YOUNGSTOWN CITY SCHOOLS

SCIENCE - - GRADE 9

Unit 4: ENERGY (5.5 WEEKS)

SYNOPSIS: Students investigate conservation of energy, transfer of energy and thermal energy; the key vocabulary terms are incorporated as each concept is introduced. Students create a demonstration to show potential and kinetic energy and design an "Energy Savers Guide for Homeowners on how prevent the loss of heat in their homes.

STANDARDS

II. ENERGY AND WAVES

A. Conservation of energy

1. Kinetic energy can be quantified.
   a. energy has no direction; it is measured in units of Joules (J)
   b. $E_k = ½ mv^2$
2. Quantifying gravitational potential energy is displayed by $E_g = mgh$
3. Energy is relative.
   a. an object's energy is measured relative to a reference (point of zero energy)
      (1) reference may change in different situations
      (2) only the change in amount of energy can be measured absolutely
   b. use conservation of energy and equations for kinetic and gravitational potential energy - -
      (1) to calculate values associated with energy (i.e., height, speed, mass)
      (2) for situations involving energy transfer and transformations
      (3) to quantify energy from data collected in experimental situations (e.g., swinging pendulum, a car traveling down incline)

B. Transfer and transformation of energy (including work)

1. If the force = F, and displacement = Δx, and they are in the same direction, work can be displayed as $W = F\Delta x$.
2. Use pie graphs or bar graphs to represent energy transformations.
3. Solve problems by combining equations for work, kinetic energy, and potential energy with the law of conservation of energy.
4. When energy is transferred from one system to another, some energy is transformed to thermal energy, but it is less organized and unavailable for doing useful work, and the total amount of energy remains constant.

D. Thermal energy

1. Transfer of thermal energy occurs during heating, cooling, and phase changes.
2. Thermal energy transfer occurs until thermal equilibrium is reached.
3. Thermal conductivity is the rate at which thermal energy is transferred from one material to another (i.e., conductors vs. insulators).
4. Whether there is absorption or emission of thermal energy depends on temperature, color, texture, exposed surface area (i.e., black, rough vs white, smooth).
5. Objects or systems continually absorb and emit thermal radiation.
   a. if they absorb more than they emit, there is no phase change, and the temperature increases
   b. if they emit more than they absorb, there is no phase change, and the temperature decreases
   c. if the amount absorbed equals the amount emitted, thermal equilibrium results, and the temperature is constant

LITERACY STANDARDS: READING (RST) and WRITING (WHST)

RST.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text. (goes with IID1, 2, 3)

RST.9 Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts (goes with IID1)

WHST.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (Goes with IID3)

VOCABULARY: Post words in room and leave up for the unit. Create a word wall where students know to look for new words.

Address roots and affixes of new words
Use a diagram to show meaning of new words
Relate the new word to a similar and/or familiar word
In the course of teaching, define the word in the context of where if falls in the unit rather than in isolation
Throughout the teaching of the unit, use the word in conversation/discussion
Require students to use the word(s) in: discussion, investigations, and in 2-and 4-point response questions
Use new words in Rubric for the Authentic Assessments

ENERGY UNIT VOCABULARY

Technical Words		Other Words
Energy	Work	Quantified
Kinetic Energy	Insulator	Relative
Thermal Energy	Convection	Constant
Potential (Gravitational) Energy	Joules	Exposure / Expose
Conservation of Energy	Transfer	Mass
Transformation	Radiation	Weight
Equilibrium	Absorption	Molecular Structure
Conductor/Conductivity		

MOTIVATION	TEACHER NOTES
1. Students locate pictures to show different types of energy (to be revisited later) **OR** have students use digital technology and take pictures of different types of energy and classify the pictures later in the unit. 2. Teacher shows a video clip from InfoOhio (e.g., sporting event, cars going down the road, construction workers, etc) to connect energy to students' real life; ask students to think of ways they can use energy. Students are asked to show how they use energy (e.g., climbing the stairs or any physical activity, producing a normal body temperature of 98.6 degrees, or maintaining the living condition to stay alive?) Ask students to show examples where energy is being released by something they do (e.g., burning a piece of paper, using gasoline in the car, turning on the TV). 3. Students do a ball toss in a group to show potential and kinetic energy. The ball toss shows the transfer of energy from the thrower to the ball to the receiver. Other examples can be used to show potential energy due to **position** (dropping a dime off the Empire State building compared to dropping it off the roof; drawing a bow, bowling position prior to release of ball, etc.) **elastic condition (**something that stretches and is released **- -** sling-shot; the more stretch you put into it the faster it will go), or **chemical composition(**chemicals in foods are broken down to mechanical energy; battery converts chemical energy to electrical energy, etc.) with the kinetic energy which results. A windup toy can be used to show relationship between potential and kinetic. Compare a few windings with a greater amount of windings. The toy will go faster or farther. 4. Students establish both academic and personal goals for this unit 5. Teacher previews the Authentic Assessments for the end of the Unit	

