Name: ______________________

Testing Water: An Environmental Impact Study

Background
What we throw away every day can harm the environment. Water supplies can become contaminated if located near waste disposal sites such as landfills and garbage dumps. All plants and animals depend upon a safe water supply.

You are a member of a research group that has been assigned to determine the quality of a water sample sent from a local zoo. The zoo staff has reported that many of the mating birds have laid clutches of eggs, but many of the eggs have failed to hatch. They suspect that something might be in the water, since this happened after there was a reported water main break, but they don’t have the equipment to determine if that is the problem or not.

To accomplish this task you will test for the presence of metal ions; and determine the concentration of metal ions in the sample. Please follow the steps below in the order shown. Record all observations and results in the spaces provided. Notify the instructor of spills or other problems immediately. Read each step carefully before carrying out the task. Wear goggles and aprons while collecting data.

Pre-lab Questions
1. What does molarity or concentration mean?

2. How would you produce a 0.100 M solution of sodium chloride only using 10.00 mL of water?

3. Define the abbreviations ppt, ppm, and ppb as they relate to water samples.

Objective
You will determine if there is a potentially harmful ion present in a sample of water.

Materials
- Sample of contaminated water to test
- Three plastic well trays with at least 12 wells
- Glass dropper bottles containing 0.100 M solutions of:
  - Barium nitrate
  - Iron (III) nitrate
  - Lead (II) nitrate
Silver nitrate
Sodium sulfate
Sodium chloride
Potassium thiocyanate

- 10.00 mL graduated cylinder
- 2 pipets
- Toothpicks
- Distilled water
- Beaker for waste

Safety
- Always wear safety goggles when handling chemicals in the lab.
- Wash your hands thoroughly before leaving the lab.
- Follow the teacher’s instructions for cleanup of materials and disposal of chemicals.

Procedures for Part 1: Performing Standard Identification Tests
1. You will need to use a well tray with 24 wells.
2. Using a plastic well tray place three drops of 0.100 M Iron (III) Nitrate in three wells in the first row. See Data Table 1.
3. Place three drops of 0.100 M Lead (II) Nitrate in three wells in the second row. See Data Table 1.
4. Place three drops of 0.100 M Silver Nitrate in three wells in the third row. See Data Table 1.
5. Place three drops of 0.100 M Barium Nitrate in three wells in the fourth row. See Data Table 1.
6. Place two drops of Sodium Sulfate in each well in the first COLUMN. See Data Table 1. Stir with a toothpick.
7. Place two drops of Sodium Chloride in each well in the second COLUMN. See Data Table 1. Stir with a toothpick.
8. Place two drops of Potassium Thiocyanate in each well in the third COLUMN. See Data Table 1. Stir with a toothpick.
9. Observe and record your results in Data Table 1 below.

<table>
<thead>
<tr>
<th>Metal Ions</th>
<th>(Na₂SO₄) Sodium Sulfate</th>
<th>(NaCl) Sodium Chloride</th>
<th>(KSCN) Potassium Thiocyanate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe³⁺ as Fe(NO₃)₃</td>
<td>Iron (III) Nitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pb²⁺ as Pb(NO₃)₂</td>
<td>Lead (II) Nitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ag⁺¹ as AgNO₃</td>
<td>Silver Nitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ba²⁺ as Ba(NO₃)₂</td>
<td>Barium Nitrate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Procedures for Part 2: Testing for the Presence of a Metallic Ion
1. You have a small beaker containing a SAMPLE OF CONTAMINATED WATER.
2. Fill your graduated cylinder about halfway with distilled water. **This is to be used as wash/rinse water for your eye-dropper.** Each time you rinse, discard the rinse water into the small waste container located at the station.
3. Using the dropper, transfer 10 drops of the CONTAMINATED WATER into each of the following wells of a clean well tray: #1, #2, and #3.
4. Place five (5) drops of the sodium sulfate testing solution in well #1. Stir with a toothpick. Observe and record your results in Data Table 2.
5. Place five (5) drops of the sodium chloride testing solution into well #2. Stir with a separate toothpick. Observe and record your results in Data Table 2.
6. Place five (5) drops of the potassium thiocyanate testing solution into well #3. Stir with a separate toothpick. Observe and record your results in Data Table 2.

<table>
<thead>
<tr>
<th>Data Table 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 Sodium Sulfate</td>
</tr>
<tr>
<td>Well and Reactant→</td>
</tr>
</tbody>
</table>

**Analysis: Part 1 & 2**
1. Use your results from Part 1 to Identify the metal ion in your CONTAMINATED WATER sample (is it Fe$^{3+}$, Pb$^{2+}$, Ag$^{+1}$, Ba$^{2+}$ or a mixture?) Write your answer below.

2. Write the balanced chemical equation **AND** the names for the products formed for your metal ion compound [i.e., barium nitrate, silver nitrate, lead (II) nitrate or iron (III) nitrate] plus the solution of Na$_2$SO$_4$.

