

**Purpose:** To measure the centripetal force using traditional circular motion formulas as well as using Newton’s laws and vectors. An experimental difference is then calculated between the 2 methods

**Materials available:** Stopwatch, toy pig/bat, meter-stick, electronic balance

**NOTE: PLEASE KEEP THE RADIUS CONSTANT THROUGHOUT THE EXPERIMENT.**

**PART I: Using Rotation Equations**

1. Measure and record the length of the string the plane is attached to.
2. Measure and record the mass of the plane.
3. Secure the plane and allow it to reach a consistent constant speed.
4. Measure and record the time it takes for the plane to make TEN revolutions.
5. Measure and record the height the plane is from the ceiling.
6. Measure and record the height of the room.

**Length of attached string =** \_\_\_\_\_

**Period for 10 revolutions =** \_\_\_\_\_

**Displacement from Ceiling =** \_\_\_\_\_

**Height of Room =** \_\_\_\_\_

**Period =** \_\_\_\_\_

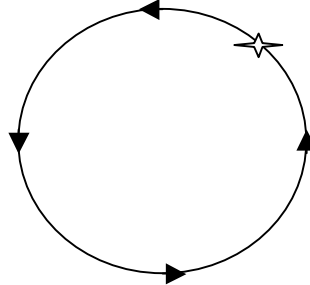
**In the space below, determine the RADIUS of the circle the plane makes. Show all work!**

**In the space below, calculate the VELOCITY of the plane. Show all work!**

**In the space below, calculate the centripetal acceleration. Show all work!**

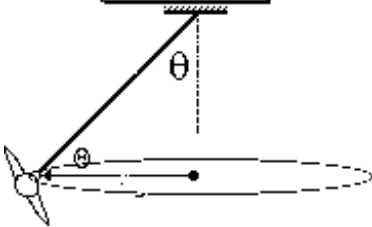
In the space below, calculate the centripetal force acting on the plane. Show all work!

Looking down from above, draw and label a VECTOR diagram showing the directions for the centripetal force, velocity, and acceleration. Draw the vectors on the star in the figure to the right.



**PART II: Using Newton's Laws**

Side View



On the picture to the left draw and label a free body diagram for the airplane.

In the box below, write the "EQUILIBRIUM" equation of motion for the vertical direction.

Solve for the tension in the string below IN TERMS of  $m, g$ , and  $\theta$ . Then solve for the value numerically.

Which of forces in the free body diagram is the "centripetal force"? Justify your answer

Write the Equation of Motion for the horizontal direction in the box below

**Calculate the Centripetal Force acting on the plane below. Show all work!**

**Suppose the string were to break. Describe the path of the plane relative the “geometric plane” that it is traveling in.**

**Calculate how LONG the plane would be in the air after the string breaks. Show all work!**

**Calculate how far away the plane would land. Show all work!**

**Calculate a % difference between the 2 values you found for the centripetal force.**

$$\frac{|Experiment1 - Experiment2|}{|Average|} \times 100 = \%difference$$

**Account for any errors, which may have affected any large % difference.**