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.

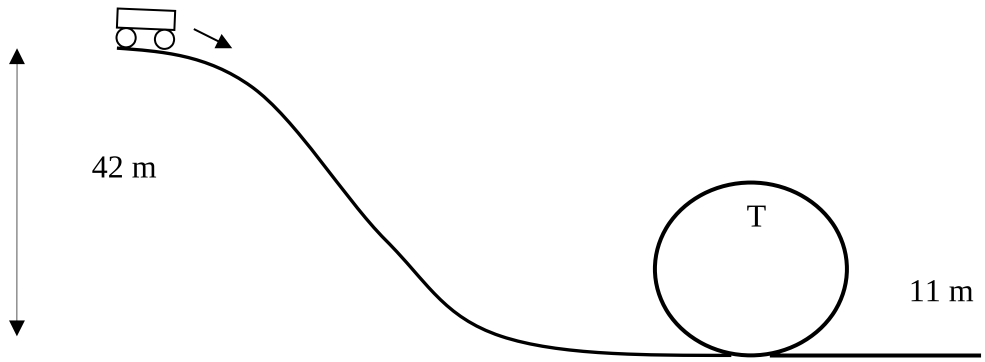
(a) For a car of mass 1 700 kg, if the angle of banking is set at 13.4° above the horizontal for a curve of radius 171 m, calculate the optimum speed that a car can go around the curve without relying on friction. [4]

(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}.

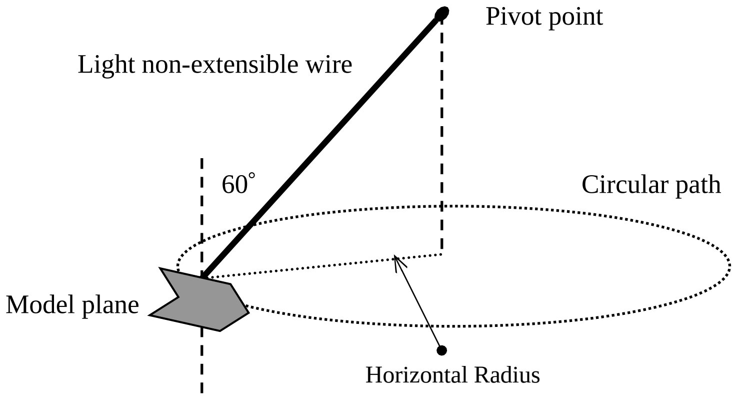


(a) Calculate the speed of the car at point T, the top of loop. [5]

(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.



(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.

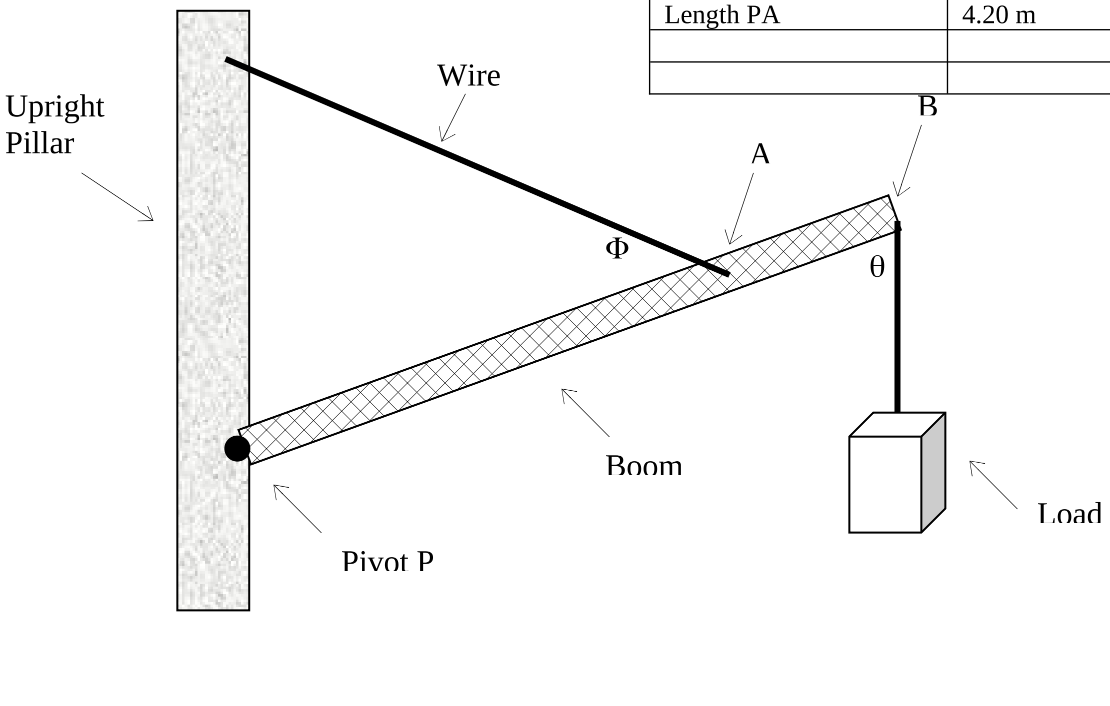
(a) Calculate the acceleration due to gravity near the surface of Mars. [2]

(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



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

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