ENERGY FUNDAMENTALS – LESSON PLAN 1.5

Work-Energy Relationships

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 5.4.1 5th
- GA S.4.P3 4th
- KY 3-PS-2-2 3rd
- KY 4-ET-U-3 4th
- KY SC-5-ET-U-1 4th
- MS 4.PS.2.c 4th
- MS 9.a 4th
- MS 9.b 4th
- MS 5.PS.2.c 5th
- NC 4.P.3.1 4th
- NC 5.P.1.1 5th
- TN 0407.10.1 4th
- TN SPI 0507.12.3 5th
- TN 0507.12.3 5th

Common Core Mathematics

- 3.OA.A.3-KY 3rd
- 4.OA.A.3-NC, TN, KY, MS, GA 4th
- 5.OA.A.3-NC, TN, MS, AL 5th

Performance Objectives

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

- **Define work.**
- **Explain energy.**
- **Define and explain kinetic energy.**
- **Define and explain potential energy.**
- **List examples of both kinetic and potential energy.**

I. Anticipatory Set (Attention Grabber)

Essential Question

What is work and how is it done?

Videos

Energy and Work Videos: http://www.neok12.com/Energy-and-Work.htm
Potential Energy – Wile E Coyote Video: https://www.youtube.com/watch?v=Jnj8mc04r9E
Kinetic and Potential Energy Song and Video: http://www.youtube.com/watch?v=vl4g7T5gw1M

II. Modeling (Concepts to Teach)

Energy wasn't understood very well during the lifetime of Isaac Newton. Today, the concept of energy is ingrained in all branches of science. Most of the energy here on Earth originated from the sun and can be transformed into many different types of energy. And, in order for work to be done, there needs to be a source of energy.

Work is defined as applying a force over a certain distance:

$$\text{Work done} = \text{force} \times \text{distance moved}$$
$$W = F \times d$$

For instance, work is done on books when a person carries them up stairs. If there are more books (more force required), then more work is done. If there are more stairs to climb (more distance traveled), then more work is done. Work is directly proportionate to both force and distance – as one increases, so does the other. **In order to say that work is done on the books, the force applied and the distance traveled have to be in the same direction** (holding books **up** and moving them **up**.) If the books were simply carried across the room, the work is not done on the stack of books. Work is done, just not on the stack of books!

Work is measured in units of **Joules** (J), after James Joule. 1 Joule is defined as the amount of work done when 1 Newton of force is applied over the distance of 1 meter.

Energy can be classified as either Potential Energy or Kinetic Energy.

Potential Energy (stored energy)

An object may store energy by virtue of its position. The energy that is stored and held in readiness is called Potential Energy (PE). Due to the fact that the energy is in a stored state, it can be used to do work.

Types of Potential Energy (PE)

1. **Elastic PE** – A stretched or compressed spring can release its stored energy to do work. Example: Launching a rock with a slingshot. The more the elastic rubber band is stretched, the more energy is stored and the more work can be done on the rock.
2. **Gravitational PE** – An elevated position (against the force of gravity) of an object allows it to do work. A boulder on top of a hill has stored energy. The higher it is, the more PE it has and the more work it can do.
3. **Chemical PE** – Chemical bonds that hold molecules together store energy. When the molecules are broken down through the process of combustion or digestion, the stored energy is released.

Kinetic Energy (energy in motion)

If an object moves, then by virtue of that motion it is capable of doing work.

Types of KE

1. **Vibrational** – This is the kinetic energy that is caused when an object is vibrating, or experiencing vibrational movement. An example of this would be a cell phone that vibrates. The cell phone will move slightly when accepting a call, and thus the energy created from its vibrations is kinetic vibrational energy.
2. **Rotational** – This is energy that is caused when an object is undergoing a rotational motion or movement. The wheel on a moving bicycle has kinetic rotational energy. Another example is the earth. As it rotates on its axis, the earth is in a constant state of kinetic rotational energy.
3. **Translational** – This is the kinetic energy that is most commonly discussed. It's the energy that occurs when an object is moving from one place to another. For example, a football that has just been kicked has translational kinetic energy.

