ENERGY FUNDAMENTALS – LESSON PLAN 1.1

#

Forces and Motion

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Public School System Teaching Standards Covered

State Science Standards

- AL GLE 3.4.1 3rd
- GA S4P3 4th
- KY SC-P-ET-U-1 3rd
- MS GLE 10.a 5th
- NC 3.P.1 3rd
- NC 5.P.1 5th
- VA 3.2 3rd

Common Core Language Arts/Reading

- KY 3.RI.1,2, and 8 3rd
- AL RI.3.1 and 2 3rd
- GA ELA.CC4.RI.1,2,and 8 4th
- CCR.R.10 5th
- Integration and Knowledge of Ideas-Cluster 7, 8, 9 NC 5th
- Key Ideas and Details-Cluster 1,2, 3 NC 3rd

Common Core Mathematics

- 3.OA.A.3-Al, KY, NC 3rd
- 4.OA.A.3-GA 4th

Performance Objectives

By the end of this lesson, students will be able to:

- **Describe force.**
- **Understand and describe types of forces, including gravitational force and frictional force.**

I. Anticipatory Set (Attention Grabber)

Essential Question

How do objects move?

Videos

Forces and Motion Video (1 min 27 seconds): https://www.youtube.com/watch?v=MztWyY9z1jY

Energy and Work Videos (many to choose from): http://www.neok12.com/Energy-and-Work.htm

II. Modeling (Concepts to Teach)

Additional Information

http://www.physicsclassroom.com/Physics-Tutorial/Newton-s-Laws

Forces

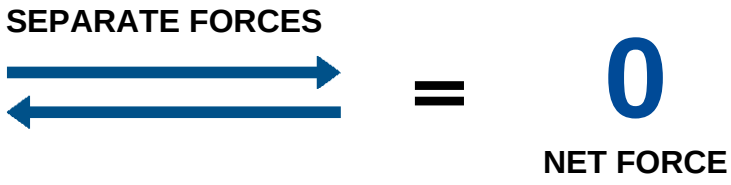
A force is defined as a push or pull. When a person writes, for example, he or she exerts a force on the pencil because the person is pushing or pulling it across the paper.

Two equal forces acting in the same direction

If two people are pushing a table across the floor in the same direction, the two forces are added together. Adding these two forces together is called the net force. In the case of the two people pushing the table, the net force is unbalanced. When there is an **unbalanced force** there is a force that changes an object's motion or causes it to accelerate. This can be shown with arrows; the wider arrow is the stronger of the forces.

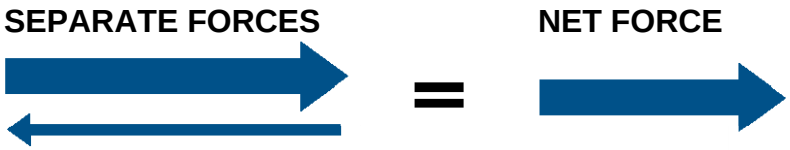
Two equal forces acting in the same direction

When the forces are equal and act in opposite directions, they balance each other out. There is no net force in this case. Using the example of two people pushing on a table, if there is a person on each of the opposite ends of the table and they are both pushing on the table with an equal amount of force, they balance each other out to a zero net force. This means the table will not accelerate.



Two unequal forces acting in opposite directions

When there are separate forces that are not equal and one force is more powerful than the other, they will not balance out to zero net force. Because there is one force stronger than the other, the weaker force is not strong enough to balance the other force. They are pushing in opposite directions, but one of them is pushing with a greater force. The motion will occur in the direction that the stronger force is moving. If two people are pushing on opposite ends of the table and one is pushing with more force, the table will accelerate in the direction that the person with the stronger force is moving. If one person is pushing the table, there is another force to examine: **friction force**. Friction force works against the applied force. If the force applied overcomes the friction force, then there is a net force on the table and it will move.



