5E Integrated STEM Lesson Plan

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Lesson Title: Energy Conversions
Time Needed: 90 minutes

Targeted Grade Level: Grades 6-8
Topic: Energy Forms and Law of Conservation of Energy

Subject Integration:
Science, Engineering and Business Studies

Justification:
This lesson is part of a larger unit on mechanics and focuses on one sub-section of the mechanics unit called energy transformations or conversions. Prior to this lesson, the students have learned that energy is a scalar quantity, which means that it only has magnitude. They have also learnt that energy is measured in units called joules. I chose this lesson because it gives students an opportunity to explore the types of energy and to also observe different types of energy conversions in a hands-on manner. The lesson will be taught in a Science class and thus Science serves as the foundation subject. Energy is perhaps the most important concept in Science and this importance is best appreciated when one can observe how it moves or transfers between different forms. Moreover, the word energy is widely used in everyday language. In spite of this, energy is one of the most difficult concepts to teach about. Although it exists in many forms all around us students often struggle to understand the fundamental principles associated with energy. The subject area of Engineering can be used to better facilitate students' understanding of energy. By integrating engineering principles into this lesson, it will allow students to see that the development of our modern society has been accomplished because scientists and engineers have learned to capture some of the energy that exists around us and transform it into ways to do useful work. Engineering helps to make the discussion on energy relatable and allows students to see applications of many of the scientific concepts on energy that they tend to find difficult to comprehend. For instance, students will be able to see from real life examples that engineer needs to know where to "find" energy resources and then how to convert them into forms that are more useful for all of the machines and gadgets we use in our daily lives. As human societies continue to expand and develop there is a constant need for more energy to supply machines and the gadgets that we use in our daily lives. Therefore, this can lead to discussions with disciplines related to Business Studies as we could discuss concepts of opportunity cost as it relates to reducing our energy consumption.

Standards:

International Technology and Engineering Educators Association - Technology

NGSS Performance Expectations MS-PS3-3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal transfer.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:
Constructing Explanations and Designing Solutions Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (MS-PS3-3)	**ETS1.B: Developing Possible Solutions** A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. *(secondary to MS-PS3-3)*	**Energy and Matter** The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS3-3)

Common Core State Standards Connections:

ELA/Literacy

CCRSL.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS3-3)

Cambridge IGCSE Business Studies

1 Understanding business activity

1.1 Business activity

1.1.1 The purpose and nature of business activity:

- Concepts of [needs, wants, scarcity and] opportunity cost

Measurable Student Learning Objectives:

After this lesson, students should be able to:

- Describe how energy is transformed in a hand-crank device being used to charge a cell phone.
- Outline at least one possible benefit and one possible drawback of applying a hand-crank charging system to meeting the energy needs of a household.
- Observe and discuss the trends on world-wide energy consumption graphs.
- Describe opportunity costs involved in decisions related to energy consumption.

Nature of STEM:

Nature of Science: The study of energy transformation or conservation, explains how energy can only be transferred but not created or destroyed. It the process of changing energy from one form to another. Students will explain energy transformations after observing it in action.

Nature of Technology: Students will utilize technology throughout the lesson; especially as it relates to accessing and using the BP energy charting tool. They will use this tool to explore different trends that are shown on various graphs. Technology will also be leveraged to enable students to work at their own pace.

Nature of Engineering:

Energy exists in many forms all around us. Engineers have determined how to capture and transform energy to enable many engineered devices to function effectively. Students will follow instructions to create their own Hand-Crank Phone Chargers so that they are able to explain the energy transformations that occur to make this device function effectively.

Nature of Math:

Students will interact with interactive graphs to discuss the trends that they are able to observe as it related to the world-wide consumption of energy, oil and renewables.

Engaging Context/Phenomena:

The engaging phenomena for this lesson is a resource obtained from Project Phenomena Database entitled “Hand crank device charges cell phone”. This resource describes a handheld device with a crank handle that is used to charge a cell phone. As the device is cranked it demonstrates energy transfer/transformations such as kinetic energy being converted into electrical energy. It can also demonstrate the conservation of energy. For example, students would see that energy is not lost but converted to other forms such as sound and electrical energy. Specifically, the “hook” for this lesson will be the video which is linked here. It begins with showing you how to build the device with materials that can be easily obtained. Hence, I thought this would be a great activity to start the unit. The students are immediately engaged with a hands-on project. After building the device they can now use it to charge their cell phones in class and then we would begin exploring energy conversions.

