

Name: \_\_\_\_\_ Peer-Leader: \_\_\_\_\_

Date: \_\_\_\_\_

## Circular Motion & Gravitation

This workshop focuses on the relationships between velocity, speed and acceleration for circular motion.

### Exercise 1:

#### Velocity

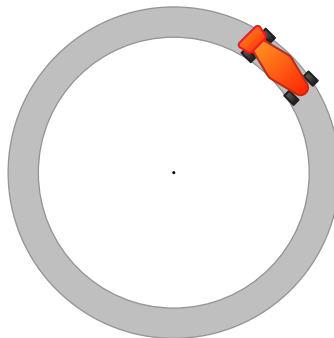
**Question 1.1** *If you are “at rest” on the Earth’s surface, how fast are you moving due to the Earth’s rotation about its axis? Can you express this result as a function of your latitude? In Chicago, we are at approximately  $42^\circ$  N latitude.*

**Question 1.2** *If you are “at rest” on the Earth’s surface, how fast are you moving due to the Earth’s revolution around the Sun? You may consider the Earth’s orbit to be circular.*

### Exercise 2:

#### Acceleration

**Question 2.1** *Illinois auto racing driver, Danica Patrick, drives her car in a clockwise direction around the circular track shown below.*



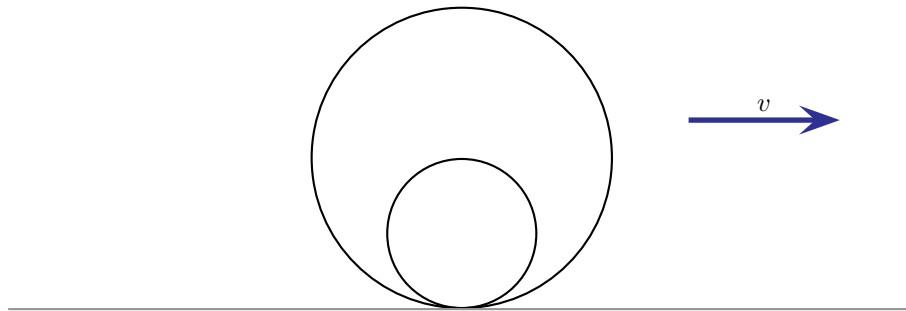
*Qualitatively sketch the direction of the acceleration vector if the speed of Danica’s car is*

- constant*
- increasing*

c. decreasing

Where do these vectors point with respect to the center of circle.

**Question 2.2** Consider two concentric, hollow cylinders which both roll without sliding. These cylinders are moving to the right at a constant speed of 3 m/s.



For a point on the surface of each cylinder Find the ratio of the accelerations as a function of the radii of the two cylinders.

### Excercise 3:

#### Force

After graduation from NEIU you are asked to evaluate and possibly redesign the exit ramps from the Edens express way on to Peterson Avenue.



**Question 3.1** *The speed on the exit ramp is 25 mph, and the exit ramps are banked so that the outside of the exit loop is higher than the inside. What should the banking angle be, as a function of the radius of curvature of the turn on exit ramp to minimize the sideways frictional force you need to stay on the exit ramp.*

**Question 3.2** *For the same exit ramp. Assume that drivers don't immediately slow to to 25 mph as posted, but instead reduce their speeds at a constant rate from 55 mph to 25 mph, reaching 25 mph at the end of the ramp. How would you adjust the radius of curvature and banking angle to keep these drivers safe?*

## Exercise 4: Gravitation

**Question 4.1** *The International Space Station.*



*The International Space Station (ISS) is an internationally developed research facility currently being assembled in orbit about the Earth. The ISS orbits the earth with a period of 91 minutes at a height above the Earth's surface that varies between 341 km in altitude at Perigee and 353 km in altitude at Apogee. The mass of the ISS is 303,663 kg.*

- a. *Astronauts aboard the ISS experience weightlessness. A friend in your class speculates that this is because the ISS orbits so high that the gravitational pull of the Earth is weak. Is the explanation accurate? If not, explain why astronauts aboard the ISS seem to be weightless.*
  
- b. *Long-term exposure to so called micro-gravity environments causes multiple health issues including bone loss. To avoid these issues how could you simulate gravity on the ISS? You are allowed to design a new module for the space station if needed.*