2016 STEM Challenge Toolkit

For 60 years, Rocky Mountain PBS has been a highly trusted and authoritative resource on science, technology, engineering and math (STEM). We inspire curiosity, understanding and appreciation for STEM through our captivating adult programs like *Nova* and *Nature*, our children's programming, and our PBS LearningMedia™.

That's why we are proud to announce an inaugural STEM Challenge, which we hope will engender a deeper understanding among middle school-aged youth in Southern Colorado about how much fun STEM can be, and how important STEM disciplines are to the world.

We thank you for your participation and offer our appreciation for your role in bringing STEM studies to life!

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Challenge Summary

Water, also known by its chemical formula, H_2O, is necessary for the survival of every organism on planet earth. From mammals to insects to plants, water is an essential ingredient for the ecosystems that keep us alive.

Over the course of the next four weeks, we will explore many facets of water, but our focus will be primarily on drinking water in general and, in particular, water purity. At the end of the challenge, student teams will have developed their own water purification system that is effective, efficient, and replicable.

We have divided our educational curriculum into four sections: Water in the World (Science), the Value of Water (Math), Purification Systems (Engineering) and Tools (Technology). Each section of the toolkit will be complemented by programming on Homework Hotline (available live each weekday at 4:30pm on Rocky Mountain PBS in Southern Colorado), with each section lasting one week.

February 8, 2016 – STEM competition launches and materials are made available online and on air
February 8-12, 2016 – science week on *Homework Hotline*
February 9, 2016 – last day for teams to register to compete at: http://www.rmpbs.org/homeworkhotline/
February 15-19, 2016 – math week on *Homework Hotline*
February 22-26, 2016 – engineering week on *Homework Hotline*
February 29-March 4, 2016 – technology week on *Homework Hotline*
March 7, 2016 – Evaluation forms due no later than 5pm

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Science: Water in the World & Water in Southern Colorado

As already noted, human beings in particular rely on water. Our bodies are made of more than 60% water, and this water serves to dissolve essential vitamins, deliver nutrients to cells, regulate body temperature and much, much more. We use water to grow and wash our food, and the presence of water regulates the temperature of the earth. Indeed, 71% of the earth's surface is covered in water, and 96.5% of that water is found in oceans, seas and bays.

Globally, we face many challenges with water. Colorado is home to many watersheds, and we have our own statewide water plan. In Southern Colorado, water has been a contentious issue in the news a Southern Delivery System is nearing completion. Recently, Flint, Michigan received national attention for the city's water issues.

Because water is so crucial to human survival, this challenge will focus on water as a life source in the form of drinking water. Drinking water comes from two primary sources: surface water, like streams and rivers, and ground water, or water found below the earth's surface, such as in wells or aquifers.

Both surface water and ground water are susceptible to contaminants that compromise the purity of the water, making water treatment a crucial step in preparing water for human consumption. Typically, surface water contamination is bacterial, while ground water contamination is mineral: different types of contamination require different methods of purification.

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Math: The Value of Water & The Cost of Purification

We've all seen it: a bottle of water being sold at the store for $3.00 or more. Maybe you've wondered how that water compares with tap water. While there are many ways of evaluating water quality, our challenge will focus on:

- pH and Alkalinity – pH level refers to the degree of acidity present in a material. Alkalinity is the ability of water to resist changes in pH, or the capacity of water to stabilize its own pH levels. pH levels can be evaluated with test strips, available online and at grocery and hardware stores everywhere.
- Turbidity – Turbidity refers to the cloudiness or haziness of a fluid – the appearance of sediment in the water. For this challenge, we encourage you to purify water from many different sources and evaluate the visual appearance of the water before and after purification.
- Hardness – Water hardness refers to the amount of calcium and magnesium present in water: water is said to be very hard if high levels of these minerals are apparent. Test strips are available online to test for water hardness, but there are low-cost common material testing methods as well.

For this challenge, an evaluation of water quality must also consider the cost of the purification system. The effectiveness of the system will be balanced against the total cost, and extra consideration will be given to teams who develop an efficient model that can be scaled at a minimum of cost in other communities and circumstances.

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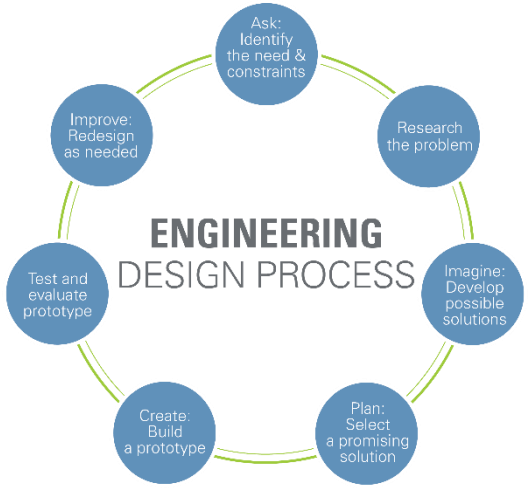
Engineering: Developing a Purification Concept with a Team

Engineering is defined on Dictionary.com as “the art or science of making practical application of the knowledge of pure sciences, such as physics or chemistry, as in the construction of engines, bridges, buildings, mines, ships, and chemical plants.” Put more simply, engineers are the people who, through the thoughtful application of science to real-world problems, devise and develop solutions that improve our world.

Engineers use the Engineering Design Process to arrive at solutions, a model consisting of six key steps: identifying needs and constraints, researching, imagining solutions, planning, building, testing and evaluating, and improving.

Most engineering happens in teams, and many engineers find it helpful in developing solutions to assign team members specific roles in the design process, some of which include: organizer, skeptic, writer, cheerleader, creative, researcher, listener, completer, and evaluator. What other roles can you think of that might help you design an effective, efficient water purification system?



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Technology: Tools, Tactics & Tips for Success

By now, you're probably ready to get started developing a water purification system prototype for testing, and you're curious about the technology that's available to you. Below, you'll find links to information about various purification systems and techniques:

- Boiling
- Chemical disinfectants
- Filters
- Ultraviolet purification
- Distillation
- Ion Exchange

It is worth noting that a successful purification system may integrate several – or all – of these techniques to purify water, as we see in waste water treatment plants.

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Resources for Additional Learning

Organizations doing work locally and internationally to support access to clean drinking water:

American Society for Civil Engineers
Clean Water Action
Earthforce
Engineers Without Borders
Water for Colorado
Water for People

Additional Resources and Lesson Plans:

Household Water Treatment
Filtration Activities
SEWCD Water Conservation Toolbox
After the Storm Video

Schedule a tour of Colorado Springs Utilities facilities
Email experts with questions

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Evaluation Questions

Please email kristymilligan@rmpbs.org a document by 5pm on March 7 that contains the following information:

Team name & school name
Team lead name & contact information
Types/sources of water tested
Itemized list (with costs) of materials
Pre and post-purification pH level
Additional information about alkalinity testing, if relevant
Information about how the engineering design process/team roles were used
Information about how water was tested for hardness and what the results were
Optional photo attachment of water pre and post-treatment

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