Dilution of Solutions Lab

Introduction
All human activity and many natural processes produce pollution. Pollution is a generic term for contamination from any activity that has a negative impact on the environment or human health. Pollution can travel by three major pathways: air, water, and land. Since it can travel using several different methods, it can be very difficult to remove pollution completely once an area has been contaminated. Sometimes even very small amounts of pollution can have a negative effect on people, animals and plants, so detecting and removing it can be complicated and expensive.

In this lab, we will take a sample of a chemical and treat it as if it is ‘polluted water’. We will then dilute the sample five times, decreasing its concentration by ten times for each step, all the way down to one-hundred thousandth of the original concentration. Finally, we'll test each sample with a drop of chemical indicator to attempt to detect ‘pollution’ at each concentration.

Purpose
Based on the introduction above, determine the purpose of this lab and include it in your lab write-up.

Prediction
Do you think you will be able to dilute the samples in this lab to levels that are no longer detectable?

Materials
- distilled water
- iron (III) chloride [FeCl$_3$], 0.1M
- phenolphthalein indicator solution, 1%
- potassium thiocyanate solution [KSCN], 0.1M
- silver nitrate solution [AgNO$_3$], 0.1M
- sodium chloride [NaCl], 0.1M
- sodium hydroxide [NaOH], 0.1M

Equipment
- graduated cylinder, 10-mL
- medium test tubes, 6
- plastic pipettes, 3
- test tube rack

Safety Considerations
- Silver nitrate and potassium thiocyanate are toxic; sodium hydroxide is caustic! Avoid contact with the skin and eyes.
- Safety goggles must be worn at all times; gloves are optional but highly recommended.
- Silver nitrate can stain light-colored clothing; you may want to wear a lab apron during this lab.
- Sometimes chemicals from previous labs still remain in glassware and on other lab equipment; wash all lab equipment before and after performing this lab.
- Wash your hands thoroughly after completing this lab.

Procedure
1. Obtain six medium test tubes and a test tube rack. Place the test tubes in the test tube rack.
2. Obtain one of the three solutions representing ‘polluted water’: NaOH, FeCl$_3$, or NaCl. Note its color in your observations.
3. Using a small graduated cylinder, measure out exactly 10 mL of ‘polluted water’.
4. Pour the 10 mL of ‘polluted water’ into the first test tube on the left. Rinse out the graduated cylinder thoroughly.
5. Return the original sample of ‘polluted water’ to the supplies table.
6. Using a plastic pipette, remove enough ‘polluted water’ from the first test tube to make 1 mL in the graduated cylinder.

7. Pour the 1 mL of ‘polluted water’ in the second test tube. Rinse out the graduated cylinder.

8. Using the small graduated cylinder, measure out exactly 9 mL of distilled water.

9. Pour the 9 mL of distilled water into the second test tube. This dilutes the polluted sample to a concentration ten times less than the original.

10. Repeat Steps 6-9 for each test tube, each time using the previous test tube to obtain your 1 mL sample until all six test tubes have ‘polluted water’ samples like this:

   ![Image of test tubes with different concentrations]

   original sample  (more concentrated)  less concentrated  (more diluted)

11. Obtain a sample of ‘indicator’:
    • for NaOH, use phenolphthalein
    • for FeCl₃, use KSCN
    • for NaCl, use AgNO₃

12. Add two drops of ‘indicator’ to each test tube. Gently wiggle or swirl the test tube to allow the reaction to mix fully. Observe any color changes and record your observations in a data table; you may want to hold a piece of white paper behind the test tubes in order to make the color differences appear more distinct.

13. Compare your known test tube concentrations to the appropriate unknown sample as described in Procedure B below.

14. Dispose of the AgNO₃ solution only in the heavy metals waste container; the other solutions can go down the sink. Wash your test tubes thoroughly with soap using a test tube brush.

15. Repeat steps #2-13 of this procedure for the other two samples of ‘polluted water’.

**Procedure B – determination of unknowns**

1. Once you have prepared your “known” standard solutions, obtain three test tubes of unknown solutions from your teacher.

2. Add two drops of the appropriate ‘indicator’ (see Step #11 above) to each test tube and compare them to your standards to determine their concentration.

3. Record your predicted concentration for each test tube in your lab notebook.

4. Obtain the actual concentration for each test tube from your teacher and record it in your lab notebook.

5. Dispose of the solutions properly as described in Procedure A.

**Additional Clean-up and Disposal**

1. Dispose of the AgNO₃ solution only in the heavy metals waste container; the other solutions can go down the sink.

2. Wash your test tubes thoroughly with soap using a test tube brush.
Data – you should create three data tables in your lab write-up that look something like this:

<table>
<thead>
<tr>
<th>Test Tube #</th>
<th>Concentration</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.1 M NaOH (original)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.01 M NaOH</td>
<td></td>
</tr>
</tbody>
</table>

Calculations (Include these answers in your Conclusion!)
1. Determine the concentration of each solution in each test tube and record it in your data table.
2. Knowing that there are $6.02 \times 10^{23}$ formula units per mole of any chemical, determine how many formula units of each chemical you tested are in the sixth, least concentrated test tube.

Questions
1. What trend did you notice in the colors of the chemical reaction as your solutions became less concentrated or more dilute? Why do you think this happened?
2. What specific steps would you take to dilute one of these solutions down to one-billionth of its original concentration?
3. Do you think it would be possible to remove pollution from a water source by simply diluting it? Why or why not?

Errors
Describe two possible errors you may have committed in this lab that may have somehow affected your results. Explain the specific steps you will take to avoid each of these errors in the future.

Conclusion
Write two or more paragraphs summarizing your results, examining the validity of your prediction, and explaining your calculations.
Dilution of Solutions Lab workspace: