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Making Science Accessible:

*A Guide for Teaching Introductory Physics
to Students Who Are Blind or Visually Impaired*

by

Michele Engelbrecht

Kate Fraser

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MAKING SCIENCE ACCESSIBLE
***A Guide for Teaching Introductory Physics
to Students Who Are Blind or Visually Impaired***



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Inside front cover

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NEWTON'S FIRST LAW OF MOTION

Teacher Information

NSES 9-12.2 Physical Science: Motions and Forces

The activity described below gets everyone's attention! Students with a visual impairment benefit from a chance to feel the weight of the various items placed on the tablecloth, as well as a chance to examine the table before and after the table cloth is pulled.

Adaptations

None needed, except for the tactual examinations described above.



STUDENT HANDOUT

Newton's First Law of Motion

Vocabulary

Inertia – the tendency of an object to keep its motion

Background Information

Inertia

Place a book on your desk. Does the book move? Unless you push the book, it will stay put just the way you left it. Imagine a spacecraft moving through space. When the engines are turned off the spacecraft will coast through space at the same speed and in the same direction. The book and spacecraft have inertia. Because of inertia, an object at rest tends to stay at rest. An object in motion tends to keep moving at a constant speed in a straight line.

Newton's First Law

Newton's first law of motion explains how inertia affects moving and nonmoving objects. Newton's first law states that an object will remain at rest or move at a constant speed in a straight line unless it is acted on by an unbalanced force. According to Newton's first law, an unbalanced force is needed to move the book on your desk. You could supply the force by pushing the book. An unbalanced force is needed to change the speed or direction of the spacecraft. This force could be supplied by the spacecraft's engine.

Effects of Inertia

You can see the effects of inertia everywhere. In baseball, for example, to overcome inertia a base runner has to "round" the bases instead of making sharp turns. As a more familiar example of inertia, think about riding in a car. You and the car have inertia. If the car comes to a sudden stop, your body tends to keep moving forward. When the car starts moving again, your body tends to stay at rest. You move forward because the car seat exerts an unbalanced force on your body.

Activity

Purpose

Attempt to show Newton's First Law of Motion

Materials

Table cloth
2 unbreakable plates
2 unbreakable cups
2 forks, spoons, napkins
The heavier the cups and plates, the better it works
A textbook

Procedure

1. Start with the table cloth on a table or desk.
2. Set the table as if for dinner.
3. Notice the difference in mass of each object. The book has the most mass and the napkin has the least.
4. Try the magician's trick of grabbing the edges of the table cloth and then quickly jerk it out from under the items on the table.
5. Hopefully you'll notice that the napkin flew off (less inertia), and things like the silverware, plates and book stayed put.

Questions and Conclusions

1. In space, a spacecraft with its engines turned off will move with constant speed in the same ____.
2. A book will not move by itself because it has ____.
3. A book will remain at rest unless it is acted on by an ____ force.
4. When a car stops suddenly, your body tends to keep moving ____.
5. Newton's first law explains how inertia affects moving and ____ objects.

Article and activity adapted from ***Concepts and Challenges: Physical Science, Fourth Edition***. Parsippany, NJ: Globe Fearon Inc., Pearson Learning Group, 2009, pages 280 to 281.

NEWTON'S SECOND LAW OF MOTION

Teacher Information

NSES 9-12.2 Physical Science: Motions and Forces

The first part of the activity described below can also be used to illustrate inertia. In the second part of the activity, mass is added to the toy car to illustrate Newton's Second Law. Give the student with a visual impairment an opportunity to feel the weight of the car before and after the clay is added.

Of course, friction is another force that affects motion, but this is disregarded as a factor in the activity.

Adaptations

An adapted meter stick



STUDENT HANDOUT

Newton's Second Law of Motion

Vocabulary

Newton - SI unit of force

Background Information

Effects of Unbalanced Forces

Unbalanced forces cause acceleration. When an unbalanced force acts on an object, the motion of the object is changed. If the object is at rest, the force makes it move. If the object is in motion, the force changes its velocity. Any change in velocity is acceleration.

Force, Mass and Acceleration

The amount by which an object accelerates depends on three things. They are the size of the force, the direction in which the force acts, and the mass of the object. If two forces act on the same object, the greater force will produce more acceleration than the smaller force.

Newton's Second Law

Newton's second law describes the relationship among force, mass, and acceleration. Newton's second law states that the unbalanced force acting on an object is equal to the mass of the object times its acceleration. Newton's second law can be describe by this equation

$$F = m \times a$$

In this equation, F is the force, m is the mass, and a is the acceleration. When the mass is measured in kilograms and the acceleration is measured in meters per second per second, the forced is measured in newtons (N). A newton is the SI unit of force. An unbalanced force of 1 N will accelerate a mass of 1 kg at 1 m/s². One Newton of force is equal to one kilogram-meter per second per second (1kg-m/s²).

Using Newton's Second Law

If no friction is involved, how much force would you have to apply to 10 kg object to make it accelerate at a rate of 45 m/s²? This may seem like a difficult problem at first. However, if you use the equation for Newton's second law, it becomes easy.

$$F = m \times a$$

$$F = 10 \text{ kg} \times 45 \text{ m/s}^2$$

$$F = 450 \text{ kg m/s}^2$$

You would have to apply a force of 450 kg m/s² or 450 N.

irIR Isaac Newton (1642-1727)

Isaac Newton was born in England on December 25, 1642. He was a physicist, an astronomer, and a mathematician. At the age of 45, Newton published his theories of motion and gravity. Newton's great book is usually called the *Principia*. It is considered one of the most important works in the history of science.

