**Teacher Guide
Phet, Ladybug Simulation, Circular Motion**

Objectives:

* To have students gain a better understanding of velocity and acceleration vectors for objects in circular motion.
* To guide students toward the relation between acceleration, velocity, and radius of the circular path.

Common Misconceptions:

* Students may believe that objects in circular motion experience an outward force (away from the center). Motion of an object in a circular path requires that there be an inward net force. There is an inward-directed acceleration which demands an inward force. Without this inward force, an object would maintain a straight-line motion tangent to the perimeter of the circle.
* Students may not realize that acceleration and velocity vectors are always perpendicular in circular motion.

Expected Outcomes:

#5 Students should observe and draw an acceleration vector from the ladybug, toward the center of the turntable. And a velocity vector perpendicular to acceleration, to the left.

#6 Students predictions and results may not agree.

#8 Example results

**NOTE:** even though the ruler is labeled in millimeters, the simulation computes velocity and acceleration as if the ruler were labeled in meters.

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| --- | --- | --- | --- | --- |
| **Angular velocity****Radians/second**  | **Radius** **m**  | **Velocity** **m/s** | **Velocity^2****(m/s)^2** | **Accelerationm/(s^2)** |
| 200 r/sec | 2m | 6.76 m/s | 45.69 (m/s)^2 | 23.59 m/s^2 |
| 250 r/sec | 2m | 8.45 m/s | 71.40 (m/s)^2 | 36.86 m/s^2 |
| 300 r/sec | 2m | 10.14m/s | 102.82 (m/s)^2 | 53.08 m/s^2 |
| 500 r/sec | 2m | 16.9 m/s | 285.61 (m/s)^2 | 147.44 m/s^2 |

#10 Students should be able to recognize that there exists a relationship between acceleration and velocity by a factor of the radius. After sufficient time has been given, discuss as a class the accepted relation. (Note, students might multiply velocity by 1/2 rather than dividing by r, if they are only focusing on the 2m radius).

 **a =** $\frac{v^{2}}{r}$

#11 Students should recognize that both velocity and acceleration are constant.

#12 In linear motion, a constant acceleration implies that velocity is increasing. Different from circular motion, when both are constant and perpendicular to each other.

References:

[www.physicsclassroom.com](http://www.physicsclassroom.com) Circular Motion and Satellite Motion - Lesson 1, “The Forbidden F-Word”
Retrieved September 29th, 2009.