

Lesson plan for [Force and Motion Basics HTML5 Version](http://phet.colorado.edu) Part 2: Friction  
<http://phet.colorado.edu>

Time for activity: 60 min

**Learning Goals:**

- Predict how forces can change motion.
- Provide reasoning and evidence to explain motion changing or not.

**NGSS references:**

**Performance Expectations:**\* 3-PS2-1 , 3-PS2-2, MS-PS2-2

- **Disciplinary Core Ideas** - PS2.A: Forces and Motion; PS2.B: Types of Interactions
- **Crosscutting Ideas**: Cause and effect, Patterns; Stability and Change
- **Practices**: Asking Questions and Defining Problems, Constructing Explanations and Designing Solutions, Engaging in Argument from Evidence, Analyzing and Interpreting Data, Planning and Carrying Out Investigations

**\*PEs more information:**

- 3-PS2-1 Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
- 3-PS2-2 Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
- MS-PS2-2 Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

**Background:**

This lesson is a follow-up of the [Simulate Net Forces to Predict an Object's Motion lesson posted on Science Friday](#) In that activity, students explored the Net Force and Motion screens of the sim. They would have had experience with both pushing and pulling forces in a frictionless environment.

**Introduction:**

The tips for teachers page can be found at <http://phet.colorado.edu/files/teachers-guide/forces-and-motion-basics-guide.pdf>

**Pre-Lesson:**

Briefly revisit the Net Force and Motion screens of the sims and ask students about their observations.

**Lesson:**

Possible places to pause for class discussion or prompt individual groups:

- After question 4 – Ask students to share their descriptions of Friction Force and Applied Force
- After question 5 – Ask students if they were able to move the refrigerator. This is impossible at the default level of friction, so students must reduce the amount of friction to move the refrigerator.

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- After question 6 – Ask students what combinations of objects they tried. Were there any that were impossible to move? Were they able to find a way to move the seemingly immovable objects (by reducing friction)?
- After question 7 – Ask students what ways they found to change the sum of forces arrow and their description of Net Force
- After question 9 – Ask students about their observations relating the net force and the change in speed

**Post-Lesson:**

Possible post-lesson activities include:

- Facilitating a class discussion about how the net force relates to the change in speed. (This can be a segue into using the Acceleration screen of the sim)
- Asking clicker questions – some are provided in this [activity](#).

**Follow-up sims:**

Balancing Act (<http://phet.colorado.edu/en/simulation/balancing-act>) would enable students to see how force acts when forces are not applied at the center of mass.

*Balancing Act description:* Play with objects on a teeter totter to learn about balance. Test what you've learned by trying the Balance Challenge game.