In the *Principia*, Newton explained his three laws of motion and his theory of gravitation. Newton also invented a branch of mathematics called calculus to help predict motion using his three laws. Newton also made many important discoveries about light and color.

Newton was a professor of mathematics at Cambridge University and a member of the Royal Society. He was knighted by Queen Anne in 1705. Newton once said about himself, "If I have further seen than others, it is because I have stood on the shoulders of giants."

Activity

Purpose

To discover the effects of change in mass on the movement of a toy car

Materials

A board (about 2 m long)
Toy car
Modeling clay
Measuring tape or meter stick
A place to record your data

Procedure

1. Lay a board about 2 meters long on the floor.
2. Place a toy car at one end of the board.
3. Slowly lift the end of the board with the car on it until the car begins to move.
4. Hold the end of the board at that level and have a partner measure the height to which the end of the board was raised.
5. Record your data.
6. Press a piece of modeling clay on the top of the car to increase its mass and repeat steps 2-5.
7. Predict how adding a second piece of clay to the car will affect the height you will have to raise the board before the car moves and record your prediction.
8. Test your prediction and record your data.

Questions and Conclusions

1. What will happen to an object at rest when an unbalanced force acts on it?
2. What will happen to a moving object when an unbalanced force acts on it?
3. What is a change in velocity called?
4. What is 1 N of force equal to?
5. Which will cause a bigger acceleration, a small force or a big force?
6. What does Newton's second law describe?
7. What is a Newton?
8. How much force is needed to give a 5 kg mass an acceleration of 20 m/s²?

Article and activity adapted from ***Concepts and Challenges: Physical Science, Fourth Edition***. Parsippany, NJ: Globe Fearon Inc., Pearson Learning Group, 2009, pages 282 and 283.

NEWTON'S THIRD LAW OF MOTION

Teacher Information

NSES 9-12.2 Physical Science: Motions and Forces

The activity described below works well for all students. The student with a visual impairment can best experience the activity as the person who has a chance to release the balloon*. Also beneficial is an opportunity to be at the end when the balloon rocket arrives. The whole class will want to do this activity again and again.

*NOTE: Balloons should **NOT** be used by students with latex allergies. If in a latex-free school, use mylar balloons.

Adaptations

None needed



STUDENT HANDOUT

Newton's Third Law of Motion

Vocabulary

Action force - force acting in one direction

Reaction force - force acting in the opposite direction

Background Information

Action and Reaction

Forces always act in pairs. The two forces act in opposite directions. When you push on an object, the object pushes back with an equal force. Imagine a person sitting in a rolling chair at a desk. When the person sitting in a rolling chair pushes on the desk, this push or force is the action force.

Now, the desk pushes back against the person with a force of the same size. This reaction force will cause the rolling chair to move backwards. Notice that the two forces act on different objects. The action force acts on the desk. The reaction force acts on the person.

Newton's Third Law

Newton's third law of motion describes action and reaction forces. The law states that for every action force, there is an equal and opposite reaction force. Imagine hitting a tennis ball. The racket exerts a force on the ball. This is the action force. The ball exerts an equal and opposite force on the racket. This is the reaction force.

Newton's third law explains how many sports injuries are caused. The more force you use to hit a tennis ball, the more reaction force your arm receives from the racket. Every time your feet hit the ground when you are running, the ground hits your feet with an equal and opposite force.

Balloons and Rockets

Newton's third law explains how balloons and rocket engines work. When the neck of an inflated balloon is released, the stretched rubber material pushes against the air in the balloon. The air rushes out of the neck of the balloon. The action of the air rushing from the balloon pushes against the balloon, moving it in the opposite direction.

When rocket fuel is burned, hot gases are produced. These gases expand rapidly and are forced out of the back of the rocket. This is the action force. The gases exert an equal and opposite force on the rocket itself. This is the reaction force. This force pushes the rocket upward.

Activity

Purpose

To describe and show Newton's third law of motion

Materials

String the length of the classroom

Balloon

Tape

Straw

Procedure

1. Feed one end of the string through the straw.
2. Tie the string to stationary objects on opposite sides of the room. Make sure to stretch the string tight.
3. Blow up the balloon and hold it so that no air can escape but don't tie it.
4. Have someone hold the balloon under the straw and tape the balloon to the straw in two places.
5. Let go of the balloon and it will take off like a rocket.

Questions and Conclusions

1. Forces always act in ____.
2. If a book is sitting on a table, is the table exerting a force? If so in what direction?
3. What effect would blowing more air into a balloon have on the motion of the balloon when released?
4. For every action force, there is an equal and ____ reaction force.
5. How are action and reaction forces different?
6. In a rocket engine, the ____ force pushes the rocket upward.
7. Action forces and reaction forces always act on ____ objects.
8. An object resting on a table weighs 100 N. With what force is the object pushing on the table? With what force is the table pushing on the object?
9. When you walk, your feet push against the ground. At the same time, the ground pushes against your feet. Which is the action force? Which is the reaction force?

Article and activity adapted from ***Concepts and Challenges: Physical Science, Fourth Edition***. Parsippany, NJ: Globe Fearon Inc., Pearson Learning Group, 2009, pages 284 to 285.