OCR
Oxford Cambridge and RSA

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 $8\,\text{ms}^{-1}$.

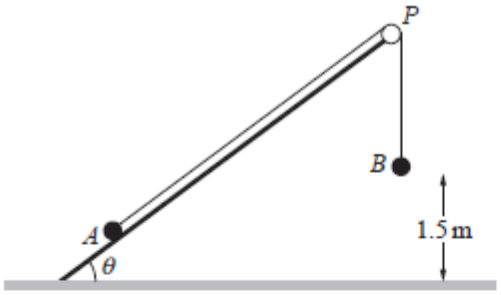
(a) State the value of c. **[1]**

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

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

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

3



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 $1.2\,\text{m s}^{-1}$.

(a) For the motion before B hits the ground, show that the acceleration of B is $0.48\,\text{m s}^{-2}$. **[1]**

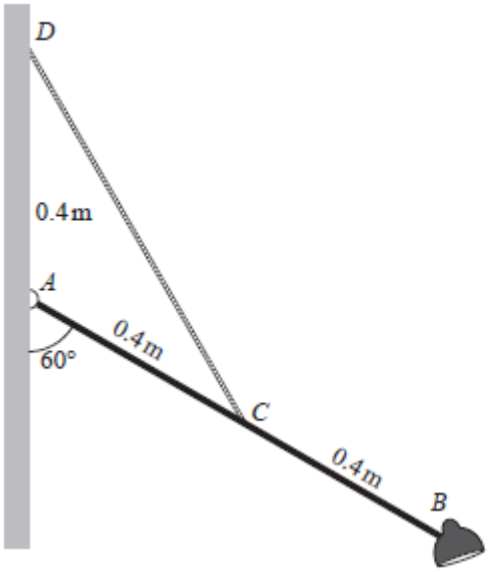
(b) For the motion before B hits the ground, show that the tension in the string is 23.3 N. **[3]**

(c) 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.

(d) 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.

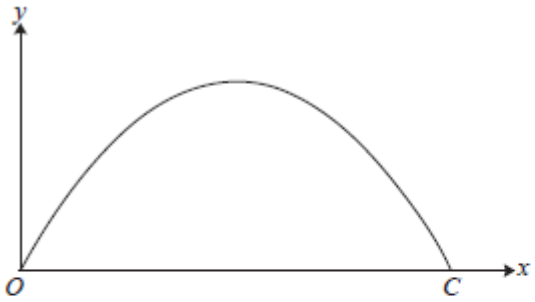
(a) By taking moments about A, determine the tension in the chain. **[4]**

(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]**

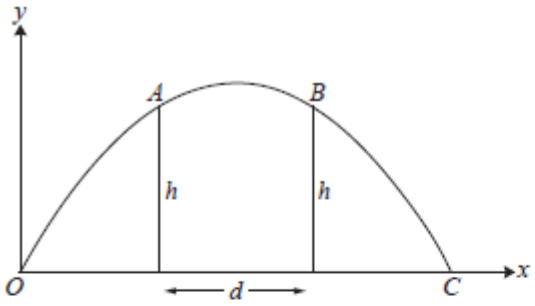
(c) Suggest one improvement that could be made to the model to make it more realistic. **[1]**

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