Inquiry Investigation 4-A

Monitoring Paper Recycling

For this investigation, imagine that you are an inspector at a paper recycling plant. You are responsible for monitoring pollutants that could be released.

Skill Check

Initiating and Planning

✓ Performing and Recording

✓ Analyzing and Interpreting

✓ Communicating

Safety Precautions

- Wear safety goggles, gloves, and a lab apron.
- The pulp material contains a small amount of chlorine bleach, which can harm skin. Avoid contact with skin, and wipe up any spills immediately.
- Use the dropping bottles with care. Do not spill the testing solutions.

Materials

- paper-pulp waste water
- 25 mL graduated cylinder
- 6 test tubes
- test-tube rack
- dropping bottles of testing solutions: potassium iodide/starch, silver nitrate, barium hydroxide, 0.5 mol/L sulfuric acid, and universal indicator

Substance	Observation
Cl_2	Dark blue
Cl^-	White precipitate
S^-	Black precipitate
SO_4^-	White precipitate
SO_3^-	Odour like burnt match
Acid	Orange/red
Base	Blue/purple

Question

What by-products from the use of bleach are released into the waste water during the manufacture of recycled paper?

Procedure

1. Read the procedure. Prepare a data table with a row for each test you will perform. Give your table a title.
2. Your teacher will supply you with 50 mL of paper-pulp waste water. Put 5 mL of the waste water into each of six clean test tubes. Label each test tube according to the substance being tested. Perform the following tests to determine the presence of elements or ions in the waste water.
   - Chlorine: Add five drops of potassium iodide/starch solution.
   - Chloride ion: Add five drops of silver nitrate solution.
   - Sulfide ion: Add five drops of silver nitrate solution.
   - Sulfate ion: Add five drops of barium hydroxide solution.
   - Sulfite ion: Add 5 mL of 0.5 mol/L sulfuric acid.
   - Acid or base: Add five drops of universal indicator.
3. Dispose of all the materials as directed by your teacher.

Analyze and Interpret

1. What elements and ions are present in the waste water? Give evidence for each.
2. List any tests that gave negative results. Does this rule out the presence of these substances? Explain your reasoning.

Conclude and Communicate

3. Should the waste water be dumped into a river? Explain.
4. Is there an undesirable component to recycling? Explain.

Extend Your Inquiry and Research Skills

5. **Research** Modern paper mills have moved away from using chlorine as a bleaching agent. Research how these new processes are being used to solve the environmental challenges posed by chlorine.

Inquiry Investigation 4-B

Keep That Toothy Grin

Your teeth are made of a compound called hydroxyapatite [pronounced hi-DRAHK-see-A-puh-tite], which is similar to the mineral compound found in eggshells. In this investigation, you will use eggshells to study the effectiveness of different toothpastes and teeth whiteners.

Skill Check

Initiating and Planning

✓ Performing and Recording

✓ Analyzing and Interpreting

✓ Communicating

Safety Precautions

- Wear safety goggles and a lab apron.
- Wash your hands thoroughly at the end of each part of this investigation.
- Clean up any spills, and report them to your teacher immediately.
- Alert your teacher if you are allergic to eggs.

Materials

Part 1

- 2 different brands of toothpaste with fluoride
- permanent marker
- hard-boiled egg
- artist's paintbrush
- concentrated lemon juice
- cup or beaker

Materials

Part 2

- 2 different brands of teeth whitener strips
- permanent marker
- hard-boiled egg, stained

Part 1: Testing the Effectiveness of Toothpastes

The sodium fluoride in toothpaste undergoes a chemical reaction with hydroxyapatite in teeth to form a new compound, which resists food acids that cause tooth decay. In this part of the investigation, you will explore the effectiveness of two different toothpastes using an eggshell to represent teeth and lemon juice to represent food acids.

Question

Is one brand of toothpaste more effective at protecting teeth from acidic substances?

Procedure

1. Make a table like the one below. Give your table a title.

Section	Observations		
	Start	Day 1	Day 2
Control			
Toothpaste 1:			
Toothpaste 2:			

2. Choose two different brands of toothpaste, and record the names of these brands in your table.
3. Use a permanent marker to divide one egg into three sections. Put a small mark on two of the sections to indicate the brand of toothpaste applied. The third section will act as a control.
4. Use the paintbrush to brush the appropriate toothpaste on each of two sections of the egg. Be sure to apply a thin but complete coat to cover the shell.
5. Examine each section of the egg, and record your observations in your table.
6. Pour lemon juice into a cup or beaker. Carefully place the egg in the cup and ensure that the lemon juice covers all of the egg.
7. Place the cup in a location designated by your teacher, where it can sit undisturbed.

