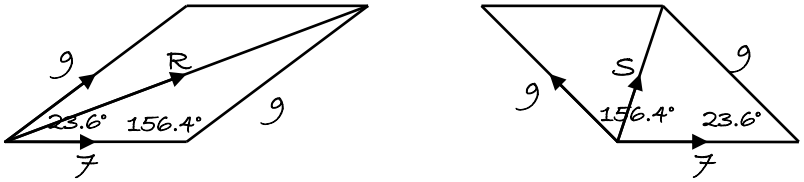
Section 1: Resolving forces

Solutions to Exercise level 2

1. $\sin\theta = 0.4 \Rightarrow \theta = 23.6°$ or $156.4°$



Using the cosine rule:

$R^2 = 7^2 + 9^2 - 2\times 7\times 9\cos 156.4°$ $\quad S^2 = 7^2 + 9^2 - 2\times 7\times 9\cos 23.6°$

$R = 15.7$ N $\quad S = 3.81$ N

The two possible resultants are 15.7 N and 3.81 N.

2. (i) Resolving perpendicular to the plane:

$R - 30\cos 20° = 0$

$R = 30\cos 20° = 28.2$ (3 s.f.)

Resolving up the plane: $F - 30\sin 20° = 0$

$F = 30\sin 20° = 10.3$ (3 s.f)

(ii) Resolving up the plane: $T\cos\theta - 7 - 10\sin 30° = 0$

$T\cos\theta = 7 + 10\times\frac{1}{2}$

$T\cos\theta = 12$ (1)

Resolving perpendicular to the plane:

$5 + T\sin\theta - 10\cos 30° = 0$

$T\sin\theta = 10\times\frac{1}{2}\sqrt{3} - 5$

$T\sin\theta = 5\sqrt{3} - 5$ (2)

Dividing (2) by (1): $\tan\theta = \dfrac{5\sqrt{3}-5}{12}$

$\theta = 17.0°$ (1 d.p.)

Substituting into (1): $T = \dfrac{12}{\cos\theta} = 12.5$ (3 s.f.)

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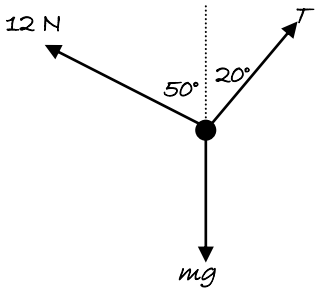
3.



(i) Resolving horizontally: $T\sin 20° - 12\sin 50° = 0$

$$T = \frac{12\sin 50°}{\sin 20°}$$

$$= 26.9 \text{ N (3 s.f.)}$$

(ii) Resolving vertically: $mg - 12\cos 50° - T\cos 20° = 0$

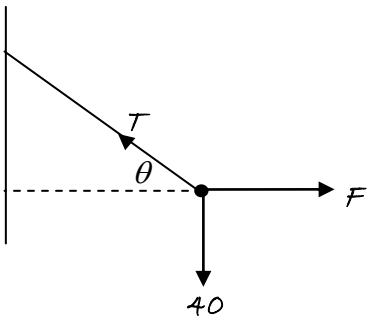
$$mg - 12\cos 50° - 26.88\cos 20° = 0$$

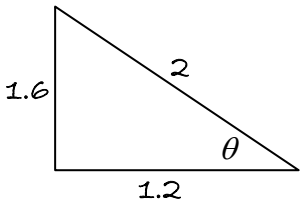
$$\Rightarrow \quad mg = 12\cos 50° + 26.88\cos 20°$$

$$\Rightarrow \quad mg = 32.97N$$

$$\Rightarrow \quad m = 3.36kg$$

4.





Resolving vertically: $T\sin\theta - 40 = 0$

$$\frac{1.6}{2}T = 40$$

$$T = 50$$

Resolving horizontally: $F - T\cos\theta = 0$

$$F = T\cos\theta = 50 \times \frac{1.2}{2} = 30$$

The magnitude of F is 30 N and the tension in the string is 50 N.

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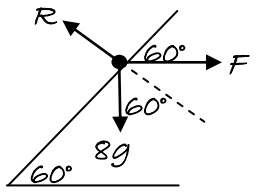
5. (i)

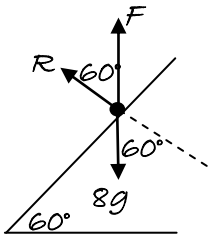


Resolving parallel to the plane: $F\cos 60° - 8g\sin 60° = 0$

$\frac{1}{2}F = 8 \times 9.8 \times \frac{1}{2}\sqrt{3}$

$F = 78.4\sqrt{3} = 135.8$ N

(ii)



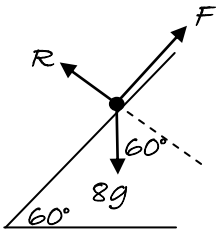
Notice that R must be zero as $F = 8g$ (consider vertical forces). This means that the particle is only just touching the plane.

