GYSTC
GEORGIA YOUTH SCIENCE & TECHNOLOGY CENTERS

Title: Smart Shower STEM Challenge

Estimated Time: 1-2 periods

S3L2. Obtain, evaluate, and communicate information about the effects of pollution (air, land, and water) and humans on the environment. a. Ask questions to collect information and create records of sources and effects of pollution on the plants and animals. b. Explore, research, and communicate solutions, such as conservation of resources and recycling of materials, to protect plants and animals.
S6E6. Obtain, evaluate, and communicate information about the uses & conservation of various natural resources and how they impact the Earth.
b. Design and evaluate solutions for sustaining the quality and supply of natural resources such as water, soil, and air.

Literacy Connections: Books	**Literacy Connections: Close Reads**
The Curious Garden, Peter Brown The Garbage Barge, Jonah Winter Save the Arctic, Bethany Stall	Saving Water Can Help Save Our Planet CR
Science and Engineering Practices: **Planning and Carrying Out Investigations:** Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. **Constructing Explanations and Designing Solutions:** Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system.	**Crosscutting Concepts:** **Stability and Change:** For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

STEM Challenge Overview:

As occupants of this planet, we are running out of the freshwater that is necessary to sustain all living things. Fresh water is a finite resource that is becoming increasingly scarce. While water is constantly recycled through the Earth's water cycle, we are using up our planet's fresh water faster than it can be replenished. As humans, we use more water than any species on the planet. If we expect to survive and thrive, we must decrease our daily use of water dramatically.

One of the places where we waste the most water is at home in the shower. Showering accounts for almost 17 percent of our daily indoor water use. If we could make our showers more efficient then this would be one important step towards reducing our water consumption. In terms of design, older showerheads tend to have fewer but larger holes through which the water flows. In contrast, newer showers tend to have a greater number of smaller holes. The question to answer in this challenge is:

Which type of showerhead uses less water and is more energy efficient?

Students will create/design one model showerhead that has 5 holes that are larger (4mm diameter) and one showerhead that has 10 holes that are smaller (2 mm diameter). They will then test the showerheads to see which one uses less water. In addition, they will evaluate the quality of the shower stream that is produced. Finally, they will recommend which type of showerhead should be recommended for use by members of their community. Finally, they will design a showerhead that produces what they consider to be the best combination of water conservation and high performance.

Ask	Allow the students to construct the showerheads using the materials and directions provided. Using a sharp pencil and a ruler, they can carefully poke holes in their model showerhead. Encourage them to be precise as they create and measure each of the holes. Encourage them to **ask** questions regarding the problem of excess water usage and the need to conserve water. You can also encourage them to ask questions relating to the size of the hole and flow rate of the water.
Imagine/Brainstorm	Students **brainstorm** ideas regarding how they will measure the flow rate of each showerhead. As needed, emphasize that the flow rate for a liquid is the rate of fluid flow per unit time (in this case, the volume of water that passes through the showerhead per second). As a group, they must determine how to measure and calculate the flow rate for each showerhead. Depending on the abilities of your students, you may decide to demonstrate a plausible approach.
Plan	Students **plan** an organized approach to solving their problem – measuring the flow rate to determine which showerhead is more efficient. This may include a diagram (sketch) of their showerhead designs and/or a procedure as well as a list of any additional materials they may need to solve the problem.
Create	Students follow their plan and **create** a potential solution to their problem. Once it is created, students **test** their showerheads to see which one uses less water. In addition, they will evaluate the quality of the shower stream that is produced on a scale of 1-5. Finally, they will recommend which type of showerhead should be recommended for use by members of their community.
Improve	After discussing, evaluating, and sharing their results, students use their results to **improve** their solution and re-test if possible. In this case, they will design a showerhead that produces what they consider to be the best combination of water conservation and high performance.

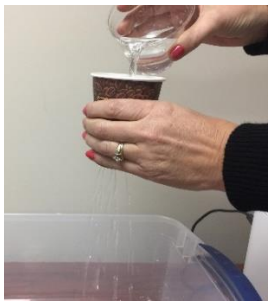
Teacher Notes:

In this STEM Challenge, the task for students is to see which type of showerhead uses less water. One of the factors that determines water usage is the size and quantity of holes in the showerhead. As it turns out, older shower heads tend to have fewer but larger holes. In contrast, newer showers tend to have a greater number of smaller holes. The question for students to answer in this challenge is:

Which type of showerhead uses less water and is more energy efficient?

