# Ladybug Lab Protocol

*Physics*

Using the Ladybug Revolution Applet from PhET, experiment with the different variables involving angular (rotational) motion. You do not need to turn in your data from this lab protocol; rather, this is your opportunity to master the applet in advance of completing the actual lab report.

After experimenting with the applet and answering the sample questions below, you should be to use BOTH actual numbers and variables to:

a) Describe, draw, and calculate the **instantaneous centripetal acceleration** of the ladybug at any time
b) Describe, draw, and calculate the **instantaneous tangential acceleration** of the ladybug at any time
c) Describe, draw, and calculate the **instantaneous overall linear acceleration** of the ladybug at any time
d) Calculate the **angular acceleration** ($\alpha$) of the ladybug
e) Calculate the **angular velocity** ($\omega$) of the ladybug
f) Relate the instantaneous linear quantities that describe the ladybug's motion to their angular counterparts
g) Use the Big 4 (8? 6?) equations to predict aspects of both the linear and angular quantities of the ladybug's motion

Here are some sample problems for you to try. **VERIFY YOUR ANSWERS** using the applet:

1. When the ladybug is 2 meters from the center of the turntable and rotating with a constant angular velocity of 3 rad/sec,
    a. What is the ladybug's linear speed?
    b. What is the ladybug's overall acceleration (include direction)?
    c. What is the ladybug's linear distance traveled after 15.5 seconds of rotation?
    d. What is the ladybug's angular displacement (in radians) after 15.5 seconds of rotation?

2. If the ladybug is 2 meters from the center of the turntable, its initial angular velocity is 4.3 rad/sec, and it decelerates at 1.2 rad/sec$^2$ for 2.0 seconds,
    a. What is its final linear speed?
    b. What is its final instantaneous centripetal acceleration?
    c. What is its tangential acceleration?
    d. What is its overall linear acceleration? (Express direction relative to its instantaneous centripetal acceleration.)

3. If the ladybug is 2 meters from the center of the turntable, and it accelerates at 2.5 rad/sec$^2$, after traveling for 48 meters, what was the ladybug's initial angular velocity if it ends up rotating at 13 rad/sec?

4. If the ladybug is 4 meters from the center of the turntable (i.e., at the very edge), what must its angular acceleration be in order to travel a total of 17.4 meters in 5 seconds? Assume the initial angular velocity is 0 rad/sec.

You should also experiment with the applet to determine how you can predict (calculate) and measure:

1. The speed (both linear and angular velocity) at which the ladybug will fly off of the turntable at various distances from the center.

2. The centripetal force (relative to the ladybug's mass) at any position and instantaneous velocity necessary to keep the ladybug moving in a circular path.

3. The linear displacement and the angular displacement (in degrees and radians) of the ladybug given its initial angular velocity, final angular velocity, and angular acceleration.