Data Integration:.
In this lesson I will be using data obtained from the BP energy charting tool. This is a database that allows users to integrate data, create charts and download reports from the Statistical Review of World Energy (BP, 2021). The first way that I will use this database in the teaching of this topic is by offering current information about world energy use. We will search for the latest tables and graphs to determine the world's current demand for the energy and to see which energy sources are being most utilized. We will also observe the world-wide consumption of oil and renewables also.

Differentiation of Instruction:
After students create a working hand-crank phone charger, ask them to diagram the energy transformations they observed by completing one of the following formative assessments on Google Drawings:

A) Create a flow chart to diagram and explain the conversion of energy into usable forms
B) Create a bubble map to diagram and explain the conversion of energy into usable forms
C) Create an infographic to diagram and explain the conversion of energy into usable forms
D) Choose any other suitable method of diagraming and explaining the conversion of energy into usable forms

Real-life Connection:
There are many real-life connections to this lesson such as:

A) Food production through the conversion of light into chemical energy in autotrophs
B) Heterotrophs using chemical energy in food to carry out their life processes
C) Automobiles convert chemical energy to mechanical energy
D) Chemical energy at power plants is converted to heat, mechanical, light and sound energy in our homes.

Possible Misconceptions:.
Students may think that energy is lost during energy conversions. Also, they may think that an object at rest has no energy or that we should not run out of energy if it is able to be conserved.

Lesson Procedure:

<table>
<tr><th>5E Model</th><th>5E Objectives</th></tr>
<tr><td colspan="2">Lesson 1: Introduction to Energy Transformations
Duration: 90 minutes</td></tr>
<tr><td>Engage</td><td>Procedure:
<table>
<tr><th>Teacher Activities</th><th>Student Activities</th></tr>
<tr><td>Play a video of how a hand crank device is able to charge a cell phone.</td><td>Watch the video.</td></tr>
<tr><td>Ask students to work with a partner to engage in a think-write-pair-share to suggest how energy is being transformed.</td><td>Work with a partner to complete the think-write-pair-share worksheet.</td></tr>
<tr><td>Ask students to share their responses with their classmates.</td><td>Share their responses.</td></tr>
</table>
Modifications Working in a small group
Standards Addressed MS-PS3
Formative Assessments: Energy Transformation (Think-Write-Pair-Share Worksheet)
Resources: How To Make A Simple Hand-Crank Phone Charger (Video) and Energy Transformation (Think-Write-Pair-Share Worksheet)</td></tr>
<tr><td>Explore</td><td>Procedure:
<table>
<tr><th>Teacher Activities</th><th>Student Activities</th></tr>
<tr><td>Ask students to continue working with their partner and to send one person to the front of the classroom to collect the materials they need for the construction of their hand-crank phone chargers.</td><td>Collect materials and return to their partner.</td></tr>
<tr><td>Ask students to follow the instructions in the video on their own device to build their own hand-crank phone charger.</td><td>Follow directions and use materials provided to build their own hand-crank phone charger.</td></tr>
</table></td></tr>
</table>

Ask the groups to test their devices.	Test their device to see if it works.
After students create a working hand-crank phone charger, ask them to diagram the energy transformations they observed by completing one of the following formative assessments on Google Drawings: A) Create a flow chart to diagram and explain the conversion of energy into usable forms B) Create a bubble map to diagram and explain the conversion of energy into usable forms C) Create an infographic to diagram and explain the conversion of energy into usable forms D) Choose any other suitable method of diagraming and explaining the conversion of energy into usable forms	Students diagram the energy transformations they observed by completing one of the following formative assessments on Google Drawings: A) Create a flow chart to diagram and explain the conversion of energy into usable forms B) Create a bubble map to diagram and explain the conversion of energy into usable forms C) Create an infographic to diagram and explain the conversion of energy into usable forms Choose any other suitable method of diagraming and explaining the conversion of energy into usable forms

