

KANSAS CITY
PUBLIC SCHOOLS



The lab of
MR. Q

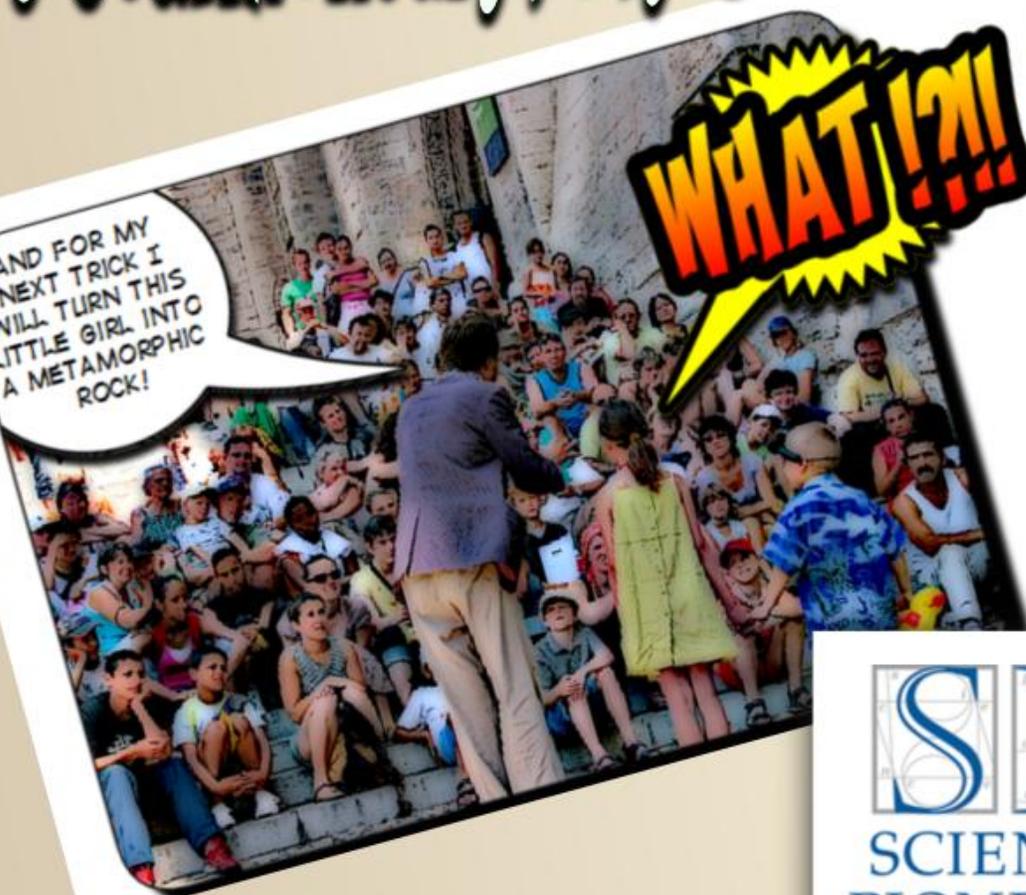
KCMO PD Workshops - Scott McQuerry

Fall 2013

It's Sedimentary, My Dear Watson

AND FOR MY
NEXT TRICK I
WILL TURN THIS
LITTLE GIRL INTO
A METAMORPHIC
ROCK!

WHAT!?!



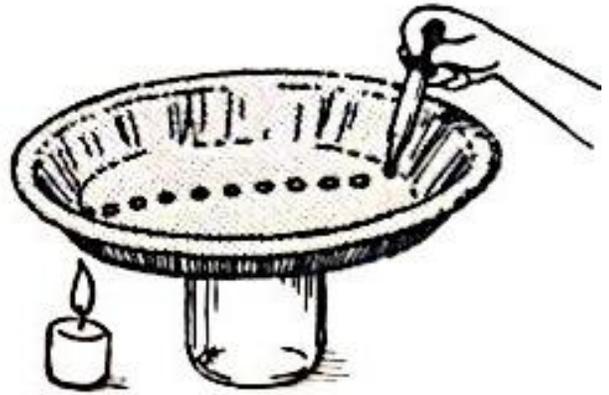
SIP
SCIENCE
PIONEERS

Igneous Rock Formation

**adapted from TOPS Learning Systems*

- 1) Lay down a row of saturated salt water drops along the diameter of an aluminum pie tin.
- 2) Rest the tin on a jar so a candle fits under the overhang, directly below the first drop.
- 3) Light the candle. Its flame should touch the bottom edge of the pie tin.
- 4) Write your observations over the next 10 minutes
- 5) How is the size of a crystal related to how fast it forms?

