

4.

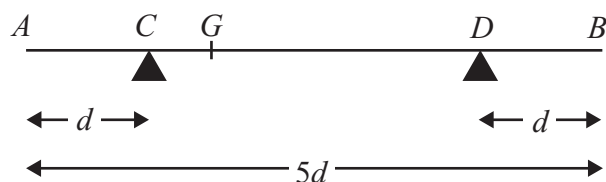


Figure 1

A non-uniform rod AB , of mass m and length $5d$, rests horizontally in equilibrium on two supports at C and D , where $AC = DB = d$, as shown in Figure 1. The centre of mass of the rod is at the point G . A particle of mass $\frac{5}{2}m$ is placed on the rod at B and the rod is on the point of tipping about D .

(a) Show that $GD = \frac{5}{2}d$. (4)

The particle is moved from B to the mid-point of the rod and the rod remains in equilibrium.

(b) Find the magnitude of the normal reaction between the support at D and the rod. (5)



Question 4 continued

Lined writing area for the answer.



6. A car moves along a straight horizontal road from a point A to a point B , where $AB=885$ m. The car accelerates from rest at A to a speed of 15 m s^{-1} at a constant rate $a\text{ m s}^{-2}$. The time for which the car accelerates is $\frac{1}{3}T$ seconds. The car maintains the speed of 15 m s^{-1} for T seconds. The car then decelerates at a constant rate of 2.5 m s^{-2} stopping at B .
- (a) Find the time for which the car decelerates. (2)

 - (b) Sketch a speed-time graph for the motion of the car. (2)

 - (c) Find the value of T . (4)

 - (d) Find the value of a . (2)

 - (e) Sketch an acceleration-time graph for the motion of the car. (3)



7. [In this question, the unit vectors \mathbf{i} and \mathbf{j} are due east and due north respectively. Position vectors are relative to a fixed origin O .]

A boat P is moving with constant velocity $(-4\mathbf{i}+8\mathbf{j})$ km h^{-1} .

(a) Calculate the speed of P . (2)

When $t = 0$, the boat P has position vector $(2\mathbf{i}-8\mathbf{j})$ km. At time t hours, the position vector of P is \mathbf{p} km.

(b) Write down \mathbf{p} in terms of t . (1)

A second boat Q is also moving with constant velocity. At time t hours, the position vector of Q is \mathbf{q} km, where

$$\mathbf{q} = 18\mathbf{i} + 12\mathbf{j} - t(6\mathbf{i} + 8\mathbf{j})$$

Find

(c) the value of t when P is due west of Q , (3)

(d) the distance between P and Q when P is due west of Q . (3)



8.

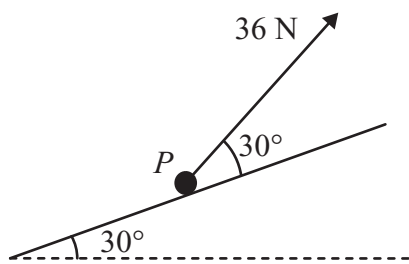


Figure 2

A particle P of mass 4 kg is moving up a fixed rough plane at a constant speed of 16 m s^{-1} under the action of a force of magnitude 36 N . The plane is inclined at 30° to the horizontal. The force acts in the vertical plane containing the line of greatest slope of the plane through P , and acts at 30° to the inclined plane, as shown in Figure 2. The coefficient of friction between P and the plane is μ . Find

- (a) the magnitude of the normal reaction between P and the plane, (4)
- (b) the value of μ . (5)

The force of magnitude 36 N is removed.

- (c) Find the distance that P travels between the instant when the force is removed and the instant when it comes to rest. (5)



