Motion and Force in a Gravitational Field

Home Assignment Circular Motion and Universal Gravitation

Name: _____ (48 marks total)

1. If a 1.50 kg ball is swung in a vertical circle at a constant speed of 2.40 ms^{-1}. Find the tension in the string at the bottom of the swing if the length of string is 1.20 m.   (3 marks)

2. While doing his Physics homework, Michael places a cup of milo (mass 0.659 kg) 10.0 cm from the centre of a microwave's turntable and then turns the microwave on. Why waiting for the milo to heat, Michael notices that the microwave's turntable spins at 5.0 revolutions per minute.
    a.   Find the tangential velocity on the cup. (3 marks)

    b.   Find the centripetal force on the cup. (2 marks)

3. A railway line goes around a curve of radius 3.50 km. It is designed to carry a very fast train travelling at 360 kmh^{-1} What would be the angle of banking for the tracks which would result in the best cornering? (3 marks)

4. A car is driven around a circular track at a constant speed of 30.0 kmh^{-1}.

    a. Is the car accelerating? _____ (1 mark)
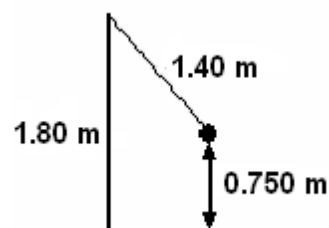
    b. Explain your answer. (2 marks) _____

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5. In a game of totem tennis, a 1.20 kg ball is swung in a horizontal circle at a constant speed on a 1.80 m tall pole. The distance from the ball to the ground is 0.750 m and the length of the rope is 1.40 m. It takes 2.10 s for one revolution of the ball.


    a. Draw a free body diagram of the situation and label the forces acting on the ball. (2 mark)

    b. What is the ball's acceleration? (3 marks)

    c. What is the tension in the rope? (4 mark)

6. In a spectacular stunt a motorcyclist, starting from rest, free wheels down a slope and into a loop. At what maximum height must the motorcycle be so that the motorcycle just completes one loop before continuing on. The diameter of the loop is 20.0 m.   (4 marks)

height, h
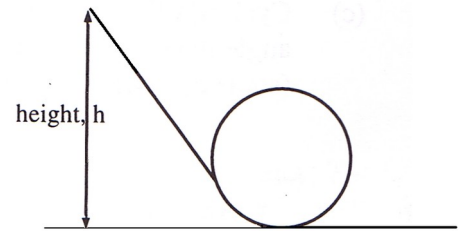
7. Sam is on a space-walk around his spaceship to repair a faulty antenna. If his spaceship is 250 km above the Earth, what is the gravitational field strength on him at this point? (3 marks)

8. The International Space Station will be finished in 2011 and is expected to operate until at least 2015. It has a mass of 344 378 kg and completes 15.7 orbits every day. Its orbit is between 278 km and 460 km but on average about 370 km.

   a. Calculate the period of the Space Station. Is it in geostationary orbit? Explain. (3 marks)

   b. Calculate the speed of the Space Station and compare it to 27 743 kmh^{-1} which is given by NASA. (4 marks)

   c. Calculate the force of attraction between the Space Station and the Earth. (2 marks)

9. A moon of Saturn moves in circular orbit of radius 1.00×10^9 m and period of 1.00×10^6 s. Calculate the mass of Saturn. (4 marks)

10. Explain, using a mathematical proof, that all geostationary satellites are at the same altitude above the Earth regardless of their mass, then calculate the actual altitude.   (5 marks)