Year 12 Physics

2011

Motion and Forces

Unit Test

Name:

Mark: / 50

= %

Notes to Students:

* You must include **all** working to be awarded full marks for a question.
* Marks will be deducted for incorrect or absent units.
* Answers should be given to 3 significant figures.

1. By banking the curves of racetracks at an angle to the horizontal, it possible for vehicles to turn in a horizontal circle without relying on friction.

(a) For a car of mass 1 700 kg, if the angle of banking is set at 13.4° above the horizontal for a curve of radius 171 m, calculate the optimum speed that a car can go around the curve without relying on friction. [4]

(b) Calculate the normal reaction force acting on the car from the track. [3]

(c) For a mass sliding down a frictionless inclined plane, the normal reaction force from the plane acting on the mass is less than the weight of the mass. In the above example of circular motion on a banked track the reaction force is now greater than the weight.

Explain how the bank can apply a normal reaction force greater than the weight. [2]

2. A roller coaster car has a mass of 470 kg and starts from a height of 42.0 m above the ground. The car relies on mechanical energy only to go around the loop. The bottom of the circular loop is at ground level and the loop has a radius of 11.0 m as shown in the diagram below. The car is initially moving at a speed of 6.10 m s-1.

42 m

11 m

T

(a) Calculate the speed of the car at point T, the top of loop. [5]

(b) Calculate the normal reaction force acting on the car at the top of the loop. [3]

(c) Determine the minimum speed that the car can have at the top of the loop before it starts to fall away from the track. [4]

3. A model plane of mass 160 g is suspended from a light non-extensible wire. When in horizontal circular motion it is noted that it makes ten revolutions in 15 seconds and that the wire is at an angle θ of 60.0° to the vertical.

Circular path

Light non-extensible wire

Model plane

60°

Horizontal Radius

Pivot point

(a) Calculate the **tension** along the wire. [4]

(b) Calculate the horizontal radius of circular motion. [4]

4. A 5.00 kg lump of rock dropped near the surface of Mars reaches a speed of 14.8 ms-1 in 4.00 seconds.

(a) Calculate the acceleration due to gravity near the surface of Mars. [2]

(b) Given that Mars has a radius of 3400 km calculate the mass of Mars. [3]

(c) Calculate the orbital period of a 50 kg satellite if it was put into orbit about the equator of Mars at an altitude of 250 km. [5]

5. Consider the non-parallel forces acting on the boom of a crane. The wire that lifts the crane connects to the boom at point A. The boom pivots at point P. A load is suspended from the boom at point B. The masses, dimensions and angles for this set up are shown in the following table.

|  |  |
| --- | --- |
| Mass of boom | 150 kg |
| Mass of load | 880 kg |
| Angle Φ | 50° |
| Angle θ | 70° |
| Boom Length PB | 5.40 m |
| Length PA | 4.20 m |
|  |  |
|  |  |

θ

Φ

Pivot P

A

B

Load

Boom

Upright Pillar

Wire

(a) Calculate the tension in the wire. [5]

(b) Calculate reaction force R acting on the boom at the pivot point P. [5]