Uniform Motion in a Circle

Question Paper 2

Level	International A Level
Subject	Maths
Exam Board	CIE
Topic	Uniform Motion in a Circle
Sub Topic	
Booklet	Question Paper 2

Time Allowed: **60 minutes**

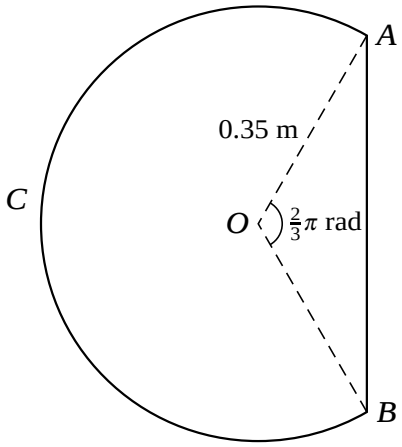
Score: **/50**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1



A uniform lamina ***ABC*** is in the form of a major segment of a circle with centre ***O*** and radius 0.35 m. The straight edge of the lamina is ***AB***, and angle ***AOB*** = $\frac{2}{3}\pi$ radians (see diagram).

(i) Show that the centre of mass of the lamina is 0.0600 m from ***O***, correct to 3 significant figures. [6]

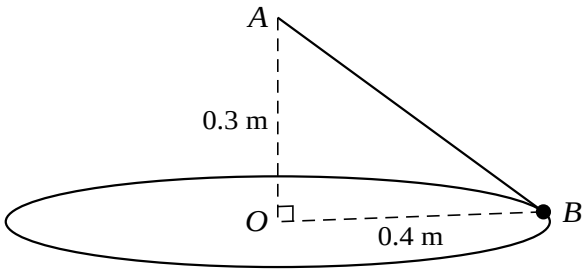
The weight of the lamina is 14 N. It is placed on a rough horizontal surface with ***A*** vertically above ***B*** and the lowest point of the arc ***BC*** in contact with the surface. The lamina is held in equilibrium in a vertical plane by a force of magnitude ***F*** N acting at ***A***.

(ii) Find ***F*** in each of the following cases:

(a) the force of magnitude ***F*** N acts along ***AB***; [2]

(b) the force of magnitude ***F*** N acts along the tangent to the circular arc at ***A***. [3]

2



A small bead B of mass m kg moves with constant speed in a horizontal circle on a fixed smooth wire. The wire is in the form of a circle with centre O and radius 0.4 m. One end of a light elastic string of natural length 0.4 m and modulus of elasticity $42m$ N is attached to B. The other end of the string is attached to a fixed point A which is 0.3 m vertically above O (see diagram).

(i) Show that the vertical component of the contact force exerted by the wire on the bead is $3.7m$ N upwards. [3]

(ii) Given that the contact force has zero horizontal component, find the angular speed of B. [2]

(iii) Given instead that the horizontal component of the contact force has magnitude $2m$ N, find the two possible speeds of B. [3]

The string is now removed. B again moves on the wire in a horizontal circle with constant speed. It is given that the vertical and horizontal components of the contact force exerted by the wire on the bead have equal magnitudes.

(iv) Find the speed of B. [3]

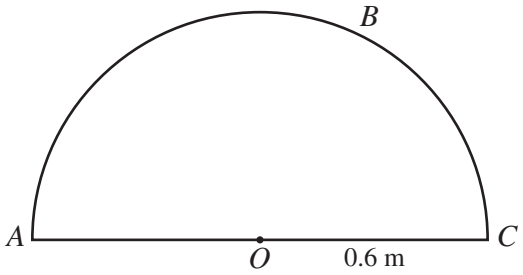
3 One end of a light inextensible string of length 2.4 m is attached to a fixed point A. The other end of the string is attached to a particle P of mass 0.2 kg. P moves with constant speed in a horizontal circle which has its centre vertically below A, with the string taut and making an angle of 60° with the vertical.

(i) Find the speed of P. [4]

The string of length 2.4 m is removed, and P is now connected to A by a light inextensible string of length 1.2 m. The particle P moves with angular speed 4 rad s^{-1} in a horizontal circle with its centre vertically below A.

(ii) Calculate the angle between the string and the vertical. [4]

4



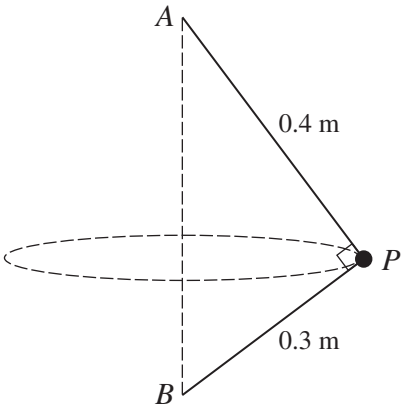
A uniform frame consists of a semicircular arc ***ABC*** of radius 0.6 m together with its diameter ***AOC***, where ***O*** is the centre of the semicircle (see diagram).

(i) Calculate the distance of the centre of mass of the frame from ***O***. [4]

The frame is freely suspended at ***A*** and hangs in equilibrium.

(ii) Calculate the angle between ***AC*** and the vertical. [2]

5

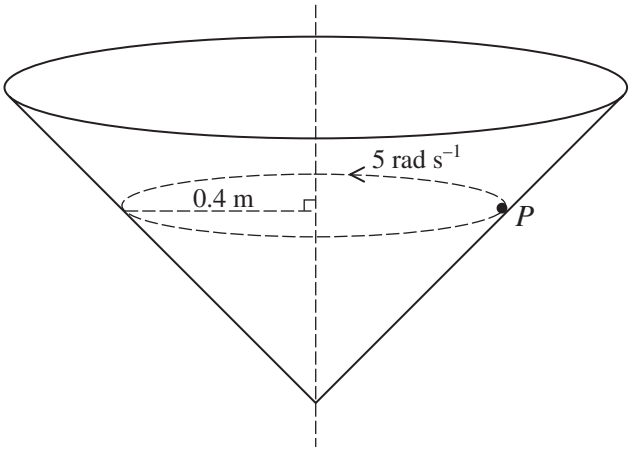


A particle ***P*** of mass 0.2 kg is attached to a fixed point ***A*** by a light inextensible string of length 0.4 m. A second light inextensible string of length 0.3 m connects ***P*** to a fixed point ***B*** which is vertically below ***A***. The particle ***P*** moves in a horizontal circle, which has its centre on the line ***AB***, with the angle ***APB*** = 90° (see diagram).

(i) Given that the tensions in the two strings are equal, calculate the speed of ***P***. [5]

(ii) It is given instead that ***P*** moves with its least possible angular speed for motion in this circle. Find this angular speed. [3]

6



A particle P of mass 0.5 kg moves in a horizontal circle on the smooth inner surface of a hollow cone which is fixed with its axis vertical and its vertex downwards. P moves with angular speed 5 rad s^{-1} in a circle of radius 0.4 m (see diagram). Show that the semi-vertical angle of the cone is 45° and calculate the magnitude of the force exerted on P by the surface of the cone. [6]