Experiment 4: Rolling Motion and Newton's Laws

Relationship Between Linear and Rolling Motion

Station One:

Equipment: Wheel, meter stick.

1. Make a hypothesis about how the number of revolutions of the wheel relates to the distance it travels. Write this hypothesis as an equation, including any relevant dimensions of the wheel.

2. Design an experiment to test this hypothesis.
   a) Describe briefly:

   b) What are some confounding factors that could affect your experiment, and how can you prevent them from biasing the results?

3. Discuss your experiment with a neighboring group. Revise your experiment as needed, from what you learn in this discussion.

4. Now perform the experiment and describe your results, comparing your predictions to what you found experimentally. Explain any sources of error.

Rotational Inertia

Station Two:

Equipment: stick with two movable weights, stick with weight at one end.

Begin this exercise by grasping the stick with the movable weights in the center and sliding the two weights close to your hand. Clamp them firmly. Now twist the rod back and forth repeatedly, noting how much torque you must apply to accelerate and decelerate the rod. Repeat the test with the weights clamped at the ends of the rod.

Now try to stand the stick weighted at one end on your finger and keep it balanced there. Decide if it is easier to balance with the weight at the bottom (near your finger) or at the top?

Construct a hypothesis regarding the effect of the location (not the amount) of the mass of an object on the rotational inertia of the object (i.e., how easily it can be accelerated rotationally).

Station Three

Equipment: Inclined plane, solid cylinder, hollow cylinder, solid ball, hollow ball..

On the basis of your hypothesis, predict which of the round objects will roll to the bottom of the inclined plane fastest by numbering them from fastest to slowest.

_____solid cylinder

_____hollow cylinder

_____solid ball

_____hollow ball

Test your prediction. List the experimental results.

Experiment 4: Post-lab Exercise

Measure and record the radius of a car tire.

Measure and record the circumference of the same tire.

Multiply the radius by 2π (π is about 3.14) to check the radius and circumference relationship. Discuss any confounds you notice.

How many times will this tire rotate in 30,000 miles of driving (the average life of a tire)?

In Experiment 3 you identified cases of Newton's 3 laws of motion. The same laws apply to rotating bodies. Identify which of Newton's laws apply in the following cases, and tell what the law predicts.

Picture a <u>frictionless</u> merry-go-round.

1) You set it spinning, then step back. What happens? According to which law?

2) You sit down on the ground and put your feet up so they rub against the edge of the moving merry-go-round. What happens? According to which law?

3) You put another frictionless merry-go-round next to the first. With both of them at rest, you stand on one merry-go-round and push to start the other one spinning. What happens? According to which law?