Name _____ Hour _____

Flying Pigs Lab and Problems

Circular Motion at Constant Speed:

Data:
1. Once the pig is flying in a circle with a constant radius, measure the radius of the circle as accurately as you can: (r is NOT length of string!)   **r =_____0.4_____ m**
2. Find the time it takes the pig to make 5 complete revolutions:

time for 5 revolutions

  Trial 1 _____
  Trial 2 _____

 Average time = ___10.62___ sec.   Average time for 1 revolution (T)= __2.12___ sec.

                                                (**T= the period- the time for one revolution**)

Derive the equation for when an object moves in a circle at a constant speed:
1. What is the 1-D equation for velocity at a constant speed? _____
2. The equation for circumference of a circle: C = 2 π r____
3. Use the velocity equation (1) and replace Δx with 2 π r. _____
4. Now replace the time (Δt) in equation (3) with a capital **T** for your new equation.

T = the period in seconds = the time for one revolution

Using the equation you derived, calculate the speed your pig flies in **m/s** *and* in **mph**.

V= _____ m/s & _____ mph

Problem 1: You are riding the swings at MOA. You hit a top speed of 4.8 m/s. At this speed, it takes you 24 seconds to make 3 revolutions. How far away from the center of the ride are you? *(6.1 m)*   *(Hint: T is 1 revolution, so change your time first)*

Centripetal Force and Centripetal Acceleration
What is Newton's 2nd law? *(It's the equation one...)*_____
Now F become F_c and a becomes a_c. Rewrite it below.

Equation for centripetal force:

F_c = centripetal force in Newtons   (force needed to move an object in a circle)
a_c = centripetal acceleration in m/s^2 (the acceleration of an object moving in a circle)

Equation for centripetal acceleration: $a_c = \dfrac{v^2}{r}$ **v = speed in m/s**
                                                                  r = radius in meters

Problem 2: Let's say your pig travels in a circle at 2.5 m/s. If he has a mass of 0.3 kg, and the radius of your circle was 0.9 m, calculate the centripetal force acting on him. (Use $a_c = v^2 / r$ first, then plug it into the Fc equation.) *(2.08 N)*

The Difference Between Centripetal Force (center-seeking) and Centrifugal Force (center-fleeing)

Read the paragraph below and answer the question that follows.

The force required for circular motion is called centripetal force…the force toward the center of the circle that keeps an object traveling at a constant speed along a circular path. This centripetal force produces centripetal acceleration. (Remember…acceleration is a vector so it can be due to a **change in speed or direction**) Let's say you are riding in a car that suddenly takes a sharp right. Which way do you go? Why? You are seemingly pushed to the left as the car turns. People often call this **centrifugal force**. It is not a reak force because there is no physical outward push on the object! It is simply inertia. Your body wants to maintain its state of motion, so it is really just going straight as the car turns in front of it. Please understand, it is centripetal force that causes circular motion and inertia which gives the illusion of a force pushing from the center of a circle.

1. Explain the difference between centripetal and centrifugal force (inertia).

2. When an object is moving in a circle at a constant speed, how can it be accelerating?

Orbiting Objects

Orbiting objects could be- a bucket you spin over your head, a satellite going around the earth, the earth orbiting the sun, etc. In order for an object to stay in that orbit, **the gravitational force is the same as the centripetal force**: $F_g = F_c$ so $mg = \dfrac{mv^2}{r}$ cancel mass $\boxed{g = \dfrac{v^2}{r}}$

Orbital velocity is the velocity needed to achieve balance between gravity's pull on the orbiting object and the inertia of the object's motion-the object's tendency to keep going. Without gravity, the object's inertia would carry it off into space. At the correct orbital velocity, gravity exactly balances the object's inertia, keeping the path of the object moving in orbit rather than flying off in a straight line.

3. Let's take the earth orbiting the sun. There is a gravitational force that attracts the sun to the earth. At just the right velocity, orbiting objects stay in orbit.
   a. What would happen to the earth if its velocity was greater than it currently is?

   b. What would happen to the earth if its velocity was too slow?

4. Let's say you decide to orbit a 2.5 kg bucket of water over your head.
   a. Calculate the minimum speed needed so that the water won't spill out if the rope has a length of 0.5 m. *(2.2 m/s- Hint- the mass of the water does not matter. It cancels out. Make g = 9.8 m/s²)*

   b. Calculate the period of the bucket's rotation assuming it was circular. *(1.4 sec.)*

5. A satellite orbits at 6.77×10^6 m above the center of the earth (r). At that location, the gravity is 8.7 m/s². At what velocity must the satellite be traveling in **mph**? (17172 mph)