3. Write the balanced chemical equation **AND** the names for the products formed for your metal ion compound [i.e., barium nitrate, silver nitrate, lead (II) nitrate or iron (III) nitrate] plus the solution of NaCl.

4. Write the balanced chemical equation **AND** the names for the products formed for your metal ion compound [i.e., barium nitrate, silver nitrate, lead (II) nitrate or iron (III) nitrate] plus the solution of KSCN.
Procedures for Part 3: Determining the Concentration of a Metal Ion
Water quality standards require the identification of ions in water and set limits for concentrations of these ions. You have determined which ion is located in the water sample, but what is the concentration?

Pick the dropper bottle that contains your ion. For example, if your sample contained barium you would use the barium nitrate; iron ions are represented by the iron (III) nitrate solution; lead ions are represented as lead (II) nitrate solution; and silver ions are represented by the silver nitrate solution.

This dropper bottle contains a 0.100 M concentration (moles per liter) of the metal ion discovered in the water sample, or one part per thousand (1 ppt). To determine the concentration of the ion in your sample you will perform a serial dilution and compare it to this 0.100 M "known standard."

1. Put 10 drops of the "known standard" solution in well #9.
2. Put 9 drops of DISTILLED WATER into each of the next three wells (#10, #11, and #12).
3. Using your second clean eye-dropper, transfer one drop from well #9 to well #10. Mix with a clean toothpick; then discard the toothpick. Rinse the pipet.
4. In a similar manner, transfer one drop from well #10 to well #11. Mix with a clean toothpick; then discard the toothpick. Rinse the pipet.
5. Finally, transfer one drop from well #11 to well #12. Mix with a clean toothpick; then discard the toothpick. Rinse the pipet.

Calculations and Analysis for Part 3
1. The solution in well #9 is 0.100 M or 1 ppt (one part per thousand) of the metal ion. What are the concentrations of the metal ion in wells #10, #11, and #12 (in scientific notation with significant figures)? THINK IN TERMS OF THE MATHEMATICAL DILUTION FACTOR.

2. Concentration Well #9: 0.100 M or 1 ppt
3. Concentration Well #10:
4. Concentration Well #11:
5. Concentration Well #12:
6. Add 10 drops of CONTAMINATED WATER to Well #5.
7. Testing:
   a. If the ion in your water sample was BARIUM then add ONE drop of the Na₂SO₄ solution to each of the solutions in wells #9, #10, #11, #12 and #5.
   b. If the ion in your water sample was IRON then add ONE drop of the KSCN solution to each of the solutions in wells #9, #10, #11, #12 and #5.
   c. If the ion in your water sample was SILVER then add ONE drop of the NaCl solution to each of the solutions in wells #9, #10, #11, #12 and #5.
   d. If the ion in your water sample was LEAD then add ONE drop of the Na₂SO₄ solution to each of the solutions in wells #9, #10, #11, #12 and #5.
8. Compare the colors of the sample in well #5 to the known concentrations of material in wells #9, #10, #11, and #12. What is the concentration of the metal ion in the CONTAMINATED WATER sample in Well #2? Explain how you obtained your answer. Use complete, self-contained sentences please!

9. How was the standard 0.100 M solution [i.e., barium nitrate, silver nitrate, lead (II) nitrate or iron (III) nitrate] prepared for all 30 students in class if each student required 25.00 mL? The answer should be in grams.

Clean-up Instructions
1. Carefully pour solutions from the wells into the waste containers located between each station.
2. Rinse and blot dry the well tray.
3. Be sure the materials are clean and dry and left exactly as you found them.
4. Remove goggles and aprons. You may go to your desk to answer the following questions.

Final Analysis
The table below shows Federal Water Quality Standards set by the Environmental Protection Agency in 2016.

<table>
<thead>
<tr>
<th>Ion</th>
<th>Concentration (Moles/Liter) allowed in water</th>
<th>Comments/Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe +3</td>
<td>$5.40 \times 10^{-4}$ M</td>
<td>Higher concentrations un-safe, bad taste</td>
</tr>
<tr>
<td>Ba +2</td>
<td>$7.30 \times 10^{-5}$ M</td>
<td>Higher concentrations un-safe</td>
</tr>
<tr>
<td>Ag +1</td>
<td>$4.60 \times 10^{-4}$ M</td>
<td>Higher concentrations un-safe</td>
</tr>
<tr>
<td>Pb +2</td>
<td>0</td>
<td>Deadly at any amount</td>
</tr>
</tbody>
</table>

1. Think back to the original problem regarding the birds and the eggs. Using what you have learned from performing this task and your knowledge of chemistry, suggest one hypothesis to explain the cause and source of the problem with the bird eggs not hatching. Answer in complete, self-contained sentences.
2. Describe the tests you would conduct to confirm or reject the hypothesis that you just suggested above. Answer in complete self-contained sentences.

**Conclusion**
As a member of the water quality analysis team, what recommendations would you make regarding the use of the water you just tested for consumption (by humans and other animals)? Justify your recommendations. Answer in complete, self-contained sentences.