Energy Curriculum Grades 4-6 Part 1:
Motion & Position: The Basics of Energy

Teacher's Guide

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This teacher' guide coincides with an interactive SMART board presentation on Motion & Position: The Basics of Energy for 4th, 5th and 6th grade. The teacher's guide contains information to coincide with the content of the SMART board lesson, additional resources, and lesson extensions. The teacher's guide is designed to serve as a stand-alone resource, or can be used along with the SMART board presentation and/or student guide. Additional energy lessons and resources can be found at www.cceoneida.com.

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Objectives – Students will be able to:	Assessments
Differentiate between kinetic and potential energy and the ability to cause change	• Science journal entry where student notes the similarity they see during the anticipatory activity • Chart paper that requires each pair of students to write the commonality they found during anticipatory activity after discussing in a Think-Pair-Share
Develop a scientific experiment to test a given energy related question	• Observation of small group work • Chart paper, which will contain all steps of the experiment • Verbal explanation of the experimental steps

Lesson Content –

Students will understand:

Concepts

- kinetic and potential
- energy products bi-products
- energy cannot be created nor destroyed
- force
- weight
- temperature
- experiments

Generalizations

- Energy can exist as potential or kinetic
- Energy cannot be created nor destroyed
- Kinetic energy can produce bi-products
- Force can alter an object's energy
- An object's weight influences it's energy
- Experiments allow us to test predictions

Terminology with Definitions

- Energy—the ability to do work
- Kinetic energy—energy of motion
- Potential energy—energy of position
- Experiment—a structured way of testing a possible answer to a question
- Control—the part of the experiment that remains constant
- Variables—the part of the experiment that you change to test your prediction
- Prediction—the proposed answer to the question or problem
- Procedures—the steps you will take to test your prediction
- Results—how you record the results of your procedures
- Conclusion—a statement that describes if your prediction is true or false
- The Law of Conservation of Energy—energy can neither be created nor destroyed
- Force-energy or power exerted on an object
- Weight-amount of heaviness of an object

Key or focus questions

- How can you create an accurate experiment?
- How can you apply the results of your energy experiment to what you know about energy? How can you change the amount of kinetic energy of an object?

NYS Learning Standards

Science within Standard 4 Physical Setting

- 4.1 b Fossil fuels contain stored solar energy and are considered nonrenewable resources. They are a major source of energy in the United States. Solar energy, wind, moving water and biomass are some examples of renewable energy resources.
- 4.1d Different forms of energy include heat, light, electrical, mechanical, sound, nuclear and chemical. Energy is transformed in many ways.
- 4.1e Energy can be considered to be either kinetic energy, which is the energy of motion, or potential energy, which depends on relative position

Preparation & Materials

This lesson requires students to conduct experiments to answer questions about energy. Ahead of time preparation of material is required as described!

Question 1—Can kinetic and potential energy be transferred a limited number of times?
Materials box items: Question/direction sheet; plastic spoon and four marshmallows (to create a catapult); Matchbox car and 2x4 to be used as a ramp; spray bottle filled with water and pan.
Students should find that while an energy source can transfer energy from kinetic to potential and back, the energy can't be created or destroyed. That's an important concept called the Law of Conservation of Energy.

Question 2—Does an object's weight affect it's kinetic energy?
Materials needed: Question/direction sheet; four balls that appear identical, but are of varying weights, 2x4 and small blocks to construct a ramp, tape measure, stopwatch.
Students should learn that the heavier an object is, the more potential and kinetic energy it has.

Question 3-- Can you alter an object's kinetic energy?
Materials needed: question/direction sheet; wooden marble ramp with 1 marble; tape measure. Stopwatch
Students should discover that you can alter an object's kinetic energy by providing more force to its course

Question 5—Does the transfer of energy produce bi-products?
NOTE: A TEACHER'S ASSISTANT IS NEEDED TO ASSIST THE STUDENTS IN IMPLEMENTING THE PROCEDURES PORTION OF THIS EXPERIMENT
Materials needed: question/direction sheet; candle and match; electric tea pot and water; and find two more items in the classroom on which to test this prediction (i.e. computer, radio, small refrigerator)
Students should learn that the transfer of energy from potential to kinetic can result in bi-products.

Rationale & Time Frame

This lesson will take approximately 90 minutes to complete.

This lesson will begin by activating students' prior knowledge of kinetic and potential energy, as well as to address any misconceptions that exist regarding the topic (Llewellyn, 2007). Students will then discover how informal "tests" they conduct during their everyday life are like scientific experiments.

After students have a preliminary understanding of scientific experimentation, they will conduct their own energy-related experiment. They will use a box of open-ended materials and their knowledge of experimentation to examine a given problem and formulate a prediction and experiment to try to answer the problem. Each small group will experiment with a different aspect of energy, thereby exposing the class to several facts about energy.

The groups will conduct hands-on investigations to test predictions they will formulate regarding four ideas related to energy. These ideas will be the Law of Conservation of Energy, an object's weight in relation to its energy, ways to alter the amount of energy, and bi-products of energy transformation.

