

1. A cyclist starts from rest and moves along a straight horizontal road. The combined mass of the cyclist and his cycle is 120 kg. The resistance to motion is modelled as a constant force of magnitude 32 N. The rate at which the cyclist works is 384 W. The cyclist accelerates until he reaches a constant speed of v m s⁻¹.

Find

- (a) the value of v , **(3)**

- (b) the acceleration of the cyclist at the instant when the speed is 9 m s⁻¹. **(3)**



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Question 1 continued

Lined area for writing the answer to Question 1.

(Total 6 marks)

Q1



Question 3 continued

Lined area for writing the answer to Question 3.

(Total 8 marks)

Q3



4.

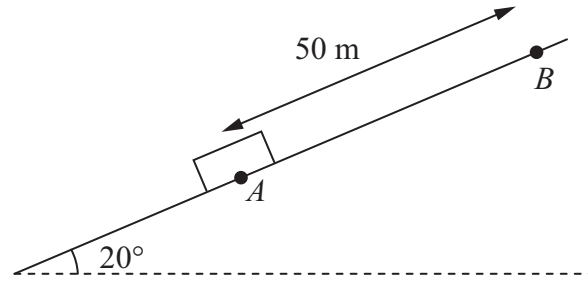


Figure 1

A box of mass 30 kg is held at rest at point A on a rough inclined plane. The plane is inclined at 20° to the horizontal. Point B is 50 m from A up a line of greatest slope of the plane, as shown in Figure 1. The box is dragged from A to B by a force acting parallel to AB and then held at rest at B . The coefficient of friction between the box and the plane is $\frac{1}{4}$. Friction is the only non-gravitational resistive force acting on the box. Modelling the box as a particle,

- (a) find the work done in dragging the box from A to B . (6)

The box is released from rest at the point B and slides down the slope. Using the work-energy principle, or otherwise,

- (b) find the speed of the box as it reaches A . (5)



Question 4 continued

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N 3 5 4 0 8 A 0 1 1 2 8

5.

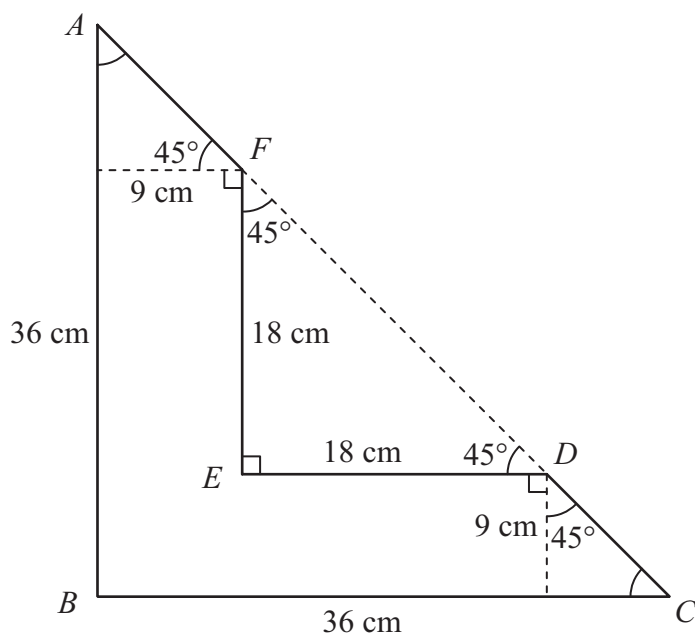


Figure 2

The uniform L-shaped lamina $ABCDEF$, shown in Figure 2, has sides AB and FE parallel, and sides BC and ED parallel. The pairs of parallel sides are 9 cm apart. The points A , F , D and C lie on a straight line.

$AB = BC = 36$ cm, $FE = ED = 18$ cm. $\angle ABC = \angle FED = 90^\circ$, and $\angle BCD = \angle EDF = \angle EFD = \angle BAC = 45^\circ$.

(a) Find the distance of the centre of mass of the lamina from

(i) side AB ,

(ii) side BC .

(7)

The lamina is freely suspended from A and hangs in equilibrium.

(b) Find, to the nearest degree, the size of the angle between AB and the vertical.

