# 

# Age Levels:

* Grades: 10-12
* Subjects: Environmental Science, Digital Electronics

# Total Time Required:

### 30 Class periods (48 minutes)

* + Should be noted that this can be accomplished in a different time frame if 2 teachers are covering material separately. Time requirements are different for Environmental Science teachers and Digital Electronics teachers.

# Prepared by:

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* June 3, 2019

# Unit Objectives:

Students will be able to:

* Understand trade-offs of alternative energy sources
* Understand Ohm’s law and basic circuit construction
* Use principles of biomimicry to create a usable product
* Observe natural systems as a source of design inspiration

# Science Standards and Standards for Technology Literacy:

**Science and Engineering Process Standards**

**SEPS.1** Posing questions (for science) and defining problems (for engineering)

**SEPS.2** Developing and using models and tools

**SEPS.5** Using mathematics and computational thinking

**SEPS.8** Obtaining, evaluating, and communicating information

**Environmental Science 2016**

**Standard 2: Flow of Matter and Energy**

**Env.2.7** Differentiate between renewable and nonrenewable resources, and compare and contrast the pros and cons of using nonrenewable resources.

**Env.2.8** Cite examples of how all fuels, renewable and nonrenewable, have advantages and disadvantages that society must question when considering the trade-offs among them, such as how energy use contributes to the rising standard of living in the industrially developing nations. However, explain that this energy use also leads to more rapid depletion of Earth’s energy resources and to environmental risks associated with the use of fossil and nuclear fuels.

**Env.2.4** Recognize and describe the different sources of energy, including fossil fuels, nuclear, and alternative sources of energy provided by water, wind, geothermal, biomass/biofuels, and the sun.

**Env.2.9** Describe how decisions to slow the depletion of energy sources through efficient technologies can be made at many levels, from personal to national, and these technologies involve trade-offs of economic costs and social values

**Digital Electronics 2016**

**Standard 3**: **Electrical Components**

**DE 3.1** Explain the importance of documentation.

**DE - 3.2** Apply sketching and annotation skills to document work.

**DE 3.5** Document project components into an engineering notebook (digital or paper).

**DE 3.6** Communicate technical knowledge in a variety of formats.

**Standard 7: Soldering, Equipment, and Supplies**

**DE 7.3** Demonstrate successful soldering and desoldering techniques

**DE 7.5** Identify the appropriate tools for working on circuit systems using safety guidelines

**Standard 9: Microprocessors**

**DE 9.1** Formulate to flow chart to correctly apply basic programming concepts in the planning of a project

**Standards for Technology Literacy**

**11-12.LST.1.1:** Read and comprehend science and technical texts within a range of complexity appropriate for grades 11-CCR independently and proficiently by the end of grade 12.

**11-12.LST.2.2:** Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

**11-12.LST.4.3:** Synthesize information from a range of sources (e.g., *texts, experiments, simulations*) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

**11-12.LST.7.1:** Conduct short as well as more sustained research assignments and tasks to answer a question (including a self-generated question), test a hypothesis, or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

# Recommended Instructor Preparation

* Teachers should be fairly familiar with circuit design, solar panel construction, and sustainable energy alternatives before beginning lesson.

Lesson Plan: What Types of Energy Are There?

# Lesson Focus:

Students should be able to describe the difference between renewable and non-renewable energy resource.

# Total Time Required:

* 5 class periods (48 minutes/period)

# Lesson Objectives:

Students will be able to:

* Define the difference between a renewable resource and a non-renewable resource
* Describe and discuss the need for renewable energy
* Describe the different types of alternative energies available today

# Equipment and Materials

|  |  |
| --- | --- |
| Tools and Materials | Quantity Needed |
| Butcher paper | 1 / group |
| Markers | Class set |
| Google Slides (or other word-editing program) | Access per group |

## Special Notes on Materials:

Paper should be large enough to allow students to create a visually-impactful poster. Students should have access to internet and computers to complete research.

**Lesson Procedures:**

1. SOLE Question (1 class period)

a. Students will complete a poster (using the SOLE system) answering the question: **How do we power the world?**

i. This introductory activity gets students investigating the different types of energy that exist and illuminate student misconceptions

ii. The procedure for how to use a SOLE question in the classroom can be found at <https://startsole.org/>

1. Energy Sources (1 class period)

a. TED-Ed video- [Can 100% renewable energy power the world?](https://ed.ted.com/lessons/can-100-renewable-energy-power-the-world-federico-rosei-and-renzo-rosei)

i. This video will invite discussion about what kind of future can we look towards and why is there a problem with the way things are going?

b.Renewable vs Nonrenewable Energy lecture

i. Background lecture on difference between and current environmental issues. This lesson focuses on the specifics of non-renewable resources such as where they are found, how they are formed, and pros and cons of their use

1. Alternative Energies (3-4 class periods (2 work days, 1-2 days to present)

a. Students break into groups and research and present on the different types of renewable energy sources: biomass, wind, hydroelectric, geothermal, hydrogen, solar

i. Students will present their findings in a Google Slides presentation and act as the experts for their type of energy. Students will generate notes for their fellow students to take with important vocabulary and practical uses and generate quiz questions that will review material.

ii. Quiz created from student-generated questions.

