



Angular Kinematics

Directions: Use the simulation “Ladybug Revolution” (in the Motion section) on the website <http://phet.colorado.edu> to complete this paper.

What is Angular Velocity? How is it Related to Velocity?

1. Select “Radians” in the Angle Units. You will use Radians for the rest of the activity. Be sure that it is always checked. Take a moment and examine the controls you have available. Explore the controls a little before you begin the activity.
2. Click on the “Reset All” button and then quickly click on “Stop” on the graph displays. Be sure that you remember to set the Angle Units to “Radians.” Under the show graphs options, select “ θ , ω , v .” Start the graphs experiment with changing the location of the ladybug on the wheel. Watch the angular velocity. What do you think angular velocity is?
3. Click on the “ruler” option and determine if distance from the center of the wheel has any effect on the angular velocity.
4. Now examine how the distance from the center changes the velocity of the ladybug, if it does.
5. Play around with the simulation to see if you can determine if anything else affects the velocity and how. Determine a mathematical relationship for velocity. (Hint: Examine ω and r).
6. Place the ladybug at 1.5 m and set ω to be 3 rad/s. Predict what the velocity would be and then run the simulation to check your prediction. Are you correct?

What is Angular Acceleration?

7. Under the show graphs options, select “ θ , ω , α .” Set the ladybug to undergo angular acceleration by setting α to be 0.25. Describe the resulting motion. What do you think angular acceleration means?

8. Examine the acceleration and velocity vectors as the ladybug undergoes angular acceleration. Which way do they point? Is this consistent with our knowledge of centripetal force and circular motion?
9. As the ladybug undergoes angular acceleration, change its distance from the center and describe how the acceleration vector changes. What do you think is the mathematical relationship between angular acceleration, radius, and acceleration?

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10. Set the angle and the angular acceleration to zero. Set the angular velocity to 2.0 rad/s. Predict how far the ladybug will rotate in radians after 5.0 s. Check your prediction with the simulation. Was it correct?
11. Set the angle to 5.0 rad and the angular acceleration to zero. Set the angular velocity to 3.5 rad/s. Predict the angle at which the ladybug will be at after 4.5 s. Check your prediction with the simulation. Was it correct?
12. Write a formula for the final angle θ_f an object will be at when it starts at an initial angle θ_i and rotates with an angular velocity ω for a certain time interval Δt .
13. Setup the same scenario you had in #10, but set the angular acceleration to be 0.30 rad/s². Predict how fast the ladybug will rotate (ω_f) after 5.0 s. Check your prediction with the simulation. Was it correct?
14. Write a formula for the final angular velocity ω_f an object will rotate when it starts at an initial angular velocity of ω_i and an angular acceleration α and rotates for a certain time interval Δt .
15. Compare your equations to the four linear kinematic equations we derived in the beginning of the course. Which two linear kinematic equations are similar to the two angular kinematic equations you came up with above?
16. What do you think the two remaining angular kinematic equations are?