Edexcel

A Level

A Level Physics

Circular Motion

Name:

M M E

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Total Marks: /30

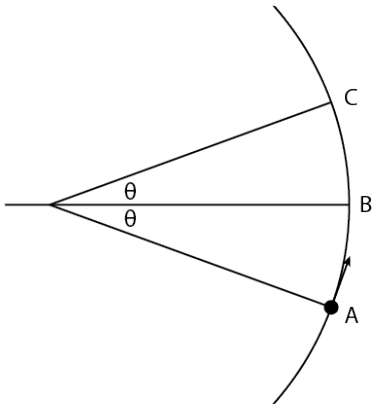
1. Total for Question 1: 13

(a) Define angular velocity. [1]

(b) Calculate the angular velocity of a car travelling at 30 kmhr^{-1} around a roundabout whose radius is 50 m. [3]

(c) Give three examples of situations in which centripetal forces arise, detailing precisely which forces contribute to the centripetal force. [3]

(d) The diagram below shows a bob tracing out a circle in a vertical plane. Points A and C are separated from B - the point at which the string is horizontal - by the angle θ. Show that the horizontal acceleration is given by $a_x = \frac{2v \sin\theta}{t}$, where v is the speed of the bob and t is the time taken to get from A to C. [3]



(e) Using this result, demonstrate that the acceleration of a mass moving around a circle with a radius of r at a speed of v is $a = \frac{v^2}{r}$. [3]

2. A cyclist is travelling around a bend with a radius of 15 m on a horizontal road. The frictional force is related to the reaction force from the ground and the coefficient of friction by the equation $F = \mu R$, where μ is the coefficient of friction and R is the reaction force.

Total for Question 2: 10

(a) In dry conditions $\mu = 0.5$. Calculate the maximum speed at which the cyclist can travel if he is not to fall off. [3]

(b) The reaction of the surface and the frictional force both act on the cyclist, but at a distance from the centre of mass. They therefore provide a torque. Qualitatively, explain why a cyclist leaning inwards when cycling around bends helps to prevent these torques destabilising the bike. [3]

(c) Rosie is feeling particularly brave and decides to conduct an experiment to calculate the coefficient of friction when the road surface is wet. She uses five different bends, each with a different radius. For each, she records her speed at the point her wheels begin to slide. Using the data in the table below, plot a graph and calculate the coefficient of friction. [4]

bend radius / m	speed / ms^{-1}
9	45
4.5	15
11	60
6.5	20
3	5

3. A conical pendulum is simply a mass suspended from a point that traces out a horizontal circle, rather than one that swings back and forth.

Total for Question 3: 7

(a) Draw a free-body diagram for the mass. [1]

(b) What provides the centripetal force in this situation? [1]

(c) Express the tension in the string in terms of the mass, the mass's velocity and the radius of the circle in which it moves. [2]

(d) By balancing the weight with the tension in the string, show that the speed of the bob is given by $v = \sqrt{rg \tan\theta}$ [3]