Had a look ☐ Nearly there ☐ Nailed it! ☐

# Resolving forces

You can answer some questions by resolving forces into **perpendicular components.**

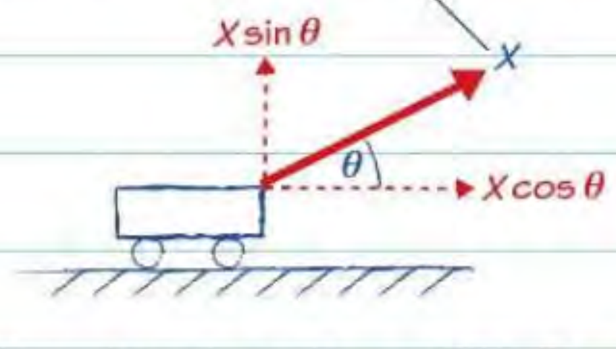
## Using sin and cos

To resolve a force into components, imagine sketching a right-angled triangle, with the force as its hypotenuse. For example, a force of magnitude $X$ acting at an angle $\theta$ to the horizontal can be resolved **horizontally** and **vertically**:

R(→): $X\cos\theta$ R(↑): $X\sin\theta$

You can use the notation R(→) and R(↑) to show which direction you are resolving in. The arrow points in the **positive** direction.

This force has the same effect as a horizontal force of magnitude $X\cos\theta$ and a vertical force of magnitude $X\sin\theta$.

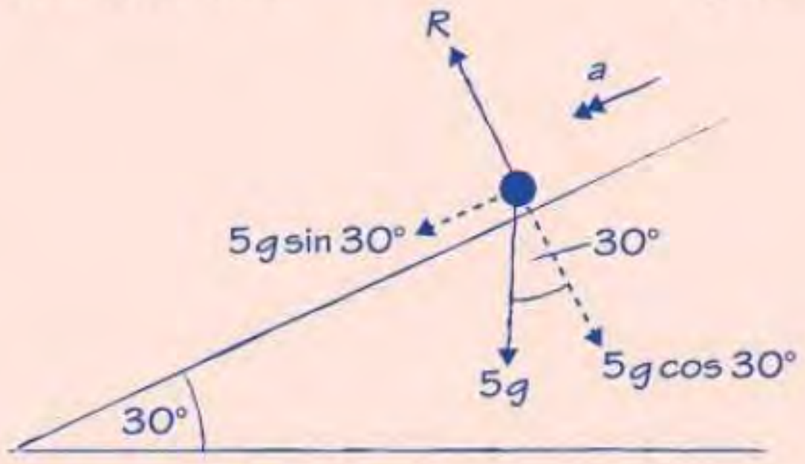



$X\cos\theta$ is **adjacent** to the angle, and $X\sin\theta$ is **opposite** the angle.

## Worked example

A box of mass 5 kg is lying on a smooth plane which is inclined at an angle of 30° to the horizontal. The box is released from rest and accelerates at $a\,\text{m s}^{-2}$ down the slope. Modelling the box as a particle, find

(a) the value of $a$ **(3 marks)**




R(↙): $5g\sin 30° = 5a$

$2.5g = 5a$

$a = 0.5g = 4.9\,\text{m s}^{-2}$

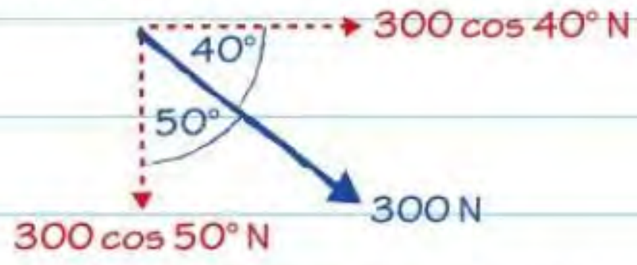
(b) the magnitude of the normal reaction of the slope on the box. **(2 marks)**

R(↖): $R - 5g\cos 30° = 0$

$R = \frac{5\sqrt{3}}{2}g = 42\,\text{N}$ (2 s.f.)

### Just cos

If the direction you are resolving in makes an angle of $\theta$ with the line of action of the force $F$, then the component in that direction is $F\cos\theta$. You can use this to resolve without using sin.




Only the component of the force which acts **down the slope** contributes to the acceleration of the box. You need to resolve the **weight** of the box ($5g$ N) into components **parallel** and **perpendicular** to the slope. Use R(↙) to show that the positive direction is **down** the slope.

The **normal reaction** always acts **perpendicular** to the plane. It is **equal in magnitude** to the component of the weight that is perpendicular to the plane, and acts in the **opposite** direction.

## Now try this

A truck is pulling a car using a light, inextensible tow-rope. The tow-rope is at an angle of 40° to the road. Together, the truck and car accelerate constantly at a rate of $2.5\,\text{m s}^{-2}$. The car has mass 800 kg and experiences a constant resistance to motion of magnitude 500 N. Find

(a) the tension in the tow-rope **Answer** **(4 marks)**

(b) the normal reaction of the road on the car. **(2 marks)**

**Answer**

The car is being accelerated by the **horizontal** component of the tension in the tow-rope.