







2. A particle  $P$  of mass 3 kg moves from point  $A$  to point  $B$  up a line of greatest slope of a fixed rough plane. The plane is inclined at  $20^\circ$  to the horizontal. The coefficient of friction between  $P$  and the plane is 0.4

Given that  $AB = 15$  m and that the speed of  $P$  at  $A$  is  $20 \text{ m s}^{-1}$ , find

(a) the work done against friction as  $P$  moves from  $A$  to  $B$ , (3)

(b) the speed of  $P$  at  $B$ . (4)

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3. A particle  $P$  moves on the  $x$ -axis. At time  $t$  seconds the velocity of  $P$  is  $v \text{ m s}^{-1}$  in the direction of  $x$  increasing, where

$$v = 2t^2 - 14t + 20, \quad t \geq 0$$

Find

(a) the times when  $P$  is instantaneously at rest, (3)

(b) the greatest speed of  $P$  in the interval  $0 \leq t \leq 4$  (5)

(c) the total distance travelled by  $P$  in the interval  $0 \leq t \leq 4$  (5)

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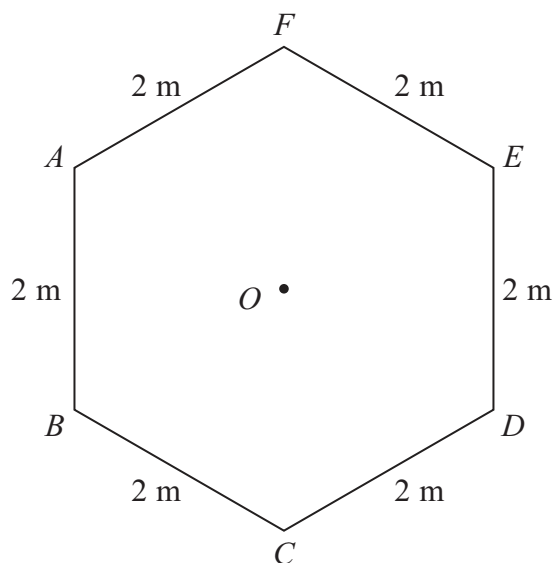






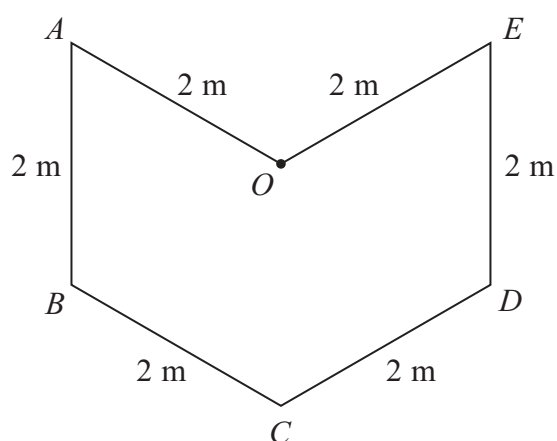


4.



**Figure 1**

The uniform lamina  $ABCDEF$  is a regular hexagon with centre  $O$  and sides of length 2 m, as shown in Figure 1.



**Figure 2**

The triangles  $OAF$  and  $OEF$  are removed to form the uniform lamina  $OABCDE$ , shown in Figure 2.

(a) Find the distance of the centre of mass of  $OABCDE$  from  $O$ . (5)

The lamina  $OABCDE$  is freely suspended from  $E$  and hangs in equilibrium.

(b) Find the size of the angle between  $EO$  and the downward vertical. (6)



**Question 4 continued**

Lined area for writing the answer to Question 4.







5.

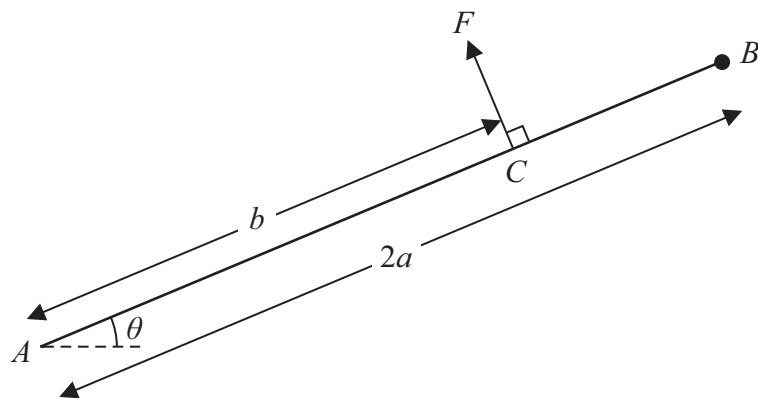


Figure 3

A uniform rod  $AB$ , of mass  $m$  and length  $2a$ , is freely hinged to a fixed point  $A$ . A particle of mass  $m$  is attached to the rod at  $B$ . The rod is held in equilibrium at an angle  $\theta$  to the horizontal by a force of magnitude  $F$  acting at the point  $C$  on the rod, where  $AC = b$ , as shown in Figure 3. The force at  $C$  acts at right angles to  $AB$  and in the vertical plane containing  $AB$ .

