SPH4U

Circular Motion Problems

Name: _____ Date: _____

$$\sum F = ma_c \qquad a_c = \frac{v^2}{r} \qquad a_c = \frac{4\pi^2 r}{T^2} \qquad a_c = 4\pi^2 r f^2$$

Solve the following problems and include FBDs where necessary

1. A rope with a 0.0025 kg mass attached to it is swinging around in a vertical circle with a radius of 0.51 m. It takes 16 seconds to make 6 revolutions. Calculate the centripetal acceleration.

2. Two kids are standing on a merry-go-round. One kid is 2m from the center and is experiencing a centripetal acceleration of 4 m/s/s. The other kid is further from the center of rotation and is moving at 19 km/h. How far from the center is the second kid?

3. A physics student (mass 60 kg) is on a roller coaster. Immediately after the first drop, the cart encounters a circular loop that has a diameter of 35 m. At the top of the loop, the scale the student is sitting on reads 1600 N
   a) Draw the FBD when student is at the top of the loop.
   b) Calculate the speed of the cart?
   c) What speed must the cart travel at to just lose contact at the top of the loop?
   d) What would the weight on the scale read at the bottom of the loop at the speed found in part c?

4. A 4 kg mass is spun in a vertical loop with a diameter of 2.4 m. The tension in the rope at the bottom of the rotation was found to be 300 N.
   a) Draw the FBD for this situation.
   b) Calculate the speed of the rotating mass?
   c) Calculate the frequency of rotation?
   d) Calculate the tension in the rope at the top of this loop if it is moving at the same speed calculated in b)

5. A pilot of mass 75 kg takes her plane into a dive, pulling out of it along a circular arc as she nears the ground. If the plane is flying at 150 km/h along the arc, what is the radius such that the pilot feels four times heavier than normal? Include a FBD.

6. A mass $m = 2.8kg$ on a *frictionless* table is attached to a hanging mass $M = 7.9kg$ by a cord through a hole in the table. Find the speed with which m must move (in a circle of radius $r = 0.19m$) in order for M to stay at *rest*.

7. A large metal disc is rotating in a horizontal plane at a constant rate. It was measured that 22 revolutions happen in 8 seconds. A dime (mass of 1.75g) is placed on the disc at some distance from the center such that it just stays in place and does not slide off. Calculate this distance. The coefficient of friction is 0.3.

8. A 1500 kg car safely turns (without slipping) on a corner banked at 30^{o} to the horizontal moving at 27 m/s. Calculate the radius of the turn if the coefficient of friction between the tires and the road is 0.2. Include a FBD. If the bank angle changed to 50^{o}, calculate how fast they could negotiate the same turn without slipping.

Additional Problems:

9. A ball rolls around a horizontal circle at height *h* inside a frictionless hemisphere bowl of radius *R*. Calculate an expression for the ball's velocity in terms of *R*, *h* and *g* (in order for the ball to maintain this horizontal circular path).

10. A train traveling at a constant speed rounds a curve of radius 225 m. A chandelier suspended from the ceiling swings out to an angle of 20^{o} throughout the turn. Calculate the speed of the train?