

A Level Mathematics A

H240/03 Pure Mathematics and Mechanics

Question Set 6

1. A particle P moves with constant acceleration $(-4\mathbf{i} + 2\mathbf{j})\text{ms}^{-2}$. At time $t = 0$ seconds, P is moving with velocity $(7\mathbf{i} + 6\mathbf{j})\text{ms}^{-1}$.

(a) Determine the speed of P when $t = 3$. [4]

(b) Determine the change in displacement of P between $t = 0$ and $t = 3$. [2]

2 A car is travelling on a straight horizontal road. The velocity of the car, $v\text{ms}^{-1}$, at time t seconds as it travels past three points, P , Q and R , is modelled by the equation

$$v = at^2 + bt + c,$$

where a , b and c are constants.

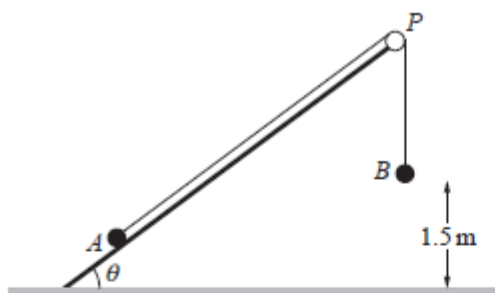
The car passes P at time $t = 0$ with velocity 8ms^{-1} .

(a) State the value of c . [1]

The car passes Q at time $t = 5$ and at that instant its deceleration is 0.12ms^{-2} . The car passes R at time $t = 18$ with velocity 2.96ms^{-1} .

(b) Determine the values of a and b . [4]

(c) Find, to the nearest metre, the distance between points P and R . [2]



One end of a light inextensible string is attached to a particle A of mass 2 kg . The other end of the string is attached to a second particle B of mass 2.5 kg . Particle A is in contact with a rough plane inclined at θ to the horizontal, where $\cos \theta = \frac{4}{5}$. The string is taut and passes over a small smooth pulley P at the top of the plane. The part of the string from A to P is parallel to a line of greatest slope of the plane. Particle B hangs freely below P at a distance 1.5 m above horizontal ground, as shown in the diagram.

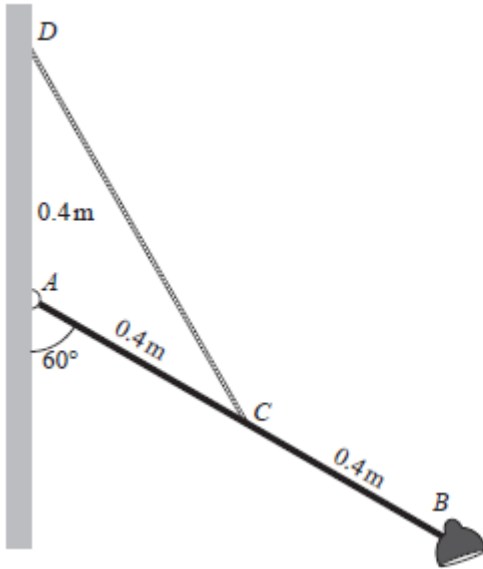
The coefficient of friction between A and the plane is μ . The system is released from rest and in the subsequent motion B hits the ground before A reaches P . The speed of B at the instant that it hits the ground is 1.2 ms^{-1} .

- For the motion before B hits the ground, show that the acceleration of B is 0.48 ms^{-2} . [1]
- For the motion before B hits the ground, show that the tension in the string is 23.3 N . [3]
- Determine the value of μ . [5]

After B hits the ground, A continues to travel up the plane before coming to instantaneous rest before it reaches P .

- Determine the distance that A travels from the instant that B hits the ground until A comes to instantaneous rest. [4]

4

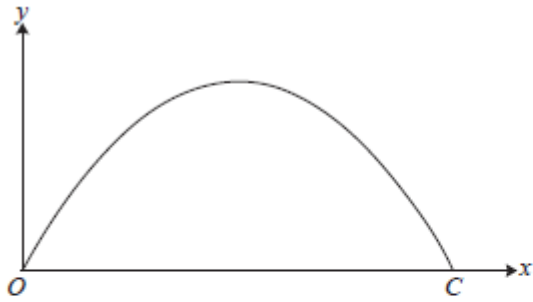


The diagram shows a wall-mounted light. It consists of a rod AB of mass 0.25 kg and length 0.8 m which is freely hinged to a vertical wall at A , and a lamp of mass 0.5 kg fixed at B . The system is held in equilibrium by a chain CD whose end C is attached to the midpoint of AB . The end D is fixed to the wall a distance 0.4 m vertically above A . The rod AB makes an angle of 60° with the downward vertical.

The chain is modelled as a light inextensible string, the rod is modelled as uniform and the lamp is modelled as a particle.

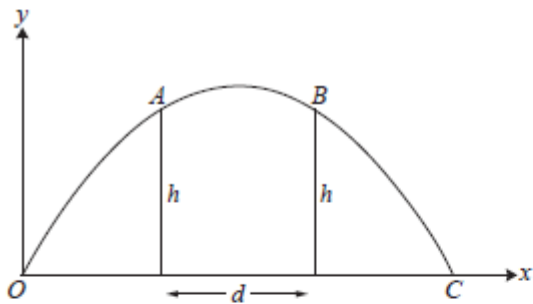
- (a) By taking moments about A , determine the tension in the chain. [4]
- (b) (i) Determine the magnitude of the force exerted on the rod at A . [4]
- (ii) Calculate the direction of the force exerted on the rod at A . [2]
- (c) Suggest one improvement that could be made to the model to make it more realistic. [1]

5



A particle P moves freely under gravity in the plane of a fixed horizontal axis Ox , which lies on horizontal ground, and a fixed vertical axis Oy . P is projected from O with a velocity whose components along Ox and Oy are U and V , respectively. P returns to the ground at a point C .

- (a) Determine, in terms of U , V and g , the distance OC . [4]



P passes through two points A and B , each at a height h above the ground and a distance d apart, as shown in the diagram.

- (b) Write down the horizontal and vertical components of the velocity of P at A . [2]
- (c) Hence determine an expression for d in terms of U , V , g and h . [3]
- (d) Given that the direction of motion of P as it passes through A is inclined to the horizontal at an angle θ , where $\tan \theta = \frac{1}{2}$, determine an expression for V in terms of g , d and h . [4]

Total Marks for Question Set 6: 50 Marks

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