Energy Detectives

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Subject: General Science
Level: Upper Elementary, Middle School
Standards: New York State- Elementary Science (www.emsc.nysed.gov/ciai/)
  Standard 1- Analysis, Inquiry and Design
  Standard 4.5- The Energy and matter interact through forces that result in changes in motion
  Standard 7- Interdisciplinary Problem Solving

Schedule: 1hr (not including presentations)
1hr for poster presentations

Objectives:

- Energy is found in several basic forms.
- Energy, in various forms, is always present.
- Energy cannot be created or destroyed.
- Understanding energy sources and how energy changes form is important in every day life.
- Energy is described using different units.

Students will:

- Work in independent groups to learn more about energy.
- Create a poster that describes a real life situation in terms of energy.
- Present their poster to the class.

Vocabulary:

<table>
<thead>
<tr>
<th>Energy</th>
<th>Degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output</td>
<td>Volts</td>
</tr>
<tr>
<td>By-product</td>
<td>Watts</td>
</tr>
<tr>
<td>Energy Source</td>
<td>MPH</td>
</tr>
<tr>
<td>Mechanical Energy</td>
<td>Horse Power</td>
</tr>
<tr>
<td>Chemical Energy</td>
<td>Meters</td>
</tr>
<tr>
<td>Electrical Energy</td>
<td>Calories</td>
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<tr>
<td>Biological Energy</td>
<td></td>
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<tr>
<td>Thermal Energy</td>
<td></td>
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<tr>
<td>Gravitational Energy</td>
<td></td>
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<tr>
<td>Energy Conversion</td>
<td></td>
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</tbody>
</table>

Materials:

For Each Group:
One of 8 blank energy scenario posters
Wet erase markers
Pens
Markers

For the Class:
Energy Station Signs
Post-it notes
Masking tape
Blank Paper
String
Scissors

Safety:

There are no safety concerns for this activity.
Science Content for the Teacher:

Taken from Wikipedia: www.wikipedia.com

Energy (General):

In physics and other sciences, energy is a scalar physical quantity that is a property of objects and systems which is conserved by nature. Energy is often defined as the ability to do work.

Several different forms of energy, including kinetic, potential, thermal, gravitational, sound energy, light energy, elastic, electromagnetic, chemical, nuclear, and mass have been defined to explain all known natural phenomena.

Energy is converted from one form to another. This principle, the conservation of energy, was first postulated in the early 19th century, and applies to any isolated system. According to Noether's theorem, the conservation of energy is a consequence of the fact that the laws of physics do not change over time.

Although the total energy of a system does not change with time, its value may depend on the frame of reference. For example, a seated passenger in a moving airplane has zero kinetic energy relative to the airplane, but non-zero kinetic energy relative to the earth.

Thermal Energy:

In thermal physics, thermal energy is the energy portion of a system that increases with its temperature. In a loose sense, "thermal energy" is a term used to describe the energy content of a system related to heating effects, e.g. temperature increase or decrease.

"Thermal energy" can only be defined as any spontaneous flow of energy (energy in transit) from one object to another, caused by a difference in temperature between two objects; thus, an object cannot possess "heat". Therefore, it is difficult to define quantities of heat energy (thermal energy).
Electrical Energy:

The electric potential energy of given configuration of charges is defined as the work which must be done against the Coulomb force to rearrange charges from infinite separation to this configuration (or the work done by the Coulomb force separating the charges from this configuration to infinity).

If an electric current passes through a resistor, electric energy is converted to heat; if the current passes through an electric appliance, some of the electric energy will be converted into other forms of energy (although some will always be lost as heat).

Mechanical Energy:

When a given amount of mechanical energy is transferred (such as when throwing a ball, lifting a box, crushing a soda can, or stirring a beverage) it is said that this amount of mechanical work has been done. In physics, mechanical work is the amount of energy transferred by a force.

Both mechanical energy and mechanical work are measured in the same units as energy in general. It is usually said that a component of a system has a certain amount of "mechanical energy" (i.e. it is a state function), whereas "mechanical work" describes the amount of mechanical energy a component has gained or lost.

Chemical Energy:

Chemical energy is the energy due to associations of atoms in molecules and various other kinds of aggregates of matter. It may be defined as a work done by electric forces during re-arrangement of electric charges, electrons and protons, in the process of aggregation. If the chemical energy of a system decreases during a chemical reaction, the difference is transferred to the surroundings in some form (often heat or light); on the other hand if the chemical energy of a system increases as a result of a chemical reaction - the difference then is supplied by from the surroundings (usually again in form of heat or light).
Biological Energy:

Any living organism relies on an external source of energy—radiation from the Sun in the case of green plants; chemical energy in some form in the case of animals—to be able to grow and reproduce. The daily 1500–2000 Calories recommended for a human adult are taken as a combination of oxygen and food molecules, the latter mostly carbohydrates and fats.

