Lesson 1: Introduction to Energy Transformation (Technology Lesson)

Section 1: Rationale/Purpose

Topic: The Law of Conservation of Energy & Energy Transformations
Grade level: 9-12 **Duration:** 60-80 minutes (2 class periods)

Standards:

- SC.912.P.10.1 - Differentiate among the various forms of energy and recognize that they can be transformed from one form to others.
- ELD.K12.ELL.SC.1 - English language learners communicate information, ideas and concepts necessary for academic success in the content area of Science.
- SC.912.N.3.5 - Describe the function of models in science, and identify the wide range of models used in science.
- SC.912.N.1.7 - Recognize the role of creativity in constructing scientific questions, methods and explanations.

Content Objectives:

- Using the PhET computer simulation Energy Forms and Changes, students will be able to differentiate between 5 forms of energy (potential energy, kinetic energy, thermal/heat energy, radiant/light energy, mechanical energy, electrical energy, and chemical energy) and recognize that they can be transformed from one form to another.
- Students will be able to draw and label their own model of energy transformation using what they've learned from the simulation. By developing a model themselves, students will recognize the role of creativity in the creation of scientific models.

Language Objectives:

- Students will be able to record written observations in their science notebooks using complete sentences and content-specific scientific terminology (such as the Law of Conservation of Energy, potential energy, kinetic energy, thermal energy, radiant energy, mechanical energy and electrical energy) to describe energy movement and transformation.
- Students will be able to identify critical vocabulary as evidenced by circling important terms to create a "fill-in-the-blank" description of their self-created model.

Section 2: Misconceptions

1. "Some objects (such as blankets) produce their own heat. Students may believe this because they have experienced feeling warmer after covering themselves with a blanket or putting on a sweater" (Fries-Gaither, 2009).

2. Energy can be created (Kruger, 1990; Lovrude, 2004; Papadouris et al., 2008).
3. An object has energy within it that is used up as the object moves (Brook & Driver, 1984; Kesidou & Duit, 1993; Loverude, 2004; Stead 1980).
4. One form of energy cannot be transformed into another form of energy (e.g. chemical energy cannot be converted into kinetic energy) (Brook & Driver, 1984).

Section 3: Detailed Procedures

Introduction / Activation of Prior Knowledge (10 minutes)

- Students are asked to **write** in their science notebooks an explanation of the word "energy". Students are encouraged to create their description by doing one or more of the following differentiated options: **writing** a definition, **using** the word in a sentence, **drawing** an example. (3 mins)
  - Students may use a definition they learned in school or explain how they would use the word with family or friends.
  - Students should get ready to share their answer.
- In small groups of 2-3, students **share** their responses, taking turns **verbally explaining** what they've written down. (5 mins)
- As a group, students **choose** one of their examples to **share** with the whole class (2 mins).

Access student prior knowledge of the term "energy" and its meaning.

Engagement Demonstration (10 minutes)

- Students are shown a ball and asked, Does this ball have energy? (Student asked to **volunteer answers**). The ball is dropped. Does the ball have energy now? (Student asked to **volunteer answers**).
- Ball is held up again, and an explanation is given.
  - Yes, it does have energy! When the ball is being held above the ground it has a type of energy called potential energy. Potential energy is stored energy. When the ball is held in the air, it has the potential to do something (in this case it has the potential to fall).
  - If I drop the ball will it still have energy? (Ball is dropped) Yes, the ball still has energy as it falls, but it is no longer just potential energy. When the ball is falling it has a different form of energy called kinetic energy. Kinetic energy is the energy of motion.
  - Take a minute to think: What happened to the potential energy? Was it all lost when the ball was dropped? Was the kinetic energy created to replace the lost potential

Students watch a teacher-led demonstration to provoke deeper thought.

energy? (30 second pause given for students to consider the answer) ○ We can explain what is happening to the ball using The Law of Conservation of Energy, which states that the energy of an isolated system cannot be lost, or destroyed. It also cannot be created. It remains constant; all it can do is change forms. This means that the potential energy of the ball was not lost. It was transformed into kinetic energy when it was dropped. Both potential and kinetic energy are types of **mechanical energy**. ● Students are asked to view the following information (either in slides or written on a whiteboard) and copy it all into their science notebooks: ○ Law of Conservation of Energy - In a closed system (a system that is isolated from its surroundings), the total energy of the system is conserved. (One of the basic, universal laws of physics). ○ Forms of Energy - mechanical energy, thermal energy, radiant energy, electrical energy, chemical energy. ○ Students are given 2 quiet minutes to write. Then, while they finish, a brief explanation is given of each form of energy on the board. ○ Students developing literacy will be given a copy of these terms pre-written on paper and may spend the time parsing the words.	*Higher-level Students may also be told they can also research these forms of energy on their own for more detailed definitions, as well as others forms of energy not mentioned here.* *Teacher will facilitate activity by circulating the room to answer any questions, scaffold learning, and extend learning by posing more in-depth questions.*
Activity (40 minutes) ● Students split into pairs. Each pair should have at least one computer or laptop. ○ Students are told that one person will manipulates the simulation, while one person records answers on a worksheet. Students will take turns working the simulation and recording answers. ○ *Each student must complete their own worksheet, so will need time to copy answers down themselves as well.* ● Each student receives one worksheet. ○ Students can **read** the introduction on the worksheet as the teacher reads aloud: "In this simulation, you will be able to "see" several different forms of energy and the changes (transfers) that can occur between them. You are also able to work with a system where you can manipulate energy input, observe the process of electrical energy generation and manipulate the output."	**** Completion of the worksheet will likely take two class periods - first period is introduction and initial exploration, second period is completion and evaluation.***

- Students are directed to **open the PhET computer simulation** "Energy Forms and Changes" on their computers, and **select the correct options on the screen** as directed to on their worksheet.
- Students complete the worksheet, pages 2-4*, while exploring the simulation visually representing energy transformations.