*Note:*

Adaptations:

* SOLE posters should be created in groups but scaffolding of the process may be needed.
* A discussion of reliable resources may be needed before SOLE project and research project.
* A handout could be written that summarizes the information contained within the video that could be used as a follow-along
* Examples of a notes outline and quiz questions could be given to scaffold student creation.

# Student Resources:

The procedure for completing a SOLE poster: <https://app.startsole.org/how>

Non-renewable resources PowerPoint adapted from Pearson

# Student Worksheets:

[Alternative Energy Research Project Details and Rubric](https://www.dropbox.com/s/jaghuyz9gew26ug/Alternative%20Energy%20Resources%20Research%20Project.docx?dl=0)

Lesson Plan: What Are the Tradeoffs of Alternative Energy?

# Lesson Focus:

Students should be able to discuss the pros and cons of the different types of alternative energies and describe how society evaluates these tradeoffs.

# Total Time Required:

* 2-3 class periods (48 minutes/period)

# Lesson Objectives:

Students will be able to:

* Calculate the tradeoffs between renewable and non-renewable resources
* Make decisions while balancing societal demands and describe their decision-making process

# Equipment and Materials

|  |  |
| --- | --- |
| Tools and Materials | Quantity Needed |
| Energy calculations worksheet | 1 per student |
| Energy City Simulation worksheet | 1 per student |

**Lesson Procedures:**

1. Energy calculations (1 class)

a. Students will complete an activity that has them compare pricing for traditional vehicles versus hybrid vehicles.

i. This activity has students calculate out the costs between cars and what the pros and cons of each are, hopefully examining how alternative sources can be a viable option.

2. Energy City Simulation (1-2 classes)

1. [Energy City Simulation](https://assets.jason.org/resource_assets/8239/3733/popup.html)

b. Students will work individually to balance tradeoffs between energy

costs, carbon outputs, and societal demands in order provide

enough energy to a town

i. This activity helps reinforce the idea of alternative energy sources

possible uses in powering a city

ii. Sponsored by National Geographic’s The Jason Project

*Note:*

* If students do not drive their own car, they can pick a car that their parent’s use or a car they happen to be interested in.
* Gas mileage for specific cars can be just be googled (an estimate works).
* Students needs access to internet and computers to complete online simulation

# Student Resources:

[Kelly Blue Book](https://www.kbb.com/)

# Student Worksheets:

* [Energy Calculations Student Worksheet](https://www.dropbox.com/s/z0b3vietfhej1db/Energy%20Calculation%20Student%20Worksheet.docx?dl=0)
* [Energy City Simulation Student Worksheet](https://www.dropbox.com/s/ziwp7j03tefp59f/Energy%20City%20Simulation%20Student%20Worksheet.docx?dl=0)

Lesson Plan: How Does Nature Solve Problems?

# Lesson Focus:

Students should be able to describe biomimicry and how it can be used as design inspiration to solve problems of space limitation.

# Total Time Required:

* 2-3 class periods (48 minutes/period)

# Lesson Objectives:

Students will be able to:

* Describe the idea and necessity of biomimicry
* Describe how nature has solved the problem of space limitation
* Complete simple folding patterns

# Equipment and Materials

|  |  |
| --- | --- |
| Tools and Materials | Quantity Needed |
| Origami paper | 4-5 sheets per student |

## Special Notes on Materials:

Any paper could be used, but origami paper makes the process easier as it is pre-cut and the students can choose colors that help enhance their designs.

**Lesson Procedures:**

1. Biomimicry

a. Students will be presented information on biomimicry

i. See Biomimicry lesson provided by TRAILS

ii. Students will use engineering notebooks to sketch sources of

design inspiration (See Engineering Notebook lesson provided

by TRAILS)

2. Origami

1. Students will be shown and try out different origami patterns
   1. This activity helps to generate ideas of possible folding patterns

and remove misconceptions about limitations of folding

possibilities

* 1. Origami lesson’s intention is to break misconceptions of limitation

of folding possibilities. Both lesson on biomimicry and origami set up possibilities of design inspiration for solar panel product.

