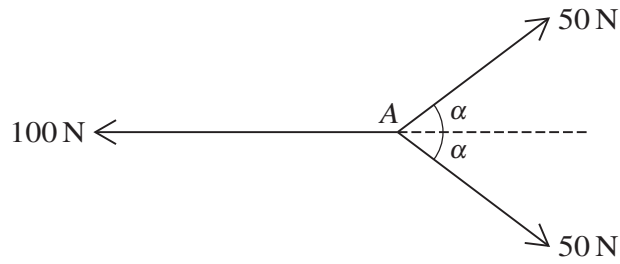**1**

Three coplanar forces of magnitudes 100 N, 50 N and 50 N act at a point A, as shown in the diagram. The value of $\cos\alpha$ is $\frac{4}{5}$.

Find the magnitude of the resultant of the three forces and state its direction. [3]

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

2 A car of mass 1800 kg is towing a trailer of mass 400 kg along a straight horizontal road. The car and trailer are connected by a light rigid tow-bar. The car is accelerating at $1.5\,\text{m s}^{-2}$. There are constant resistance forces of 250 N on the car and 100 N on the trailer.

(a) Find the tension in the tow-bar. [2]

....

....

....

....

....

....

....

....

....

(b) Find the power of the engine of the car at the instant when the speed is $20\,\text{m s}^{-1}$. [3]

....

....

....

....

....

....

....

....

....

....

3 A particle P is projected vertically upwards with speed $5 \, \text{m s}^{-1}$ from a point A which is 2.8 m above horizontal ground.

   (a) Find the greatest height above the ground reached by P. [3]

   ....

   ....

   ....

   ....

   ....

   ....

   ....

   ....

   ....

   ....

   (b) Find the length of time for which P is at a height of more than 3.6 m above the ground. [4]

   ....

   ....

   ....

   ....

   ....

   ....

   ....

   ....

   ....

   ....
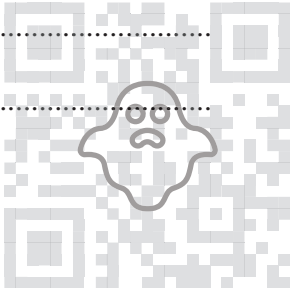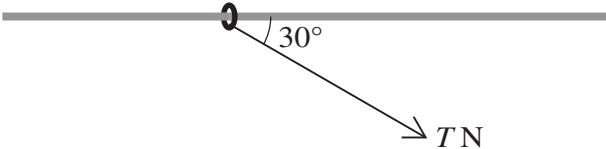
4

The diagram shows a ring of mass 0.1 kg threaded on a fixed horizontal rod. The rod is rough and the coefficient of friction between the ring and the rod is 0.8. A force of magnitude T N acts on the ring in a direction at 30° to the rod, downwards in the vertical plane containing the rod. Initially the ring is at rest.

(a) Find the greatest value of T for which the ring remains at rest. [4]

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....
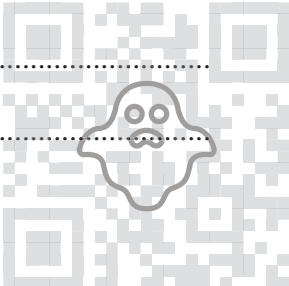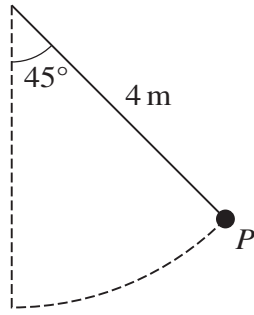
(b) Find the acceleration of the ring when $T = 3$. [3]

5

A child of mass 35 kg is swinging on a rope. The child is modelled as a particle P and the rope is modelled as a light inextensible string of length 4 m. Initially P is held at an angle of 45° to the vertical (see diagram).

(a) Given that there is no resistance force, find the speed of P when it has travelled half way along the circular arc from its initial position to its lowest point. [4]

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

(b) It is given instead that there is a resistance force. The work done against the resistance force as P travels from its initial position to its lowest point is X J. The speed of P at its lowest point is $4\,\mathrm{m\,s^{-1}}$.

Find X. [3]

6 A particle moves in a straight line AB. The velocity $v \, \text{m s}^{-1}$ of the particle t s after leaving A is given by $v = k(t^2 - 10t + 21)$, where k is a constant. The displacement of the particle from A, in the direction towards B, is 2.85 m when $t = 3$ and is 2.4 m when $t = 6$.

(a) Find the value of k. Hence find an expression, in terms of t, for the displacement of the particle from A. [7]

....

....

....

....

....

....

(b) Find the displacement of the particle from A when its velocity is a minimum. [4]

....

....

....

....

....

....

....

....

....

....

....

....

....

7

0.3 kg
P
2.5 m
30°
Q 0.2 kg
1.5 m

A particle P of mass 0.3 kg, lying on a smooth plane inclined at 30° to the horizontal, is released from rest. P slides down the plane for a distance of 2.5 m and then reaches a horizontal plane. There is no change in speed when P reaches the horizontal plane. A particle Q of mass 0.2 kg lies at rest on the horizontal plane 1.5 m from the end of the inclined plane (see diagram). P collides directly with Q.

(a) It is given that the horizontal plane is smooth and that, after the collision, P continues moving in the same direction, with speed $2\,\text{m s}^{-1}$.

Find the speed of Q after the collision. [5]

(b) It is given instead that the horizontal plane is rough and that when P and Q collide, they coalesce and move with speed $1.2 \, \text{m s}^{-1}$.

Find the coefficient of friction between P and the horizontal plane. [5]