Rocks and Minerals



Igneous rock crystallizes from molten magma by cooling slowly over thousands of years in deep underground areas. These types of rocks are known as plutonic rocks. If the magma erupts through cracks in the earth's crust, these igneous rocks are known as volcanic rocks. Basalt is an example of a volcanic rock and its tiny crystals were formed through the rapid cooling of magma within the atmosphere. Granite is a plutonic rock as its crystals are very large and well-formed as it cooled slowly underground.

Within this experiment, "volcanic rocks" are formed rapidly and can be observed closer to the heat source. You should have noticed that the water drops evaporate one by one, leaving salt crystals behind. Near the flame this happens so rapidly, the crystals sizzle and splatter. Farther from the flame, the drops evaporate more and more slowly.

The crystals that formed rapidly are too small to see individually. Their dull white appearance is similar to crushed sugar. The crystals that formed more slowly are much larger much like those found in plutonic rocks. Their uniform shape and translucence is similar to granulated sugar.

Measuring the strength of our resources

Children will interpret the hardness or softness of objects.

**adapted from TOPS Learning Systems*

Materials:

Penny

Paper clip

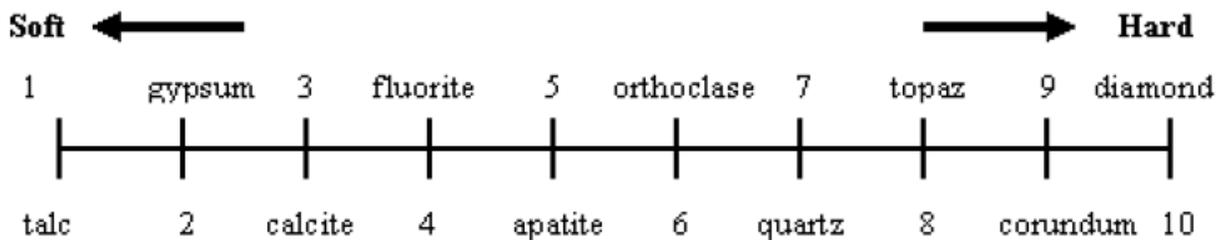
A brick

Chalk

Old glass jar

Activity:

Have the child try to scratch the penny with the paperclip and the paperclip with the penny. The harder paperclip scratches the softer penny. Ask the child which object is harder? They should state that the paperclip is harder. Inform the child that they will be given several items and will be asked to test what scratches what". For example, on the following scale:



#8 Topaz will scratch all of the softer minerals (#1-7)

Provide the child with the penny, a paperclip, a brick and a piece of chalk. Inform them that the brick has already been discovered for them and is already written down on their "hardness scale sheet".

Give the child the "hardness scale sheet" and observe them test the hardness of each object. An adult may choose to scratch the brick with the glass jar as a demonstration for the child. Then, the child may place the glass jar on the "hardness scale sheet" in the appropriate location.

When they are completed, ask them where their fingernail would be placed on this hardness scale. Have them test and see.

Explanation:

In 1822, Friedrich Mohs, a German mineralogist devised a crude but practical method of comparing hardness or scratch resistance of minerals. It has become universally known as Mohs scale. This activity is a basic method of studying the hardness of minerals in order to identify and classify them for future study.

The following items have been ranked for you in order from softest to hardest: chalk, fingernail, penny, paperclip, brick and glass jar

Toxic Popcorn Design Challenge

**adapted from the tryengineering.org*

Lesson Goal

The goal of this lesson is that teams of students use the engineering design process to solve the Toxic Popcorn Challenge. Students must develop a product and process to transfer toxic popcorn to a safe location and save the city.