*Note:*

* Students that have issues with fine motor movement or following directions may fine the origami folding to be difficult. YouTube videos outlining the process could be substituted.

# Student Resources:

* Origami Designs: <https://www.origami-resource-center.com/origami-insects.html>
* [Origami PowerPoint](https://www.dropbox.com/s/04bvrzdhp8pzxhq/Origami%20PowerPoint.pptx?dl=0)

# Student Worksheets:

None needed

Lesson Plan: What is the Advantage of Having a Flow Chart Prior to Programming?

# Lesson Focus:

What is flowcharting and how is it used in the design of an electrical system? How is flowcharting used in industry to share ideas in a simple manner?

# Total Time Required:

# 2 classes (48 minutes/period)

# Lesson Objectives:

Students will be able to:

* Use a flow chart
* Interpret other’s flow charts
* Program from flowchart

# Equipment and Materials

|  |  |
| --- | --- |
| Tools and Materials | Quantity Needed |
| Butcher paper | 1 sheet per group |
| Markers | 1 per student |

**Lesson Procedures:**

1. Flowcharting (1 class)
2. Present the concept of flow charting in electrical systems. Give the students a chance to view different types and styles of flow charting and explain the importance of having a plan prior to designing a final product.
3. Flowcharting and Digital Electronics (1/2 class)
4. Guided lecture about the history, importance, and methods of flow charting in the Digital Electronics world
   * 1. Explain best practices in flow charting
     2. Introduce if/then statements.
     3. Correlate the flow chart to the final programming language
     4. Practice using flowcharting for everyday tasks
     5. What does your daily routine look like in flow charting?

3. Flowcharting Practice (1/2 class)

1. How to make a peanut butter and jelly sandwich with a flow chart

# Student Resources:

None needed

# Student Worksheets:

None needed

Lesson Plan: What is the Foundation of Electric Systems?

# Lesson Focus:

Students should be able to describe Ohm’s law and how it pertains to basic circuits. Students will learn when and how to wire things in series and/or parallel.

# Total Time Required:

# 5 class periods (48 minutes/period)

# 2 classes for instruction. 3 class periods for work on APB

# Lesson Objectives:

Students will be able to:

* Manipulate various circuits
* Draw a circuit
* Perform calculations based on circuits given

# Equipment and Materials

|  |  |
| --- | --- |
| Tools and Materials | Quantity Needed |
| Resistors | various sizes based on curriculum |
| MyDAQ | 1 per 2 students |

## Special Notes on Materials:

Do NOT measure amps with the MyDAQ in this activity to save yourself from replacing fuses. Multisim will be used for simulating the circuits.

**Lesson Procedures:**

1. Ohm’s Law (4 classes)
2. Present the concept of Ohm’s law. Give the students circuits to view and design series and parallel circuits and model them in Multisim. Allow students to manipulate the circuits to see how parallel and series resistors and batteries function.
3. Use Ohm’s law to calculate the voltage, current and resistance in a circuit. (PLTW activity 1.1.5 a-c)

2. Wiring Solar Collectors (1 class)

1. Discuss wiring solar collectors in parallel and series and view the advantages and disadvantages of each configuration. Students should determine if a solar cell more like a battery or a resistance?

*Note:*

# Student Resources:

PLTW Lesson 1.1.5

# Student Worksheets:

PLTW APB 1.1.5a, 1.1.5b, 1.1.5c

Lesson Plan: Which Design is Best?

# Lesson Focus:

Students should be able to determine which design is the best product. They should be able to determine the audience for the product and how to best reach them.

# Total Time Required:

# 7-8 class periods (48 minutes/period)

# Lesson Objectives:

Students will be able to:

* Use brainstorming techniques learned in earlier classes
* Use a decision matrix
* Perform a product analysis

# Equipment and Materials

|  |  |
| --- | --- |
| Tools and Materials | Quantity Needed |
| Butcher paper | 1 piece per group |
| Colored makers | 1 set per group |
| Initial designs | 1 per each group shared with class |

**Lesson Procedures:**

1. Constraints and Criteria (1 class)
   1. Students will be given the design brief and spend time working to determine constraints and criteria of the design.
2. Brainstorming (1 class)
   1. Students will work as a group to brainstorm potential ideas for their product
   2. Use Brainstorming lesson provided by TRAILS
3. Decision matrix (1 class)
   1. Students will be presented information on how to set-up and use a decision matrix
      1. Decision matrix lesson provided by TRAILS
   2. Using decision matrix, students will determine the best design from all group members.

3. Prototyping (1 class)

1. Students will collaborate to design a prototype of their model.
   1. Students can use whatever materials may be available to them but prototype should be constructed as close to final size as possible.

