Unit Overview – Socially Responsible Engineering & Technology (POS)

Course: Y1U3

Unit Title: Recycled Light Source

Approximate Length of Unit: 6 Weeks (based on five day weeks; 45 minute periods each day)

Unit Summary

Students are challenged to design a new portable light source for use by people that do not have access to the power grid or in situations where power will be out for an extended period. This unit begins by having students work in teams to disassemble two common electronic products, flashlights and solar yard lights. Prior to disassembly they will be asked to predict what they expect to find inside each product. During disassembly they will keep notes and prepare sketches including exploded view drawings to document how the products were assembled. Related lessons will introduce students to the basics of electronics including components, circuits, circuit diagrams as well as the building and testing of temporary and permanent circuits. The knowledge gained through these activities will provide students with the background that will enable them to design and model a new battery operated light.

Throughout the unit students will continue to increase their knowledge of electronics and acquire insight into the wide range of career opportunities in electronics.

Primary interdisciplinary connections: Math, Science

21st century themes: Creativity and Innovation, Critical Thinking and Problem Solving, Communication, Life and Career Skills

Unit Rationale

Because electronics is an integral part of so many of the products that we use every day it is desirable for everyone to have a good understanding of how some of the products work. Students are familiar with flashlights, solar yard lights and similar products but they probably have not given much thought about how they work. Through hands-on activity this unit will give students an opportunity to learn how they work and challenge them to use this understanding to develop the prototype of a new product. Students will develop a level of understanding and skill that will prepare them to learn how more complex products are made and operate.

Suggested Materials:

A variety of inexpensive incandescent and LED flashlights

Solar yard lights

Common electronic components including LED's, resistors, batteries and other parts obtained through the disassembly of existing lights

Batteries

Insulated wire (red and black)

Breadboards

Electrical tape

Test leads

Solder

Safety glasses

Suggested Tools/Machines:

Basic material processing and electronics tools. Such as:

Hand tools such as screwdriver and pliers
Power tools
Wire strippers
Multimeters
Soldering irons

Unit Assumptions

Students have been exposed to the engineering design process and that the steps are understood.
Students have experience using hand and power tools to safely and accurately process materials.
Students have experience working as part of a team to accomplish a goal.
Students have been introduced totechnical drawing including sketching.

Learning Targets

Math (NJCCCS 4)

4.2 Units of Measurement: Measurement helps describe our world using numbers. An understanding of how we attach numbers to real-world phenomena, familiarity with common measurement units (e.g., inches, liters, and miles per hours), and a practical knowledge of measurement tools and techniques are critical for students' understanding of the world around them.

CPI #	Cumulative Progress Indicator (CPI)
4.2.12.D.2	Choose appropriate tools and techniques to achieve the specified degree of precision and error needed in a situation.

Science (NJCCCS 5)

5.1 Science Practices: All students will understand that science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge and reasoning skills that students must acquire to be proficient in science.

CPI #	Cumulative Progress Indicator (CPI)
5.1.12.C.2	Use data representations and new models to revise predictions and explanations.

Engineering and Technological Literacy (NJCCCS 8.2)

8.2Technology Education, Engineering, and Design: All students will develop an understanding of the nature and impact of technology, engineering, technological design, and the designed world, as they relate to the individual, global society, and the environment.

CPI #	Cumulative Progress Indicator (CPI)
8.2.12.F.1	Determine and use the appropriate application of resources in the design, development, and creation of a technological product or system.

21st Century Skills (NJCCCS 9.1)

9.121st-Century Life & Career Skills: All students will demonstrate the creative, critical thinking, collaboration, and problem-solving skills needed to function successfully as both global citizens and workers in diverse ethnic and organizational cultures.

CPI #	Cumulative Progress Indicator (CPI)
9.1.12.A.1	Apply critical thinking and problem-solving strategies during structured learning experiences.
9.4 Career and Technical Education: All students who complete a career and technical education program will acquire academic and technical skills for careers in emerging and established professions that lead to technical skill proficiency, credentials, certificates, licenses, and/or degrees.	
CPI #	**Cumulative Progress Indicator (CPI)**
9.4.12.O.17	Employ critical thinking skills (e.g., analyze, synthesize, and evaluate) independently and in teams to solve problems and make decisions.
9.4.12.O.68	Employ planning and time management skills and tools to enhance results and complete work tasks.
9.4.12.O.(1).11	Demonstrate understanding of processes and concepts that are key to understanding the design process.

