LESSON 1:
Newton's First Law

NEXT GENERATION SCIENCE STANDARD
MS-PS2-2 Motion and Stability: Forces and Interactions

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.

Time: 2-3 50 minute classes

Lab 1:

The purpose of this lesson is to help students to better understand Newton's First Law of Motion, a.k.a. The Law of Inertia. Newton's First Law is often defined as

To understand this law, it is helpful first to understand the meaning of an unbalanced force. Students should have learned this in prior grades according to NGSS standards. Regardless, a short review will be helpful. First, give the students a few examples (to the right) of an unbalanced force (a.k.a. Net Force).

The PHET website has a great simulation: https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_en.html

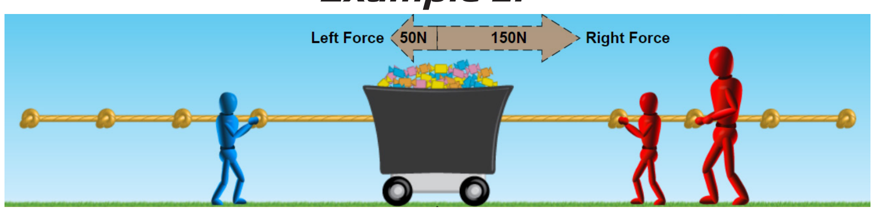
Open "Net Force" option ➜ Check the "values" box ➜ Drag the figures up to the ropes

What is the Net Force in each scenario below and describe the motion of the car.

Example 1:

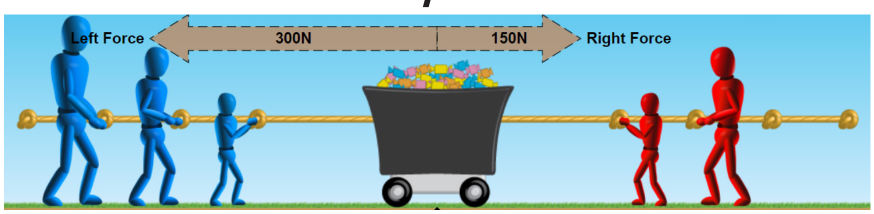
Answer: +3,000 N

Example 2:



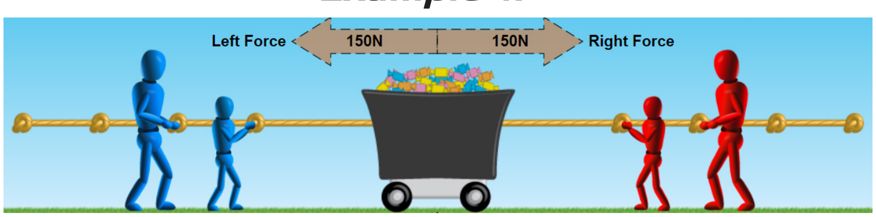
Answer: +100 N

Example 3:



Answer: -150 N

Example 4:



Answer: 0 N

If you have time, allow students an opportunity to explore this simulation.
ADDITIONAL CORRESPONDING WORKSHEETS AVAILABLE.

Lab 1 Student Worksheet - Net Force

1) Find the Net Force on each car below and explain the motion.

Net Force: ____________________

Motion: ______________________

Net Force: ____________________

Motion: ______________________

Net Force: ____________________

Motion: ______________________

2) Draw the forces on Jeff's car from the video at the time of impact. Explain your reasoning.

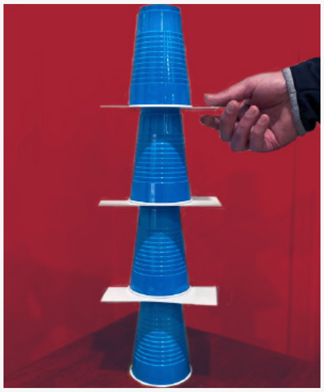
Lab 2: Law of Inertia

The next part of this lab will have students perform several mini experiments to observe the Law of Inertia at work. It is suggested that students rotate around to several stations and complete each activity and make observations. The stations and number of stations you choose will depend on your access to supplies, number of students and space. Upon finishing, students will answer the questions that follow. A final whiteboard session can then be used to allow students to develop a model for inertia. Your facilitation of this whiteboard session will guide students to developing their own version of Newton's First Law of Motion.

