ANDRETTI FASTTRACK XPERIENCE | Official Partner

LESSON 3:
Newton's Third Law

NEXT GENERATION SCIENCE STANDARD
MS-PS2

Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

Time: 50 minute class period

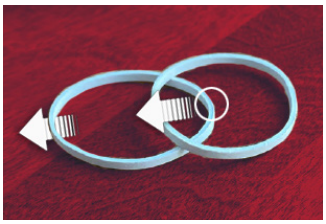
Lab 1:

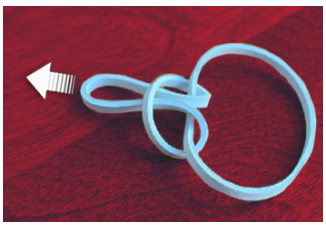
This lesson will introduce/review **Newton's Third of Motion**:

For every action, there is an equal & opposite reaction.

Understanding this law will help students prepare for Jeff's

Rubber Band Activity.





Show the students a rubber band. Discuss the fact that it takes a force to stretch that rubber band and that the amount of the stretch is related to the force applied. The bigger the force, the further the stretch.

Give students two similar rubber bands and have them attach them together as shown.

Instruct the students to pull the rubber bands apart and observe the stretch distance of each band. Challenge them to see if they can pull harder on one band so that one band stretches more than the other. Tell them to be creative and to try different methods. Remind them of safety procedures as well. Distribute the rubber bands and give them 10-15 minutes to explore.

Upon finishing, discuss the results with the students. Unless science is broken that day, students should observe an equal stretch in all cases. Remind them of Newton's Third Law of Motion:

For every action, there is an equal and opposite reaction.

Regardless of how much force is applied to one band, the other will pull back with the same exact force. The problems below allow students to practice using Newton's Third Law. It might be helpful to discuss the first two and then perform guided practice for the last two.

1)

You hit a baseball with a bat. Describe the action and reaction forces involved.

Action - Bat hits baseball.

Reaction - Baseball hits bat with the same but opposite force.

2)

Jose walks down the sidewalk. Explain the action reaction forces involved.

Action - Jose pushes the sidewalk backwards.

Reaction - Sidewalk pushes Jose forward.

3)

Jeff's race car moves down the track at high speed. Describe the action - reaction forces that cause the car to move forward?

Action - Tires push the ground backwards.

Reaction - Ground pushes the car forward.

4)

An airbag is used as a safety device in a car. Describe the action-reaction forces between the airbag and the person.

Action - Person applies force to air bag.

Reaction - The air bag applies an equal and opposite force to the person.

- How does the airbag help to reduce the force on a person in a car accident? (Newton's Second Law states that the Force and change of motion (acceleration) are directly proportional. The airbag causes the person to slow down over a longer time which in turn reduces the force. Less acceleration means less force).

Student Worksheet - Newton's Three Laws of Motion

1) An astronaut in deep space throws a rock. Describe its motion. What forces act on the rock? For how long will it travel?

2) An elephant is chasing you in the middle of nowhere. What is the best way to avoid the elephant?

3) You push a car which causes it to accelerate. If some of your friends help push too, and together you push with twice the force, what happens to the acceleration of the car?

4) You push a car which causes it to accelerate. If a bunch of friends jump in the car and causes the mass of the car to double as you're pushing, what happens to the acceleration of the car?

5) When you jump off the table, why do you bend your knees as you land?

6) You're in a car and all of the sudden the driver stops the car quickly. The book in the backseat suddenly flies forward. Why? What forward force acts on the book?

7) A seat belt is used to keep you in your seat when you slow down quickly. Describe the action - reaction forces on the seatbelt and you.

8) Give a few ideas on how you can use Newton's Three Laws of Motion to solve the challenge problem. (Find a way to reduce the force on the driver.)

Lesson 3

Student Worksheet - Newton's Three Laws of Motion

ANSWER KEY

1) An astronaut in deep space throws a rock. Describe its motion. What forces act on the rock? For how long will it travel?

The rock will travel at the same speed forever and never slow down unless a force acts on it. In deep space, there will be no forces acting on the rock. The rock does not need a force to keep moving. The rock will move forever unless a force slows it down.

2) An elephant is chasing you in the middle of nowhere. What is the best way to avoid the elephant?

Change directions often. The elephant has a large mass, which gives it a lot of inertia, which means it wants to keep going in a straight life which would make it difficult to turn.

3) You push a car which causes it to accelerate. If some of your friends help push too, and together you push with twice the force, what happens to the acceleration of the car?

Twice the acceleration.

4) You push a car which causes it to accelerate. If a bunch of friends jump in the car and causes the mass of the car to double as you're pushing, what happens to the acceleration of the car?

Half the acceleration.

5) When you jump off the table, why do you bend your knees as you land?

Bending your knees causes the time of impact to increase, which decreases the acceleration, which decreases the force.

6) You're in a car and all of the sudden the driver stops the car quickly. The book in the backseat suddenly flies forward. Why? What forward force acts on the book?

The book has inertia. The book wants to keep going in a straight line. No forward forces act on the book.

7) A seat belt is used to keep you in your seat when you slow down quickly. Describe the action - reaction forces on the seatbelt and you.

Action: You push against the safety belt.
Reaction: The safety belt pushes back against you with an equal and opposite force.

8) Give a few ideas on how you can use Newton's Three Laws of Motion to solve the challenge problem. (Find a way to reduce the force on the driver.)

Keep thinking about this, it's almost time for the challenge...

Extension Activity: Egg Drop Experiment

NEXT GENERATION SCIENCE STANDARDS

MS-PS2-1 Motion and Stability: Forces and Interactions

Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

MS-PS2-2: Engineering Design

Apply scientific ideas or principles to design an object, tool, process or system.

Time: 2-3 50 minute class periods

This lesson will allow students to apply Newton's Three Laws to solve an engineering problem. The objective is to build a device that protects a raw hen's egg when dropped from any height. You can provide students with a variety of materials to build their device.

> ***For example, materials could include: a few sheets of paper, a length of tape, a few cups, rubber bands, foil, paper clips and pipe cleaners. You can use whatever supplies you have laying around. It's best to limit the supplies as this gives constraints which are often necessary in engineering and helps the students to be more creative.***

The hope is that the students will apply the concepts from Newton's Three Laws to solve this problem. In addition, this problem is very similar to Jeff's challenge. A thoughtful solution here will bring them closer to a solution to the challenge problem.

You may choose to give the students a class period or two to design and construct their devices. Another period may be required to drop/destroy the devices. Students love competition. You might try small heights at first and then increase each round until a winner can be declared. The final class period can be used to evaluate the projects and discuss the related science concepts. The following questions might be helpful to get that dialogue started.

Egg Drop Questions

1) What was most difficult about this project?

2) How did you use Newton's First Law in the design of your project?

3) How did you use Newton's Second Law in the design of your project?

4) How did you use Newton's Third Law in the design of your project?

5) Of all of the designs, which did you think was most effective and why?

6) How could this activity be applied to "the challenge"?