Industry Standards

NOCDI

- Employability skills – Workplace Readiness
- STEM – Pre-Engineering, Engineering Technology

Unit Essential Questions

- What is a circuit?
- What kinds of components are commonly used in electronic circuits?
- How can the disassembly of electronic products lead to an understanding of how they work?
- How can new lighting products satisfy human needs and wants?

Unit Enduring Understandings

- Electronics is a key element of many of today's most popular products.
- The same basic electronic components are found in many different products.
- New circuits and products can be developed through use of the engineering design process.
- Through innovation existing products can evolve into new products.

Unit Learning Targets

Students will ...

1. Research, discuss and document the tasks that need to be addressed in the design. (9.4.12.O.(1).8), (5.1.12.D.1)
2. Demonstrate an understanding of the Engineering Design Process by using it to create a solution to the recycled light problem, and document the process.(9.1.12.A.1) (9.4.12.O.(1).11)
3. Summarize brainstorming and research to describe how the product meets specifications and limitations. (8.2.12.A.1), (9.4.12.H(5).1), (9.4.12.H(5).5), (5.1.12.D.1)
4. Describe how different circuits and products work. (8.2.12.D.1), (8.2.12.F.2)
5. Demonstrate safe and proper use of tools used for building electronic circuits. (4.2.12.D.2) (9.4.12.O.(1).11).
6. Research, discuss and document how existing devices work. (9.4.12.O.(1).8), (5.1.12.D.1)
7. Model selected solution. (8.1.12.A.2), (5.1.12.D.1)
8. Present project design to peers. (9.4.12.M.9), (5.1.12.D.1)

Project-Based Learning Plan: Engineering Design Process (Sequence and Assessments)	
Teacher Instruction	**Student Evaluation**
Step One: Identify the Problem	
Lessons/ Topic(s) Lesson 1: Overview of Design Challenge • What is electricity? • What is a circuit? • Why are flashlights and yard lights used? • Review the engineering design process • Researching on your own – the history of the flashlight and how solar yard lights work	**Formative Assessments:** ○ Teacher questioning to determine student knowledge of electrical concepts and the engineering design process ○ Teacher will provide feedback to clear up student misconceptions **Summative Assessments:** ○ Quiz – Basic electrical concepts (ULT #5)
Notes: Useful website: http://www.energizer.com/learning-center/pages/flashlighthistory	**Notes:**
Step Two: Frame the Design Brief	
Lessons/ Topics Lesson 2: Framing the design brief for the Recycled Light Source • Review design brief requirements • Review specifications • Review constraints • Review list of available materials Lesson 3: Key electronic components and symbols	**Formative Assessments:** ○ Teacher conference with student groups to make sure that they have a clear understanding of all aspects of the design brief. **Summative Assessments:** ○ Teacher-generated rubric to evaluate team understanding of the design brief. (ULT #1) ○ Quiz – Electronic Symbols and components (ULT #5)
Notes: Discuss the design brief for creating a new portable lighting device that could be used by people that do not have access to the power grid or in situations where power will be out for an extended period. Remind students that the device must be primarily made from recycled materials. Allow time for student questions. Initial team meetings.	**Notes:**
Step Three: Research & Brainstorming	