Modifications Working in a small group; Providing visual instructions; Allowing students to work at their own pace
Standards Addressed MS-PS3, CCRSL.3
Formative Assessment Check each group's device to see if it is working as intended
Resources Materials for Hand-Crank Phone Charger (DC Motors, Gears, Boost Converters, Wooden Dowels, Popsicle Sticks, Small Wooden Craft Blocks, Metal Sticks) and How To Make A Simple Hand-Crank Phone Charger (Video) and Google Drawings

Lesson 2: Introduction to the BP Energy Charting Tool
Duration: 90 minutes

Explain

Procedure:

Teacher Activities	Student Activities
Ask students to reflect on and share one possible benefit and one possible drawback of applying a hand-crank charging system to meeting the energy needs of their household by engaging in a chalk talk activity.	Silently reflect and then add their thoughts, to the paper provided, on the benefits and drawbacks of applying a hand-crank charging system to meeting the energy needs of their household.
Read a few of the drawbacks and benefits that were shared and ask students to volunteer to elaborate on these responses.	Volunteer to elaborate on the selected responses.
Explain that the world has a very high energy demand by showing the "Growth in World Primary Energy Consumption" graph on the BP website.	Listen to the explanation given and view the graph.
Ask students to navigate to the BP energy charting tool on their own devices to learn more about its features.	Navigate to the BP energy tool and learn more about its features.
Ask students to complete the BP Energy Definitions Worksheet using an online dictionary.	Complete the BP Energy Definitions Worksheet using and online dictionary.

Modifications Working in a small group, Written instructions, Allowing students to work at their own pace
Standards Addressed MS-PS3
Formative Assessment Chalk Talk
Resources Butcher or Chart Paper for Chalk Talk Activity

Elaborate

Procedure:

Teacher Activities	Student Activities
Ask students to select the icon leading to the "Growth in World Primary Energy	Select the icon leading to the "Growth in World Primary Energy Consumption" graph.

Consumption" graph.	
Ask students to discuss the trends shown on the graph.	Share their views on the trends that they are able to observe.
Ask students to select Oil and then Consumption from the left pane to view a graph showing the worldwide consumption of oil from1965 to the present.	Select Oil and then Consumption from the left pane to view a graph showing the worldwide consumption of oil from1965 to the present.
Ask students to discuss the trends shown on the graph.	Share their views on the trends that they are able to observe.
Engage students in a discussion on the use of fossil fuels such as oil and their contribution to global warming.	Engage in class discussion.
Ask students to select Renewables and then Consumption from the left pane to view a graph showing the worldwide consumption of renewables from1965 to the present.	Select Renewables and then Consumption from the left pane to view a graph showing the worldwide consumption of renewables from1965 to the present.
Ask students to discuss the trends shown on the graph.	Share their views on the trends that they are able to observe.
Ask students to play "Quizlet Live" in small teams to test their understanding of renewable and non-renewable energy sources.	Play "Quizlet Live" in small teams to test their understanding of renewable and non-renewable energy sources.

Modifications Allowing answers to be given orally, Working in a Small Group
Standards Addressed MS-PS3
Formative Assessments Quizlet Live on Renewable vs Non-Renewable Energy
Resources BP Energy Charting Tool and Quizlet on \Renewable vs Non-Renewable Energy

Lesson 3: The Opportunity Costs of Reducing Energy Consumption
Duration: 90 minutes

Evaluate

Procedure:

Teacher Activities	Student Activities

	Explain the concept of opportunity costs in terms of the opportunity that is passed up when one decision is taken instead of another.	Listen to the explanation.
	Ask students to watch this video on "Opportunity Costs" and complete a Think-Pair-Write-Share worksheet.	Watch the video and complete a Think-Pair-Write-Share worksheet.
	Divide students into small groups and give each of them an proposal that is aimed at reducing energy consumption.	Receive their proposal.
	Ask students to prepare a Google Slides presentation to address the questions on this handout.	Prepare a Google Slides presentation to address the questions on this handout.
	Ask students to present what they have created to their classmates.	Comment on what is said and give their views.
	Modifications Working in a Small Group **Standards Addressed** Cambridge IGCSE Business Studies (1.1.1) **Formative Assessment Google Slides Presentation** **Resources** Energy and Economics for the Senior High Grades. Unit III. Lessons and Activities for the Senior High Grades.	

Teacher Background:.

Links to Resources:

Energy and Economics for the Senior High Grades. Unit III. Lessons and Activities for the Senior High Grades.

BP Energy Education Programme