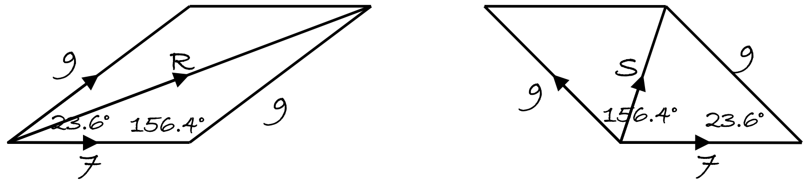
Section 1: Resolving forces

Solutions to Exercise level 2

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



Using the cosine rule:

$R^2 = 7^2 + 9^2 - 2\times 7\times 9\cos 156.4^\circ \qquad S^2 = 7^2 + 9^2 - 2\times 7\times 9\cos 23.6^\circ$

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

The two possible resultants are 15.7 N and 3.81 N.

2. (i) Resolving perpendicular to the plane:

$$R - 30\cos 20^\circ = 0$$

$$R = 30\cos 20^\circ = 28.2 \text{ (3 s.f.)}$$

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

$$F = 30\sin 20^\circ = 10.3 \text{ (3 s.f)}$$

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

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

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

Resolving perpendicular to the plane:

$$5 + T\sin\theta - 10\cos 30^\circ = 0$$

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

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

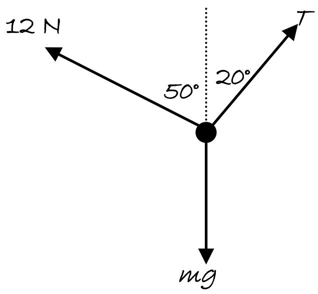
Dividing (2) by (1): $\tan\theta = \dfrac{5\sqrt{3}-5}{12}$

$\theta = 17.0^\circ$ (1 d.p.)

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

Edexcel A level Maths Forces in 2D 1 Exercise solns

3.



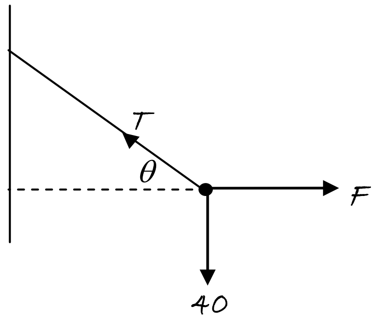
(i) Resolving horizontally: $T\sin 20^\circ - 12\sin 50^\circ = 0$

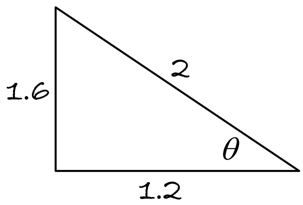
$$T = \frac{12\sin 50^\circ}{\sin 20^\circ}$$
$$= 26.9 \text{ N (3 s.f.)}$$

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

$$mg - 12\cos 50^\circ - 26.88\cos 20^\circ = 0$$
$$\Rightarrow \quad mg = 12\cos 50^\circ + 26.88\cos 20^\circ$$
$$\Rightarrow \quad mg = 32.97 N$$
$$\Rightarrow \quad m = 3.36 kg$$

4.





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

$$\frac{1.6}{2}T = 40$$
$$T = 50$$

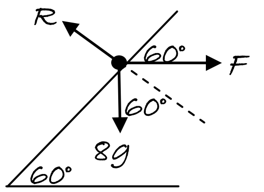
Resolving horizontally: $F - T\cos\theta = 0$

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

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

Edexcel A level Maths Forces in 2D 1 Exercise solns

5. (i)

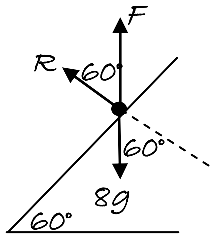


Resolving parallel to the plane: $F\cos 60° - 8g\sin 60° = 0$

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

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

(ii)



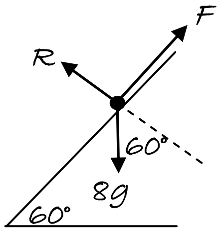
Notice that R must be zero as $F = 8g$ (consider vertical forces). This means that the particle is only just touching the plane.

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

$F = 8 \times 9.8$

$F = 78.4$ N

(iii)

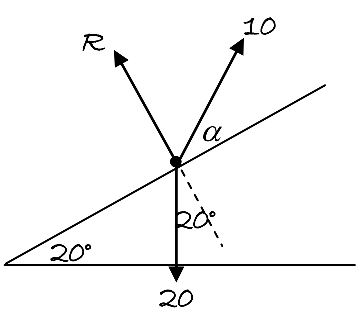


Resolving parallel to the plane: $F - 8g\sin 60° = 0$

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

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

6.



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

$\cos\alpha = 2\sin 20°$

$\alpha = 46.8°$

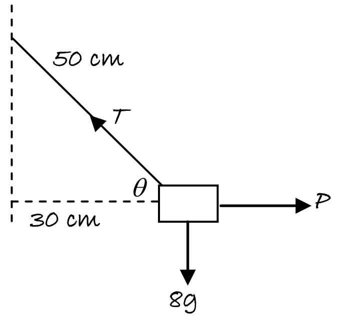
Resolving perpendicular to the plane: $R + 10\sin\alpha - 20\cos 20° = 0$

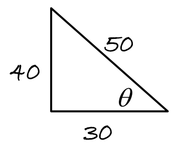
$R = 20\cos 20° - 10\sin\alpha$

$R = 11.5$

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

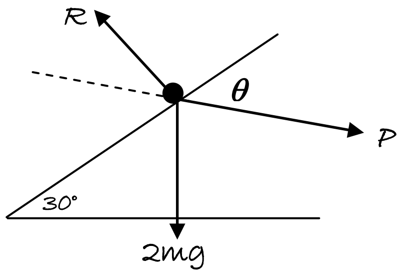
$T = \frac{8g}{\sin\theta} = 8g \times \frac{5}{4}$

$T = 98$ N

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

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

8.



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

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

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

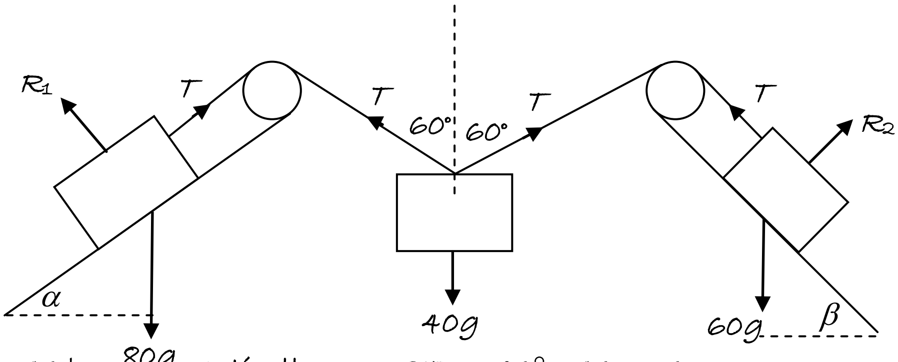
Since $R = 2.5mg$, $\frac{5}{2}mg - mg\sqrt{3} - \frac{mg}{\cos\theta}\sin\theta = 0$

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

$\theta = 37.5°$ (3 s.f.)

Edexcel A level Maths Forces in 2D 1 Exercise solns

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: $T - 60g\sin\beta = 0$

$60g\sin\beta = 40g$

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

$\beta = 41.8°$