(3)



6. [In this question, the unit vectors \mathbf{i} and \mathbf{j} are in a vertical plane, \mathbf{i} being horizontal and \mathbf{j} being vertically upwards.]

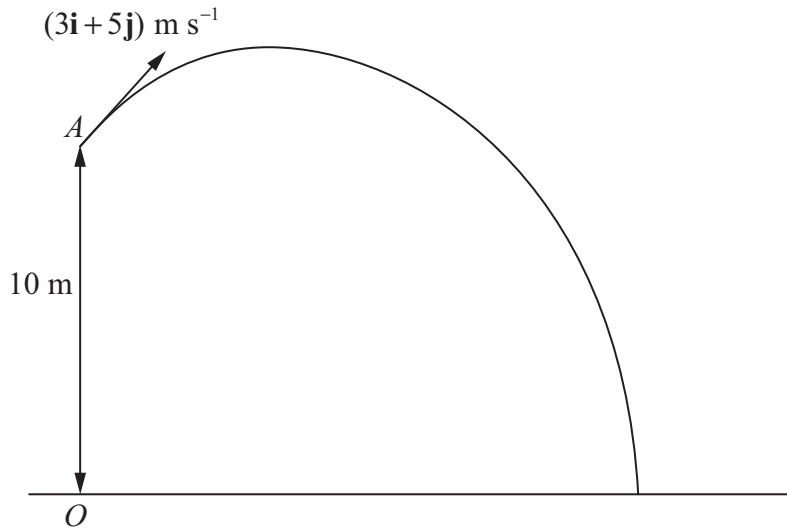


Figure 3

At time $t = 0$, a particle P is projected from the point A which has position vector $10\mathbf{j}$ metres with respect to a fixed origin O at ground level. The ground is horizontal. The velocity of projection of P is $(3\mathbf{i} + 5\mathbf{j}) \text{ m s}^{-1}$, as shown in Figure 3. The particle moves freely under gravity and reaches the ground after T seconds.

- (a) For $0 \leq t \leq T$, show that, with respect to O , the position vector, \mathbf{r} metres, of P at time t seconds is given by

$$\mathbf{r} = 3t\mathbf{i} + (10 + 5t - 4.9t^2)\mathbf{j} \quad (3)$$

- (b) Find the value of T . (3)
- (c) Find the velocity of P at time t seconds ($0 \leq t \leq T$). (2)

When P is at the point B , the direction of motion of P is 45° below the horizontal.

- (d) Find the time taken for P to move from A to B . (2)
- (e) Find the speed of P as it passes through B . (2)



7.

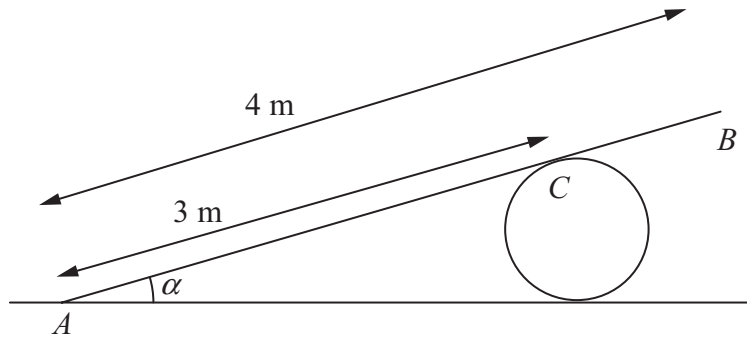


Figure 4

A uniform plank AB , of weight 100 N and length 4 m , rests in equilibrium with the end A on rough horizontal ground. The plank rests on a smooth cylindrical drum. The drum is fixed to the ground and cannot move. The point of contact between the plank and the drum is C , where $AC = 3\text{ m}$, as shown in Figure 4. The plank is resting in a vertical plane which is perpendicular to the axis of the drum, at an angle α to the horizontal, where $\sin \alpha = \frac{1}{3}$. The coefficient of friction between the plank and the ground is μ . Modelling the plank as a rod, find the least possible value of μ .

(10)



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Question 7 continued

A series of 26 horizontal lines for writing the answer to Question 7.

(Total 10 marks)

Q7

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