4. Presentations (3-4 classes)

1. Students will create a presentation to convince the rest of the class that their product is the best and most effective product.

i. Students will design a persuasive presentation outlining the specifics of their project and why an investor should invest in the creation of their product. Students will also create a flyer that could be handed out that draws interest to their product.

ii. Peer editing of final presentation is encouraged

*Note:*

* Materials for prototype can be any materials easily available including construction paper, cardboard, and posterboard
* Lessons can be spiraled with other PLTW classes to gather prior knowledge.

# Student Resources:

# Student Worksheets:

* [Nature’s Origami Design Brief and Constraints and Criteria](https://www.dropbox.com/s/orf8v5h4vaybzz1/Nature%27s%20Origami%20Design%20Brief%20and%20Constraints%20and%20Criteria.docx?dl=0)
* [Solar Panel Presentation](https://www.dropbox.com/s/xdzvlmghdzl55wd/Solar%20Panel%20Presentation.docx?dl=0)
* [Peer Editing Checklist](https://www.dropbox.com/s/qsxdick3h86jlg6/Peer%20Editing%20Checklist.docx?dl=0)
* [Solar Panel Project 4C’s Rubric](https://www.dropbox.com/s/5r0y0xxzv9wtpmi/Solar%20Panel%20Project%204C%27s%20Rubric.doc?dl=0)

Lesson Plan: How Do We Harvest and Direct Solar Energy?

# Lesson Focus:

Students should be able to understand and describe how solar collectors function. Components to understand include: How do you wire solar collectors to perform a certain task and how is Ohm’s law related to the design of the final solar array system?

# Total Time Required:

# 2 class periods for instruction (48 minutes/period)

* 3-5 classes for building of product

# Lesson Objectives:

Students will be able to:

* Explore how solar collectors function.
* Manipulate different wiring schemes to provide adequate power.
* Define and use Ohm’s Law to build a system.

# Equipment and Materials

|  |  |
| --- | --- |
| Tools and Materials | Quantity Needed |
| Various sizes of solar cells | Dependent on design specifications |
| Tabbing and regular wire | Dependent on design specifications |
| 12 volt power inverter | 1 per group |
| 12 volt battery | 1 per group |
| Solar charge controller | 1 per group |

## Special Notes on Materials:

There needs to be esurance that the number of solar cells provide enough amperage to charge the selected battery. Most solar cells are very delicate search for flexible rather than rigid solar cells.

**Lesson Procedures:**

1. Solar Panel Design
   1. Present the concept of solar collection and the components needed in the system. Consideration should be given to making sure students understand that it’s not just a solar panel there are other component in the system.
   2. Evaluate a solar collection system for its parts and describe which each part is responsible for. (ie: battery, solar collector array, solar charge controller, and battery regulator)
   3. Discuss wiring solar collectors in parallel and series and view the advantages and disadvantages of each configuration.
   4. Discuss the system wiring a s a whole. Present the lesson on wiring a solar array.

# Student Resources:

[Photovoltaic PowerPoint](https://www.dropbox.com/s/2pk3jxhppmtkzu6/Photovoltaic%20PowerPoint.pptx?dl=0)

Lesson Plan: How Do I Make Things Do What I Want Them To When I Want Them To?

# Lesson Focus:

Students should be able to describe what programming is and how it is used in industry. Students should focus on the common themes in programming language and how we can use programming to solve everyday tasks.

# Total Time Required:

# 2 class periods for instruction (48 minutes/period)

* 1-2 class periods for writing programming

# Lesson Objectives:

Students will be able to:

* Explore programming language
* Write a basic program

# Equipment and Materials

|  |  |
| --- | --- |
| Tools and Materials | Quantity Needed |
| Arduino | 1 per group |

## Special Notes on Materials:

There needs to be esurance that the number of solar cells provide enough amperage to charge the selected battery. Most solar cells are very delicate; search for flexible rather than rigid solar cells.

**Lesson Procedures:**

1. Programming
2. Introductory lecture on programming languages and the similarities and evolution of the different forms of programming languages.
3. Using if/then logic, learned in the flow charting lesson, define a problem and work through the pathways that the program will follow.
4. Introduce the programming tutorial project (PLTW DE 4.2.2 Introduction to Microcontrollers) and work through the different basic programs.
5. Provide sample programs and the devices that will be used in the design of the capstone project and experiment with adjusting values in the program to solve the problem of “How do we detect light and use it to activate various kinds of outputs?”

# Student Resources:

PLTW Lesson 4.2.2

# Student Worksheets:

PLTW APB 4.2.1, 4.2.2, 4.2.3, 4.2.4



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