Lesson Plan: Forms, States, and Conversions

Concepts

1. Energy can be neither created nor destroyed, but converted from one form to another. This can be represented as the first law of thermodynamics.
2. Energy can be classified by its form or state.
3. Energy is stored in a variety of ways and must be released to do useful work
4. The seven major forms of energy are: sound, chemical, radiant (light), electrical, atomic (nuclear), mechanical, thermal (heat). Remembered as "SCREAM Today"
5. The two states of energy are potential and kinetic
6. Energy can be converted to useful forms by various means.
7. Energy and its conversion between forms can be expressed quantitatively.
8. When converting energy, a significant fraction of that energy can be lost from the system (in the form of heat, sound, vibration, etc.)

Key Questions

1. Can energy be transformed/converted from one form to another?
2. What types of conversion processes can be used to convert energy into a more usable form?
3. What forms of energy losses can occur during an energy conversion?
4. How is heat related to combustion?
5. How can energy conversions be modeled with block diagrams?

Student Learning Objectives
Students will be able to describe at least three examples of how energy is converted from one form to another.
Students will be able to demonstrate and diagram the conversion of energy into usable forms using a flowchart.
Students will be able to state the law of conservation of energy.
Students will be able to identify seven forms and two states of energy.
Students will be able identify the form and state of energy in everyday items as we use them to do useful energy.

Educational Standards

- NSES Science (5-8): B3.1, B3.4, B3.5

Anticipatory Set

- Students have learned about energy, work and power.
- Energy has 7 primary forms and 2 states
- Energy must be converted to make it usable.

Key Terms

Vocabulary

Block Process Flow Diagram	A physical representation of inputs and outputs of a process, used by engineers.
Chemical energy	Energy stored within chemical bonds.
Combustion	The process of burning organic chemicals to release heat and light.
Conservation	Careful use of resources with the goal of reducing environmental damage or resource depletion.
Efficiency	Ability of a process or machine to convert energy input to energy output, efficiency is always less than 100% in real processes. Efficiency of a system can be quantified as the ratio of the useful output energy (or power) to the input energy (or power)
Electrical energy	Energy made available by the flow of electric charge through a conductor.
Electromagnetic energy	A form of energy that is reflected or emitted from objects in the form of electrical and magnetic waves that can travel through space Examples include gamma rays, x rays, ultraviolet radiation, visible light, infrared radiation, microwaves and radio waves.
Energy Conversion	Transformation of one form of energy into another, usually to convert the energy into a more useful form
First Law of Thermodynamics	Energy can neither be created nor destroyed.
Forms of energy	Primary forms of energy include thermal (heat), radiant (light), electrical, mechanical, atomic (nuclear), sound and chemical
Heat energy	A form of energy related to its temperature. More formally described as thermal energy
Input	Matter or energy going into a process
Kinetic energy	Energy of motion, influenced by an objects mass and speed
Mechanical energy	A form of energy related to the movement of an object
Nuclear energy	Energy produced by splitting the nuclei of certain elements
Output	Matter or energy coming out of a process
Potential energy	Energy that is stored and that comes from an object's position or condition.
Radiant Energy	Energy transmitted to the Earth from the Sun by light (or by any source of light). Light is also a subset of electro-magnetic radiation

Sound energy	the energy of vibrating sound waves
State of energy	States of energy include kinetic and potential

Teaching Plan:

General Plan

- Day 1: Introduce Forms and States – lots of demonstrations.
- Day 2: Combustion Demo and Forms and Conversion Activity

Day 1:

- Introduction to Forms, States and Conversions of Energy
  - Introduce the concept of **states of energy**
    - potential (stored energy) (hold ball up)
    - kinetic (energy in motion) (drop ball)

