

Newton's Third Law

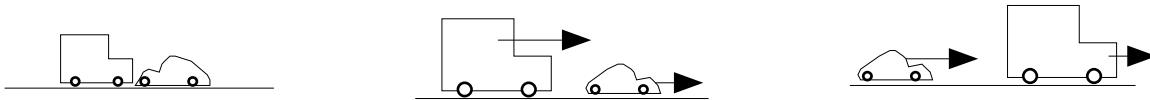
Name: _____

A common (but confusing) statement of Newton's Third Law is "For every action there is an equal and opposite reaction" In this activity you will measure forces with force sensors and try to understand the real meaning of Newton's Third Law.

Predictions

- Two objects, a truck on the left, and a car on the right, are on a horizontal rough surface (friction present) and are in contact. The vehicles can have their motors on or their brakes applied, or be in neutral. When the truck and car are in contact, there is a horizontal contact force between them, meaning that the truck pushes or pulls on the car, and the car pushes or pulls on the truck. Compare the **magnitudes** of these two forces in different situations. All motion is along a straight line.

In **Parts (a) to (d)** vehicles are of equal mass, in **Parts e and f** the truck is much more massive than the car.



Parts (a) to (d), Equal mass Part (e) Massive truck, light ca Part (f) Massive truck, light ca

Discuss your answers with the others in your group and record your consensus answers.

Summary of predictions

In parts a-d the car and truck are of equal mass. In parts e and f the truck is much more massive than the car.	Force magnitude of car on truck is (>, =, <) the Force magnitude of truck on car.	Measurements (later)
(a) Equal masses, Truck and car push but there is no motion.		
(b) Equal masses, Truck pushes car to the right at constant speed.		
(c) Equal masses, Truck pushes car to the right, both are accelerating to the right		
(d) Equal masses Truck pushes car and both move to the right, car sets brakes and they are slowing down, accelerating to the left.		
(e) Very Massive truck moves to the right and rear ends a light car that is also moving right. They separate after the collision.		
(f) Light car moves to the right and rear ends a massive truck that is also moving right. They separate after the collision.		

Measurements

2. Get a computer, LabPro, two force sensors with adaptors, and two massive bars. Connect the LabPro to the computer. Use the adaptors at the ends of the force probe cables, and connect the force probes to CH1 and CH2 of the LabPro. The truck is the sensor connected to CH 1, and the car is the sensor connected to CH2.

[Note: you do NOT need to use carts and a track for this experiment.]

Be sure the slide switch on the force sensors is at 50N. Drag the file *Newton's Third Law* to *MyDocuments* from the server. Calibrate the sensors. Place the sensors on the table and zero both sensors (*CNTRL-0*). Check the zero by collecting data with the sensors horizontal and not touching. **Beware the Tare: There is a tare button on the side of the force sensor. Be very careful not to accidentally press it. If you do, you will need to re-zero the sensors., but will not need to recalibrate.**

Replace the hooks on the force sensor with rubber bumpers.

Push on each bumper with your hand while collecting data to see how data are collected. If the truck is on the left, pushing to the left on its bumper should give a negative force. A push to the right on the car bumper should give a positive force.

3. Set up experiments to check the results that you predicted in parts (a) to (d). Enter your observations into the appropriate column in the table on the previous page.

To check parts e and f of Newton's Third Law during collisions, you must make a couple of changes to the program.

Click on the clock icon (or on menu, Experiment: Data Collection) and a window will open. In the window make the length of the experiment 1 s, and collect 1000 samples per second. Then click the Triggering tab and check Enable Triggering.

Check parts e and f of your predictions. Enter your observations into the appropriate column in the table on the previous page.

4. This experiment is designed to help you learn something about Newton's Third Law. Write a clear statement of Newton's Third Law based on what you measured.

Calibrating the force sensor: Be sure the slide switch is in 50 N position. Hold sensor vertically and enter zero for the force. Now hang about 500 grams (be sure to include the mass of the hanger) and enter the weight that is hung ($W = m g$)