Circular Motion 1

Have a go at the following exam questions.

OCR, G484, JUNE 2011

1 **(a)** **(i)** State Newton's first law of motion.

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..... **[1]**

(ii) Define the *newton*.

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..... **[1]**

(b) A jet plane on the deck of an aircraft carrier is accelerated before take-off using a catapult. The mass of the plane is 3.2×10^4 kg and it is accelerated from rest to a velocity of $55\,m\,s^{-1}$ in a time of 2.2 s. Calculate

(i) the mean acceleration of the plane

mean acceleration = ... $m\,s^{-2}$ **[2]**

(ii) the distance over which the acceleration takes place

distance = ... m **[2]**

(iii) the mean force producing the acceleration.

mean force = ...N **[1]**

(c) The jet plane describes a **horizontal** circle of radius 870 m flying at a constant speed of 120 $m\,s^{-1}$.

(i) State the direction of the resultant horizontal force acting on the plane.

..... **[1]**

(ii) Calculate the magnitude of this horizontal force.

force = ...N **[2]**

(d) By changing the velocity of the plane it can be made to fly in a **vertical** circle of radius 1500 m. At a particular point in the vertical circle, the contact force between the pilot and his seat may be zero and the pilot experiences "weightlessness".

(i) State and explain at what point in the circle this weightlessness may occur.

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..... **[2]**

(ii) Calculate the speed of the plane at which weightlessness occurs.

speed = ... $m\,s^{-1}$ **[2]**

[Total: 14]

Eduqas, A420U10-1, JUNE 2017

3. *(a)* The magnitude of the acceleration of a body travelling at speed v in a circle of radius r is given by:

$$a = \frac{v^2}{r}$$

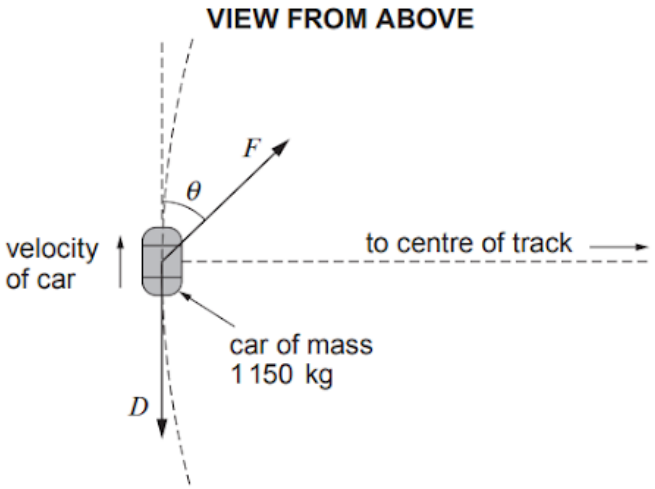
(i) Show clearly that this equation is homogeneous in terms of units. [2]

(ii) A teacher claims that the equation gives a 'sensible' value for the centripetal acceleration as r becomes extremely large. Justify her claim. [2]

(b) A car of mass 1150 kg moving at constant speed takes 52 s to complete a lap of a flat circular track of radius 200 m.

(i) Show that the magnitude of the centripetal force on the car is approximately 3400 N. [3]

(ii) The diagram shows the car at one point on its journey (clockwise) around the track. D is the force of air resistance on the car, and F is the horizontal component of the force on the car's tyres from the road. $F = 5\,500\,\text{N}$.



I. Calculate the angle, θ, at which F must act in order to provide the centripetal force calculated in *(b)*(i). [2]

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II. Calculate D, giving your reasoning. [3]

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16 In order to make an object move around a circular path at a constant speed a resultant force must act on it.

(a) Explain why a resultant force is required and state the direction of this force.

(2)

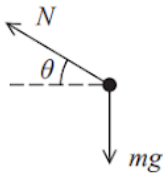
(b) When vehicles move around a bend on a level road, the resultant force is provided by friction between the tyres and the road. For a given vehicle and road surface there is a maximum value for this sideways frictional force.

Explain why roads designed for high-speed travel, such as motorways, do not have any sharp bends.

(2)

(c) Some cycling tracks are banked. When cornering, a cyclist moves up the track until the sideways frictional force is zero.

The free-body force diagram for a cyclist and bicycle is shown. The normal contact force exerted by the track is N and the weight of cyclist and bicycle is mg.



(i) By considering the vertical and horizontal motion, show that

$$\tan \theta = gr/v^2$$

where r is the radius of the cyclist's path and v is the cyclist's speed.

(3)

(ii) Calculate the value of θ for a cyclist travelling at 11.0 m s^{-1} around a bend of radius 18.7 m.

(2)

$\theta =$ .....