AP Physics Unit 5

Lab 5-2: When Pigs Fly

**Purpose:**

To determine the centripetal force acting on an object in uniform circular motion from two different methods and then compare those values to one another.



**Materials:**

Pig

String

Stopwatch

Measuring Tape

**Procedure:**

1. Once it reaches equilibrium, the pig flies in constant velocity in what is called a "conical pendulum". Draw and clearly label a force diagram of the flying pig. To do this, consider a snap-shot of the pig from the side. Show the angle the string makes with the vertical, θ, and the radius to the center of the circle (Hint: the radius of the circle in which it flies is not the length of the string). Use dotted line to show the horizontal and vertical components of the tension on the string.
2. Use the Force Diagram to write the Newton's Second Law equations. Derive a formula for the centripetal force of the pig in terms of the forces you used in your force diagram.
3. Now derive a formula for the theoretical speed of the pig in equilibrium based on its mass, period, and radius (from your Newton's Second Law formula, substitute for v).
4. Now start the pig flying. Once the pig is up and flying in a circle of constant radius, measure the radius of the circle and the angle *θ* as accurately as you can. Express your answer in meters. Measure the mass of the pig.

*There are several ways to determine the angle the string makes with the vertical, θ, without using a protractor. (Think trigonometry; think of ways to document or "freeze" its motion). Describe your method and then record your value for θ. Maybe you need to use a couple methods and compare them? Include in your report a clearly-labeled, neat sketch(s) that shows how you measured θ and r.*

1. Now measurethe period of the pig and plug in to see how it compares to the theoretical value for the force. Describe in your report how you measured this and the reasons you chose that method as an accurate one.
2. Compute the percent difference between the value for the force you computed in the two steps. Show your work.

**Data:**

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| **Radius (m)** | **Time for 10 swings (s)** | **Average Period (s)** | **Average Speed (m/s)** |  **Theta(deg)** |
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**Data Analysis:**

1. If the string were longer, how would it change the flight of the pig? Do the Newton's 2nd law equations shed any light on this? Why or why not?
2. Turn to Chapter 6 p. 175 problem #63 (the airplane). Assume the plane has a mass of 10,000 kg, and there is no string, and find the force of aerodynamic lift that must be on its wings to fly at that 40° angle, and if the radius of turning is 1 mile what would the velocity be.
3. What other conical pendulums can you think of?