Small Cooperative Learning Groups will be utilized when students participate in a teacher-initiated inquiry exercise. Homogeneous groups will be created matching children with similar unit pre-test scores together. Utilizing this method allows students to appropriately develop and extend their interpersonal skills, while exploring the topic of energy in a way that will encourage students' innate

interest and inquisitiveness about science (Llewellyn, 2007).

Differentiated learning—the open-endedness of the small group exercise lends itself to allow students of various cognitive levels successfully complete the exercise. Groups will be given a specific question to investigate. All groups will investigate topics related to basic energy, but different concepts will be investigated; the difficulty of experimenting with the question will be based on the students' unit pre-test scores. (Tomlinson, 1999)

Learners with a variety of learning style, including interpersonal, logical, verbal-linguistic, and naturalistic learners will benefit from this lesson.

Lesson Plans

Page 3—What is Energy?

Have a ball, a book and a small pitcher of water (with pan) ready. Tell the students you want them to watch what you are going to do with the different items and think about what they all have in common. They will write their ideas in their science journal.
Toss the ball against the wall, and catch it as it comes back to me. Explain what I am doing, "The ball is setting in my hands. The ball is moving to the wall. The ball hit the wall. The ball is coming back to me. The ball is in my hands again." Do it one or two more times. Next, hold the book at chest level and drop it onto the ground. Again explain, "I'm holding the book. The book is falling. The book stopped when it hit the floor." Again, repeat a time or two. Finally, pour the water from the pitcher into an empty pan. Repeat by transferring the water back to the pitcher. Again, give a verbal explanation, "The water is in the pitcher. The water is moving from the pitcher to pan. The water is setting in the pan."
Give the students two—three minutes to jot down their ideas.
Review the ideas and list on the whiteboard. Depending on the ideas, provide the students with some hints—all of the objects were still, all of the objects were moving, all of the objects stopped.

Page 4—Energy of Motion, Energy of Rest

Explain to the students that all of the objects were sources of both potential and kinetic energy. Illustrate this using the examples. When the book is in my hands, it is at rest, it's not moving, so it's potential energy. What happens when I let go of the book? Do so and illicit responses from the class. Ask students to come up and verbally explain how the energy was transferred from one form, to another, and back again.

While energy can take many forms, including light, heat, chemical and motion, it all comes down to motion or rest. All energy falls into one of these two categories:
Potential
stored energy
energy of position or waiting
gravitational energy
Kinetic
is motion of waves, molecules & substances
Can exert force on the matter it comes in contact with

Page 5—Experiments!

Ask students if they think they informally use experiments in their own life? I'm sure they do! Ask the class if anyone has an

example of an "experiment" they have conducted at home. If not, or to help them think of some, give them an example of your own (i.e. my skin was really itchy, and I had changed by soap, lotion and laundry detergent all in the same week. How could I determine which item was causing my itchy skin?).

We conduct experiments all of the time in our lives without even knowing it. But today, you are all going to be scientists conducting energy experiments in our class!
Before we can do that, though, let's talk about experiments

Page 6—

There are components of experiments that are required for the experiment to be successful. Who can think of a part of an experiment? Solicit ideas from the class and write ideas on the board.

Page 7—The Makings of an Experiment

Let's talk about the specific parts of an experiment. Sort the parts of an experiment on the SMARTboard, and in doing so, talk in detail about each part of an experiment.

Part of Experiment:	Center discussion on.
Problem or Question	Here we state the problem or question that we want to investigate.
Prediction	Think of a possible solution or answer to your problem/question.
Variables	Variables are the things you can change; they are part of your problem, and the part of your prediction that you will test. Why is it important to only change one variable at a time?
Control	The control is the part of the experiment that remains constant—you don't change it.
Measurement	When thinking about your own examples, what are some other ways we can use measurement in experiments—distance, time, sound. Measurement always has to be consistent. Why is that important? (It becomes another variable if it's not consistent).
Procedures:	This is your step-by-step plan of action. What are you going to do to see if your prediction is correct or not?
Results:	This is where you actually implement your plan and start recording your results. What ways could you use to record your results? Graphs, charts, notes. It's important that your results are always measured in the same way (i.e. always use inches, not centimeters)
Conclusion:	This is a statement that fully answers the question, and can

	incorporate your prediction. Is ok for your prediction to be wrong? Yes! It happens to scientists all of the time. What is important is that you are following the steps of your experiment as you have written them up. An untrue prediction just means that a scientist would have to try to determine another prediction, thinking about other solutions, and test again!

If time allows, run through an example experiment as a class, allowing students to identify the different experiment components.

Now that we have an idea of what scientists do when they conduct experiments, we are ready to conduct our own!

Page 8—Energy—It's all around us!

Living things like people, animals and plants use energy, and so do non-living things—who can give me some ideas of non-living things that use energy? Briefly list some class examples on the board (i.e.—cars, computers, TV) . Prompt the students to offer a diversity of examples.

For this lesson, we are going to focus on non-living examples of energy.

Page 9—Questions About Energy

I have thought of some questions about energy I want you to experiment with. Here are the questions:

1. Can energy changed between kinetic and potential a limited number of times?
2. Does an object's weight play a role in the energy it has?
3. How can you alter the amount of an object's kinetic energy?
4. Do sources of kinetic energy produce bi-products?