    In some classes giving the equations for potential and kinetic energy reinforces that mass, height, and velocity affect the values

$$PE = mass * gravity * height$$

$$KE = \frac{1}{2} * mass * velocity^2$$

  - Ask some exploratory questions with demonstration

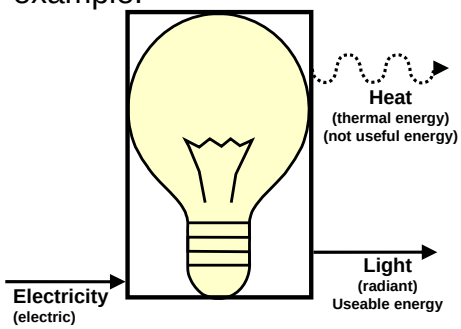
    - If I drop a bowling ball and a golf ball from the same height, which will have more potential energy? (the bowling ball) What about kinetic energy? (the bowling ball)
    - If I drop 2 golf balls from different heights which will have more PE? (the higher one)
    - If I drop one golf ball, and throw the other one down from the same height, which has more KE? (the thrown one)

  - Reinforce the concept of potential and kinetic energy by doing a cup-crushing demo.
    - Place a cup on the floor and hold a small weight or baseball, 6 inches above the paper cup.
    - Drop the ball and point out that the ball starts out with potential energy and converts to kinetic energy
    - Repeat for a height of 12 inches and 36 inches (use some sort of tube or pipe to direct the weight so it stays on course!).
    - Ask the students to predict the behavior
    - Now use a bowling ball, or heavier weight.
    - This is a good time to refresh (or introduce, if you did not get to it during the human power activity) the concept of acceleration due to gravity. Use the traditional "Newton experiment" with a baseball and a piece of crumpled paper
    - Have 2 students come to front of room, give one the ball and the other the paper (tightly crumpled). Ask the class which one will fall to the floor faster when dropped? Why? (They both should hit the

floor at the same time – the acceleration due to gravity is constant.)

- All energy also has a **FORM** – there are 7 *forms* (NYS standards): sound, chemical, radiant (light), electrical, atomic (nuclear), mechanical, thermal (heat). Remembered as "**SCREAM T**oday"
  Sound – from vibration of sound waves
  Chemical (fuel, gas, wood, battery)
  Radiant (light) (note – this is part of the broader "electromagnetic" group)
  Electrical Energy (electrons move among atoms – as in the conductive wire of an electrical cord)
  Atomic (Nuclear) (from nucleus of atom)
  Mechanical (walk, run)
  Thermal (Heat) (rub hands together)

- Emphasize that electricity is just a way or transporting energy, but is not an energy SOURCE
- Use various tools, appliances, and materials to introduce the students to the forms, and states of energy. Possible demonstrations or discussion topics are electrical appliances (light bulb, blender, hairdryer, toaster, etc.); human movement; a fire; and a roller coaster. For at least a few of them, draw a process flow diagram that identifies the forms/states of energy going into the device and those coming out of the device. For example:



Day 2:

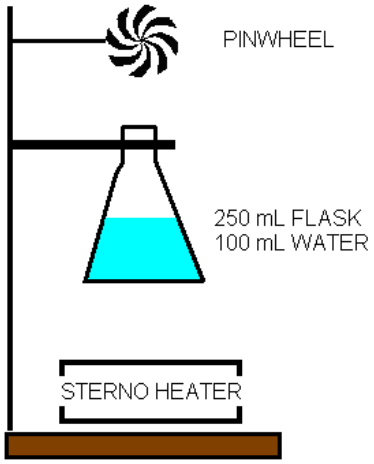
- Introduce Energy Conversions
  - State the law of conservation of energy: **Energy can neither be created nor destroyed….**But it can be converted!
  - Relate back to the Energy Forms and energy flow diagrams discussed earlier
    - The items had different starting and ending energy forms in some cases. There were conversions going on. (The truck has chemical energy being converted to mechanical and heat through the COMBUSTION of fuel).