TEACHING-LEARNING	TEACHER NOTES
1. <u>Energy and Work</u>: Teacher demonstrates with students what <u>energy</u> and <u>work</u> are by having one student not moving; another student shifting a ball from hand-to-hand; another student touching his/her toes; 1 student walking a short distance and returning; one student standing in one spot but shifting weight from one leg to another. Also, show one student studying, one daydreaming, and one student reading a book. Ask students in the class who is doing work and who is not to see if students know what work is. Teacher explains that energy is ability to do	

TEACHING-LEARNING	TEACHER NOTES
work and students relate energy to the students who were at the front of the class. Students record definitions for work and energy in their notebooks. Work Formula: ($W = F\Delta x$): Teacher clarifies what work is; use example of moving a refrigerator and add real-life problems for students to work such as pushing a stalled car, throwing a ball, lifting a gallon of water, lifting weights, etc) **(IIB1, 3)** Students must solve problems by combining equations for work, kinetic energy, and potential energy with the Law of Conservation of Energy. 2. Measure and calculate kinetic and potential energy: Teacher lectures on Joules, Kinetic Energy ($E_k = ½ mv^2$) and Potential Energy ($E_g = mgh$), showing students how to use the formulas. Students take notes and work sample problems. Connect to real-life example, (e.g., moving a refrigerator, pushing a stalled car); then use some examples that don't involve people doing something but ones they have observed in everyday life (e.g., snowplow pushing snow, crane hoisting beams, escalator in department store) **(IIA1)** Students complete lab on Kinetic and Potential energy (e.g., pushing something up a ramp, rolling cars down a ramp, marbles down a rule, students running or walking up steps); students vary the height and length of a ramp and make calculations for potential and kinetic energy. **(IIA1, 2)** 3. Energy is Relative: Teacher demonstrates that energy is relative by e.g., lying on the table to show no energy, then moving to show that the person has energy when he/she moves. Measuring kinetic energy and using this calculation to show change illustrates that energy is relative. In order to measure kinetic energy and understand what the measurement means, students must first investigate the variables that are involved: the mass of the object and the velocity of the moving object. If one were to roll a matchbox car down a ramp, it would be necessary to measure the mass of the object, determine the velocity of the moving object, and calculate the kinetic energy. After conducting several trials of the same set-up, they can **change** the mass or they can **change** the height of the ramp to see how those changes affect the kinetic energy. Then students can summarize how the changes in the variables affected the kinetic energy. **(IIA3a)** 4. Conservation of Energy: Use Newton's Cradle to show conservation of energy; students predict what will happen with 2 balls or 3 balls, etc. and why. **(IIA3b)** Another option might be if the teacher shows students with just a few balls and then gives them the chance to try this out. Students can try different combinations (the number of balls falling and/or the ones being hit, the height of the ramp being altered on one or both sides). 5. Energy cannot be created or destroyed, only changed from one form to another: Students have the misconception that once something stops doing what is it doing, there is no energy; Use a series of lab stations for students to investigate: a flashlight, a video of a burning a piece of wood, turning on or off a computer, pop with ice, eating a piece of food, etc.. Students pair up and examine each station and explain how each is an example of conservation / transfer of energy. They compare one of the stations to all of the others in terms of: (a) energy involved (kinetic/potential); (b) when does change occur; (c) what is the change? Include other less common examples involved with energy: gravitiational (e.g. an elevator descending, a meteor falling from space), sound energy (e.g., jet breaking the sound barrier, an explosion), light energy (e.g., a star, black light), mechanical (e.g., earthquake, tsunami). **(IIA3b)** 6. Thermal Energy: Teacher demonstrates thermal energy using a paper clip, bending it to show that the clip gets warmer at the bending / breaking point; rubbing hands together; holding an ice cube in one's hand and asking why does the ice cube melt - - students explain what happens in	

TEACHING-LEARNING	TEACHER NOTES
each instance and why after reading text on thermal energy, radiation, convection, and conduction. Students then compare what was read with examples shown in class, noting findings and how they support or contradict previous explanations. Students look for transfer of thermal energy in the world (e.g., sunlight, uneven heating of land and water, hot and cold fronts, circulation of water from the equator to the poles, differences in climates, seasonally changes) and associate the types of transfer of energy involved. Relate thermal energy transfer to a heating system in a home, and illustrate convection. **(article attached on page 6 of unit plan) (IIB4) (RST.9)** 7. Phase Change and Transfer of Thermal Energy: Students heat water to 80°C; pour equal amounts into containers of: Styrofoam, aluminum, plastic, and glass. Students then record the temperature of the water in each container as it cools by taking a reading every 30 seconds; students graph data in a line graph for each type of container and then draw two inferences from the collected data. **(IIB2, IID1) (RST.3)** 8. Teacher provides instruction on **conductors and insulators**; students take notes. Following this, the teacher asks questions: **(IID3)** (1) What do you think the difference is between the containers in terms of those that serve as **insulators** and those that are **conductors**? (2) What do you think molecular structure might look like? (NOTE: This may not be done this first year, as students will not have had the background at middle school). They may need to see a model or diagram to understand this. (3) What is the best substance to keep liquid hot the longest? Students should calculate the rate at which thermal energy is transferred from one material to another for each container and determine the extent of **insulating or conducting properties** for each type of container. 8. Students create a pie graph to show proportion of students who found a certain container to retain heat the best **(IIB2)** 9. Students heat water to 80°C, and pour into glass containers, one covered with black paper and one covered with white paper; one container gets warmer (absorption). Another student sets up containers covered with felt and silk; students measure the temperature every 30 seconds to determine the heat loss and graph results. Students then use the graphs to compare heat loss in different types of containers. **(IID4)** 10. Students compare different substances in terms of energy transformation by completing an investigation outside on a sunny day with little or no wind using blacktop, grass, and concrete. They determine heat in a substance and heat given off by that substance. Students then write a report on one of the results and compare their results to all others' results and discuss why they might be alike or different. **(WHST.5)** Students should include air temperatures at varying distances from the surface: on the surface, 3 cm above surface, 5 cm above surface. Since a phase change should be included with this activity, an ice cube, shallow plate of water, and/or a wet paper towel can be placed on the surface to see if a phase change occurs. **(IID1)** 11. Give Traditional Paper-Pencil Test after this!	