Section 4: Evaluation

Evaluation Portion (20 minutes)

1. At the end of the activity, students independently **write in complete sentences** an answer the following question in their science notebooks. Teacher reads out loud and also displays the directions in writing on the board. (5 minutes)
    a. "In your science notebook, **Explain** why this simulation is a good way to illustrate the Law of Conservation of Energy. Use specific examples to support your answer. Please **proof read** your response as well as your partner's response. Make sure your answer is complete and makes logical sense." (Teacher should circulate and give feedback - this portion is not graded, and is a casual formative assessment)
    b. Students developing literacy may have other benchmarks besides writing in complete sentences; such as identifying key concepts or drawing an accurate model. Such students may be grouped together and will proof for that benchmark instead. Teacher will give individual feedback to these students.
2. Students should then complete page 5 of the worksheet, **creating their own labeled sketch** of a system where energy is being transferred. (15 minutes)
    a. Students may either **draw** a real system (from home or the classroom) or draw an imaginary system, involving at least 3 forms of energy.
    b. Students then **write** their own "fill in the blank" description of the forms of energy and energy transfer within the system, involving at least 5 key phrases.

	Advanced (4)	**Proficient (3)**	**Partially Proficient (2)**	**Nonproficient (1)**
Drawing of a valid model	Student's drawing displays	Student's drawing displays	Student's drawing displays some	Student's drawing displays little

Page 5 of the worksheet may be done as homework or as an in-class extension.

Page 5 should be done completely independently (not in pairs).

Student worksheets will be graded as a formative assessment.

	advanced understanding of scientific model creation, is understandable and well-labeled.	understanding of scientific model creation, is understandable and has some labeling.	understanding of scientific model creation, but is hard to understand.	understanding of scientific model creation, and is either irrelevant to the task or hard to understand.
Displayed understanding of energy transfor-mations	Student has three or more energy transformations in model, labeled accurately and used in the proper context.	Student has three or more energy transformations in model, at least two of which are used in the proper context.	Student has two or more energy transformations in model, at least one of which are used in the proper context.	Student has one to two energy transformations in a model, but none are used in the proper context or are very poorly labeled.
Written description of model displays understanding of model and of energy transformation.	Student excels in their written literacy benchmark, and clearly communicates transformations in the model in written format, with complete sentences (if applicable)	Student meets their written literacy benchmark, with two or fewer minor errors that do not distract from the purpose of the writing.	Student shows room for improvement on their written literacy benchmark, with three or more minor errors or one or more major error.	Student shows little improvement on their written literacy benchmark, with many errors and/or wording irrelevant to the task.
Labeling of critical content in description.	Students identify five or more critical content terms for their "fill in the blank" section by circling the terms, all of which are relevant and well-chosen.	Students identify five or more terms, at least four of which are critical content terms. May have 1-2 minor errors.	Students identify 2-3 critical content terms. May mistakenly include others that are not actually critical content.	Students identify 1 critical content term. May mistakenly include others that are not actually critical content.

Section 5: Plan for Individual Differences

1. All activities within student's science notebook are differentiated; options of drawing, writing complete sentences, writing key phrases/incomplete sentences, and drawing graphic organizers are all available.
2. Displayed definitions of "Conservation of Energy" and the five forms of energy allow student understanding without individual research. Higher-level students may choose to do additional research to better understand different forms of energy.
3. The worksheet scaffolds understanding of the concepts, and repeatedly models examples of energy transformation systems and descriptive fill-in-the-blank explanations prior to the student creating one of their own.
4. ELL Students may be provided the worksheet the day beforehand to highlight and translate any difficult words.

Section 6: Materials

- Ball (any kind, 1 per class)
- A chalkboard, whiteboard, or projection apparatus to display slides with definitions.
    - Pre-printed definitions to hand to students developing literacy.
- Computers with Internet access and the latest version of Java (1 per group)
    - Free Java Download: https://java.com/en/download/
- Link to PhET Simulation (ensure it is not blocked by any school filters): https://phet.colorado.edu/en/simulation/legacy/energy-forms-and-changes
- Energy Forms and Changes Simulation Worksheet (5 pages, 1 worksheet per student)
    - Worksheet may be printed from https://drive.google.com/open?id=1QDWSjtKKgX2WJsRQ_lkjLREM1_UuLDkr
    - Worksheet is adapted from the worksheet by A. Norberg, original available on PhET website (Norberg, 2014).
- Pencils (1 per student)
- Crayons or colored pencils (if page 5 of worksheet is completed in class)

Section 7: Safety

- Prior to this lesson, students must be instructed in digital conduct expectations.
- Students should not handle or throw the ball used in the demonstration.
- Students should be warned not to try to mimic any of the digital models in real life; handling electricity or chemicals without proper training may lead to injury or death.

Section 8: References

Brook, A., & Driver, R. (1984). Aspects of secondary students' understanding of energy: Full report. Leeds, UK: The University of Leeds, Centre for Studies in Science Education and Mathematics Education.

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