$\Rightarrow R_2 = \frac{1}{2}mg\cot\alpha$$

Resolving forces horizontally:

$$T = R_2$$

3. Let the length of the rod be l. Take moments about B so as to exclude the tension:



$$mg\frac{l}{2}\sin\theta = Rl\cos\theta$$

$$\Rightarrow R = \frac{1}{2}mg\tan\theta$$

Next, resolve perpendicular to BC:

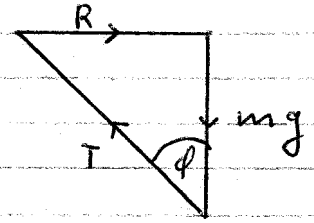
$$R\cos\phi = mg\sin\phi$$

$$\Rightarrow \tan\phi = \frac{R}{mg} = \frac{1}{2}\tan\theta$$

$$\therefore \underline{\tan\theta = 2\tan\phi}$$

Alternatively, form a triangle of forces:

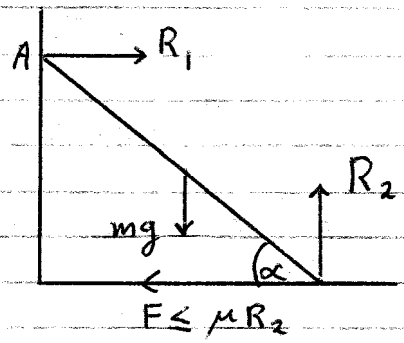
$\tan\phi = \frac{R}{mg}$ and result follows.



4. Let the length of the ladder be l.
Resolving forces vertically:

$$R_2 = mg$$

Taking moments about the point A:



$$mg\frac{l}{2}\cos\alpha + Fl\sin\alpha = R_2 l\cos\alpha$$

or

$$F = \frac{1}{2}mg\cot\alpha .$$

But $F \le \mu R_2 = \mu mg$.

Hence,

$$\underline{\underline{\frac{1}{2}\cot\alpha \le \mu}}$$