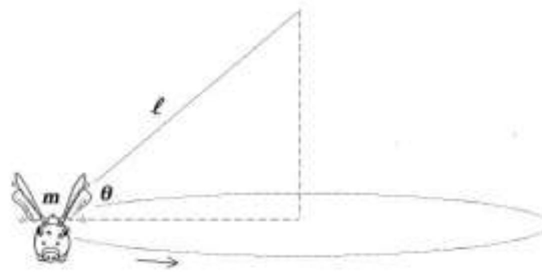
Flying Pig Investigation Name:

Purpose

To show the net force for a conical pendulum is

$F_c = mv^2/r$



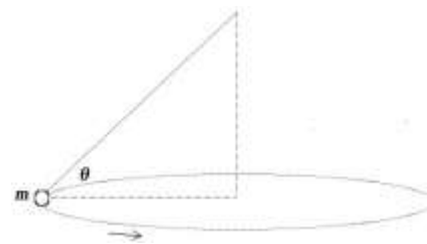
Equipment and Supplies

Flying Pig, stopwatch, meter stick

Background

When an object travels at constant speed along a circular path, we say it has uniform circular motion (if its speed were changing, then its motion would not be uniform). Any object moving in uniform circular motion is accelerated toward the center of its circular path. This acceleration is called *centripetal acceleration* (A_c), and equals v^2/r, where v is the speed and r the radius of the circular path. Since the net force on any object equals ma, during uniform circular motion the net force, called *centripetal force* (F_c) equals mv^2/r and is directed toward the center. This is what happens when an object suspended by a string moves in a circular path—a *conical pendulum*. The string of a conical pendulum sweeps out a right-circular cone. In this experiment you will measure the speed of an object that comprises a conical pendulum and show that the net force is mv^2/r.

Pre-Lab Preparation & Analysis



***Step 1*:** Draw a free-body diagram, identify and label all the force vectors (however, ignore air resistance) of a conical pendulum (in this case the pig).

***Step 2*:** Resolve any force that is neither horizontal nor vertical. Show and label all the horizontal and vertical components. Also write down the equations for the vector resolution,

Horizontal: ______________________________________ *Vertical:* ______________________________________

***Step 3*:** In the vertical direction, write down the relation between the vertical component of tension force (T) and the weight:

____

***Step 4*:** In the horizontal direction, apply $F_c = mv^2/r$, *and* write down the relation between the horizontal component of tension force (T) and the centripetal force:

____

Step 5*:** Algebraically solve for the tangential speed (v***) of the pendulum from your equations in Step 3 & 4. Show your work. Hint: ***tan θ*** is useful here.

v = _________________________________

***Step 6* (Challenge):** Design a procedure to measure all the data (Hint: identify & measure them one by one.) required to measure the linear speed of the flying pig.

Flying Pig Investigation	Name:

Lab Reminder

Setup the *Flying Pig*. Be careful not to damage their delicate wings as you click them into their fixed-wing position. Carefully hold the pig by its body and give it a *slight* shove about 60° from the horizontal, just enough so that the pig "flies" in a circle. The goal is to launch the pig *tangent* to the circle of flight. It's better to launch it too easy than too hard. If the pig does not fly in a stable circle in 10 seconds or so, carefully grab it and try launching it again.

Once the pig is up and flying in a circle of constant radius, measure the radius of the circle as accurately as you can. Use it as the theoretical value and express your answer in meters. Also use it to calculate the theoretical value of linear speed (v).

r = ________________________________ v = ________________________________

Record all the measured data in a table, and show all your calculation of the measured linear speed (v).

Calculate the percent difference between the value for the theoretical linear speed and the measured one by following your procedure.

% Error = __________

Post-Lab Analysis

1) For uniform circular motion, the tension will always be (less than) (the same as) (greater than) the weight.
2) For uniform circular motion, the centripetal force will always be (less than) (the same as) (greater than) the tension in the string.
3) What do you conclude about the direction of the net force that keeps the flying pig in uniform circular motion?
4) If the mass of the pig is 150 g, the angle θ is 60°, and the distance from the hanger to the center of mass of the pig is 80 cm, calculate the following:
    a) The weight of the pig,
    b) the tension force of the rope,
    c) the centripetal force for the circular motion,
    d) the tangential (or linear) speed of the pig,
    e) the period of the circular motion, and
    f) the angular (or rotational) speed of the pig,
5) List sources of errors in your lab.