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STEM
E-CONTENT
3D VIRTUAL REALTY

The Key To Global Life,
Digital Change Of Nature

Total Duration: 3 - 8 hours

Student's Age: 12-18 Years

Application Area:
- Water quality,
- Geography,
- Chemistry,
- Biology.

Keywords: Water, pollution, filters, deposits, electricity, conductivity, resistance, multimeter.

W3 - Prepare a water filter like NASA

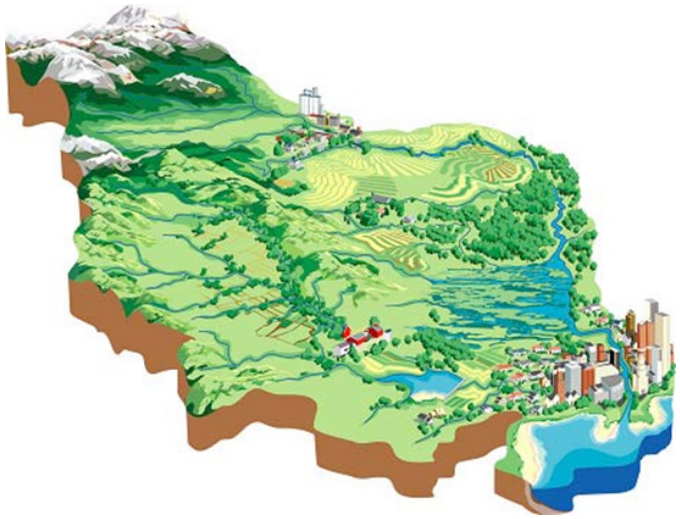
Module
- Water and healthy food

W3 - English Version

Materials:
- Plastic bottles
- Balances for weighing filter media
- Graduated cylinders 250 ml
- Scissors
- Paper towels
- Gauze cheesecloth
- Rubber bands
- Various materials to be used as filter media (eg. gravel, sand, coffee filters, activated carbon,...)
- Paper cups
- Simulated wastewater
- Conductivity test equipment and/or pH test strips

Notes:
- NASA's Marshall Space Flight Center, the water filtration system used on the ISS should be investigated and its structure should be examined.
- The stages of the event should be planned.
- The necessary materials for the construction of the event must be provided.

Introduction



Picture 1. Examples of different watershed or basins

In this activity, students are challenged to design and build a water filtration device using commonly available materials following the same design process used by the engineers and scientists who developed the International Space Station Water Recovery System for NASA.

They have to measure and evaluate the best system they made. They need to think about a consistent way to measure water pollution and possibly apply both PH test strips and conductivity tests to evaluate water purity.

A watershed is an area of land from which all the water drains to the same location, such as a stream, pond, lake, river, wetland, or estuary (see figure below). A watershed can be large, like the Colorado River drainage basin, or very small, such as all the water that drains to a small farm pond. Large watersheds are often called basins and contain many small watersheds (Picture 1).

Watersheds can be affected by nonpoint source pollution and the water in rivers can transport the pollutants. Non-point source pollution is associated with rainfall and snowmelt moving above soils /rocks (surface runoff) or underneath surface (groundwaters), carrying natural and human made pollutants affecting water quality sources. Examples of nonpoint source pollutants are fertilizers, pesticides, sediment, organic material, pathogenic organisms, plastics, gas, and oil. Pollutants accumulate in watersheds as a result of various human and natural activities. These pollutants, while sometimes inevitable, drastically alter the state of the ecosystem. If we can determine the type of pollutant and its cause, then we can classify the source of the pollutant and take preventative measures to reduce any further contamination.

There's also a need for water filtration systems beyond Earth, like for astronauts on the International Space Station. For example, NASA's Marshall Space Flight Center is responsible for the design, construction and testing of an important system on the ISS that not only provides the crew with a comfortable environment, but also minimizes the number of resupply missions needed to keep the ISS and its crew functioning.

In this activity, students will design a water filtration device with the same design used by engineers and scientists who developed the NASA International Space Station Water Filtration System. In this way, the water filtration system used in space will also be used on Earth to prevent water pollution. After designing the model, students will apply pH meters and conductivity tests to assess the "purity" of the water.

Considerations

- NASA's Marshall Space Flight Center, the water filtration system used on the ISS should be investigated and its structure should be examined.
- The stages of the event should be planned.
- The necessary materials for the construction of the event must be provided.

