

Name of the Student: _____

Max. Marks : 20 Marks

Time : 20 Minutes

Q1.

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)

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(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)

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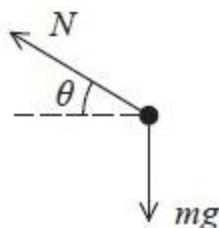
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(c) Some cycling tracks are banked. When cornering, a cyclist moves up the track until the sideways frictional force is zero.

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)

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(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)

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$\theta =$

(Total for Question = 9 marks)

Q2.

The photograph is of a roundabout in a children's playground.



A child of mass 20 kg sits on the roundabout without holding the bars.

The distance from the centre of the roundabout to the centre of gravity of the child is 0.80 m .

The maximum frictional force between the roundabout and the child is $0.35 \times$ the weight of the child.

(a) Calculate the minimum time taken for one revolution of the roundabout if the child is not to slide off.

(4)

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Minimum time = ...

(b) State and explain how this time would change if a child of larger mass sat at the same place on the roundabout.

(2)

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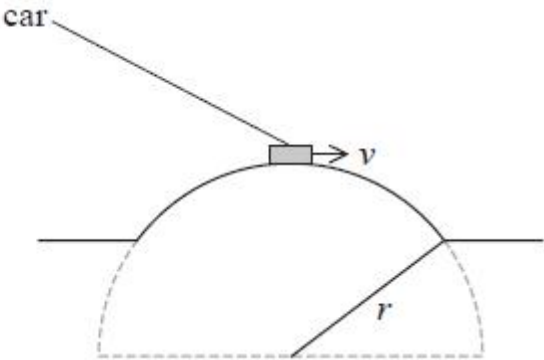
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(Total for question = 6 marks)

Q3.

Hump back bridges are sometimes found in country areas. The road surface is curved, describing an arc of a circle. If cars cross the bridge at too high a speed there is a danger they will lose contact with the road surface.



The responsibility for setting speed limits on many roads on which hump back bridges are found rests with the local traffic authority. One local traffic authority has suggested that a speed limit of 25 mph is appropriate for a hump back bridge with radius of curvature 10 m.

Assess the suitability of a speed limit of 25 mph for this bridge.

$10 \text{ mph} = 4.5 \text{ m s}^{-1}$

(5)

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(Total for question = 5 marks)