Materials

One full set of material for each team

2 containers (plastics containers with lips are great)- should be slightly different size than the containers used for the actual toxic zone

100-200 pennies in a zip lock bag (represents the toxic popcorn)

6-8 pieces of 7.5 foot rope

1 bicycle tire tube 18" diameter

1 hula-hoop 3'-4' diameter (other options: rope taped down or a circle cut from a paper table cloth)

1 piece of large flip chart paper

1 marker

Student worksheet

One full set of material for ACTUAL TOXIC ZONE

2 containers (plastics containers with lips are great)

Popcorn kernels (fill about 1/2 of the container)

1 hula-hoop 3'-4' diameter (other options: rope taped down or a circle cut from a paper table cloth)

Procedure

- 1) Break class into teams of 4 (or up to 6).
- 2) Hand out the Toxic Popcorn worksheet.
- 3) Discuss the Scenario, Design Challenge, Criteria, Constraint and Materials.
- 4) Provide each team with their testing materials. Discuss why they can't "test" at the "actual" toxic site and explain that you were able to find some similar items that they can use to test their device and process.
- 5) Explain that they only have 60 minutes to save the city. They will have 40 minutes to design, build, test, and redesign their solution and the class will have 10 minutes to choose the very best class solution and save the city. So students don't feel rushed, you can take two periods and give a full period to design and test and take another period to choose the best design and save the city.
- 6) Use a timer or an on-line stopwatch (count down feature) to ensure you keep on time. (www.online-stopwatch.com/full-screen-stopwatch). Give students regular "time checks" so they stay on task. If they are struggling ask questions that will lead them to a solution quicker.
- 7) Provide each team with one large flip chart paper to draw their design and write out (as well as sketch) their final process. Each team must be prepared to explain their design and process to the class.
- 8) After 40 minutes of designing, building, testing and revising, have each team explain their final design and process with the class using their flip chart paper as an aid. Have the class vote on the design that they think will save the city. Remind the students that this is not about them, but about saving the city and choosing the best design possible.
- 9) Have the chosen team implement their process. Remind them how important communication is for success and that you want to hear them communicate with each other. Tell the rest of the class to

offer encouragement and support. It is fun if the rest of the class forms a circle around the team and cheers on the team. If they see something that is going wrong they need to share that with the team trying to save the city. For example, "John, be careful your left hand is close to the circle. Remind students that THE CLASS needs to save the city so we all need to help by supporting the team implementing their process.

10) Once the team chosen hopefully saves the city, let each team implement their process. It is important that each team get an opportunity to do this. They worked hard on their design and need to know if they could have saved the city. The class should continue to provide encouragement and support to each implementing team.

NOTE: In connection with the toxic popcorn activity, you may want to take time to discuss toxic materials and the ethics of illegal dumping. You could lead a class discussion about the effects of toxic waste dumping and more specifically the damage pollution has done to our planet. For an overview of toxic waste view: (<http://environment.nationalgeographic.com/environment/global-warming/toxicwaste-overview.html>)

Possible Solutions

There are multiple solutions, but here are two of the more common successful solutions.

Lifting the Container

Tire Tube. The tire tube is just a large rubber band. Most students realize its value and use it in their design.

Tension. Students tie two ropes on either side of the tire tube and once it is around the container they pull. Using TENSION, the students can lift the container with the toxic popcorn.

Compression. Students make a figure 8 with the tire tube and then fold it over so they have a circle that is smaller than the diameter of the container. They tie an equal number of ropes around the tire tube and pull so that the tire tube is larger than the diameter of the container. Once the tire tube is around the container, they can let go and the tire tube will snap onto the container using compression.

Just Ropes. Some students attempt to use just ropes and not use the tire tube. With containers that have lips, this can be successful, but most often fail because of the lack of control. You'll also see students attempt to lasso the container. Even if they do get the rope over the container; they cannot tip it with one rope without having their hand cross the plane of the circle. Try to redirect them by asking questions that lead down a successful path.