A **net force** is required to cause changes in motion (speed or direction). If an object is at rest, a net force is required to put it into motion. If an object is in motion, a net force is required to slow it down/bring it to rest. This change in motion is called acceleration. When an object increases its speed/direction (velocity) it is called ***acceleration***, when an object decreases its speed/direction (velocity) it is called ***deceleration***.

Types of Forces

Contact Forces

- Frictional Force*
- Tension Force
- Normal Force
- Air Resistance Force
- Applied Force
- Spring Force

Action-at-a-Distance Forces

- Gravitational Force*
- Electrical Force
- Magnetic Force

Note that action-at-a-distance forces are the ones required by state standards for grades 3-5 and are defined below. Definitions of the other forces listed can be found at ***http://www.physicsclassroom.com/class/newtlaws/Lesson-2/Types-of-Forces***

***Gravitational Force**

The force of gravity is a result of a massively large object, such as the earth or moon, attracting to it other objects that have mass. By definition, an object's weight is due to the impact of gravitational force. This is NOT to be confused with an object's mass or size. An object's weight changes depending on the gravitational pull exerted on it. A person's weight on the moon is less than their weight on Earth because the moon is less massive and exerts less gravitational force. Their mass, however, never changes.

$$F_{grav} = m * g$$

where g = 9.8 N/kg (on Earth)
and m = mass (in kg)

***Frictional Force**

Friction is the name given to the force that acts between materials that are moving past each other. Friction happens because of irregularities in the surfaces of sliding objects. Some surfaces have more irregularities than others and therefore cause more friction when objects slide over them. The friction force works against the applied force and must be overcome in order to move an object from rest. In addition, the friction force also slows a moving object so that it will eventually come to rest. If friction were absent, a ball moving horizontally would move forever.

Measuring Forces

Forces can be measured using a **spring scale** (force meter). Spring scales contain a spring connected to a metal hook. The spring stretches when a force is applied to the hook. The bigger the force applied, the longer the spring stretches, thereby resulting in a larger reading.

The unit of force is called the **Newton**, and it has the symbol **N**. So 100 N is a bigger force than 5 N.

FORCE METERS

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	What is an unbalanced force? What is a unit of force called? How is force measured? (Class discussion)
UNDERSTAND	Explain force using your own words. (Class discussion)
APPLY	Apply your knowledge of a force and explain how something moves, accelerates, and decelerates. (Class discussion)
ANALYZE	Explain an unbalanced force. What is the result of a force being applied to an object? What kind of force creates a net force? (Class discussion)
EVALUATE	How must our force overcome frictional force to create a net force? (Class discussion)
CREATE	How would you create movement? (Class discussion)

IV. Guided Practice Ideas

Recommended Items

Newton's First Law Using Balls (see below)

Experiments

Newton's First Law of Motion Experiment Using Balls: **http://www.metrofamilymagazine.com/July-2012/Simple-Science-Experiments-Newtons-First-Law-of-Motion/**

Games

Forces in Action Game: **http://www.bbc.co.uk/bitesize/ks2/science/physical_processes/forces_action/play/**

Activity

- Rolling a Ball: Teachers ask students to apply force to ball, putting ball into motion.
- Teachers start a game of tug-of-war and add students on each side to help demonstrate pull force and net force.

Practice that uses math/reading standards:

- Math: Equation for force (Force = Mass x Acceleration) **http://www.softschools.com/quizzes/science/force_mass_acceleration/quiz389.html**
- Reading: Article about force and motion, students write summary: **https://suite.io/harvey-craft/624s2a6**

V. Independent Practice Ideas

Recommended Item

At-home Activity: Find Push & Pull Forces at Home Worksheet and Answer Key provided

Other Resources

Personal Practice

Writing Activity: Teachers write the following question on the board and ask students to copy and answer the question on a sheet of paper: Describe force in your own words.