To begin the challenge, students create/design one model showerhead that has 5 holes that are larger (4mm diameter) and one showerhead that has 10 holes that are smaller (2 mm diameter). A sharp pencil works great for making these holes and paper cups are preferred. Encourage them to be careful and precise as they make these holes (it is easier to poke the holes with the cup upside down but then turn it over and re-poke them so that the flow of water is not impeded by the excess paper).

Next they must determine how to test each of the showerheads to determine the flow rate of each of the models. In doing so, they will see which one uses less water and is more energy efficient. Encourage your students to be detailed and precise in planning out how they will make and record these measurements. As needed, emphasize that the flow rate for a liquid is the rate of fluid flow per unit time (in this case, the volume of water that passes through the showerhead per second). To calculate the rate of flow, they must measure both the amount of water used and the time elapsed.



In completing the challenge, students should find that the combination of large holes that are less in number creates a greater flow rate than small holes that are greater in number. This is expected mathematically, since the area of the holes produced by the 10 small holes is about 125 mm^2 whereas the area produced by the 5 larger holes is about 250 mm^2. This means that there is double the area for water to flow through with the larger holes. When students measure how long it takes for the water to flow through the cup, they typically get results that are close to those expected mathematically. If possible, have your students complete these calculations. It should also be noted that other factors such as surface tension have an impact on the results.

Sample calculations:

Area of circular hole = πr^2

Area of small hole = $\pi 2mm^2 = 12.5mm^2$, Total area of small holes = $12.5mm^2$ x 10 holes = 125 mm^2

Area of large hole = $\pi 4mm^2 = 50.2mm^2$, Total area of large holes = $50.2mm^2$ x 5 holes = 251 mm^2

Flow rate for 230 ml (1 cup) of water:

Flow rate = total ml of water/seconds required

Flow rate for cup with small holes = 230 ml/18 sec = 12.8 ml/sec

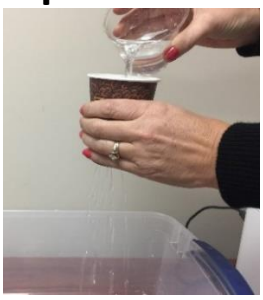
Flow rate for cup with large holes = 230 ml/9 sec = 25.5 ml/sec

Older showers typically use between 5 to 8 gallons of water per minute consuming up to 80 gallons of water during a 10 minute shower. Fortunately, newer low-flow showerheads use only 2.5 gallons per minute and so a 10 minute shower uses only 25 gallons of water. If you're really into water conservation, you can install ultra low-flow showerheads that use only .8-1.5 gallons per minute. While water conservation is important, there are other shower criteria used so that consumers don't have to sacrifice satisfaction in order to save water. These include spray intensity, spray pattern, and pressure compensation. So there's no excuse for not installing a low-flow showerhead in your home.

Materials Needed (per group:

3 paper cups (coffee cups work well)	Ruler
Plastic tub or pan to catch water.	Water
Graduated cylinder or measuring device	Stop watch or timer

Vocabulary Cards:

consumption the using of a resource 	**conserve** to use and preserve wisely 
reduce to make smaller in amount 	**flow rate** volume of fluid flow per unit time 
energy efficient uses less energy to provide services 	**engineer** to design, build, and improve things 

Smart Shower STEM Challenge:

Which type of showerhead uses less water and is more energy efficient?

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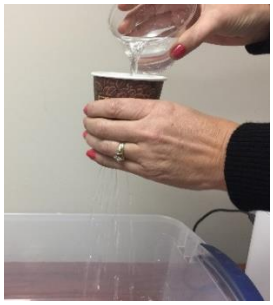
Which type of showerhead uses less water and is more energy efficient?

1. Your challenge is to design one model showerhead that has 5 holes that are larger (4mm diameter) and one showerhead that has 10 holes that are smaller (2 mm diameter).

2. Next you must plan how to test each of the showerheads in order to determine the flow rate of each of the models. In doing so, you will see which one uses less water and is more energy efficient. The flow rate for a liquid is the rate of fluid flow per unit time (in this case, the volume of water that passes through the showerhead per second). To calculate the rate of flow, you must measure both the amount of water used and the time elapsed. Make sure to sketch/record your plan.
3. Test your showerheads according to your plan. Make sure to record your data including the amount of water used and the time taken.



4. Evaluate the quality of the shower stream that is produced on a scale of 1-5. You can do this by refilling each cup and carefully observing and feeling the shower stream that is produced by each showerhead. Be prepared to advise which type of showerhead your group would recommend for use by members of their community.
5. Finally, as time permits, you will try to improve the showerhead by designing a pattern of holes that produces what you consider to be the best combination of water conservation and high performance.