Tipping the Container

The process of tipping the container can be done with as few as two students. With the tension or compression method, after the container is lifted with two ropes on each side of the tire tube, the two people can together tip the container by, in unison, moving one rope to the top and the other to the bottom so that their hands are ultimately crossed. They need to do this very slowly and steadily or it can go too fast with popcorn missing the container. Another model is to have 3 ropes, using two ropes to lift the container with tension and one other rope (or two tied together for length) to do the tipping. Two people would stand next to the two lifting the container with their rope across the circle and on one side of the container. They can then pull the bottom of the container upward slowly tipping it and transferring the popcorn into the other container.

Student Resource:

What is the Engineering Design Process?

In order to understand the Engineering Design Process you first need to understand technology and engineering.

Technology is all around us. It is any product (an object created by a person) or process (a series of steps that brings about a result) that is designed by people to solve a problem. Most of the things you are in contact with each day are technology. For example: paperclip, cup, glasses, stapler, bottle, and pencil etc. What technology do you use everyday?

Engineering is the application of science and mathematics to design or redesign technology to solve problems and meet needs. Where scientists study the natural world, engineers design the human-made world.

Engineers design everything from sandwich bags to submarines, robots to roller coasters and air bags to artificial hearts! Can you name more technology that engineers have designed? Check out the Greatest Engineering Achievements of the 20th Century: (www.greatachievements.org) and see how engineers have made the world a better place. Engineering is a profession with a vast number of disciplines. For example: mechanical engineering, electrical engineering, civil engineering, biomedical engineering, systems engineering, ocean engineering, materials engineering, etc. Can you name more disciplines? To learn more about engineering and the different disciplines, visit www.tryengineering.org

The Engineering Design Process

All engineers have one thing in common and that is the process they use to solve problems -- it is called the engineering design process. The engineering design process is to engineering what the scientific method is to science.

Identify the Problem

What is the problem you want to solve?

Research Problem

What do you know about the problem? Find out as much about the problem as you can. What are the criteria (conditions that the design must satisfy—its overall size or weight, etc.) and constraints (limitations with material, time, size of team, etc.) of this problem?

Develop Possible Solutions

Brainstorm as many solutions as possible.

Select Best Possible Solution

Which of your designs do you think is the best possible solution?

Construct Prototype

Using the materials given, build a prototype (a working model) of your design. Don't forget about the criteria (conditions that the design must satisfy) and constraints (limitations that need to be designed around).

Test & Evaluate Solution

Test and evaluate your design. Did you satisfy the criteria and constraints?

Redesign

Did your design solve the problem? If not, brainstorm a new design, build and test it until you have successfully solved the problem.

Communicate

At each step in the process you must communicate with your team members. You need to also communicate with others outside of your team to get feedback on your design. You need to communicate verbally as well as by describing your design through writing and drawings. Communication is at the core of the engineering design process.

Student Worksheet:

Toxic Popcorn Design Challenge

Scenario

A can of highly toxic popcorn has contaminated a circle of approximately 4 feet in diameter. The toxic area extends to the ceiling. If the toxic popcorn is not transferred to a safe container for decontamination, then it will contaminate and destroy the entire city. The popcorn is estimated to have a safe life of exactly 60 minutes before it explodes. It's up to us to save the city!

Design Challenge

Inside the circle you will find two containers. One (unsafe container) is half full of the toxic popcorn. The other (safe) container is available for decontamination. Find a way to safely transfer the toxic popcorn from the unsafe container to the safe container, using only the materials provided to you.

Criteria

1. No one may cross the plane of the circle with any part of the body.
2. The popcorn and containers cannot cross the plane of the circle. Only the ropes & tire tube may cross.
3. No spills are allowed, or the popcorn will explode.