Energy is measured in Joules, too.

In the process of doing work, an object producing the work exchanges energy with another object on which the work is done. Therefore, work equals energy.

III. Checking for Understanding

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

REMEMBER	What unit of measurement is used when measuring work and energy? (Class discussion)
UNDERSTAND	Which type of energy does the rock have when it is sitting at the top of the hill? What must be done for the rock to roll down the hill? When the rock is rolling down the hill, what type of energy does it have now? (Class discussion)
APPLY	Illustrate how work would be done on a classroom object. (Ex. Teacher or student lifts an object from the floor to table height.)
ANALYZE	Using a Venn diagram, compare and contrast potential and kinetic energy. **http://www.learninggamesforkids.com/graphic_organizers/writing/venn-diagram.html**
CREATE	Construct a drawing of something that might make work easier. (Teachers can ask students to draw their pictures on a sheet of paper. Ex. Ramp, pulley, etc.)

IV. Guided Practice Ideas

Recommended Items

Plastic Cup Bottle Launcher Experiment (see below)

Experiments

- **Plastic Cup Bottle Launcher Experiment**: **http://frugalfun4boys.com/2011/10/19/make-a-plastic-cup-rocket-launcher/**
- **Paper Plate Marble Track Experiment**: **http://frugalfun4boys.com/2012/09/05/paper-plate-marble-track/**
- **Magic Rollback Can Experiment**: **https://www.stevespanglerscience.com/lab/experiments/magic-rollback-can-sick-science**
- **Toy Experiment** to show potential to kinetic energy: **http://littleshop.physics.colostate.edu/tenthings/WhatIsEnergy.pdf**

Games

Interactive Game – Coaster Creator: **http://www.brainpop.com/games/coastercreator/**
http://discoverykids.com/games/build-a-coaster/

V. Independent Practice Ideas

Recommended Item

At-Home Scavenger Hunt: Students find household items with potential energy (see below)

Other Resources

Personal Practice

Potential vs. Kinetic Energy Worksheet and Answer Key provided

Practice That May Involve Parents or Guardians

- At-Home Scavenger Hunt: Students find 5 things in their home that have potential energy and list them on a sheet of paper. (Ex. A stretched rubber band, a ball at the top of the stairs, etc.)
- At-Home Activity: Are there more things in your home with potential energy or kinetic energy? Students observe things in their home and write one or two sentences on a sheet of paper describing their conclusion.

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if grades are desired.

- Potential vs. Kinetic Energy Worksheet and Answer Key provided
- Experiments found in section IV. Guided Practice

VII. Materials Needed

The following materials are needed for the **Plastic Cup Bottle Launcher Experiment** in “Recommended Items” in the Guided Practice Ideas section.

- 2 plastic cups
- Tape
- Two rubber bands

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

What is work and how is it done?

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WORKSHEET FOR WORK-ENERGY RELATIONSHIPS LESSON 1.5

NAME: _____

Potential vs. Kinetic Energy

Objective: Students will be able to explain energy and define, explain and list examples of potential and kinetic energy.

1. **Define and explain kinetic energy.**

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2. **Define and explain potential energy.**

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3. **Explain how mechanical energy works.**

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4. **Provide two examples of kinetic energy.**

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5. **Explain Newton's Third Law of Motion in your own words.**

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Answer Key

ANSWER KEY FOR WORKSHEET: POTENTIAL VS. KINETIC ENERGY

1. **Define and explain kinetic energy.**

   Ex. Kinetic energy is defined as energy in motion. It can be vibrational, rotational, or translational.

2. **Define and explain potential energy.**

   Ex. Potential energy is energy that is stored and held in readiness.

3. **Explain how mechanical energy works.**

   Ex. In the process of doing work, the object doing the work exchanges energy with the object on which the work is done.

4. **Provide two examples of kinetic energy.**

   Ex. A train going down the tracks, forcing a straw into a juice box, etc.

5. **Explain Newton's Third Law of Motion in your own words.**

   Ex. Newton's Third Law states that for every action force there is an equal, but opposite reaction force.