Rainwater Harvesting

TechXcite Discover Engineering

Youth Handouts

Activity 1: The Magic of Surface Tension

Name: _____ Date: _____

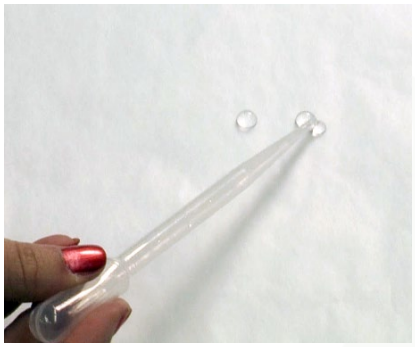
Materials List

- Penny
- 2 Droppers
- 2 Plastic cups
- Wax paper
- 2 Glass slides
- Liquid dish detergent
- Paper towels
- Water

Procedure

Part A: Wax Paper

1. Drop several droplets of water on the wax paper and use the dropper to push two or more water droplets together (see photo).



2. Add a couple droplets of detergent in a dry place on the wax paper. Place a couple of drops of water near the spots of detergent.
3. Now try to get two or more of the water droplets to join together. You may want to put a little detergent on the tip of the dropper first.

   Is it harder or easier to push the droplets together this time? Why?
4. Discard the wax paper and wash your dropper.

Part B: Glass Slides

5. Gently rub the glass slides together. Notice whether you feel any resistance.
6. Now place three drops of water on one slide and put the other slide on top.
7. Gently rub the slides together and note the amount of resistance.
8. Try to pull the slides apart.
9. Place two drops of water and one drop of detergent on one slide. Put the other slide on top and then gently rub the slides together. Again, note the resistance.

Part C: Penny

10. Half-fill a plastic cup with water and add a squirt of dish detergent.
11. Make sure your penny is dry and relatively clean. Place it heads-up on the work surface.
12. Predict how many drops of *clean water* can you put on top of the penny before it spills over the edge. Record in the table below.

Activity 1: The Magic of Surface Tension

13. Use the dropper to place drops of clean water on the penny, one at a time, counting as you go. Note: it can be difficult to count the drops if there are too many bubbles inside the dropper.

    How many drops of water did the penny actually hold?

14. Dry off your penny and place it back on your work surface, heads up.
15. Predict how many drops of water-detergent mixture can you put on top of the penny before it spills.
16. Repeat Step 13 with water-detergent mixture. How many drops of water-detergent mixture did the penny actually hold?

	Predicted Drops	Actual Drops
Without Detergent		
With Detergent		

Exploration Questions

1. What are some everyday examples of surface tension?

2. When soap is added, does it increase or decrease the resistance between the glass slides? Why?

Apply

Now that you understand surface tension and surfactants work, can you guess how the surfactant (soap) reduces surface tension?

Activity 2: Water on the Rise

Name: _____ Date: _____

Materials List

- Coffee stirrer
- Drinking straw
- Glass capillary tube
- Ruler
- Shallow plastic disposable plate
- Plastic cup
- 6 Sugar cubes
- Paper towels
- Food coloring
- Water

Procedure

Part A: Paper Towel

1. Half-fill your plastic cup with water, add a few drops of food coloring, and mix with the coffee stirrer.
2. Fold the paper towel lengthwise several times and touch the tip of it to the water. What happens? Why?

Part B: Sugar Cubes

3. Build a tower of sugar cubes on the plate. The sugar cubes must be touching one another.

   What would happen if you poured water onto the plate?

4. Pour some of the colored water around the base of the tower and observe. What happens? Why?

Part C: Straws

5. Dip your drinking straw into the water and hold it in place for a few seconds. Do not stir.
6. Notice the water level on the outside of the straw and the inside of the straw. Remove the straw from the water and use a marker or pen to mark the inside and outside water levels on the straw.
7. Repeat this step with the glass capillary tube.
8. Use the ruler to determine the water rise (or difference between the inner and outer waters levels) in each tube and record below.

	Water Rise (mm)
Drinking Straw	
Capillary Tube	

Activity 2: Water on the Rise

Exploration Questions

1. Does the water rise higher in a tube with a smaller diameter or a larger diameter? Why?

2. Would adding a surfactant, such as detergent, increase or decrease the amount of water rise in a given tube? Why?

Apply

Using your knowledge of capillary action, what factors might you consider when designing a shingled roof?

Activity 3: Rainwater Collection System

Name: _____ Date: _____

Materials List

- Aluminum foil
- Corrugated cardboard box
- Scrap cardboard
- Craft sticks
- Foam craft sheet
- Tape
- Water
- Measuring cup
- Watering can with sprinkler head
- Glue gun & glue sticks (Optional)
- Additional scrap material, if available

Engineering Design Challenge

Build a roof for your cardboard house that will protect it from the rain. In addition, you should collect as much rainwater from the roof as possible.