Constraints

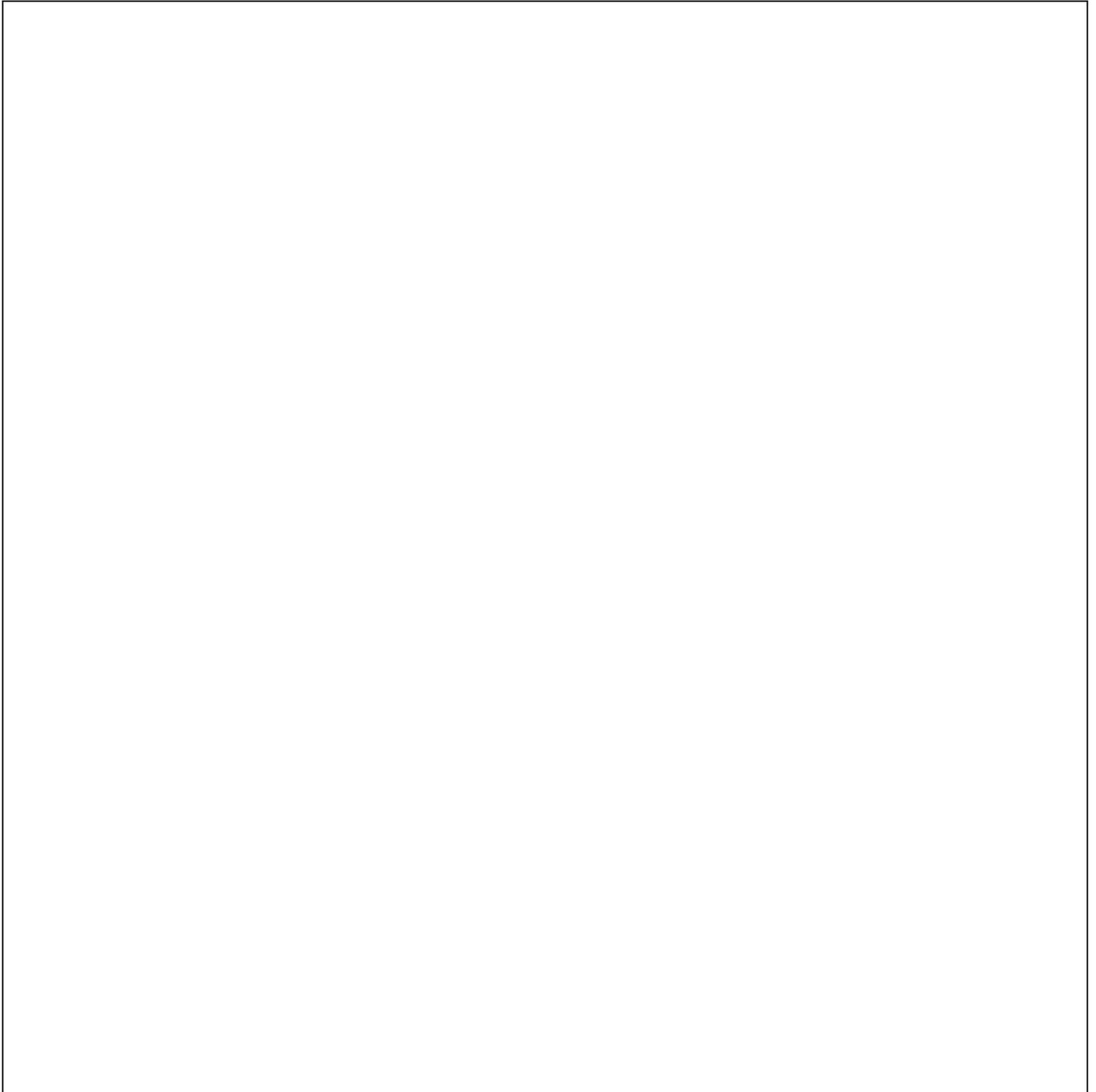
1. You may use only the materials provided.
2. The popcorn must be transferred within 60 minutes or there will be a disaster.

Team members: _____

Identify, Research, and Design Stage

Meet as a team and discuss the problem you need to solve. Then develop and agree on a process for solving the challenge. You'll need to determine what materials you want to use.

Draw your design below, and be sure to indicate the description and number of parts you plan to use.

A large, empty rectangular box with a thin black border, intended for drawing a design. The box is currently blank.