Lessons/ Topic(s)	**Formative Assessments:**
Lesson 4: Forming a design/build team Lesson 5: Exploded view drawing Lesson6: Conductors, insulators, semiconductors. Lesson 7: Series and parallel and combination circuits. Lesson 8: Using a multimeter for measuring voltage, current and resistance.	○ Teacher will provide feedback to each team as they complete hands-on exploded view drawings and electrical activities **Summative Assessments:** ○ Evaluation of exploded view drawings using a rubric (ULT # 2) ○ Teacher-generated rubric to evaluate discussion of similarities and differences between flashlights and solar yard lights (ULT #6) ○ Performance task with a rubric that requires students to build series and parallel circuits and test the circuits with a multi-meter. (ULT #5)
Notes: The students should begin by working in their teams to predict what they will find in the flashlight prior to disassembly. Each team should prepare an exploded view drawing showing the internal arrangement of the components. Later on the same process should be used with the solar yard light. Show students several examples of exploded view drawings of simple products. Provide resources such as the Internet so that students can conduct additional research. Assist the teams in selecting a feasible design problem. It is important that they choose a problem that is appropriate considering the available resources and the constraints specified in the design problem. At the completion of the flashlight disassembly and documentation the student teams should be given the opportunity to disassemble a solar yard light. Discuss similarities and differences between the products, the components they contain and the circuits. Allow time for the teams to use the brainstorming process to identify new, useful lighting products that could be made primarily from components contained in the flashlight and solar yard light that they were given. Here is a website that describes how many products work including solar yard lights: http://www.howstuffworks.com	**Notes:** Suggested team member assignments: Project Manager (1) – Focuses on completing documentation and maintaining work schedule to ensure project is completed on time. Designer (1) – should conduct research to make sure that a similar device does not already exist. Responsible for making sure that the solution meets the specifications and constraints. Production Manager (1) – needs to be able to lead the development of a prototype that will be made primarily from materials obtained from the recycled flashlight and solar yard light.

Another useful website: *The Electronics Club* http://www.kpsec.freeuk.com/study	
Step Four: Generation Alternate Solutions	
Lessons/ Topic(s) Lesson 9:Technical Drawings and Schematics	**Formative Assessments:** ○ Students will use a teacher-generated checklist for self and peer assessment of the technical drawings for the structure of their projects and schematic drawings for the circuits. **Summative Assessments:** ○ Completed drawings and schematics assessed using rubrics/rating scales (ULT #3)
Notes: Each team should prepare a series of sketches and refined drawings of possible lights made from the recycled materials. Schematic circuit drawings using proper symbols should also be prepared.	**Notes:**
Step Five: Chosen Solution with Rationale	
Lessons/ Topic(s) Lesson 10: Bulbs, Batteries and LED's	**Formative Assessments:** ○ Students will be provided with schematic diagrams and model the circuits. Teacher will provide feedback. **Summative Assessments:** ○ Performance task with rubric (ULT #4)
Notes: Teams should focus on identifying the best possible solution from among those developed in the prior step. Share examples of exemplary, satisfactory and unsatisfactory levels of documentation to guide students. The teacher will provide feedback as the teams prepare their documentation.	**Notes:**
Step Six: Developmental Work	
Lessons/ Topic(s) Lesson 11: Working Drawings	**Formative Assessments:** ○ Self and peer assessment of working drawings using a teacher-generated rating scale **Summative Assessments:**

	○ Quiz – Working Drawings (ULT #7)
Notes: Teacher will monitor class activities to ensure that students complete tasks, while utilizing the engineering design process. Students will complete working drawings and notes, gather materials, and test modeling techniques in order to develop an optimum solution to the design problem.	**Notes:**
Step Seven: Prototype	
Lessons/ Topic(s) Lesson 12: Temporary circuits: breadboards .	**Formative Assessments:** ○ Teacher questioning as students model circuits using breadboards **Summative Assessments:** ○ Individual and team performance tasks using breadboards to model circuits (ULT #5)
Notes: Teacher will demonstrate the use breadboards as a means of building and testing circuits for possible use in the prototype.	**Notes:**
Step Eight: Testing and Evaluation	
Lessons/ Topic(s) Lesson 13: Permanent circuits and soldering	**Formative Assessments:** • Teacher feedback with suggestions for improving the prototype (ULT #7) • Teacher will critique circuit assembly and soldering techniques with each team of students as they assemble their permanent circuits. **Summative Assessments:** ○ Demonstration with teacher-generated performance rubric (ULT #4)
Notes: Teacher will guide students in developing methods to test and evaluate their circuits and models. Teacher will demonstrate soldering and the process of changing a circuit built on a breadboard to one that is	**Notes:**

