

1. Two particles *B* and *C* have mass *m* kg and 3 kg respectively. They are moving towards each other in opposite directions on a smooth horizontal table. The two particles collide directly. Immediately before the collision, the speed of *B* is 4 m s^{-1} and the speed of *C* is 2 m s^{-1} . In the collision the direction of motion of *C* is reversed and the direction of motion of *B* is unchanged. Immediately after the collision, the speed of *B* is 1 m s^{-1} and the speed of *C* is 3 m s^{-1} .

Find

(a) the value of *m*, **(3)**

(b) the magnitude of the impulse received by *C*. **(2)**



3.

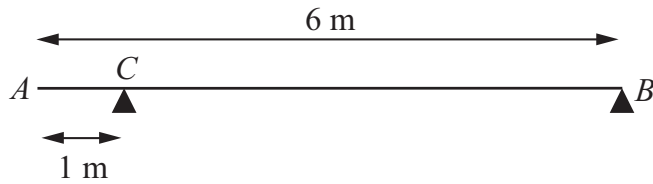


Figure 1

A uniform beam AB has mass 20 kg and length 6 m . The beam rests in equilibrium in a horizontal position on two smooth supports. One support is at C , where $AC = 1 \text{ m}$, and the other is at the end B , as shown in Figure 1. The beam is modelled as a rod.

(a) Find the magnitudes of the reactions on the beam at B and at C . (5)

A boy of mass 30 kg stands on the beam at the point D . The beam remains in equilibrium. The magnitudes of the reactions on the beam at B and at C are now equal. The boy is modelled as a particle.

(b) Find the distance AD . (5)



5. A car accelerates uniformly from rest for 20 seconds. It moves at constant speed $v \text{ m s}^{-1}$ for the next 40 seconds and then decelerates uniformly for 10 seconds until it comes to rest.

(a) For the motion of the car, sketch

(i) a speed-time graph,

(ii) an acceleration-time graph.

(6)

Given that the total distance moved by the car is 880 m,

(b) find the value of v .

(4)



6.

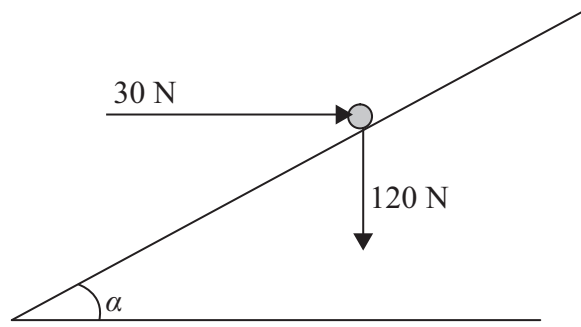


Figure 2

A particle of weight 120 N is placed on a fixed rough plane which is inclined at an angle α to the horizontal, where $\tan \alpha = \frac{3}{4}$.

The coefficient of friction between the particle and the plane is $\frac{1}{2}$.

The particle is held at rest in equilibrium by a horizontal force of magnitude 30 N, which acts in the vertical plane containing the line of greatest slope of the plane through the particle, as shown in Figure 2.

- (a) Show that the normal reaction between the particle and the plane has magnitude 114 N. (4)

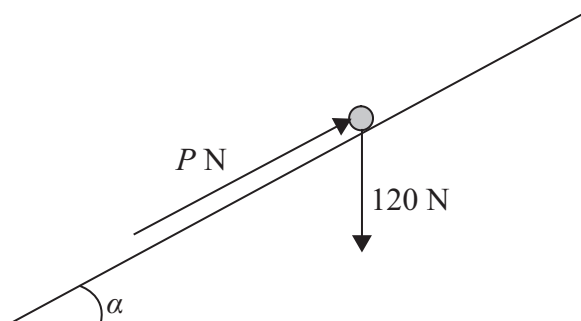


Figure 3

The horizontal force is removed and replaced by a force of magnitude P newtons acting up the slope along the line of greatest slope of the plane through the particle, as shown in Figure 3. The particle remains in equilibrium.

- (b) Find the greatest possible value of P . (8)
- (c) Find the magnitude and direction of the frictional force acting on the particle when $P = 30$. (3)



7.

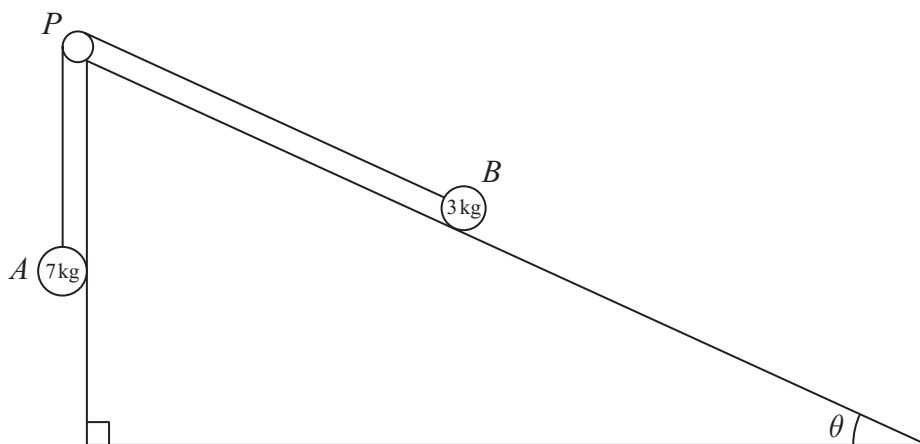


Figure 4

Two particles A and B , of mass 7 kg and 3 kg respectively, are attached to the ends of a light inextensible string. Initially B is held at rest on a rough fixed plane inclined at angle θ to the horizontal, where $\tan \theta = \frac{5}{12}$. The part of the string from B to P is parallel to a line of greatest slope of the plane. The string passes over a small smooth pulley, P , fixed at the top of the plane. The particle A hangs freely below P , as shown in Figure 4. The coefficient of friction between B and the plane is $\frac{2}{3}$. The particles are released from rest with the string taut and B moves up the plane.

(a) Find the magnitude of the acceleration of B immediately after release. (10)

(b) Find the speed of B when it has moved 1 m up the plane. (2)

When B has moved 1 m up the plane the string breaks. Given that in the subsequent motion B does not reach P ,

(c) find the time between the instants when the string breaks and when B comes to instantaneous rest. (4)