Aim of the Activity

- By designing a working device, they test the results and apply the engineering design cycle for this work.
- Students work in teams of two to three to collaborate with the entire class to produce the filtering device.
- Students measure the effectiveness of filtration devices by testing them with a pH test strips (and a conductivity tester – optional).
- Gain awareness to prevent water pollution.

Activity Process

Before Activity

Ask the questions to the students:

1. What is the most effective filter for removing the different types of water pollutants?
2. Will the same type of filter be efficient to remove different types of pollutants (example: in solution, in suspension, ...)?
3. How can you further improve the water filter design?

Preparation Phase:

- Research the definition of pure water.
- Prepare some "simulated wastewater samples" using e.g. mix water with distilled vinegar, food coloring, dust, topsoil or sand, human hair, …. Or go on a field trip and collect water samples from different sources.
- Discuss how polluted are the "simulated wastewater samples"?
- Discuss methods to measure water purity: with pH test strips or conductivity tests.

Let's Start

1 Water purification system

1. How to construct a purification system is a challenge, therefore no specific instructions are given. The students must research how this could be done. There are many easy examples that can be found online.
2. Describe to students the materials that can act as filters available and have them research any materials with which they are unfamiliar (usually activated carbon, if using).
3. Discuss with students how to use the conductivity testers (if you have it or if you made them).

Picture 2. . Example of a "Do it Yourself" (DIY) purification system

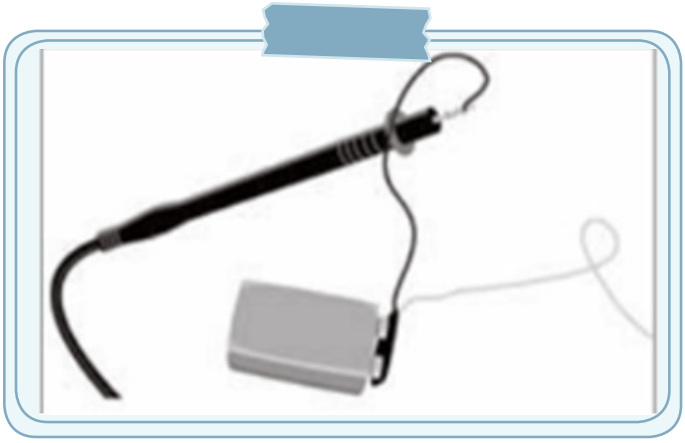
4. Let the student research how they could build their filter systems and let them propose different possibilities. They should research how NASA International Space Station Water Filtration System station works.
5. Let them build various prototypes and test the systems and evaluate (compare the results) (Picture 2).

2 Simple conductivity tester

Allow approximately 30 minutes to build and test each conductivity tester.

1. Strip each of the wires attached to the battery snap connector so that approximately 2.5 cm (1 in) of wire is exposed. Instructions for stripping a wire: You will need wire strippers. Measure and mark a point 1 to 1.5 inches down on your piece of wire. Take your wire strippers and score a line all the way around the wire at the mark. Do not cut the actual wires. Take the wire strippers, and find the measurement marked on them for the size wire you're using for your project. Place the wire inside the wire strippers where the correct wire measurement is. Place it above the score line you made earlier. Gently pull up on the wire strippers to pull the coating off of the wire. Trim the wires, if needed, to make them all straight. Repeat Steps 1 through 5 if you accidentally cut through too far and damage the wires (Picture 3).

Picture 3. Preparing conductivity tester.

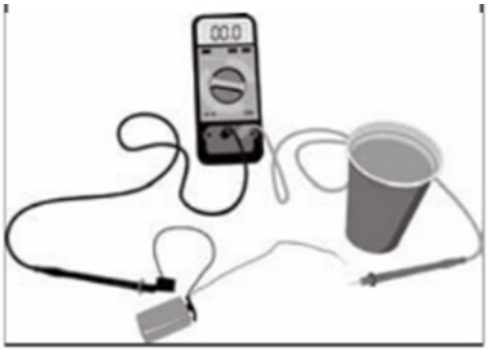


Picture 4. Step 2 of preparing conductivity tester.

2. Insert one lead of the multimeter into the slot labeled COM on the multimeter. Insert the other lead into the slot marked mA. It does not matter which color lead goes into which slot (Picture 4).

