Background Information

This lesson is specifically designed for a freshman-level physics class. Before engaging with this material, students will have already participated in lectures, completed practice problems, and submitted homework assignments focused on Newton's Laws of Motion. The primary goal of this lesson is to solidify their understanding of these foundational concepts and to address any lingering questions or areas of confusion that may have arisen during prior instruction. By providing an opportunity for reinforcement and clarification, this lesson aims to ensure that all students achieve a comprehensive grasp of Newton's Laws before moving on to more advanced topics in physics. Additionally, this is intended as an inquiry lesson for students to test their knowledge in specific experiments with various masses.

Learning Outcomes

- Students will be able to connect forces to Newton's First Law.
- Students will be able to explore unbalanced forces and explain the effects of unbalanced forces on an object's velocity and acceleration.
- Students will be able to explore experimentally the Second Newton's Law and its relation between force, mass and acceleration.
- HS-PS2-1. Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

Lesson Plan

The teacher will…

The teacher will introduce the phet simulation, demonstrate one example of how to utilize the vet simulation and put students into groups. During lab exploration the teacher will circulate the classroom and answer questions as needed.

The students will…

The students will watch the teacher demonstration, and complete the following lab simulation in groups. Each student will turn in their own lab report.

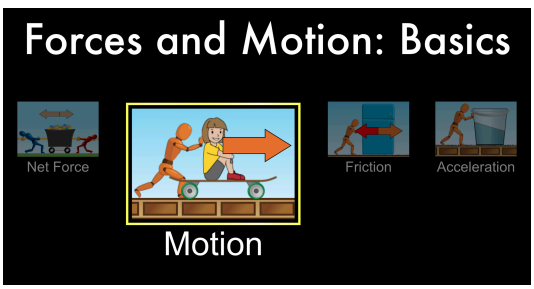
CORE Science 1 - Unit 6 - Forces: PhET Quick Lab - Change Your Motion

Objectives

1. To connect forces to Newton's First Law.
2. To explore unbalanced forces.
3. To understand the effect of the forces of friction during the motion of objects.
4. To explore experimentally the Second Newton's Law (relation between force, mass and acceleration)

Click on the link below to open the simulation:
http://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_en.html

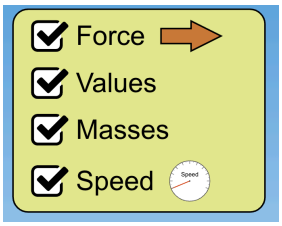
Your screen should look like the following:



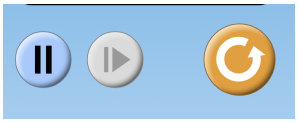
Observation 1

Click on the 'box' that is titled 'Motion', when it 'pops up' click on it again to open the motion simulation.

Check the boxes for Force, Values, Masses and Speed.

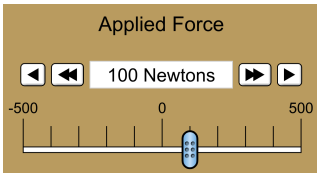


Click the blue 'pause' button.



So that the 'play' and 'step forward' buttons show.

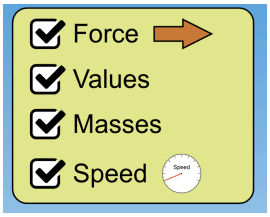
Adjust the 'Applied Force' slider to 100 N



Use a stopwatch function on your phone or on the computer (https://stopwatch.online-timers.com/online-stopwatch is one option), press the 'play' button for 10 seconds and then press 'pause'.

What is happening to the speed?

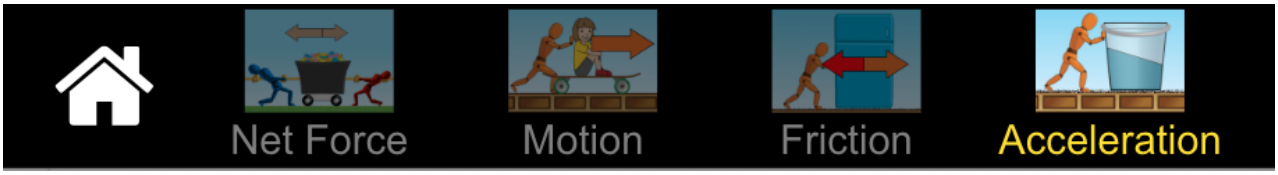
Reset the simulation with the tan/orange 'refresh' button. All the check boxes should still be checked, if not check them.



Drag the 'Applied Force' slider to about 100 Newtons until the speed gets to 15 m/s (or close) and then release it. What happens? Why? What law is in effect once you stop pushing?

Observation 2

Click on the 'Acceleration' box at the bottom of the screen.



Check all of the boxes and move the 'Friction' slider to 'None'

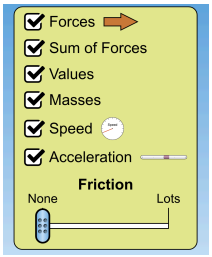
A. Push the pause button (as before) and adjust the 'Applied Force' slider to some positive value.

B. Record the force, mass and acceleration in the table below after 15 seconds.

C. Repeat steps A & B 5 more times with a different force but keep the same mass.

D. Add more mass and repeat steps A-C.

E. Add even more mass and repeat steps A-C.



Trial	Applied Force	Mass	Acceleration
1			
2			
3			
4			
5			
6			
7			
8			

Observation 3

G. Move the 'Friction' slider to the right – about 1/2 the way is fine.

Push the pause button (as before) and adjust the 'Applied Force' slider to 50 N. What happens when you press play? Why? (HINT: Look at the "Sum of Forces")

Push the pause button again and adjust the 'Applied Force' slider to 100 N. What happens when you press play? Why? (HINT: Look at the "Sum of Forces")

"Play" with the simulation. See if the same kinds of observations can be made with other objects and other forces, especially negative forces and different amounts of friction.

Summing Up

When you apply force to the object, what happens to the velocity as time increases?
Answer
What happens to the velocity once the force is stopped with no friction?
Answer
What happens to the velocity once the force is stopped with friction?
Answer
What is the relationship between acceleration and force? What is your evidence?
Answer
What is the relationship between acceleration and mass? What is your evidence?
Answer