- Energy conversions are necessary when we desire a certain form or state of energy (example – heat for our house) but the only form available is different (chemical energy in fuel).
- Conversions are also useful for transporting energy to where it is needed. For example the hydropower plant in Massena is miles from our home, so how do use its energy? We convert its mechanical energy (flowing water) to electromagnetic, which is easily transported to our home, and then back to mechanical energy in our blenders.

- Do the Combustion Demo to illustrate how we can add conversion processes to our energy flow diagrams

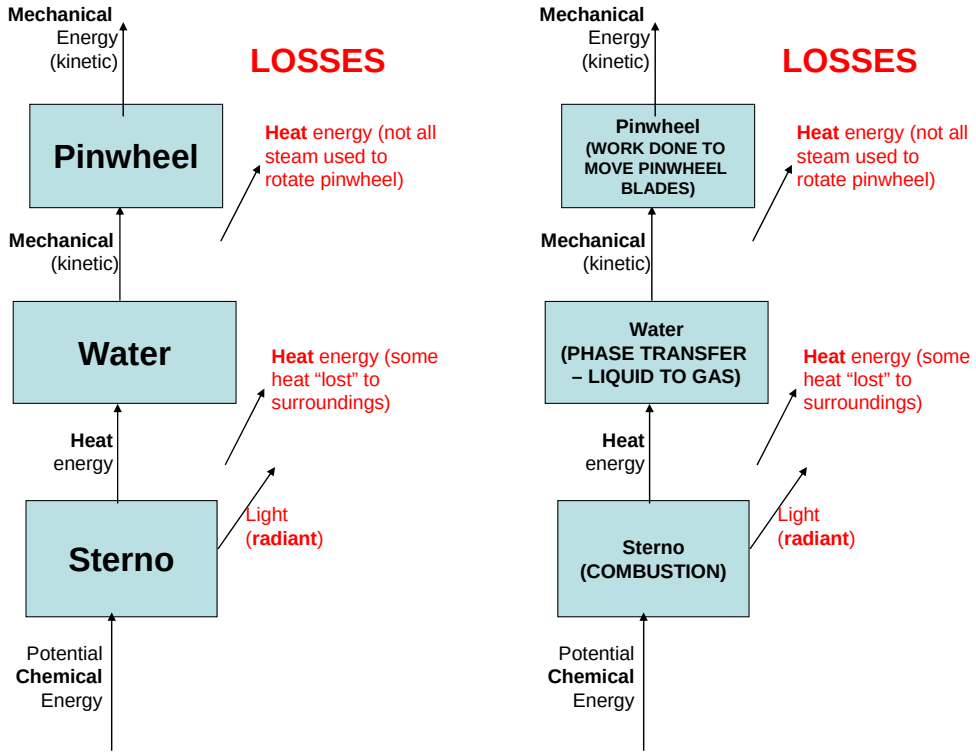
  Note: Heat water before the start of the class to speed up the boiling process. Use a flask with a narrow top to concentrate more of the steam to the pinwheel. Ask teachers about a stand and clamps. Use a paperclip or tape to connect the pinwheel to the stand. Use lighter provided to ignite the sterno heater. Make sure to have the step-up done before you light the heater.

  - Set-Up



  - Draw energy flow diagrams starting with various **forms** of energy. Students should be able to help define the forms and states.

Block Diagram for Combustion:



We already know about **Forms** of energy in this process (on left), now we have to define the **conversion processes** (see added words on right figure). This model is similar to a coal fired power plant. There would be one more step – the steam would rotate a turbine that has magnets and coils of copper wire. The moving magnetic field causes electrons in the copper to wiggle, thereby creating an electric potential (voltage)

- Discussion Topics
  - Who knows what important process is happening between the different forms of Energy? State that this conversion is something we use today. Relate it to our use of fossil fuels and the specific combustion process.
  - Make sure students understand that there are energy 'losses' (energy is converted to an undesired form) as the energy is converted from one energy form to the next.
- Use this demonstration as a model for the Energy Forms and conversions activity.
- Explain that we can model many different energy conversions in household appliances.