Picture 5. Step 3: preparing conductivity tester.

3. Using one of the wires from the battery snap connector, twist the wire around the metal end of the lead inserted into the slot labeled COM. It does not matter which color wire is connected to which lead. Secure the wire to the lead using a small piece of electrical tape (Picture 5).

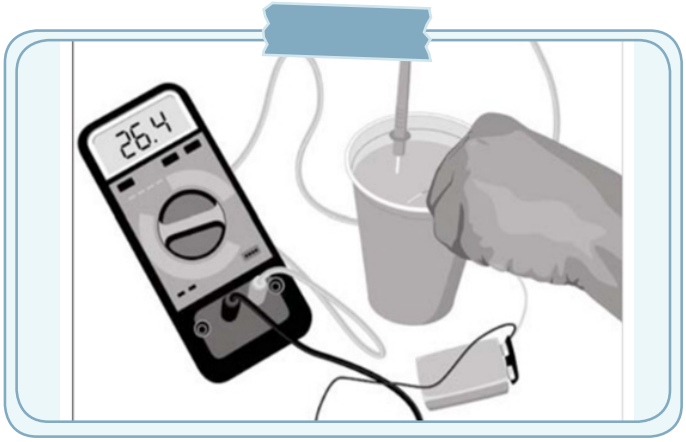


Picture 4. Step 4

4. Attach the battery connector to the 9-volt battery by snapping it to the top of the battery (Picture 6).

Do not allow the loose battery snap connector wire to touch the metal part of the lead inserted into the slot labeled mA. This creates a circuit and could zap the multimeter or cause the battery to overheat. Also, do not touch the metal ends simultaneously. This also creates a circuit and could cause the holder to receive a small shock

5. Turn the dial on the multimeter to the section labeled A or DCA. Set the dial to 200 m or 200 mA, depending on the labeling of your multimeter (Picture 7).
6. Test the conductivity tester.



Picture 6. Step 5

Closure

3 Discussion

Ask the students the following questions.

- Which materials that can act as filters were most effective at filtering the water?
- How might you further improve upon the water filter design?

Learning points:

There are five steps to basic water purification: aeration, coagulation, sedimentation, filtration, and disinfection. Our project took us through the first four.

*1. **Aeration*** adds air to the water. It allows gasses trapped in the water to escape and adds oxygen to the water.
*2. **Coagulation*** is the process that allows dirt and other suspended solid particles to chemically stick together (clumps of alum and sediment). During this step, the water is also purified or made clear and colorless.
*3. **Sedimentation*** is the process that occurs when gravity pulls the particles to the bottom of the container. So as the water sits undisturbed, most of the floc settles, preparing the water for the next step.
*4. **Filtration*** is the process where the remaining solid smaller particles and floc are separated and removed from the water.

Picture 6. Discussion

*5. **Disinfection*** is the final step, in which water is chemically treated to remove bacteria, pathogens, and other microorganisms. These unseen bacteria can cause severe sickness and even death in humans.

Because we didn't disinfect our water, it is NOT safe to drink.

In the community:

- Encourage friends and neighbors to recycle
- Plan a science fair project about water quality and pollution remediation
- Talk to friends and neighbors about what they have learned
- Pick up trash in your neighborhood
- Encourage parents to fix leaky cars
- Talk to parents about using less fertilizers and pesticides
- Recycle items at home
- Do not dump waste urban waters, oil, gas, or other pollutants in the storm drains

Assesment

Evaluation

- Different products can be created by diversifying waste materials used.
- Different filter materials can be tested (example: organic materials – banana peels).
- The design of students can be displayed within the school (science fair exposition).

Goals	Must be Improved (1)	Medium (2)	Good (3)	Very Good (4)
Introduce yourself	(.....)	(.....)	(.....)	(.....)
Join discussion	(.....)	(.....)	(.....)	(.....)
Follow Application Steps	(.....)	(.....)	(.....)	(.....)
Originality and effectiveness of the purification system	(.....)	(.....)	(.....)	(.....)
Operability of the system	(.....)	(.....)	(.....)	(.....)
Total				

Links

- Filter water as they do it on the space station ISS
- Advanced NASA Technology Supports Water Purification Efforts Worldwide: https://www.nasa.gov/mission_pages/station/research/benefits/water_purification.html
- How to build a conductivity tester: See for example this instructable.