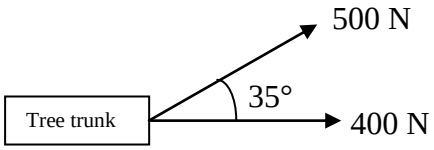
Section 1: Resolving forces

Section test

1. A force of 5 N acts due north and a force of 2 N acts due east. What is the magnitude of the resultant force?

2. A tree trunk is being pulled by cables from two tractors, as shown in the diagram below. One cable has a tension of 400N and the other a tension of 500N. The angle between the two cables is 35º. These two tractors are replaced by a single tractor, which pulls on a single cable with a with a force equivalent to that of the other two tractors combined.



What is the tension in the cable from the single tractor?

3. Three forces of sizes 15 N, 7 N and 19 N pulling at 120º to one another are acting on a particle.
What is the size of the resultant force?
What is the direction of the resultant force, to the nearest degree?

4. ABCD is a square. Forces of 2 N, $3\sqrt{2}$ N and 9 N act on a particle at A in the directions of AB, AC and AD respectively. An additional force X is applied at A so that the particle is in equilibrium.
What is the magnitude of the force X?
What is the direction of the force X?

5. A particle of mass 5 kg lies on a smooth plane inclined at an angle of 30° to the horizontal. The particle is prevented from sliding down the plane by a string parallel to the plane.
What is the tension in the string?
What is the normal reaction force between the particle and the plane?

6. A mass of 50 grams hangs in equilibrium on a string. The mass is pulled aside and upwards by a force of 0.3 N which makes an angle of 30º with the horizontal.
What angle does the string makes with the vertical?
What is the tension in the string?

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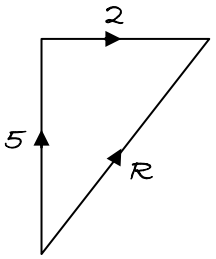
Solutions to section test

1. $R^2 = 5^2 + 2^2 = 29$

$R = 5.39$

The magnitude of the resultant force is 5.39 N.

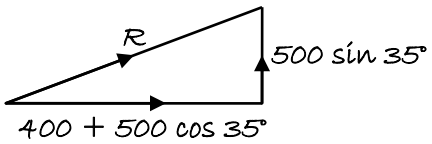


2. Total force in the x-direction $= 400 + 500\cos 35°$

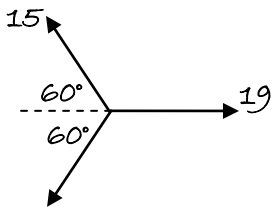
Total force in the y-direction $= 500\sin 35°$

$|\underset{\sim}{R}| = \sqrt{(400 + 500\cos 35°)^2 + (500\sin 35°)^2}$

$= 859$ N (3 s.f.)



3.



Total force in the x-direction $= 19 - 15\cos 60° - 7\cos 60°$

$= 19 - 7.5 - 3.5$

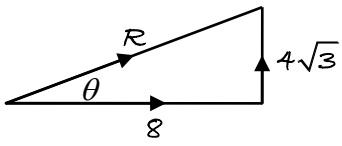
$= 8$

Total force in the y-direction $= 15\sin 60° - 7\sin 60°$

$= 8 \times \frac{\sqrt{3}}{2}$

$= 4\sqrt{3}$

Magnitude of resultant $= \sqrt{8^2 + (4\sqrt{3})^2} = 10.6$ N (3 s.f.)



$\tan\theta = \frac{4\sqrt{3}}{8}$

$\theta = 41°$ (to nearest degree)

The resultant force acts in a direction 41° from the 19 N force.

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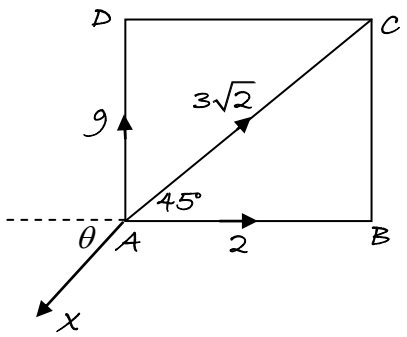
4.



Resolving in direction AB:

$$2 + 3\sqrt{2}\cos 45° - X\cos\theta = 0$$

$$X\cos\theta = 2 + 3\sqrt{2} \times \frac{1}{\sqrt{2}} = 5 \qquad (1)$$

Resolving in direction AD:

$$9 + 3\sqrt{2}\sin 45° - X\sin\theta = 0$$

$$X\sin\theta = 9 + 3\sqrt{2} \times \frac{1}{\sqrt{2}} = 12 \qquad (2)$$

$X^2\cos^2\theta = 25$

$X^2\sin^2\theta = 144$

Adding: $X^2 = 169$

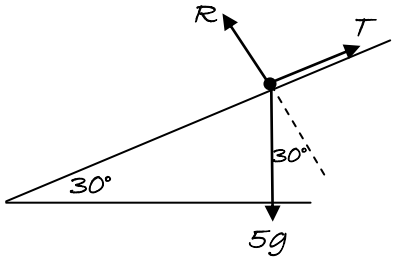
$X = 13$

Dividing (2) by (1): $\tan\theta = \frac{12}{5}$

$\theta = 67.4°$

The direction of the force X is at 67.4° to BA.

5.



Resolving up the plane: $T - 5g\sin 30° = 0$

$T = 5 \times 9.8 \times \frac{1}{2} = 24.5$

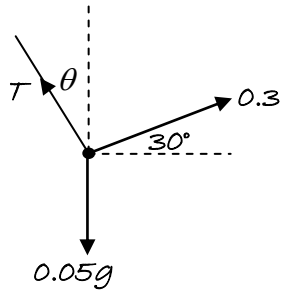
The tension in the string is 24.5 N.

Resolving perpendicular to the plane: $R - 5g\cos 30° = 0$

$R = 5 \times 9.8 \times \frac{1}{2}\sqrt{3} = 42.4$

The normal reaction force is 42.4 N (3 s.f.)

6.



Resolving horizontally: $0.3\cos 30° - T\sin\theta = 0$

$T\sin\theta = 0.3 \times \frac{1}{2}\sqrt{3}$

$T\sin\theta = 0.15\sqrt{3}$ (1)

Resolving vertically: $T\cos\theta + 0.3\sin 30° - 0.05g = 0$

$T\cos\theta = 0.05 \times 9.8 - 0.3 \times \frac{1}{2}$

$T\cos\theta = 0.34$ (2)

Dividing (1) by (2): $\tan\theta = \dfrac{0.15\sqrt{3}}{0.34}$

$\theta = 37.4°$

The string makes an angle of 37.4° with the vertical.

Using equation (2): $T\cos 37.4° = 0.34$

$T = 0.428$

The tension in the string is 0.428 N.