TEACHER LESSON PLAN
The POWER Shower Activity
Developed by Jon Olson, Hilary Olson and Sabrina Ewald

Standards:

Middle School (TEKS)

6th	7th	8th
1.A-B	1.A-B	1.A-B
1.D-G	1.D-G	1.D-G
2.A-C	2.A-C	2.A-C
3.A-C	3.A-C	3.A-C
4.A-B	4.A-B	4.A-B
5.A-C	5.A-C	5.A-C
7.A	8.A	11.B
11.A-B		

Environ. Sys. TEKS

1.A	6.C
1.B	6.E
1.D-G	7.B
2.A-C	12.A
3.A-C	12.C-E
4.A	13.A-B

ESS TEKS

1.A	12.E
1.B	13.A
1.E-G	13.B
2.A-C	
3.A-C	
4.A-B	

AP Enviro. Sci. Standards

6.1
6.2
6.3
6.5
6.13

NGSS Standards

K-2-ETS1-1	MS-ESS3-4	HS-ETS1-1
3-5-ETS1-1	MS-PS2-2	HS-ETS1-3
3-5-ETS1-2	MS-PS3-5	HS-ESS3-3
4-PS3-1		HS-ESS3-4
4-PS3-2		
4-PS3-4		

Level: 6-12, undergraduate, graduate

Objectives:

During this activity students will:

- Identify and define various units of energy (e.g., joule, BTU).
- Identify and define various units of power (e.g., watt, horsepower).
- Define the relationship between energy and work, calculate work using the formula ***Work = Force x Distance***, and identify relevant units of work (newton-meter or joule, ft-lb_f or BTU).
- Differentiate between energy and power and explain the relationship between energy and power (power is the rate at which energy is used/delivered).
- Engage in a kinesthetic activity to visualize how energy is generated and calculate the quantity of energy being generated by picking up and dropping a 5-lb sack.
- Evaluate the quantity of energy consumed when engaging in everyday activities such as taking a hot shower and recognize how machinery and technology of the modern world make our lives easier and richer.

Background Information:

What is energy, and how is it measured? Is a significant amount of effort required to generate the energy needed for daily activities? This activity offers a hands-on approach to understanding how energy is produced and measured. Generating energy can be an abstract concept. This kinesthetic activity helps students grasp what it takes to meet their daily energy demands and become familiar with the units used to measure energy, work, and power.

Time Requirements:

20-25 minutes

Teacher Preparation:

Materials:

1. Teacher presentation (PPT) (located in Supporting Documents below)
2. 5-lb sacks of rice, wrapped in duct tape OR order 5-lb ballast (sand) bags (option 1, option 2)
   **There are many other varieties/options online.*
3. Timers
4. Student Worksheet (located in Supporting Documents below)
5. Pen or Pencil

Procedure:

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1. After introducing the activity, use the **presentation** provided to define energy and power. Explain the units related to each and provide an overview of how each is calculated. **Slide 1, Slide 2**

2. Explain to students that you will ask them to calculate how much energy is required to heat water for a 20-minute shower to illustrate the concept that *Energy on Demand = Luxurious Living*. **Slide 3, Slide 4**

3. Give each student a copy of the **Student Worksheet** so that they can follow along and complete their worksheet.

4. Guide students to quantify the variables for their calculations: **Slide 5**
    a. Initial tap water temperature and final hot water temperature (°F)
    b. Shower head rate (gal/min)
    c. Duration of the shower (min)

5. Help students recognize the physical properties and physics concepts needed to complete their calculations: **Slide 5**
    a. Density of water
    b. Definition of a BTU

6. Explain to students that the energy will be calculated in BTU's and point out the definition of the unit (referenced in part **1d** of their worksheet). **Slide 6**

7. Discuss with students the approach to solving the problem and then work with them to complete parts **1a, 1b** and **1c** of their worksheet. **Slide 7, Slide 8**

8. Review the answers to parts **1a, 1b** and **1c** of their worksheet. **Slide 9** (first 3 equations)

9. Discuss with students the approach to solving the problem and then work with them to complete part **1e** on their Student Worksheet.

10. Review the answer to part **1e** of their worksheet. **Slide 9** (4th and last equation), **Slide 10**

11. Next, explain the link between energy and work to students. Describe how energy comes in various forms (e.g., heat, mechanical). Emphasize that all forms of energy can be described with the same units. Have students rub their hands together to demonstrate how mechanical energy can be converted to heat energy. This is not necessarily the most efficient way to provide heat (usually we burn a fuel), but this specific energy conversion is the premise for our kinesthetic exercise for providing the energy for a hot shower. **Slide 11**

12. Introduce the concept that lifting a weight to a higher elevation stores energy, and letting it fall releases that energy to be used to meet energy demand. The energy required to do mechanical work can be readily calculated. Guide students to complete parts **2a** and **2b** of their worksheet. The slides in the presentation can help you walk students through the steps for calculating the amount of energy generated by doing a specific task (=work). **Slide 11, Slide 12, Slide 13**

13. Using the presentation slide deck, explain to students the concept of a cycle of storing energy by lifting weight, and then releasing the energy by dropping the weight. These concepts will be important for our kinesthetic activity. Guide students to complete parts **2c** and **2d** of their

worksheet. **Slide 14**

14. Explain to students that you are going to make them human-powered generators by having them pick up and drop a 5-lb sack for 1 minute. Organize the groups: **Slide 15**
    a. Students are in groups of 3-4.
    b. 1 student is the lifter, 1 student is the counter, 1 student is the timer. *If in groups of 4, the 4th student can be another counter.

15. You will want to demonstrate a 5-ft-high reference and remind them of the concept of a cycle for this activity. One cycle is bending down to pick up the sack, lifting the sack to 5 ft while the student stands up (storing energy), and then dropping the sack from a standing position (releasing energy). Students will often try to cheat and not actually drop the sack OR not lift it back up to the full 5-ft-high reference. The goal is to see how many cycles the student can complete in 1 minute. [The expectation is that the number of cycles will be on the order of 31, but some will be more or less POWERFUL than others.]

Procedure:

16. Once groups are organized and each group has a 5-lb sack and a timer, have the groups begin! The groups do not necessarily have to start at the same time if each group has its own timer, but it can make it more of a contest or game if you have all groups start simultaneously.

17. After 1 minute has passed, have each counter call out OR write the total number of cycles on the whiteboard. Guide students to use an average of 31 cycles/min for their calculations so that everyone can come up with the same answers on their worksheets. Ask students to complete part **2e** of their worksheet. **Slide 16**

18. How long is it going to take one person to generate the energy? How can we generate the energy in real time? Guide students through the calculations in parts **2f** and **2g** of their worksheet. **Slide 17, Slide 18**

19. Discuss the results of the activity. Use the presentation to relate back to the amount of energy needed to heat water for a 20-minute shower and discuss the feasibility of using human-power to generate the energy you need for daily activities.

20. If desired, you can complete the exercise with the appropriate slide by calculating the horsepower (parts **2h** and **2i** on their worksheet) of one person doing this exercise to compare it to something familiar to most students: a lawn mower. **Slide 19**

21. Show the video embedded in the presentation to provide more context for students and have students reflect on the presentation and activity. *Note: in the past we used 5-lb sacks of potatoes for this activity, but the potatoes could only be used once, so we went to the more sustainable formats of rice or sand. **Slide 20**

22. Summarize the main goals of the lesson using the appropriate slide. **Slide 21**

Supporting Documents:

Teacher Presentation (PPT)
Student Worksheet
Student Worksheet - Key