SN EDUCATOR GUIDE

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Drinkability

Student Guide: Martian Water Challenge

Get ready to embrace your inner chemist and mechanical engineer! In the film *The Martian*, astronaut Mark Watney is marooned on Mars and must use his scientific creativity to find enough resources to stay alive. Among other challenges, Watney must purify wastewater to use as drinking water until he can be rescued. Now imagine that you are stuck on the Red Planet with an assortment of materials. Your life (or at least your grade) depends on how well you can use those materials to make dirty wastewater from your spacecraft as clean and clear as possible. And remember, you can't always see everything you need to remove from a solution.

Create a stepwise plan to reclaim as much water as possible from your wastewater, then build a model of your purification system and test it.

Part 1: Initial observations

Make observations of the wastewater sample. Pour some of the water into a test tube.

1. Are there any visible particles suspended in the wastewater sample, or settling at the bottom of the sample?

2. Is the wastewater clear or cloudy? What color is it?

3. Measure the pH of the wastewater sample using colorimetric pH measuring strips. The test strips change colors to indicate how acidic (pH<7) or alkaline (pH>7) a sample is. Cut the test strips in half lengthwise, dip a strip into the sample for two seconds, then let it dry. Compare the strip's color to the color code on the packaging to determine the sample's pH.

Part 2: Filtration

The most apparent problem with the wastewater sample is the visible particles in it, so work on that problem first.

4. What general principles are used in water filtration?

5. Using the materials available to you, what design do you think will work best for water filtration?

6. Build and implement your water filtration design. Sketch your design or take a photo to show what it looks like.

7. Pour the wastewater through your filtration system. Are there any visible particles suspended in the filtered sample, or precipitating to the bottom of the water sample?

8. Is the water clear or cloudy? What color is it?

9. Use a colorimetric pH measuring strip to test the filtered water. What is the pH of the sample?

Part 3: Precipitation

10. The water's blue color is caused by an ion contaminant that also produces blue colors in flames, minerals and metals. What is the contaminant? Do a little research if necessary.

11. If you add other specific ions to the wastewater, those ions could combine with the ion contaminant to make a salt that would precipitate to the bottom of the water, turning the water clear. Fill six test tubes about half full with filtered blue water. Weigh about 0.25 grams of each of the five salts listed below, and add each salt to one of the five test tubes. Keep the sixth tube unchanged for comparison. Cap and shake the tubes to mix, then let the tubes sit for at least two minutes and observe them for any changes.

Possible salts to add to wastewater:

- Epsom salt (magnesium sulfate, $MgSO_4$)
- Sodium carbonate (Na_2CO_3)
- Table salt (sodium chloride, NaCl)
- Baking soda (sodium bicarbonate, $NaHCO_3$)
- Sidewalk ice melter (calcium chloride, $CaCl_2$)

12. Which powders and quantities best eliminated the blue color from the wastewater?

13. Test and record the water's pH. How can you adjust the water's pH to make it more drinkable?

14. Clean your equipment and your lab area.

Part 4: Analysis

15. After filtering and purifying the wastewater, is it drinkable? What other tests would you run to determine if the wastewater is safe to drink?

16. What have you learned about filtration for water purification?

17. What have you learned about chemical additives and precipitation for water purification?