Construction Phase

Choose your best product design and your best process design. Build your design. During construction you may decide you need additional materials or that your design needs to change. This is ok – just make a new sketch and revise your materials list.

Testing and Evaluation Phase

Each team will test their design and process. If your design and process were unsuccessful, redesign and test again. Continue until you are happy with your solution. Be sure to watch the tests of the other teams and observe how their different designs worked.

Sketch your Redesigned idea (make sure to label your sketch):

A large, empty rectangular box with a thin black border, intended for students to draw and label their redesigned ideas. The box is currently blank.

Evaluation Phase

- 1) Did your solution save the city?
- 2) What went well?
- 3) What didn't go well?
- 4) What is your favorite step in the engineering design process and why?
- 5) What is your favorite element of your design and why?
- 6) If you had time to redesign again, what changes would you make?

Filtration Investigation

**adapted from the tryengineering.org*

Lesson Goal

Lesson focuses on how engineered filtration systems have impacted the availability of drinking water. Through this lesson, student "engineering" teams are challenged to remove as much sediment or "dirt" as possible from a muddy water source. The students work in teams to determine which everyday items they will use, then design and build their filtration system. Student teams test their own filters and compare their results with those of other student "engineering" teams. The team with best plan will be the test with the clearest "filtered" water. Students evaluate the effectiveness of their own filter systems and those of other teams, and present their findings to the class.

Materials

Student Resource Sheet

Student Worksheets

Classroom materials:

Water basin for testing student filter systems

Supply of "muddied water" which can be made by taking a quart of drinking water and adding two tablespoons of dirt.

One set of materials for each group of students:

Two cups of "muddied water"

Plastic or paper cups, straws, cardboard, cotton balls, sand, aluminum foil, rubber bands, tape, toothpicks, paper towels, plastic wrap, aquarium or other small rocks, cornmeal, flour, tape, and/or other materials (such as grass or charcoal if available)

Procedure

1. Show student "engineering" teams their various Student Reference Sheets. These may be read in class, or provided as reading material for the prior night's homework.
2. Divide students into groups of 2-3 students, providing a set of materials per group.
3. Explain that students must work as a team to design a filtration system to remove as much dirt or sediment from a provided water supply. The team with the clearest resulting water (based on a visual inspection) will have developed the best filter in the class.
4. Students meet and develop a plan for their filtration system, including a list of all materials they require for construction.
5. Student teams draw their plan and present their plan to the class. Students may adjust their plan based on feedback received at this stage.
6. Student teams build their filtration system. They may determine that additional materials are needed to complete this step. If so, they need to indicate the new materials or quantity of materials on their design worksheet.
7. Next...teams will test their filtration system using "muddy" water provided by the teacher. Students will evaluate the clarity of the "filtered" water based on the "grade of clarity" scale below, and assign a number to each team's work.

Completely clear (as drinking water might appear)	About a quarter of the dirt remains	About half of the dirt remains	About three quarters of the dirt remains	Completely muddy (as original source water appeared)
0	1	2	3	4

8. Teams then complete an evaluation/reflection worksheet, and present their findings to the class.

Tips

- Be sure to stress that the "filtered" water, no matter how clear, is not suitable for drinking.
- For younger students, do not provide charcoal as a filtration option.
- Suggest to student teams that layers of filters -- or perhaps many filtration stages - may result in the most effective filtration system.
- Teams may require additional materials which they will request of the teacher, or they may be encouraged to exchange building materials with other teams.

Student Resource:

What is Filtration?

There are many different methods of filtration, each has a goal of separating substances. Filtration systems are important to providing safe drinking water, to separating materials for many purposes such as research or gathering pure samples of an element. The simplest way to "filter" is to pass a mixture, or solution, of a solid and a fluid (such as water and dirt or mud) through a porous material or system so that the solids are trapped as the fluid passes through. Panning for gold is an example of a filter, where prospectors hold pans with holes punched in the bottom, or fitted with a screen through riverbeds thought to contain gold nuggets. The materials too big to fit through the screen are then explored to see if gold has been gathered.

