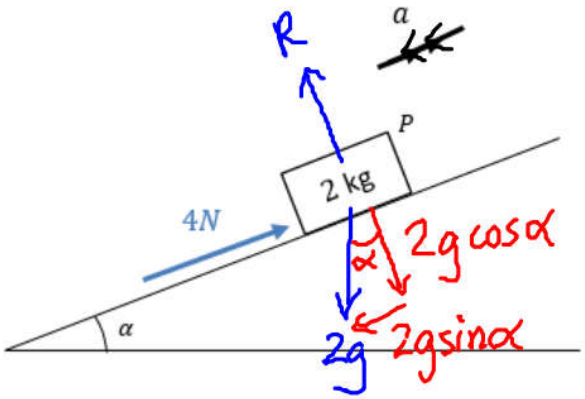
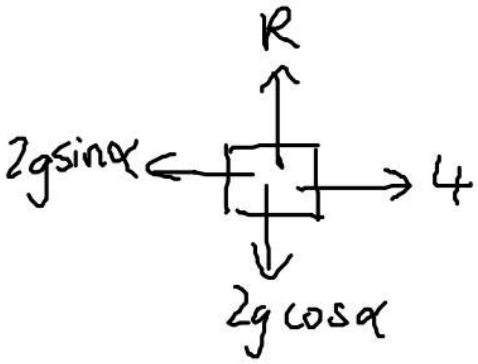
A particle P of mass 2kg is moving on a smooth slope and is being acted on by a force of 4N that acts parallel to the slope, as shown.
The slope is inclined at an angle α to the horizontal, where $\tan\alpha = \frac{3}{4}$. Work out the acceleration of the particle.



~~$\tan\alpha = \frac{3}{4}$~~

~~$\alpha = \tan^{-1}\left(\frac{3}{4}\right)$~~

$\sin\alpha = \frac{3}{5}$ $\cos\alpha = \frac{4}{5}$



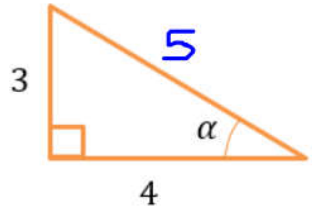
$F = ma$

$2g\sin\alpha - 4 = 2a$

$\frac{2g \times \frac{3}{5} - 4}{2} = a$

$a = 3.88\ ms^{-2}$ down the slope

Hint: Don't find α explicitly. We can find $\cos\alpha$ and $\sin\alpha$ by forming a suitable triangle such that $\tan\alpha$ would be $\frac{3}{4}$:

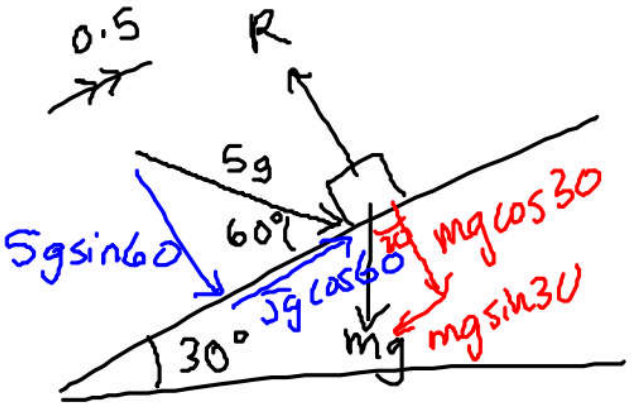


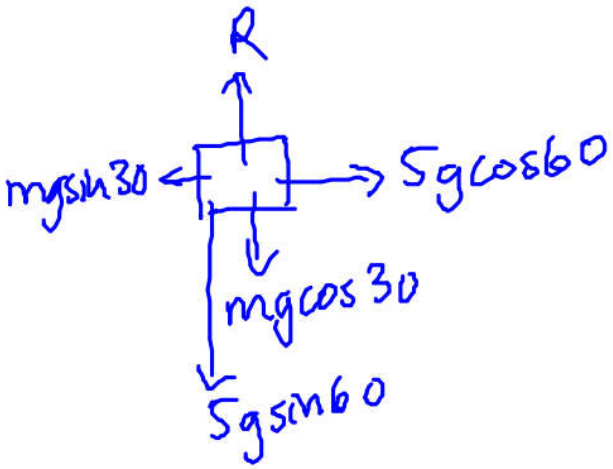
$\cos\alpha = \frac{4}{5}$

$\sin\alpha = \frac{3}{5}$

A particle of mass m is pushed up a smooth slope, inclined at $30°$ by a force of magnitude $5g$ N acting at angle of $60°$ to the slope, causing the particle to accelerate up the slope at 0.5 ms^{-2}.

Show that the mass of the particle is $\left(\frac{5g}{1+g}\right)$ kg





$F = ma \nearrow$

$5g\cos 60 - mg\sin 30 = 0.5m$

$2.5g - 0.5mg = 0.5m$

$5g - mg = m$

$5g = m + mg$

$5g = m(1+g)$

$m = \left(\frac{5g}{1+g}\right)$ kg

Exercise 5B

1 A particle of mass 3 kg slides down a smooth slope that is inclined at 20° to the horizontal.

a Draw a force diagram to represent all the forces acting on the particle.

b Work out the normal reaction between the particle and the plane.

c Find the acceleration of the particle.