(a) Show that  $F = \frac{3amg \cos \theta}{b}$ . (4)

(b) Find, in terms of  $a$ ,  $b$ ,  $g$ ,  $m$  and  $\theta$ ,

(i) the horizontal component of the force acting on the rod at  $A$ ,

(ii) the vertical component of the force acting on the rod at  $A$ . (5)

Given that the force acting on the rod at  $A$  acts along the rod,

(c) find the value of  $\frac{a}{b}$ . (4)

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**Question 5 continued**

Ruled area for writing the answer to Question 5. The area consists of 30 horizontal lines.

**(Total 13 marks)**

**Q5**

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6.

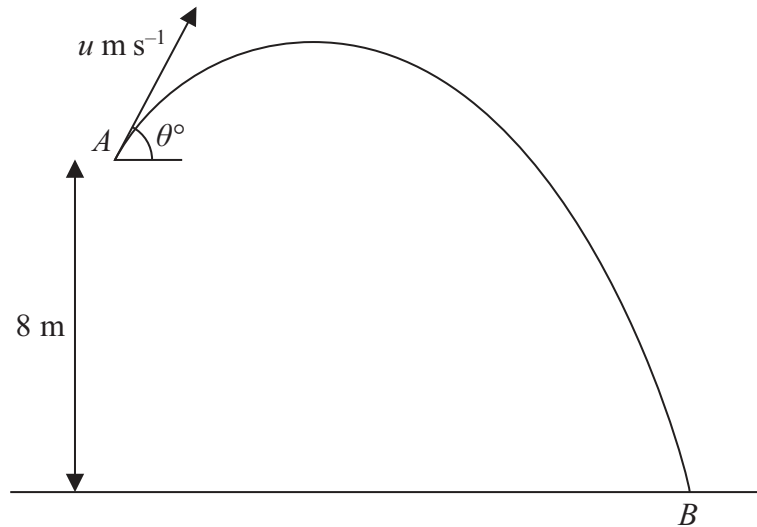


Figure 4

A ball is projected from a point  $A$  which is  $8\text{ m}$  above horizontal ground as shown in Figure 4. The ball is projected with speed  $u\text{ m s}^{-1}$  at an angle  $\theta^\circ$  above the horizontal. The ball moves freely under gravity and hits the ground at the point  $B$ . The speed of the ball immediately before it hits the ground is  $2u\text{ m s}^{-1}$ .

(a) By considering energy, find the value of  $u$ . (5)

The time taken for the ball to move from  $A$  to  $B$  is 2 seconds. Find

(b) the value of  $\theta$ , (4)

(c) the minimum speed of the ball on its path from  $A$  to  $B$ . (2)

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7. Three particles  $P$ ,  $Q$  and  $R$  lie at rest in a straight line on a smooth horizontal table with  $Q$  between  $P$  and  $R$ . The particles  $P$ ,  $Q$  and  $R$  have masses  $2m$ ,  $3m$  and  $4m$  respectively. Particle  $P$  is projected towards  $Q$  with speed  $u$  and collides directly with it. The coefficient of restitution between each pair of particles is  $e$ .

(a) Show that the speed of  $Q$  immediately after the collision with  $P$  is  $\frac{2}{5}(1+e)u$ . **(6)**

After the collision between  $P$  and  $Q$  there is a direct collision between  $Q$  and  $R$ .

Given that  $e = \frac{3}{4}$ , find

(b) (i) the speed of  $Q$  after this collision,

(ii) the speed of  $R$  after this collision. **(6)**

Immediately after the collision between  $Q$  and  $R$ , the rate of increase of the distance between  $P$  and  $R$  is  $V$ .

(c) Find  $V$  in terms of  $u$ . **(3)**

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**Question 7 continued**

Lined writing area for question 7.

**Q7**

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**(Total 15 marks)**

**TOTAL FOR PAPER: 75 MARKS**

**END**