Resolving parallel to the plane: $F\sin 60° - 8g\sin 60° = 0$

$F = 8 \times 9.8$

$F = 78.4$ N

(iii)

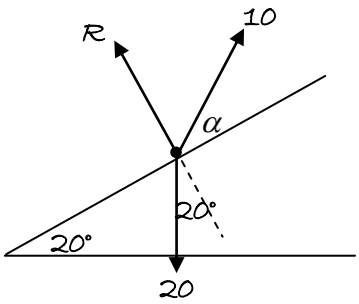


Resolving parallel to the plane: $F - 8g\sin 60° = 0$

$F = 8 \times 9.8 \times \frac{1}{2}\sqrt{3}$

$F = 39.2\sqrt{3} = 67.9$ N

6.



Resolving parallel to the plane: $10\cos\alpha - 20\sin 20° = 0$

$\cos\alpha = 2\sin 20°$

$\alpha = 46.8°$

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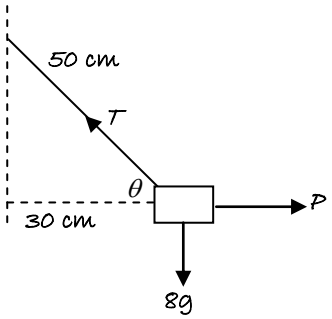
Resolving perpendicular to the plane: $R + 10\sin\alpha - 20\cos 20° = 0$

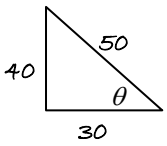
$$R = 20\cos 20° - 10\sin\alpha$$

$$R = 11.5$$

The value of α is 46.8°
and the reaction between the block and the plane is 11.5 N.

7.





$$\sin\theta = \frac{4}{5}$$

$$\cos\theta = \frac{3}{5}$$

Resolving vertically: $T\sin\theta - 8g = 0$

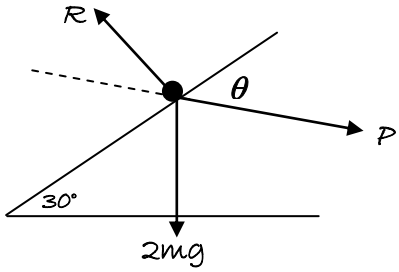
$$T = \frac{8g}{\sin\theta} = 8g \times \frac{5}{4}$$

$$T = 98 \text{ N}$$

Resolving horizontally: $P - T\cos\theta = 0$

$$P = \frac{3}{5}T = 58.8 \text{ N}$$

8.



Resolving up the plane: $P\cos\theta - 2mg\sin 30° = 0$

$$P = \frac{mg}{\cos\theta}$$

Resolving perpendicular to the plane: $R - 2mg\cos 30° - P\sin\theta = 0$

Since $R = 2.5mg$, $\frac{5}{2}mg - mg\sqrt{3} - \frac{mg}{\cos\theta}\sin\theta = 0$

$$\tfrac{5}{2} - \sqrt{3} = \tan\theta$$

$$\theta = 37.5° \text{ (3 s.f.)}$$

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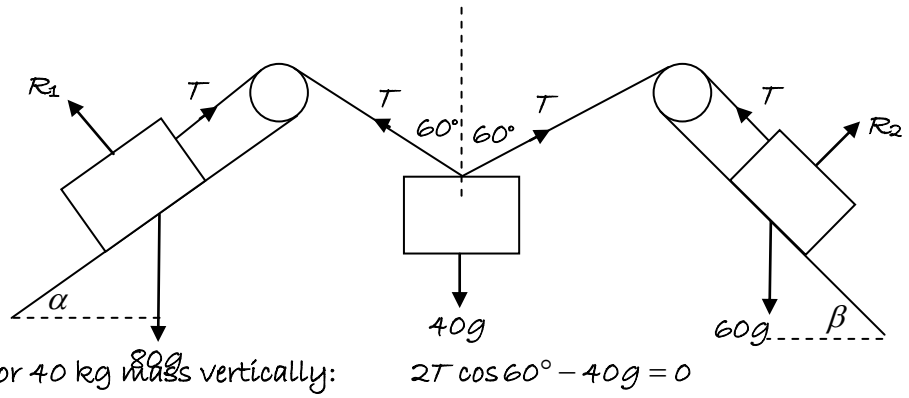
9. By symmetry (considering the 40 kg mass) the tensions in both ropes are the same.



For 40 kg mass vertically: $2T\cos 60° - 40g = 0$

$T = 40g$

For 80 kg mass, parallel to the plane: $T - 80g\sin\alpha = 0$

$80g\sin\alpha = 40g$

$\sin\alpha = \frac{1}{2}$

$\alpha = 30°$

For 60 kg mass, parallel to the plane: $T - 60g\sin\beta = 0$

$60g\sin\beta = 40g$

$\sin\beta = \frac{2}{3}$

$\beta = 41.8°$