8. Examine the eggshell each day for several days. Record your observations in your table.

9. Clean up and dispose of the materials as instructed by your teacher.

Part 2: Testing the Effectiveness of Teeth Whitening Strips

Even though teeth may be strong, they may develop stains. In this part of the investigation, you will explore the effectiveness of two different teeth whitening products, again using an eggshell to represent teeth.

Question

Is one brand of teeth whitening strip more effective for removing stains from teeth?

Procedure

1. Make a table like the one below. Give your table a title.

Teeth Whitener	Observations		
	Start	Day 1	Day 2
Control			
Brand 1:			
Brand 2:			

2. Choose two different brands of teeth whitening strips, and record the names of these brands in your table.

3. Use a permanent marker to divide the egg into three sections. Put a small mark on two of the sections to indicate the brand of whitening strip applied. The third section will act as a control.

4. Examine each section of the egg, and record your observations in your table.

5. Apply each whitening strip to the appropriate section of the egg, according to the manufacturer's instructions.

6. Examine the egg each day for several days. Record your observations in your table.

Analyze and Interpret

1. Compare the untreated eggshell with the eggshell you treated with toothpaste in Part 1.

2. Compare the results obtained by the teeth whiteners in Part 2.

3. Identify unexpected variables that might have influenced your results for both experiments.

Conclude and Communicate

4. Identify which brand of toothpaste, if any, better protected the eggshell from decay.

5. Infer why it is a good idea to brush with fluoride toothpaste.

6. Identify which teeth whitener, if any, better removed the stains from the eggshell.

7. Would you expect teeth treated with a teeth whitener to remain stain-free? Explain.

Extend Your Inquiry and Research Skills

8. **Inquiry** Some toothpastes claim to whiten teeth, in addition to protecting them. Design an experiment to test this claim.

9. **Research** Gather information about different teeth whitening products for at-home use and for in-office use by dentists. Research, as a consumer, the factors that should be taken into account when considering these products.

Sodium fluoride is now added to most toothpastes.

Inquiry Investigation 4-C

Skill Check

Initiating and Planning

✓ **Performing and Recording**

✓ **Analyzing and Interpreting**

✓ **Communicating**

Comparing the Masses of Reactants and Products

In this investigation, you will use Lavoisier's approach to investigate the law of conservation of mass.

Question

Do the masses of reactants and products in a reaction support the law of conservation of mass?

Safety Precautions

- Wear safety goggles, gloves, and a lab apron.
- Rinse any spills with plenty of water, and report them to your teacher immediately.

Materials

- graduated cylinder
- 0.1 mol/L sodium hydroxide solution
- 200 mL Erlenmeyer flask
- 0.1 mol/L iron(III) nitrate solution
- small test tube
- stopper
- balance

Science Skills

Go to **Science Skills Toolkit 7** for information about creating data tables.

Carefully place the test tube in the Erlenmeyer flask.

Procedure

1. Make a data table to record the masses and your observations of materials before and after the reaction. Give your table a title.
2. Using a graduated cylinder, measure 20 mL of sodium hydroxide solution. Pour the solution into the Erlenmeyer flask.
3. Pour iron(III) nitrate solution into the small test tube until the test tube is about half full.
4. Tilt the Erlenmeyer flask and carefully place the test tube inside. Do not let the solutions mix. Seal the flask with the stopper.
5. Determine the mass of the flask and its contents. Record your measurement, as well as the appearance of both solutions.
6. Tip the flask to allow the solutions to mix.
7. Measure the mass of the flask and its contents. Record the mass and appearance of the contents.
8. Dispose of the materials according to your teacher's instructions. Clean up your work area.

Analyze and Interpret

1. How did the mass of the reactants and glassware before the reaction compare with the mass after the reaction?

Conclude and Communicate

2. Do your results support the law of conservation of mass? Explain.
3. The products of the reaction are sodium nitrate and iron(III) hydroxide. Write a balanced chemical equation for the reaction.

Extend Your Inquiry and Research Skills

4. **Inquiry** Suggest ways to redesign the experiment in order to reduce errors.