

1. Three posts P , Q and R , are fixed in that order at the side of a straight horizontal road. The distance from P to Q is 45 m and the distance from Q to R is 120 m. A car is moving along the road with constant acceleration $a \text{ m s}^{-2}$. The speed of the car, as it passes P , is $u \text{ m s}^{-1}$. The car passes Q two seconds after passing P , and the car passes R four seconds after passing Q . Find
- (i) the value of u ,
 - (ii) the value of a .

(7)



3. Two particles A and B are moving on a smooth horizontal plane. The mass of A is $2m$ and the mass of B is m . The particles are moving along the same straight line but in opposite directions and they collide directly. Immediately before they collide the speed of A is $2u$ and the speed of B is $3u$. The magnitude of the impulse received by each particle in the collision is $\frac{7mu}{2}$.

Find

(a) the speed of A immediately after the collision, (3)

(b) the speed of B immediately after the collision. (3)



5.

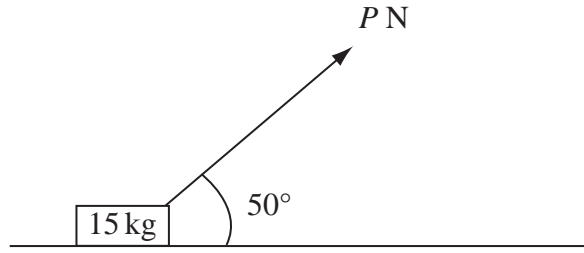


Figure 1

A small box of mass 15 kg rests on a rough horizontal plane. The coefficient of friction between the box and the plane is 0.2. A force of magnitude P newtons is applied to the box at 50° to the horizontal, as shown in Figure 1. The box is on the point of sliding along the plane.

Find the value of P , giving your answer to 2 significant figures.

(9)



7.

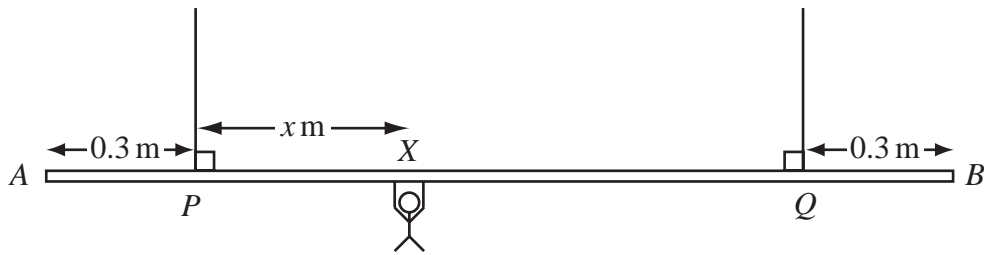


Figure 2

A beam AB is supported by two vertical ropes, which are attached to the beam at points P and Q , where $AP = 0.3$ m and $BQ = 0.3$ m. The beam is modelled as a uniform rod, of length 2 m and mass 20 kg. The ropes are modelled as light inextensible strings. A gymnast of mass 50 kg hangs on the beam between P and Q . The gymnast is modelled as a particle attached to the beam at the point X , where $PX = x$ m, $0 < x < 1.4$ as shown in Figure 2. The beam rests in equilibrium in a horizontal position.

(a) Show that the tension in the rope attached to the beam at P is $(588 - 350x)$ N. (3)

(b) Find, in terms of x , the tension in the rope attached to the beam at Q . (3)

(c) Hence find, justifying your answer carefully, the range of values of the tension which could occur in each rope. (3)

Given that the tension in the rope attached at Q is three times the tension in the rope attached at P ,

(d) find the value of x . (3)



8. [In this question \mathbf{i} and \mathbf{j} are horizontal unit vectors due east and due north respectively.]

A hiker H is walking with constant velocity $(1.2\mathbf{i} - 0.9\mathbf{j}) \text{ m s}^{-1}$.

(a) Find the speed of H .

(2)

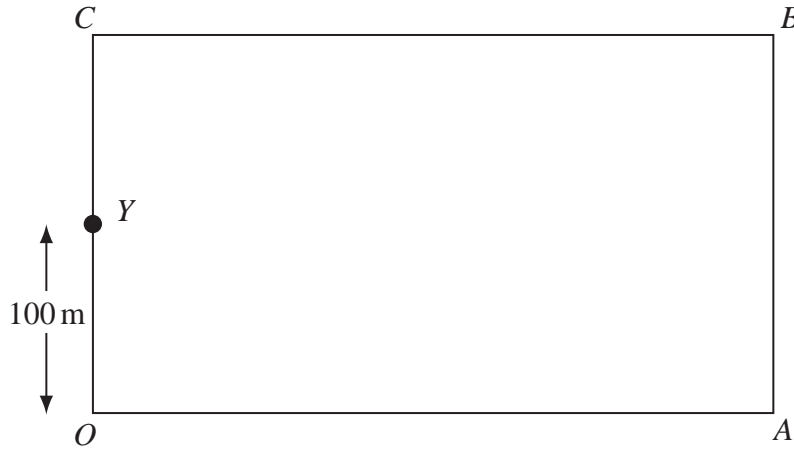


Figure 3

A horizontal field $OABC$ is rectangular with OA due east and OC due north, as shown in Figure 3. At twelve noon hiker H is at the point Y with position vector $100\mathbf{j}$ m, relative to the fixed origin O .

(b) Write down the position vector of H at time t seconds after noon.

(2)

At noon, another hiker K is at the point with position vector $(9\mathbf{i} + 46\mathbf{j})$ m. Hiker K is moving with constant velocity $(0.75\mathbf{i} + 1.8\mathbf{j}) \text{ m s}^{-1}$.

(c) Show that, at time t seconds after noon,

$$\overrightarrow{HK} = [(9 - 0.45t)\mathbf{i} + (2.7t - 54)\mathbf{j}] \text{ metres.}$$

(4)

Hence,

(d) show that the two hikers meet and find the position vector of the point where they meet.

(5)



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Question 8 continued

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Q8

(Total 13 marks)

TOTAL FOR PAPER: 75 MARKS

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