5.1 The First Law: The Law of Inertia

How does changing an object's inertia affect its motion?

Newton's first law states that objects tend to keep doing what they are doing unless acted on by an unbalanced force. This law applies to both objects at rest and objects in motion.

In this investigation, you will:

- change the Energy Car's inertia to see what affect it has on the Energy Car's motion.
- apply Newton's first law to describe the Energy Car's motion.

Materials List

- SmartTrack
- Energy Car
- Steel marbles
- Rubber band
- Track feet (2)
- Bubble level
- Distance-Velocity sensor
- DataCollector

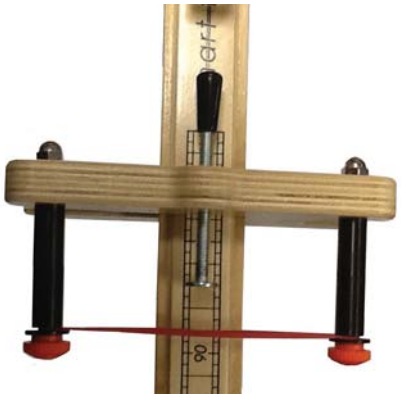
1 Making a prediction

Newton's first law of motion applies to objects at rest and objects in motion. The first law can also be called the law of inertia. To understand why, consider what inertia is. Inertia is a property of matter that resists a change in motion. Inertia comes from an object's mass. Because of inertia, objects at rest remain at rest, and objects in motion remain in motion, unless acted upon by a net force. You will investigate the first law by launching the Energy Car on a flat track and seeing what happens when you change the car's inertia.

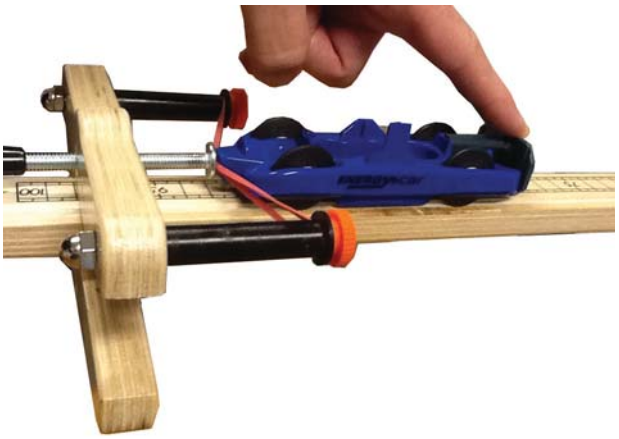
a. You will launch an Energy Car several times on the flat track, and you will change the number of marbles in the car each time. Write a hypothesis to address the question; "How will changing the inertia of the car affect the car's motion on the flat track?" Your hypothesis should follow this format: "If inertia affects the car's motion on the flat track, then when I add more marbles to the car, the car____."

2 Setting up the experiment

1. Attach a foot to each end of the SmartTrack so it sits level on the table. Check it with the bubble level and pieces of paper under the feet to adjust the height as necessary to make the track level.
2. Attach the distance-velocity sensor to the start end of the SmartTrack.
3. Fasten a rubber band on the launcher and attach it to the SmartTrack. It is best to have the rubber band to twist into an "x."
4. Set the adjustable screw so that theflat end is two centimeters behind the rubber band.
5. Turn the DataCollector on and then plug the distance-velocity sensor into the DataCollector.
6. At the home window, select data collection mode.
7. At the go window, choose setup at the bottom of the screen.
8. At the setup window, choose standard mode, 50 samples, and 20 Hz. This will allow the DataCollector to collect 20 samples of data from the sensor each second.



9. Put the target on the EnergyCar
10. Practice launching the Energy Car with no marbles. Once you have a consistent launch technique, get the car ready to launch, press the go button on the DataCollector, and launch the car.
11. Make a note the target distance value at the launch location. This value will be a reference when you look at the data table and graph.
12. Switch to table and graph views to study your data.



a. Describe what happens to the Energy Car's velocity as it moves along the track. Explain why this happens.

b. An object at rest remains at rest unless acted upon by an outside force. What is the outside force that acts on the car to disturb its state of rest at the start of the track?

c. An object in motion remains in motion unless acted upon by an outside force. What outside force acts on the car to change its motion as it moves along the track?

3 Conducting the experiment and reporting back

a. Design an experiment to test the hypothesis you stated in part 1a. What is your procedure?

b. Create a data table and a graph to communicate your results.

c. Summarize your findings. Be sure to refer back to your hypothesis.

4 Reflecting on Newton's first law

a. State Newton's first law in your own words.

b. Place the Energy Car in the center of the track so it stays at rest. What do you know about the forces on the Energy Car? Identify the forces acting on it.

c. If the Energy Car is moving, and there are no unbalanced forces acting on it, does its speed increase, decrease, or remain the same? Explain.

d. Were any forces acting on the Energy Car as it rolled along the level track? Identify the forces. Explain how Newton's first law is applied to describe the motion you observed.

e. What changes occur in the forces acting on the Energy Car when the track is tilted slightly up or down? Explain how the first law is applied to describe the observed motion in the case of an uphill or downhill slope.