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SCED 536: Physics in Motion

Elective 8: Tying Together Resources with NGSS Crosscutting Concepts

The focus of the resources below is to introduce my students to Newton's 2nd Law of Motion. I will use these resources to address the following physical science learning standards:

- **NGSS:** MS-PS2-2 Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the force on the object and the mass of the object.
- **Pennsylvania:** S8.C.3.1 Describe the effect of multiple forces on the movement, speed, or direction of an object.

Resources:

Resource 1: Phet: Forces and Motion Basics (Acceleration)

I will first use the Phet: Forces and Motion Basics simulation resource focusing on acceleration to introduce my students to Newton's second law of motion. My students will be given five minutes to independently play with the simulation to see all of the different things that they can change and do. After given time to explore the simulation, students will work in pairs to complete part 1 of the Student Discovery: Newton's Second Law of Motion guide (attached). Students will need to discover how to make objects of various masses move using applied force. From this simulation, students will begin to see that mass and force have an effect on the acceleration and speed of an object.

Resource 2: STEMonstrations: Newton's Second Law of Motion

After exploring the simulation, I will then show my students the STEMonstrations: Newton's Second Law of Motion video. In this video, astronaut Randy Bresnick introduces the formal definition of Newton's second law of motion. Randy demonstrates Newton's second law by applying the same amount of force to a tube of Chap Stick, a small spaceship, and a large bag of bedding materials. The objects accelerate at different rates due to their mass. After viewing the video, students will complete part 2 of the Student Discovery: Newton's Second Law of Motion guide. By this point, students should have a general understanding of Newton's second law of motion. Students will work with a small group to answer the conclusion questions of the guide. Groups will share their responses with the class to ensure everyone has a complete understanding of the relationship between mass, force, and acceleration.

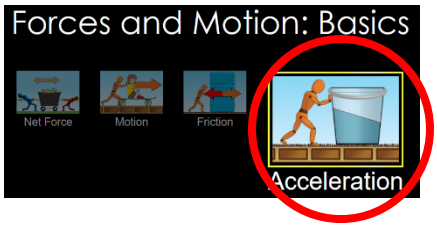
Resource 3: Newton's Second Law Classroom Connections

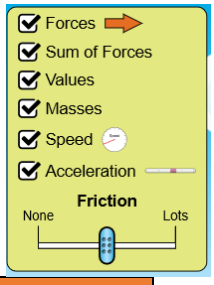
During the following class, students will complete the Newton's Second Law Classroom Connections activity to further investigate Newton's second law of motion. In this activity, students work together to create a small car using paper and straws. The students use pennies to adjust the mass of the car. Using an air pump, the students measure the distance the car is able to travel at different masses. After graphing their data, students conclude if mass affects the distance the car travelled. This hands-on investigation will engage students with Newton's second law of motion by demonstrating how the motion of an object depends on its mass.

Crosscutting Concepts:
Stability and Change: Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. (MS-PS2-2)

Scientists must recognize how change occurs in natural and designed systems. A stable system indicates that aspects of the system are not changing. If there is a change, a system will stay or return to stability or equilibrium. Each of the resources used to introduce Newton's second law of motion represents motion in a system. This crosscutting concept is directly addressed in the conclusion questions of the Student Discovery: Newton's Second Law of Motion guide. From the Phet simulation and STEMonstrations video, students will recognize that the systems were stable when no motion was occurring, the object was traveling at a constant speed, or the object had a net force of zero Newton's. The students will then realize that the systems changed when the net force was not equal to zero Newton's, which caused the object to move and accelerate. By manipulating the force applied to an object in the Phet simulation and seeing the demonstrations by astronaut Randy, students will recognize that the objects reacted in a similar way even though they were in different systems. This conclusion will help students further understand how Newton's second law of motion applies to objects in many different situations.

Student Discovery: Newton's Second Law of Motion





Part 1: [Phet: Forces and Motion Basics (Acceleration)]
-Click on **Acceleration.**
-Check all of the possible options.

Use the simulation to complete the table below.

Mass	Applied Force	Friction Force	Sum of Forces	Movement? (Yes or No)	Speed	Acceleration
50 kg	95 N	95 N				
50 kg	120 N					
100 kg	120 N					
100 kg				YES		
200 kg			0 N			
200 kg				YES		

1. What is the relationship between the sum of forces and the object's movement?

2. As the mass increased, what was necessary to move the larger objects?

3. Apply 200 Newton's of force to a 100-kg box and then apply 200 Newton's of force to a 50-kg box. What happens to the speed and acceleration?

Part 2: [STEMonstrations: Newton's Second Law of Motion]

1. Summarize what happened when astronaut Randy launched the Chap Stick, spaceship, and bedding bundle aboard the international space station.

Newton's Second Law of Motion Conclusion:

1. Describe the relationship between force, mass, and acceleration as illustrated in the Phet simulation and the STEMonstrations video.

2. Both the simulation and the STEMonstrations video represented motion in a system. Explain when each system was stable. What caused the systems to change?