Stations

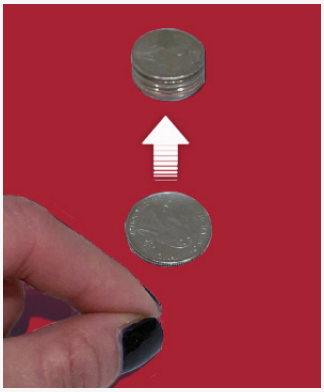
A) Card Flick

Place a penny on top of a notecard on top of a cup. Pull the card quickly to see what happens. What happens when the card is pulled slow? Fast?



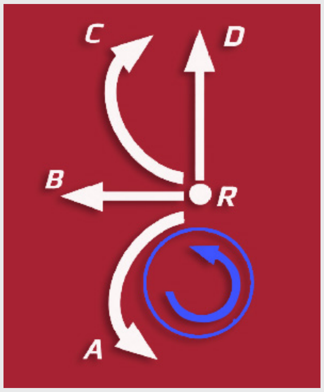
B) Stack Cups

Make a stack of 4 solo cups separated by index cards. Have students pull out index cards one by one without making the cups fall off. Which method worked best? Why? What was the best strategy?



C) Quarter Stack

Stack 6 quarters on top of each other and place them on a desk. Quickly push another quarter into the bottom quarter and explain what happens. Try the same process with pennies. Which was easier, why?



D) Sock Toss

Fill the end of a sock with a small amount of sand. What would happen if you swung the sock around over your head in a horizontal circle and released at point R? Which path would it take? Have a short discussion. Go outside and give it a try. Please be careful.

More Station Ideas

E) Tablecloth pull

Put a water bottle on top of a piece of paper. Pull the paper out quickly without moving the bottle. Remove half of the water from the bottle and try again. Remove all of the water and try again. Which was easiest? See if you can explain.

F) Swinging bucket

Swing a small water bucket filled with a small amount of water in a vertical circle so that the water does not fall out. Why does the water stay in the bucket at the top?

G) Rotating Penny

Put a penny inside of a balloon and blow up the balloon. Swirl the balloon around so that the penny moves in a circle inside of the balloon. Stop swirling and then watch the penny move on its own. How long does it travel for? Why does this happen?

H) Pool Ball Trick

Stick a quarter on top of a pool ball. Draw a 10 inch diameter circle around the pool ball with a whiteboard marker or chalk. Hit the pool ball with a pool stick (or meter stick) and try to get the quarter to land outside of the circle. Why was this difficult?

I) Pennies on Elbow

Bend your elbow with your hand facing upward. Stack about 5 pennies above your elbow. Try to catch the pennies. See how many pennies you can catch. Explain why this works.

J) Water Bottle Trick

Set a water bottle on the table and take the lid off. Set a notecard on top of the bottle with 5 pennies on top of that. Pull or flick the card out so that the pennies remain in place. See how many pennies you can use without them falling. Discuss your strategy.

TEACHER NOTES: Let the students develop their own working model for Newton's First Law. Strive to have the class reach consensus on a model that fits their observations. Interesting fact: Inertia comes from the Latin word, iners, meaning idle, sluggish or lazy. A lazy object doesn't want to change what it was doing. To change, effort (force) is required. An object at rest stays at rest. At the same time an object moving through space requires an effort to slow it down or stop. Object's "want" to keep doing what they were doing.

It would also be helpful to give students an official definition for Newton's First Law and compare it to the one they derived.

Lab 2 Student Worksheet - Law of Inertia

1) What types of patterns did you notice with all of the activities?

2) Did the mass of the object make a difference in the activities? Explain.

3) You're in a car, holding a drink and the driver stops quickly. What happens to your drink? Why?

4) Compare pushing an empty shopping cart with one filled with several stacks of water bottles. Which cart is easier to start? Which cart is easier to return? Explain.

4) Write two or three sentences that could be used to explain all of your observation with one explanation.

6) A car rolls across the floor with no friction. What is the net force on the car?

7) How could the information from this activity be used to help solve the Challenge Problem? **(Find a way to reduce the force on the driver.)**