Design Constraints

- Rainwater collector must be placed at least 5 inches from the house.
- Only use materials provided by your instructor.
- Must work within the amount of time allotted.

Testing Procedure

1. Measure the amount of water to be put in the watering can and poured on the house. Record the amount poured for each group in the table below.
2. Hold the watering can over the roof, and pour until it's empty. It's okay if some of the water lands next to the house, but most should hit the roof. Do not pour directly into the collector.

   If it's raining, put the houses out in the rain for a few minutes. The collectors will catch some rain on their own but the amount landing on the houses and in the collectors should be roughly the same.
3. Measure and record the amount of water in each collection system.

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Water Poured						
Water Collected						

Activity 3: Rainwater Collection System

Exploration Questions

1. Which of your ideas worked well and which ones didn't? How might you improve your design next time?

2. Why might someone install a rainwater collection system?

3. Outside of your home, what are some important uses of fresh water?

Apply

Pretend you're a real engineer, with the ability to use or create anything you wanted, and design a rainwater harvesting system. Sketch and label your design. Be creative.

Activity 4: Building a Water Filter

Name: _____ Date: _____

Materials List

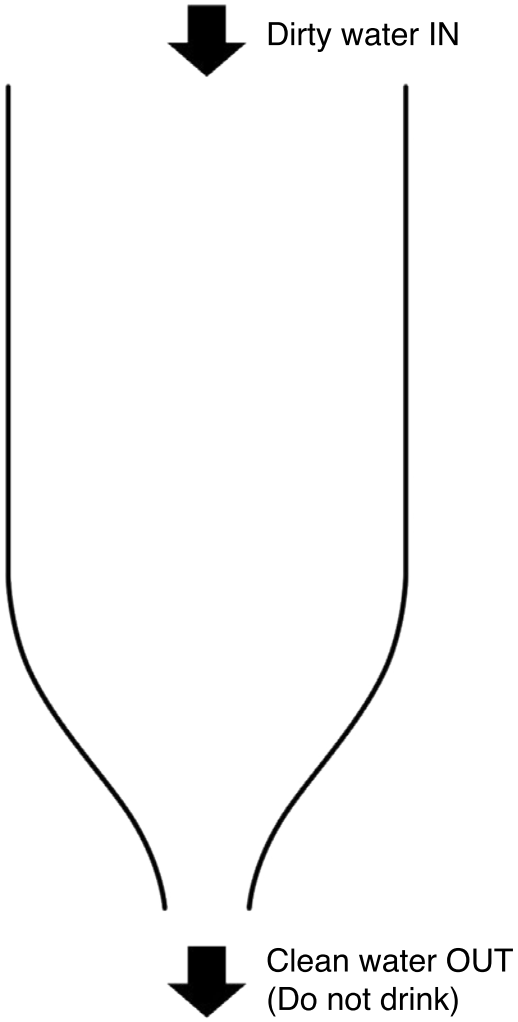
- Scissors
- 2 Clear plastic cups
- Measuring cup
- 20-ounce soda bottle
- 2-liter soda bottle
- Wax paper or newspaper
- Soil
- Gravel
- Sand
- Limestone rocks

Procedure

1. Use scissors to cut 2 to 3 inches off the bottom of your bottle. Discard the bottom piece and the bottle cap. The bottle opening will be the filter drain.
2. Place larger pieces of gravel and rocks the bottom to hold the components of your filter in the bottle.
3. Now design your own unique filter by choosing which materials to use and how to arrange them in the bottle. Record your materials, their quantities (using the measuring cup), and the order in which they are added to the bottle using the diagram and table on the next page.

   Note: When adding your materials, hold the bottle over a piece of wax paper or newspaper to catch anything that may fall through.
4. After your design is complete, the class will fill a single 2-liter bottle with dirt and water and shake the bottle well.
5. Fill a plastic cup with the dirty water.
6. Place an empty plastic cup under your filter to collect water and pour the dirty water into your filter.
7. Compare your clean water sample with your classmates. Discuss the materials and quantities used to make each filter and the approximate amount of time that it took for the dirty water to pass through it.

Activity 4: Building a Water Filter



Order	Material	Quantity
1		
2		
3		
4		
5		
6		

Note: Order starts with 1 at the bottom of the filter

Exploration Questions

1. In the United States, harvested rainwater is generally not used for drinking, so the water does not need to be as clean. What are some non-drinking uses of water in the home?

2. What determines how fast the water will pass through a filter?

Activity 4: Building a Water Filter

3. How should you configure your filter to make it as efficient as possible at removing contaminants?

4. How might you improve your design?

Apply

Design a water filtration system for a city that removes particle, chemical, and biological contaminates. Draw and label each step in the process.