Chemical energy in the carbohydrate or fat is converted into heat: the ATP is used as a sort of “energy currency”, and some of the chemical energy it contains when split and reacted with water, is used for other metabolism (at each stage of a metabolic pathway, some chemical energy is converted into heat). Only a tiny fraction of the original chemical energy is used for work.

Gravitational Energy:

Gravitational energy is the potential energy associated with gravitational force. If an object falls from point A to point B inside a gravitational field, the force of gravity will do positive work on the object and the gravitational potential energy will decrease by the same amount.

For example, consider a book, placed on top of a table. When the book is raised from the floor to the table, the gravitational force does negative work. If the book is returned back to the floor, the exact same (but positive) work will be done by the gravitational force. Thus, if the book is knocked off the table, this work (called potential energy) goes to accelerate the book (and is converted into kinetic energy). When the book hits the floor this kinetic energy is converted into heat and sound by the impact.

The factors that affect an object's gravitational potential energy are its height relative to some reference point, its mass, and the strength of the gravitational field it is in. Thus, a book lying on a table has less gravitational potential energy than the same book on top of a taller cupboard, and less gravitational potential energy than a heavier book lying on the same table. An object at a certain height above the Moon's surface has less gravitational potential energy than at the same height on Earth because the Moon's gravity is weaker. (This follows from Newton's law of gravitation because the mass of the moon is much smaller than that of the Earth.) It is important to note that "height" in the common sense of the term cannot be used for gravitational potential energy calculations when gravity is not assumed to be a constant. The following sections provide more detail.
Preparation:

- Distribute Energy Station Signs evenly around the room to encourage students to progress between stations without disrupting each other.

- Make poster making materials (post-its, markers, scissors, etc) available at one location in the room, or distribute these materials to each group separately.

Classroom Procedure:

This activity is designed as an introduction to thinking about energy in a scientific way.

Engage (Time: 15 minutes)

- Begin a discussion with students about energy by asking what they know about it. What comes to mind when they think about energy?
- Tell students that energy is the ability to do work and that “work” can mean a lot of different things
- Give students the example of the toaster. What is the “work” that a toaster does? It heats up bread, turning it into toast. Heating up takes energy. Where does that energy come from? The electricity from the outlet the toaster is plugged into.
- Point out to students that when they start to think about energy at this level, they will begin to notice that energy is all around us, in objects as well as systems (such as our body).
- Explain that, working in groups, students will create a poster to help explain the energy present in several different scenarios. Groups will have to work as detectives to trace the energy throughout a process like that of the toaster toasting the bread. The stations around the room will provide clues and instructions to help them along the way.
Explore (Time: 30 minutes)

- Before students begin visiting the stations, explain to them about the materials available to them for developing their posters.
- Give a very brief explanation (most of the learning should be independent) for each of the stations and reassure students that you will be available to answer any questions.
- Suggest that before visiting the stations, each group should draw simple a diagram (you may want to model this on the board with the toaster example) to go in the center of their poster.
- Allow students to visit stations and develop their poster.

Explain (Time: 5-10 minutes per group)

- Each group takes 5-10 minutes to present their poster.
- Groups are responsible for describing:
  1. outputs and by-products
  2. units of energy (why what they chose is the appropriate choice)
  3. energy sources
  4. forms of energy present
  5. where energy is converted (students should explain this chronologically at the end of their presentation)
- Classmates should be encouraged to ask questions and make constructive comments.
Assessment:

The following rubric can be used to assess students during each part of the activity. The term “expectations” here refers to the content, process and attitudinal goals for this activity. Evidence for understanding may be in the form of oral as well as written communication, both with the teacher as well as observed communication with other students. Specifics are listed in the table below.

1= exceeds expectations
2= meets expectations consistently
3= meets expectations occasionally
4= not meeting expectations

<table>
<thead>
<tr>
<th>Engage</th>
<th>Explore</th>
<th>Explain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shows leadership in the discussion and offers creative ideas reflecting a good scientific understanding energy.</td>
<td>Completes work accurately and completely. Contributes greatly to the depth and quality of the poster. Works very well with group.</td>
</tr>
<tr>
<td>2</td>
<td>Participates in the discussion and shows an understanding of energy’s role in everyday life.</td>
<td>Completes work accurately and completely. Works cooperatively with group.</td>
</tr>
<tr>
<td>3</td>
<td>Contributes to the brainstorm, but shows little understanding of energy.</td>
<td>Contributes somewhat to the development of the poster. Works cooperatively with group.</td>
</tr>
<tr>
<td>4</td>
<td>Does not participate in brainstorm. Shows no understanding of energy.</td>
<td>Has trouble working with group. Does little to complete the poster.</td>
</tr>
</tbody>
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Safety:

There are no safety concerns associated with this activity.

Acknowledgments:

Wikipedia (www.wikipedia.com)