Filtration is used in waste treatment facilities where settling tanks allow for separation. The concept of filtration is found all around us, in community services and everyday items at home. An example is a coffee filter used in a coffee maker. The filter prevents the coffee grounds from reaching a coffee cup, but allows for smaller materials or particles of the coffee to pass through, resulting in a cup of coffee without coffee grounds. There are many different types of filters used in making coffee, some made out of paper, some out of recycled paper, and some using metals coated in gold. In each case, the size of the openings -- even microscopic -- will determine how much of the particles will make it through.

How Gravity Can Help

Liquids usually flow through the filter by gravity. This is the simplest method, and can be seen by revising the coffeemaker example. The water usually sits in the filter, and then drips down to a receptacle (cup or coffee pot) as a result of gravity. In chemical plants, gravity is also used to separate -- and is an economical method as it requires no additional energy. Sometimes pressure is added to speed up the filtration process...but if too much pressure is added to the system, the filter may clog or even tear or break.

Filtration Materials and Stages

Many materials can be used for making a filter...all depending upon the types of liquids, solids, or gases that need to be separated. Some filtration materials include paper, sand, cloth, charcoal, and rocks. Often staged filters are employed...where a liquid, for example, might pass through a series of different filters. In this case, sometimes the first filter will eliminate larger particles, while the second, third, or fourth filter will eliminate smaller and smaller particles or sediment. The image to the right shows a rough filtration system that might be made from sticks using three different stages of filtration...but there are many ideas for systems and engineers must develop new systems based on the challenges they face!

Student Worksheet:

Design Your Own Filtration System

You are part of a team of engineers who have been given the challenge of developing an filtration system to eliminate as much dirt or mud as possible from a water sample you have been provided. If your system works, you'll end up with water that looks completely clear. How you accomplish the task is up to your team! The team with the clearest resulting water (based on a visual inspection) will have developed the best filter in the class.

Planning Stage

Meet as a team and discuss the problem you need to solve. You'll need to determine which materials you'll request from the many everyday items your teacher has available. As a team, come up with your best design and draw it in the box below. Be sure to indicate the materials you anticipate using, including the quantity you'll request from your teacher. Present your design to the class. You may choose to revise your teams' plan after you receive feedback from class.

Design Stage



Materials Required (list each items and the quantity you expect to use):

Construction Phase

Build your filter system. During construction you may decide you need additional items or that your design needs to change. This is ok -- just make a new sketch and revise your materials list. You may want to trade items with other teams, or request additional materials from your teacher.

Testing Phase

You will be provided with two cups of "muddy" water by your teacher. You'll test your filter in a classroom basin and gather the "filtered" water for later evaluation. Be sure to watch the tests of the other teams and observe how they designed their filters, including what materials they selected.

Evaluation Phase

You and your class will be responsible for assigning a "grade of clarity" to each sample of filtered water. Use the following chart to determine the results of each team's work.

Completely clear (as drinking water might appear)	About a quarter of the dirt remains	About half of the dirt remains	About three quarters of the dirt remains	Completely muddy (as original source water appeared)
0	1	2	3	4

Then, evaluate your team's results, complete the evaluation worksheet, and present your findings to the class.

Reflection Questions:

1. Did you succeed in creating a filtration system that passed the source water? What "grade of clarity" did you achieve?
2. What aspect of your design do you think worked best? Why?
3. What aspect of your design would you have revised if given more time? Why?
4. What was unique about the design of the filtration system in your class that had the best results on this challenge? How did it work better than yours, if it did, and what would you have done differently if you had seen this design prior to developing your own?
5. Did you decide to revise your original design while in the construction phase? Why? How?
6. Do you think that engineers have to adapt their original plans during the construction of systems or products? Why might they?
7. Do you think your filter would have been able to withstand water running through it for an hour? Why?
8. Do you think you would have been able to complete this project easier if you were working alone? Explain...
9. If you could have used a material or materials that were not provided to you, what would you have requested? Why do you think this material might have helped with the challenge?
10. What was your favorite part of the challenge? Design Phase? Building Phase? Testing Phase? Why?