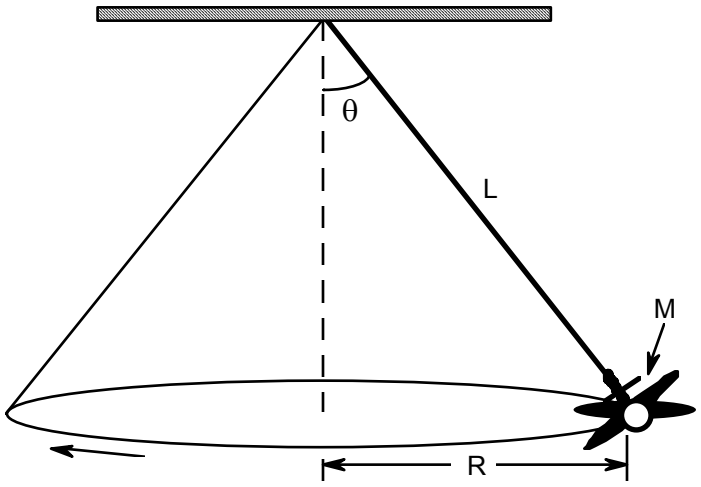
AP Physics Name: _____

The Conical Pendulum Date: _____ Per. _____

The drawing at the right represents a toy airplane moving in a horizontal circle at constant speed, i.e., it is moving with uniform circular motion. The airplane is suspended from a string that sweeps out a cone as the plane flies around. A system moving in this fashion is called a conical pendulum.

In this lab Newton's laws will be applied to the conical pendulum to determine the period of rotation of the airplane, its speed, acceleration, and the tension in the support string.



DATA

Measure the following quantities.

The mass of the airplane: M = _____

The period of rotation of the airplane: T_m = _____

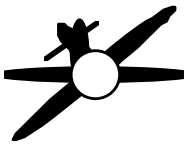
As illustrated in the drawing above: L = _____

R = _____

Knowing L and R, determine θ: θ = _____

ANALYSIS

1. Draw the free-body diagram showing all the forces on the airplane. Let F_s represent the tension in the string so that it isn't mistaken for the period of rotation, T, of the airplane. Label θ in the diagram and indicate an appropriate coordinate system.



2. Apply Newton's second law and show that the period T, of the airplane is given by $T = 2\pi\sqrt{R/(g\tan\theta)}$.

$$\sum F_x = Ma_x \qquad \sum F_y = Ma_y$$

3. Using the equation for the period of rotation derived in #2, calculate the period, T_c, of the airplane and the per cent difference between T_c and the measured value of the period, T_m.

T_c = _____ T_m = _____ % difference = _____

4. Using the expression for $\sum F_y = Ma_y$ from #2, calculate the tension, F_s, in the support string.

F_s = _____

5. Write the expression for the force or forces responsible for the centripetal force on the airplane (hint: see #2), substitute in the appropriate quantities, and calculate the magnitude of the centripetal force. (Do NOT use $F_c = Ma_c$ for this part.)
Expression before substitution: F_c = _____

F_c = _____

6. Use the measured values of the radius (R) and period (T_m) to calculate the speed (v) of the airplane and its centripetal acceleration (a_c).

Calculation of v Calculation of a_c

v = _____ a_c = _____