Practice That May Involve Parents or Guardians

At-home Activity: Find Push & Pull Forces at Home Worksheet and Answer Key provided

VI. Assessment

This item provides a check for understanding so teachers can easily determine whether concepts need to be reinforced. This item can be graded, if a grade is desired.

- Find Push & Pull Forces at Home Worksheet and Answer Key provided

VII. Materials Needed

The following materials are needed for the “Recommended Items” in Guided Practice & Independent Practice sections.

- Soccer ball, basketball, or any bouncy ball
- Smaller bouncy ball (tennis ball or racquet ball)
- Assortment of other balls of various sizes for further experimentation

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

How do objects move?

WORKSHEET FOR FORCES AND MOTION LESSON 1.1

NAME: _____

Find Push & Pull Forces at Home

Objective: Students will be able to understand and describe force, acceleration, and deceleration.

1. **What types of forces can be used to open your bedroom door?**

_____

_____

_____

_____

2. **Draw and label an example of a force being applied to push an object (use arrows to explain how force is moving):**

3. **Draw and label an example of a force being applied to pull an object (use arrows to explain how force is moving):**

4. Explain the difference between *acceleration* and *deceleration*.

5. How does friction interact with objects?

Answer Key

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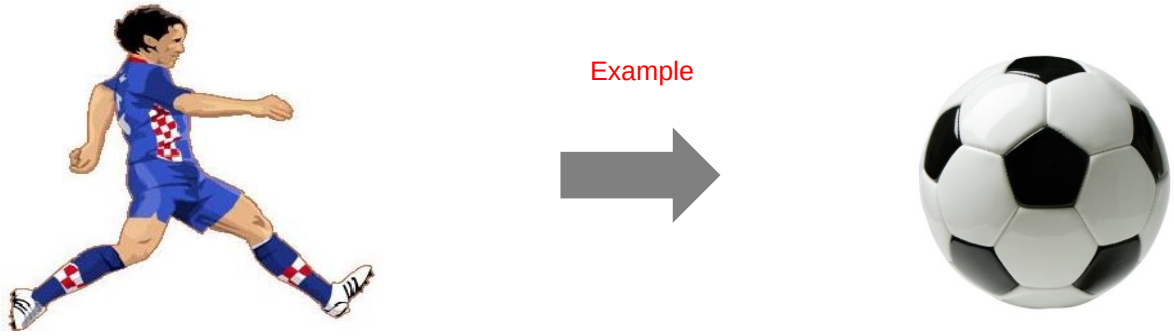
ANSWER KEY FOR WORKSHEET: FIND PUSH & PULL FORCES AT HOME

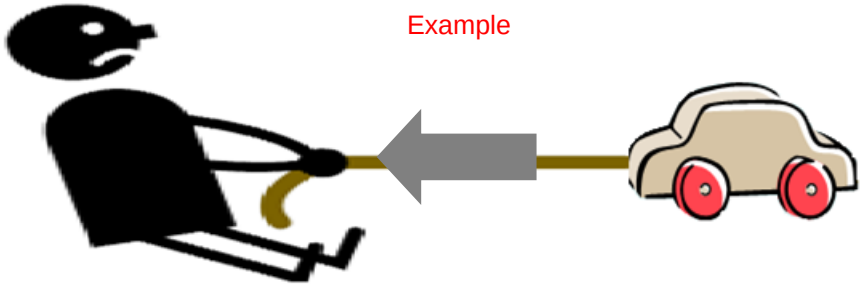
1. **What types of forces can be used to open your bedroom door?**

   Ex. Pull the handle to open the door or push the door open.

2. **Draw and label an example of a force being applied to push an object (use arrows to explain how force is moving):**



3. **Draw and label an example of a force being applied to pull an object (use arrows to explain how force is moving):**



4. **Explain the difference between acceleration and deceleration.**

   Ex. Acceleration = object increases its velocity; Deceleration = object decreases its velocity

5. **How does friction interact with objects?**

   Ex. Friction works against the applied force and must be overcome in order to move an object at rest.