Activity 1

Radians and Angular Velocity

1. Understanding Radians.
   - Choose two spokes on the bicycle wheel
   - Measure the distance along the tire between the spokes and the radius of the tire.

2. What is the angle between the spokes in radians?
   - Now measure the angle between them with the protractor.
   - Compare to your measurement.

3. How do they compare? Does this measurement match with your radian measurement?

4. There are $2\pi$ radians in going around the entire wheel. This makes $\pi$ the ratio of what to what?
   - Prove to yourself that this ratio is the same value for different size wheels.
5. Angular Velocity

- Clamp the bicycle wheel to the table so you can spin it.
- Spin the wheel and hold the cardboard strip in the spokes near the rim of the wheel.
- Count the number of clicks in 10 seconds.

6. What is the velocity of the rim (called the linear velocity) at that point (meters per second)?

7. What is the angular velocity (radians per second)?

8. (Consider) Is the angular velocity the same halfway out on a spoke? Is the linear velocity the same there? Why or why not?

- Clamp a smaller wheel to the original one.
- Hold the cardboard clicker near the rim of the larger wheel again and hold the plastic one near the rim of the smaller one. Each clicker makes a different sound.
- With your partner(s) help, spin the wheel and count the number of clicks for each clicker in ten seconds.

9. Calculate and compare the angular velocities at each point.

10. Calculate and compare the linear velocities at each point (how fast each rim is moving).
11. Explain the differences and similarities of both the angular and linear velocities. How does each depend on the arc-length of the wheel rim? What is the relationship between linear velocity and angular velocity?

12. (Consider) What is the advantage of having gears on a bicycle? (Think of the smaller wheel as the gear)?

13. Playing with gears

- Clamp a second small wheel to the bench
- Wrap the rubber-coated cord around each small rim and tie it tightly.
- Count the number of clicks on each small rim in 10 seconds.

14. Calculate and compare the angular and linear velocities.
• Change out the single wheel for a mid-sized wheel
• Repeat above.

15. Calculate and compare the angular and linear velocities.

16. Compare and contrast the two situations – small and mid-size wheel.

• Two one-speed bicycles are going the same velocity. One has 52 cm tires and the other has 68 cm tires. They are identical in all other ways. Which would you rather be pedaling? Why?

17. Thinking ahead:
Linear acceleration is the rate of change of linear velocity \((dv/dt)\). Similarly, angular velocity is the rate of change of the angular velocity \((d\omega/dt)\). If you found a relationship between linear velocity of the wheel and its angular velocity.

• (Consider) Is this the same relationship true of the angular and linear accelerations? Why or why not?