Uniform Circular Motion Assignment

1. Show using vector subtraction that the change in the velocity (and hence the acceleration) of an object over a very small time interval is directed towards the centre of the circle. /4

2. You are trying to sleep one night but a local hoon is cruising the streets in his car of mass 1.2×10^3 kg and the squeal of his tyres is keeping you up.

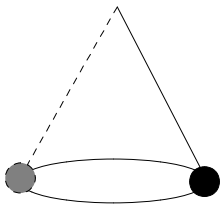
a) Calculate the magnitude of frictional force required to keep the fool from sliding off the road if the radius of the curve is 22m and he is travelling at $15ms^{-1.}$

/2

b) Suddenly it starts to rain, and as the relaxing sound helps you drift off to sleep you hope that the hoon has the sense to drive a lot slower. With the aid of at least one equation, explain the physics behind such sense.

/3

3. A ball on a string is rotated in a horizontal circle of fixed radius with constant speed, as in the diagram below.



a) Identify the force providing centripetal acceleration for the circular motion. /1

b) If the mass of the ball is m and its *centripetal* acceleration is a_c, explain why the tension in the string must be greater than ma_c. /2

c) If the mass of the ball is 2.00kg, explain why the vertical component of the tension in the string must be 19.6N. /2

4.

a) Derive the equation $v = \dfrac{2\pi r}{T}$ for the relationship between the speed of an object in uniform circular motion, the radius of the circle it traces, and the period of motion. /2

b) Hence calculate the speed of a Porsche going around a circular test track of radius 200m if it takes 22.6 seconds to complete a circuit. /2

c) Derive the equation $\tan\theta = v^2/rg$, relating the banking angle θ to the speed v of the vehicle and the radius of curvature r. /4

d) Hence calculate what angle the curve would have to be banked at for none of the Porsche's centripetal acceleration to be provided by friction. /2

TOTAL /24