We are going to be scientists studying different sources of energy. We are going to explore different ideas related to energy. Each group is going to conduct an experiment one of these questions, and at the end of class, we are all going to come back together to share our findings with the entire class.

It will be up to each group to form a prediction and follow an experiment through using the formula we talked about yesterday. Each group will have a recording sheet (the recording sheet is actually a sheet of chart paper that the groups will complete and present from) that they will have to complete.

Each group will receive a materials box and one of these questions. Take a look at the items in your box and then formulate your prediction. You can use all or some of the materials in the box to test your prediction.

Note: Small groups should be formulated by the teacher ahead of time. If homogeneous groups are utilized, the teacher should consider the group ability in relation to the question.

Page 10—Try it yourself—let's learn more about energy!

Discuss the logistics of group work.
Group rules-- respect, sharing work, welcome ideas

Group Roles--tiimekeeper, recorder, material handler and recorder.
You are free to choose your own roles, but try a role you haven't yet had.

Assign groups and get started!

Page 11—Experiment!

Set the stop watch to keep track of time for the groups. The groups will need at least 20 minutes to conduct their experiments.

Allow the groups to work on their independently, but move from group to group to observe group interaction, as well as to determine what prediction the group is making and how the group is testing their prediction. Be sure that all groups understand the terminology and steps of an experiment based on the entire experiment, not the success of a prediction.

Page 12-15—What did we learn?

Call on each group to explain their prediction, their test strategy, their results and their final statement. They may use the SMART board to illustrate information about their experiment, using text or graphics, or graphs.

Be sure that each concluding statement uses correct terminology and facts regarding energy.

At a minimum, guide discussion to the following results:
Question 1-- while an energy source can transfer energy from kinetic to potential and back, the energy can't be created or destroyed. That's an important concept called the Law of Conservation of Energy.
Question 2-- the heavier an object is, the more potential and kinetic energy it has.
Question 3-- you can alter an object's kinetic energy by providing more force to its course.
Question 4-- kinetic energy sources can give off bi-products. As we move on in our study of energy we are going to find out if the bi-products of energy are always good, always bad, or a mixture of both.

Page 16—Law of Conservation of Energy

The group with question 1 proved this law. Can you think of other examples that prove this law?

Page 17—Thermal Energy

Kinetic energy is not always visible.
When particles inside of an object move, they create thermal energy.

The more thermal energy an object has, the hotter it is.

Hold your hands up—what kind of energy do your hands have right now? (Potential). Now rub your hands together—what kind of energy are they producing now? (Kinetic) After rubbing for several seconds, ask students to feel their hands—they are hot—when particles inside an object more, they create thermal energy—a product of kinetic energy.

Question four proved that!

Pages 18—Temperature measures kinetic energy

Same oven, different temperatures.

Which oven has the greater kinetic energy?

How could we make the ovens have equal kinetic energy?

Page 17—Environmental Impact of Bioenergy

Energy is needed for many aspects of our daily life to go smoothly. Every day, most of us use energy for:

1. Fuel for transportation
2. Heating/cooling homes and other buildings
3. Electricity

But where does the energy come from? In our next lesson, we are going to learn about resources that provide us with the energy we need to do the things on this list.

Group Question/Direction Sheets

Experiment Question:

Can energy changed between kinetic and potential a limited number of times?

Use these directions to guide your experiment:

1. Make a prediction about what you want to know. (3 min)
2. Chose your control, your variable(s) and your method of measurement (3 min)
3. Formulate your procedures (3 min)
4. Test your prediction and record your results. (7 min)
5. Review your results and form your concluding statement. (4 min)

Does an object's weight play a role in the energy it has?

Use these directions to guide your experiment:

1. Make a prediction about what you want to know. (3 min)
2. Chose your control, your variable(s) and your method of measurement (3 min)
3. Formulate your procedures (3 min)
4. Test your prediction and record your results. (7 min)
5. Review your results and form your concluding statement. (4 min)

How can you alter the amount of an object's kinetic energy?

Use these directions to guide your experiment:

1. Make a prediction about what you want to know. (3 min)
2. Chose your control, your variable(s) and your method of measurement (3 min)
3. Formulate your procedures (3 min)
4. Test your prediction and record your results. (7 min)
5. Review your results and form your concluding statement. (4 min)

Do sources of kinetic energy produce bi-products?

Use these directions to guide your experiment:

1. Make a prediction about what you want to know. (3 min)
2. Chose your control, your variable(s) and your method of measurement (3 min)
3. Formulate your procedures (3 min)
4. Test your prediction and record your results. (7 min)
5. Review your results and form your concluding statement. (4 min)

References & Resources

Berk, Laura E. (2008). *Infants, Children, and Adolescents, sixth edition.* Pearson Education, Inc.

Llewellyn, D. (2007). *Inquire Within, second edition*. Corwin Press.

Tomlinson, C. (1999). The Differentiated Classroom: Responding to the Needs of All Learners. ASCD.