2 A force of 50 N is pulling a particle of mass 5 kg up a smooth plane that is inclined at 30° to the horizontal. Given that the force acts parallel to the plane,

a draw a force diagram to represent all the forces acting on the particle

b work out the normal reaction between the particle and the plane

c find the acceleration of the particle.

3 A particle of mass 0.5 kg is held at rest on a smooth slope that is inclined at an angle α to the horizontal. The particle is released. Given that $\tan\alpha = \frac{3}{4}$, calculate:

a the normal reaction between the particle and the plane

b the acceleration of the particle.

(E) **4** A force of 30 N is pulling a particle of mass 6 kg up a rough slope that is inclined at 15° to the horizontal. The force acts in the direction of motion of the particle and the particle experiences a constant resistance due to friction.

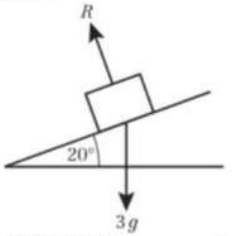
a Draw a force diagram to represent all the forces acting on the particle. **(4 marks)**

Given that the particle is moving with constant speed,

b calculate the magnitude of the resistance due to friction. **(5 marks)**

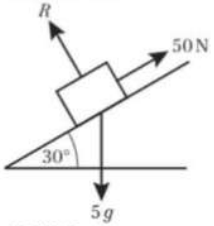
Exercise 5B

1 a



b 27.6 N (3 s.f.) **c** 3.35 ms^{-1}

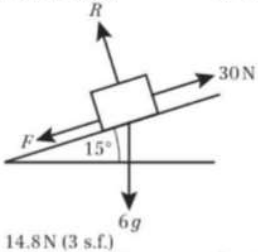
2 a



b 42.4 N (3 s.f.) **c** 5.1 ms^{-2}

3 a 3.92 N (3 s.f.) **b** 5.88 ms^{-2} (3 s.f.)

4 a



b 14.8 N (3 s.f.)

5 a 0.589 kg (3 s.f.) **b** 4.9 ms^{-2}

6 0.296 ms^{-2} (3 s.f.)

7 15.0 N (3 s.f.)

8 R(↗): $26\cos 45 - mg\sin\alpha - 12 = m \times 1$

$13\sqrt{2} - 12 = m + \frac{1}{2}mg$

$m = \frac{13\sqrt{2} - 12}{1 + \frac{g}{2}}$

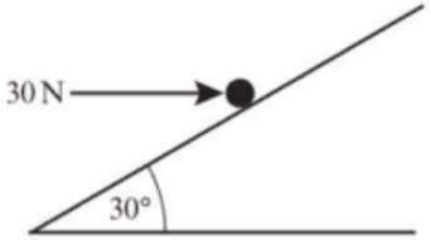
$m = 1.08$ kg (3 s.f.)

(E) **5** A particle of mass m kg is sliding down a smooth slope that is angled at 30° to the horizontal. The normal reaction between the plane and the particle is 5 N.

a Calculate the mass m of the particle. **(3 marks)**

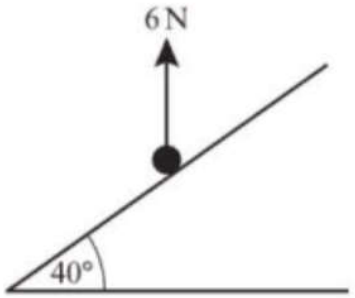
b Calculate the acceleration of the particle. **(3 marks)**

(E/P) **6** A force of 30 N acts horizontally on a particle of mass 5 kg that rests on a smooth slope that is inclined at 30° to the horizontal as shown in the diagram.
Find the acceleration of the particle.



(4 marks)

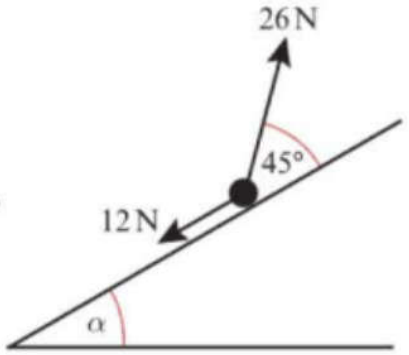
(E/P) **7** A particle of mass 3 kg is moving on a rough slope that is inclined at 40° to the horizontal. A force of 6 N acts vertically upon the particle. Given that the particle is moving at a constant velocity, calculate the value of F, the constant resistance due to friction.



(4 marks)

(E/P) **8** A particle of mass m kg is pulled up a rough slope by a force of 26 N that acts at an angle of 45° to the slope. The particle experiences a constant frictional force of magnitude 12 N.

Given that $\tan\alpha = \frac{1}{\sqrt{3}}$ and that the acceleration of the particle is 1 m s^{-2}, show that $m = 1.08$ kg (3 s.f.).



(5 marks)