TRADITIONAL ASSESSMENT	TEACHER NOTES
Traditional Paper-Pencil test with multiple-choice and 2- and 4-point questions	

AUTHENTIC ASSESSMENT	TEACHER NOTES
1. Describe a demonstration using readily available materials to illustrate both kinetic and potential energy. Include **- -** a. a list of materials needed b. clear and precise directions for set-up and performance, including a diagram as needed c. a demonstration of kinetic energy d. a demonstration of potential energy e. a statement telling why/how the demo will clarify the differences between the two types of energy. **(IIA1, 2)** 2. Design an "Energy Savers Guide" for Youngstown City Schools. **(II D 4)** Pick a building with which you are familiar. Design a guide to save energy in and around the building. You may NOT rebuild the building. Your guide must include a. multiple ideas to save energy that are **- -** 1. logical (valid, likely to succeed) 2. practical (do-able for the average person) b. anticipated savings inside the building c. anticipated savings outside the building d. why this is important to do	

LEVELS OF QUESTIONS		
CONVERGENT		**DIVERGENT**
LEVEL 1 (Explicit)	**LEVEL 2 (Inferential)**	**LEVEL 3 (Hypothetical)**
What is energy? (IIA1, 2, 3) Where does energy go? (IIA3) What is an insulator? (IID3) If there were a person sitting and a person walking, who is doing work? (IIA1)	How might you compare/contrast kinetic and potential energy? (IIA1,2) There are two identical glass containers that each holds 80° C water. One is covered with aluminum foil and one is covered with plastic wrap. Which one would be the better insulator and why? (IID4)	You are packing clothes for a camping trip to Florida, where the temperature will be 110°. Considering absorption, evaporation, etc., what materials and clothing would you pack and why? (IID4 If you had to design a container to keep water cold for runners, meaning it could not be held, what materials and what design could be used? (IIB2, IID1, IID3, IID4)

THERMAL ENERGY TRANSFER ARTICLE

Matter will transfer thermal energy in one of three ways: through conduction, convection, and radiation. When two objects of differing temperatures are put together, the objects will endeavor to reach thermal equilibrium. That is, heat will be transferred from the higher concentration to the lower concentration—from hot to cold. In other words, the hotter object will transfer heat to the cooler object until both objects have the same temperature. Once the objects reach equilibrium, they will tend to stay there unless there is some sort of external change.

The molecules in an object with higher thermal energy vibrate faster than an object with low thermal energy. The moving molecules can then bump into other molecules, causing them to move as energy is transferred. Conduction is what happens when objects transfer thermal energy by molecules bumping against each other. This can be seen when a metal spoon is dipped in hot tea. The molecules from the tea vibrate against the molecules in the spoon, causing the molecules to speed up and thus causing the spoon to heat up.

Another way to transfer thermal energy is convection. Convection has to do with heat being transferred through the movement of fluids. There are two types of convection: natural and forced convection. Forced convection uses objects like a pump or a fan to move fluids and transfer heat. Examples of forced convection include convection ovens and fluid heat radiator systems.

Natural convection occurs when a fluid has two different temperatures causing differing densities. An example of natural convection is water being heated on a stove. The heat from the stove heats up the bottom of the water, causing the molecules to vibrate faster. When molecules vibrate, they expand and lose density, causing the warmer water to rise and the cooler water to sink. The cooler water will then heat up and rise to the top. The circular current this process produces is called a convection current and is responsible for many aspects of the weather.

The last method the world uses to transfer thermal energy is radiation. With radiation, objects can transfer thermal energy through a vacuum. This is the type heat transfer by which the sun warms the earth. In this process, thermal energy is transferred in the form of infrared rays. Though thermal energy can be transferred through radiation, we feel the heat when the infrared rays strike an object, like air, and cause the molecules to move faster, thus heating up.

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