permanent.	
Step Nine: Redesign and Reflect	
Lessons/ Topic(s) Lesson 14: Redesign Circuit and Product to Optomize Performance	**Formative Assessments:** ○ Teacher will conference with each group to verify that they are preparing for final presentations. ○ Teacher will provide feedback related to the circuit design and product performance.
Notes: Students will document the need for redesign. It is important that they utilize testing results when describing the need for modifications.	**Notes:**
Step Ten: Communicate	
Lessons/ Topic(s) Lesson 15: Presentation Guidelines	**Formative Assessments:** ○ Practice presentation with teacher/peer feedback using teacher-generated rating scale **Summative Assessments:** ○ Presentations with rubrics/rating scales for the quality of the presentation and of electronics content knowledge. (ULT #8)
Notes: Teacher will establish procedures and time allocation for student presentations. The team-based presentations should demonstrate an understanding of electronics and prototyping concepts. Classmates should be encouraged to provide constructive feedback.	**Notes:**
Corresponding Technology Student Association (TSA) Activities	
Technology Problem Solving Engineering Design Manufacturing Prototype	

Lesson Plans	
Lesson	**Timeframe**
Lesson 1 Overview of the design challenge What is electricity? What is a circuit?	45 minutes /1 day

Lesson 2 Framing the design brief	45 minutes / 1day
Lesson 3 Key electronic components and symbols	45 minutes /1day
Lesson 4 Forming a design/build team	45 minutes /5 days ½ day to form teams and 4.5 days of project work
Lesson 5 Exploded view drawing	45 minutes /2days 1 day to lecture and 1 day to prepare drawings
Lesson 6 Conductors, insulators and semiconductors	45 minutes /1day Lecture and project work
Lesson 7 Series, parallel and combination circuits	45 minutes /1day Lecture and project work
Lesson 8 Using a multimeter to measure voltage, current and resistance	45 minutes /1day Lecture and project work
Lesson 9 Technical drawing and schematics	45 minutes / 1day Lecture and project work
Lesson 10 Bulbs, batteries and LED's Lesson 11 Working drawings Lesson 12 Temporary circuits: breadboards Lesson 13 Permanent circuits and soldering Lesson 14 Redesign Circuit and Product to Optomize Performance Lesson 15 Presentation Guidelines and Presentations	45 minutes / 1 day Lecture and project work 45minutes/3 days Lecture and project work 45 minutes/2days Lecture and project work 45 minutes/4days Prototype completion 45 minutes/3 days Prototype testing and revision 45 minutes 3 days

Curriculum Development Resources

Instructables is updated daily and features homemade, creative and sometimes useful products.www.instructables.com

International Technology and Engineering Educators Association http://iteea.org/

New Jersey Technology and Engineering Educators Association http://njtea.org/

Make Magazine http://makezine.com/

Design Brief

Background/Scenario:

Most of the new and exciting products used by today's students rely on electronics. Using the experience of creating a new light source made primarily from recycled materials, combined with knowledge gained from the lessons in the unit, will enable students to develop an understanding of engineering and key electronic concepts.

Problem/Opportunity Statement:

Teams of three students will design and build a new portable lighting device for use by people who do not have access to the electric grid or in situations where there will be an extended power outage. Most of the materials needed to construct a prototype of the device will be obtained by recycling parts obtained from inexpensive flashlights and solar yard lights.

Specifications/Criteria:

- The device should satisfy an identified need.
- It should be made primarily from recycled materials
- The total cost for the device should be $5.00 or less
- The device should be durable and easy to use.

Constraints:

Time:

- The device needs to be completed within thirty 45 minute class periods

Money:

- The prototype should be made from $5 or less in materials.

Energy:

- Energy efficiency should be considered during the design of the device.

Tools/Machines:

- Hand tools.
- Power tools.

People

- Three students per group. Students should be encouraged to seek advice about the need for their proposed device and from others who may be able to provide technical assistance

Information

- Knowledge gained from lessons included in the unit, research and prior experiences.

Materials

- Electronics.
- Construction/Prototyping.
- Other materials obtained by recycling inexpensive flashlights and solar yard lights

Stakeholders:
Potential users
Disaster relief agencies
Community at large