Marshall University Sustainability Department

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Light & Energy

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OBJECTIVES

Students will learn about the basics of Energy and Electricity, and then compare and contrast the efficiency of lightbulbs through experimentation of incandescent, fluorescent, and LED light. They will understand the differences and transfer of energy. Students will connect energy use at home to energy use nationwide and worldwide.

LESSON PARAMETERS

1. **Key Terms** - Energy efficiency, power (watts), energy transfer, incandescent light bulb, compact fluorescent light bulb (CFL), light emitting diode bulb (LED)
2. **Group Size** - groups of 3 to 5 students; applicable for a class ranging from 3 to 30 students
3. **Grade Levels** - 3rd- 12th
4. **Duration** - one 60 minute session
5. **Setting** - indoors
6. **Disciplines** - Science, Mathematics, Engineering, Technology, Environmental Education
7. **Learning Techniques -**
    a. Hands-On
    b. Group-based Collaboration
    c. Interdisciplinary
    d. Critical Thinking
    e. Activity-based
    f. Real-world application

GREEN CONNECTIONS

- **Connections to Home and Community -** Students connect learning to home as they are challenged to take an inventory of light bulbs used in their house along with energy usage. This also connects to the community as students realize that energy comes from a shared source.
- **Sustainable Perspectives -**
    - Energy efficiency
    - Energy consumption
    - Eco-friendly steps
    - Going green at home

LESSON SUMMARY

Students and instructor will participate in a whole class discussion about saving energy (discussion questions 1-5). This will activate prior knowledge and serve as a transition into the activity. Each student must hypothesize which light bulb they think saves the most energy and record how to test the hypothesis. The class will share their hypotheses and testing propositions (hopefully some will suggest testing the temperature or electricity usage).

Then the instructor will demonstrate how they're actually going to test the bulbs for this lesson's activity. After the demonstration, each student will receive a light bulb experiment handout where they must record all of their data. The class will be split into groups of 3-4 (depending on class size and available resources) to work on the experiment. During the experiment, the students must fill in a table for the watts consumed, starting temperature, final temperature, change in temperature, and describe the light emitted for each lightbulb over a 10 minute period. Upon completion, the groups must analyze their data and draw conclusions, answering the post-lab questions on their handout.

The lesson will end with a discussion of the results and further application. The instructor should ask discussion questions 6-11 to help students realize exactly what they were testing, how it's relevant to them, and how it applies elsewhere in the "big picture". The instructor will then challenge students to start paying attention to energy use in their own home. Students can take an inventory of what light bulbs they use at home. Maybe they can ask their parents how much their electricity bill is each month. Students could even see if their parents want to do their own energy experiment and change their lightbulbs to LED and see if it changes their monthly electricity bill.

ACTIVATING STRATEGY

The students will discuss the first five discussion questions to pique their interest since everybody would like a hundred dollars. This may activate prior knowledge if they are familiar with energy use or instigate curiosity. The instructor may add to the discussion and begin transitioning into the lightbulb activity.

LESSON DEVELOPMENT

Exploration Lesson - Students explore the significance of energy use through discussion. They will also investigate the efficiency of various lightbulbs through experimentation.	**Explanation Lesson -** Students will gather new information through discussion as well as analyzing experimental data.	**Application Lesson -** Students will learn how they can apply what they've learned and discovered in this lesson with the concluding challenge of changing the lightbulbs in their own homes. The students can't actually apply this during the lesson but they will discuss how they will at home or in the future. They will also dream of what they can do with the money they will save from being more energy efficient.

LESSON ADDITIONS

If time allows, the instructor can feed off of the concluding discussion, asking further questions about fossil fuels and clean energy. If time still allows, students may use the computers to research more energy saving ideas.

DISCUSSION QUESTIONS

- Pre-Lab
    - What would you do with a hundred dollars?
    - How can saving energy save you money?
    - How can we save energy?
    - How can YOU save energy?
    - Which light bulbs do you think save the most energy? Do they cost the same?
- Post-Lab
    - Which light bulb seems to be more energy efficient? How do you know?
    - Why was the incandescent bulb hotter? How does that relate to energy?
    - Was energy transferred in the experiment? How?
    - What's the differences between types of energy?
    - How much does each light bulb cost? Which lightbulb would save money in the long-run?
    - Why is saving energy important (besides saving money)?

MATERIALS

- An incandescent light bulb per group
- A fluorescent light bulb per group
- A LED light bulb per group
- Electricity usage monitors per group (if available)
- Heat guns per group (if available)
- Informational resources for the instructor (optional):
    - Lesson 8: Light Bulbs and Energy Efficiency (http://www.powersleuth.org/docs/EnergyLightsMaine-Lesson8.pdf)
    - Energy Efficiency Ambassadors (https://www.energystar.gov/ia/partners/promotions/change_light/downloads/classroom_activity_6_8.pdf)

- This Little Light of Mine: Understanding Light Bulbs http://www.earthday.org/sites/default/files/This%20Little%20Light%20of%20Mine%205-8_Lesson%20Plan.pdf
- Light Bulb Cost Comparison http://www.energyclassroom.com/pdfs/EC_CO_AC_LightBulbCost.pdf

- Experiment worksheets for each student from the website:
  - Hands-on Activity: Light vs. Heat Bulbs https://www.teachengineering.org/view_activity.php?url=collection/cla_/activities/cla_activity3_household_light_bulbs/cla_activity3_household_light_bulbs.xml
  - Student worksheet https://www.teachengineering.org/collection/cla_/activities/cla_activity3_household_light_bulbs/household_light_bulbs_activity3_student_worksheet.pdf

RATIONALES

- Next Generation Science Standards
  - **MS-LS2-1-** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
  - **MS-PS1-4 -** Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.
  - **MS-PS1-6 -** Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.
  - **MS-PS3-4 -** Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.
  - **HS-PS3-1-** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
  - **HS-PS3-3 -** Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

- **MS-ETS1-3 -** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- **HS-ETS1-1-** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- **HS-ETS1-2 -** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

- 21st Century Science Content Standards and Objectives for WV Schools
  - **SC.O.6.1.05 -** cooperate and collaborate to ask questions, design and conduct investigations to find answers and solve problems.
  - **SC.O.6.1.10 -** utilize experimentation to demonstrate scientific processes and thinking skills (e.g., formulating questions, predicting, forming hypotheses, quantifying, or identifying dependent and independent variables).
  - **SC.O.6.1.11 -** construct and use charts, graphs and tables to organize, display, interpret, analyze and explain data.
  - **SC.O.ES.2.28 -** research alternative energy sources and evaluate the ecological, environmental and economic cost-benefit ratio.
  - **SC.O.ENV.2.4 -** evaluate environmental and economic advantages and disadvantages of using nonrenewable and renewable energy.
  - **SC.O.ENV.2.5 -** differentiate various means of generating electricity in terms of the transformation of energy among forms, the relationship of matter and energy, and efficiency/production of heat energy.
  - **SC.O.7.2.23 -** explain conservation of matter and energy and investigate the different forms of energy (e.g., mechanical, potential, kinetic, or gravitational).
  - **SC.O.8.2.18 -** examine the various sources of energy (e.g., fossil fuels, wind, solar, geothermal, nuclear, biomass).
  - **SC.O.8.2.21-** relate the conservation of energy theory to energy transformations (e.g., electrical/heat, or mechanical/heat).