- Energy Conversions Activity
  - Have the students look at 4 different energy conversions and fill in the appropriate information for each conversion on the activity sheet.
  - You can select different objects for each station depending on what is available at the moment. Some examples are:

- Flashlight (Chemical to Electric to radiant (chemical reaction inside battery)
- Shaking flashlight (mechanical (work to move magnet) to electric to light (radiant) (electrical resistance in light bulb)
- Light-Solar Panel-Lego Motor Set-up (radiant (light) to electric to mechanical)
- Personal Heat Packet (Chemical to thermal (Heat) (exothermic chemical reaction))
- Genecon Generator (Mechanical (do work to move magnet) to Electric)
- Hairdryer (Electric to Thermal (Heat) and Motion (electrical resistance in wire to create heat, work done by fan to move air))
- Glow Stick (Chemical to radiant (light) (chemical reaction))

o Stress that conversions end with a 'usable' and 'unusable' form of energy. Reiterate that energy is never lost.
o In a large class assign each group one station. For smaller classes the groups can rotate between stations.
o Tell them to use the same block diagram procedure for each object. It should be diagramed in the space provided
o Once they have the information for their station (or all stations) have each group present a station to the rest of the class.
o Make sure that they can identify the forms and states. Also ask them to show where potential energy loses may occur.

Resources

Energy Forms and Conversions Activity

URL

All lesson plans in this unit are included at
http://www.clarkson.edu/highschool/k12/project/energysystems.html

This URL has been included in the Engineering Pathways web site (http://www.engineeringpathway.com/ep/index.jhtml) and can be found with a search on "energy choices."

Owner

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Contributors

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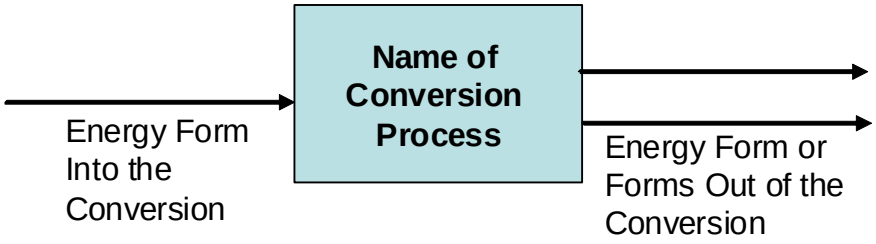
Activity: Energy Forms and Conversions

Purpose

Energy conversions are constantly occurring around us to transform one form of energy into another. In this activity you will learn about some of the most common forms and conversions. These conversions change energy from one energy form to another in hopes to attain energy that is more useful to us.

Procedure

1. Students will break into groups of three, each group going to one of the appropriate tables
2. Each table has an appliance or machine that shows a specific energy conversion. Students should fill out the table according to what they think is the correct starting and ending form of energy and the conversion process involved. A block diagram of each conversion should be drawn with forms and conversion process labeled.



3. Each group will be asked to present one of the example conversions.
4. Students should take notes on what the other groups present, in order to check their own answers.

Discussion Questions

1. What is 'usable' energy?

2. Provide at least three examples of various forms of energy that are directly useful for human activities

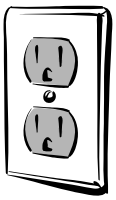
3. Name 2 situations where an energy form is not useful?

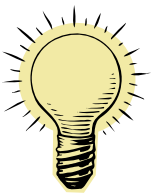
4. What were the most common forms of energy encountered in the examples you observed?

5. What does it mean when we say that energy is ‘conserved’?

6. We often say that “energy is lost”. Is this a scientifically correct explanation? Explain your answer.

Name_____ **Date**_____





Object Name	Starting Energy Form	Conversion process	Usable Form of Energy	Non-Usable Form of Energy
1.				
2.				
3.				
4.				