MAKING A MODEL OF A WASTEWATER TREATMENT WORKS

ACTIVITY OVERVIEW

This activity simulates the treatment of wastewater at a wastewater treatment works using a step-by-step experiment.

MATERIALS AND APPARATUS

For each group:

- a copy of the instruction sheet
- a set of 8 posters entitled “How is Wastewater Cleaned?”
- 2 cups (±/− 500ml) of warm water
- a mixture of the contents of 2 ROOIBOS teabags combined with 2 teaspoons finely crushed dried leaves
- 2 pinches cut up teabags
- 2 teaspoons (10ml) washed small stones about 2–4mm in diameter (e.g. river sand)
- 1 teaspoon cooking oil
- 2 teaspoons sugar
- a mixture of fine dry sand (1 teaspoon) and ENO’s effervescent fruit salts (2 teaspoons)
- 2 teaspoons of household bleach or sterilizing fluid (preferable Miltons)

(Note: Miltons is slightly more expensive than household bleach, but its bleaching properties are very weak when in contact with clothing. Learners should however still be careful when using either of these chemicals.)

- 7 clear clean bottles (e.g. 2 litre cold drink bottles cut in half)
- newspaper or plastic bags to protect the working surface from any spillage
- 1 marker pen that will write on the clear bottles
- 1 netting with large holes and big enough to fit over the top of the cut-off bottles (e.g. an orange or onion bag)
- an elastic band
- a smaller piece of netting (10 cm X 10 cm) that can be wrapped around a teaspoon
- cotton wool
- 1 teaspoon
- paper towel
- kettle for warming the water
- 1 litre measuring jug
**STEP 1: MAKING WASTEWATER**

1. Use the marker pen to label the cut-off bottles as follows:
   - Wastewater
   - Wastewater Control
   - Grit Chamber
   - Primary Settling Tank (P.S.T.)
   - Bioreactor
   - Secondary Settling Tank (S.S.T.)
   - Disinfection

2. Mix a set of the ingredients that are listed below into the bottles labelled: Wastewater and Wastewater Control (The one mixture will be used for the experiment and the Control will be used to compare the results of the experiment):
   - **1 cup (+/- 250ml) warm water** - this represents the water component of wastewater. Ensure that the water is not hot enough to burn hands, but warm enough to allow the tea to brew.
   - **1 teaspoon Rooibos tea leaves and crushed leaves** - this represents the fine human solids (from human wastes). The brown tea colour represents tiny organisms including germs (from human wastes).
   - **1 pinch cut up teabags** - this represents large objects like rags, papers and plastics.
   - **1 teaspoon washed small stones** - these represent the grit (stones, sand and soil).
   - **1/2 teaspoon cooking oil** - this represents the oils.
   - **1 teaspoon sugar** - this represents dissolved nutrients (from human waste and soap).

3. Allow the tea to brew for 1 minute while stirring occasionally.
4. Take the bottle marked “Wastewater Control” and leave it in a safe place where you can see it and compare the changes occurring during each step.
5. Read the “WASTEWATER” poster.
**STEP 2: SCREENING**

1. Place the netting over the neck of the bottle labeled “Grit Chamber”. Make a small hollow in the net and secure with an elastic band.
2. Stir the Wastewater mixture and pour it through the netting into the “Grit Chamber” bottle. What did the netting trap?
3. Compare your water to the water in the control bottle. Is there any difference? What?
4. Read the “SCREENING” poster.  
   Q: Why is this step needed?  
   Q: What happens to all the screenings?

**STEP 3: GRIT REMOVAL**

1. Use the teaspoon to stir the mixture in the “Grit Chamber” bottle quite quickly. While the mixture is still spinning, carefully hold the bottle up so that you can look at the bottom. What collects at the bottom of the bottle?
2. Read the “GRIT REMOVAL” poster.  
   Q: Why is this step needed?  
   Q: What happens to all the grit?
3. Pour the mixture from the “Grit Chamber” bottle into the bottle labeled “Primary Settling Tank (P.S.T.)”, being careful to leave the grit behind in the “Grit Chamber” bottle.
**STEP 4: PRIMARY SETTLING**

1. Let the mixture in the “P.S.T.” stand on a flat surface for 1 minute and observe what happens. What collects at the surface of the mixture? Why? What settles at the bottom? Why?

2. Take the teaspoon and place a piece of cotton wool on it. Make sure the teaspoon is clean.

3. Wrap the smaller netting around the cotton wool and teaspoon and secure with an elastic band. This represents a scraper.

4. Tilt the “P.S.T.” bottle to the side and use the scraper to scoop off the layer of oil and any leaves floating on the surface of the water.

5. Compare your water to the water in the control bottle. Is there any difference? What?

6. Pour the mixture in the “P.S.T.” bottle into the “Bioreactor” bottle. Try not to let the primary sludge enter the “Bioreactor” bottle. (Place your index finger on the side of the bottle where the water is flowing out. This acts as an additional scraping method to remove any leaves that may still be present on the surface of the water.)

7. Read the “PRIMARY SETTLING” poster.
   - Q: What happens to the oils?
   - Q: What makes up the primary sludge?
   - Q: How is primary sludge treated and why?
STEP 5: BIOLOGICAL TREATMENT

1. Add the mixture of fine dry sand and ENO’s into the “Bioreactor” bottle. This represents the special organisms used in the Bioreactor to remove the dissolved nutrients from the water.

2. Mix well until all the bubbling stops.
   Q: What did you see?
   Q: What wastes are still present in the water when it enters the Bioreactor?

3. Read the “BIOLOGICAL TREATMENT” poster.
   Q: What do the river sand and ENO’s represent?
   Q: What wastes are removed in the bioreactor?
   Q: How are these wastes removed?

4. Mix the contents in the “Bioreactor” bottle well, and pour all the contents into the “Secondary Settling Tank (S.S.T.)” bottle, making sure that nothing is left behind.

STEP 6: SECONDARY SETTLING

1. Let the mixture in the “S.S.T.” stand on a flat surface for 1 minute. What do you see happening?

2. Read the “SECONDARY SETTLING” poster.
   Q: What is the secondary sludge?
   Q: What happens to the secondary sludge, and why?
3. Pour the liquid from the “S.S.T.” into the “Disinfection” bottle, leaving the secondary sludge behind.

**STEP 7: DISINFECTION**

1. Pour 2 teaspoons of either MILTONS sterilizing liquid or household bleach into the “Disinfection” bottle.

2. Stir with a clean teaspoon.
   Q: What happened to the water?
   Q: What waste is still present in the water when it enters the Disinfection Chamber?

3. Compare your water to the water in the control bottle. Is there any difference? What?

4. Read the “DISINFECTION” poster.
   Q: What is disinfection?
   Q: Why is it necessary?

**STEP 8: DISCHARGE**

1. Read the “DISCHARGE” poster.

   Q: Where does the water go after the treatment process is complete?

   Q: What would happen if wastewater was discharged directly into a river without being treated first?