Uniform Motion in a Circle

Question Paper 1

Level	International A Level
Subject	Maths
Exam Board	CIE
Topic	Uniform Motion in a Circle
Sub Topic	
Booklet	Question Paper 1

Time Allowed: **60 minutes**

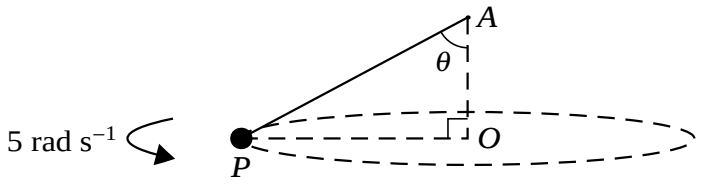
Score: **/50**

Percentage: **/100**

Grade Boundaries:

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

1



One end of a light inextensible string is attached to a fixed point A and the other end of the string is attached to a particle P. The particle P moves with constant angular speed 5 rad s^{-1} in a horizontal circle which has its centre O vertically below A. The string makes an angle θ with the vertical (see diagram). The tension in the string is three times the weight of P.

(i) Show that the length of the string is 1.2 m. [3]

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

2 A particle P of mass 0.6 kg is on the rough surface of a horizontal disc with centre O. The distance OP is 0.4 m. The disc and P rotate with angular speed 3 rad s^{-1} about a vertical axis which passes through O. Find the magnitude of the frictional force which the disc exerts on the particle, and state the direction of this force. [3]

3 One end of a light inextensible string of length 0.5 m is attached to a fixed point A. The other end of the string is attached to a particle P of weight 6 N. Another light inextensible string of length 0.5 m connects P to a fixed point B which is 0.8 m vertically below A. The particle P moves with constant speed in a horizontal circle with centre at the mid-point of AB. Both strings are taut.

(i) Calculate the speed of P when the tension in the string BP is 2 N. [5]

(ii) Show that the angular speed of P must exceed 5 rad s^{-1}. [3]

4 A particle P of mass 0.7 kg is attached to one end of a light inextensible string of length 0.5 m. The other end of the string is attached to a fixed point A which is h m above a smooth horizontal surface. P moves in contact with the surface with uniform circular motion about the point on the surface which is vertically below A.

(i) Given that $h = 0.14$, find an inequality for the angular speed of P. [4]

(ii) Given instead that the magnitude of the force exerted by the surface on P is 1.4 N and that the speed of P is 2.5 m s^{-1}, calculate the tension in the string and the value of h. [7]

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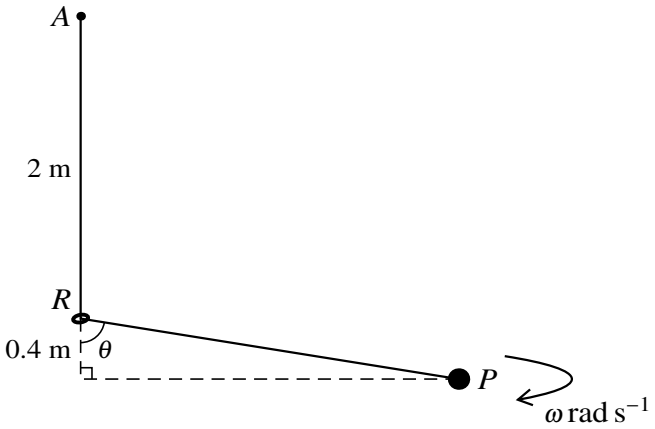

One end of a light elastic string with modulus of elasticity 15 N is attached to a fixed point A which is 2 m vertically above a fixed small smooth ring R. The string has natural length 2 m and it passes through R. The other end of the string is attached to a particle P of mass m kg which moves with constant angular speed ω rad s^{-1} in a horizontal circle which has its centre 0.4 m vertically below the ring. PR makes an acute angle θ with the vertical (see diagram).

(i) Show that the tension in the string is $\dfrac{3}{\cos\theta}$ N and hence find the value of m. [4]

(ii) Show that the value of ω does not depend on θ. [4]

It is given that for one value of θ the elastic potential energy stored in the string is twice the kinetic energy of P.

(iii) Find this value of θ. [4]

6 A horizontal disc with a rough surface rotates about a fixed vertical axis which passes through the centre of the disc. A particle P of mass 0.2 kg is in contact with the surface and rotates with the disc, without slipping, at a distance 0.5 m from the axis. The greatest speed of P for which this motion is possible is $1.5\,\text{m}\,\text{s}^{-1}$.

(i) Calculate the coefficient of friction between the disc and P. [2]

P is now attached to one end of a light elastic string, which is connected at its other end to a point on the vertical axis above the disc. The tension in the string is equal to half the weight of P. The disc rotates with constant angular speed $\omega\,\text{rad}\,\text{s}^{-1}$ and P rotates with the disc without slipping. P moves in a circle of radius 0.5 m, and the taut string makes an angle of 30° with the horizontal.

(ii) Find the greatest and least values of ω for which this motion is possible. [5]

(iii) Calculate the value of ω for which the disc exerts no frictional force on P. [2]