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1.

(a) Define angular velocity.

Total for Question 1: 13 [1]

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

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





(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 [3] of r at a speed of v is $a = \frac{v^2}{r}$.





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 nuctional 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.

NNN

[3]

www.youtube.com/megalecture



(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.

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



[4]



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

Total for Question 3: 7
[1]

[1]

- (b) What provides the centripetal force in this situation?
- (c) Express the tension in the string in terms of the mass, the mass's velocity and the radius of the [2] circle in which it moves.



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(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]

