**Worksheet 5:**

**Effects of pH on Solubility**

You probably have heard that it is important to manage proper soil pH. Have you ever wondered why? Why do farmers worry if the soil is too acidic or basic? What is the right range of pH for healthy plant growth? In this experiment, you will test the solubility of iron (III) nitrate and make inference as to why pH is a critical factor in plant growth.

**Learning objectives:**

* Observe and qualitatively characterize how pH affects solubility of iron (III) nitrate
* Reason about what might happen when the pH of soil or hydroponic solution is not in the right range

**Materials**

* 0.1 M Iron (III) Nitrate
* 6 M Hydrochloric Acid
* 6 M Ammonium Hydroxide
* 100 mL beaker
* pH probe
* Gloves S, M, L
* Volumetric pipets and bulbs (10 ml)
* Graduated cylinders (100 ml)

**Safe Notes**

* Waste can go down the drain.
* The experiment should be performed in the fume hood.

**Procedure**

1. Prepare 0.5 M Hydrochloric acid and 0.5 M ammonium hydroxide from the 6 M stock solutions.
2. Add about 40 ml of the Iron (III) nitrate solution to a 100 mL beaker.
3. Using the pH probe, measure the pH of the solution and record it in the table below.
4. Using the volumetric pipet, add 0.5 M Ammonium Hydroxide to the Iron (III) nitrate solution by the amount indicated in the left-most column of Table 1. With each addition, calculate the total ammonium hydroxide solution added and record it in the second column. Then, measure the pH, make observations of the reaction in the beaker, and record in the table.

Table 1

|  |  |  |  |
| --- | --- | --- | --- |
| Ammonium Hydroxide Solution Added | Total Volume of Ammonium Hydroxide Solution Added | pH probe reading | Observations  |
| Initial (0 mL) | 0 |  |  |
| 0.5 mL | 0.5 |  |  |
| 0.5 mL | 1.0 |  |  |
| 4 mL | 5.0 |  |  |
| 1 mL | 6.0 |  |  |

1. To the same beaker of solution used above, add 0.5 M Hydrochloric Acid in the amount indicated in the left-most column of Table 2. With each addition, calculate the total hydrochloric acid solution added and record it in the second column. Then, measure the pH, make observations of the beaker, and record in the table.

Table 2

|  |  |  |  |
| --- | --- | --- | --- |
| Hydrochloric Acid Added  | Total Volume of Hydrochloric Acid Solution Added | pH probe reading | Observations |
| Initial (0 mL) | 0 |  |  |
| 2 mL |  |  |  |
| 2 mL |  |  |  |
| 1 mL |  |  |  |
| 1 mL |  |  |  |
| 1 mL |  |  |  |

Data Analysis and Discussion

1. Summarize the findings and explain the relationship between pH and solubility of iron (III) ion.
2. What might be the precipitation observed in Step 3? Why do you think so?
3. Based on this finding, explain why it is important to manage pH of soil or hydroponic solution. Think of what might happen to soil and hydroponic solution if its pH is high and how plants might be impacted.

**Extension:** Can we precipitate out salts in tap water?

**Materials**

* 6 M Hydrochloric Acid
* 6 M Ammonium Hydroxide
* Tap water
* Deionized water
* Disposable pipettes
* 100 mL beaker

**Procedure**

1. Add about 20ml tap water in a 100-mL beaker. Label appropriately. Record your observations in the table below.
2. In a second beaker, add about 20ml deionized water. Record your observations in the table below.
3. Describe the 6M Ammonium Hydroxide.
4. Using a disposable pipette, gradually add 6M Ammonium Hydroxide to both beakers. Add approximately the same amount to both beakers to be able to compare the two. Make careful observations and record your observation in the table below.
5. Describe the 6M Hydrochloric Acid.
6. Using a disposable pipette, add 6M Hydrochloric Acid drop by drop to both beakers. Make careful observations and record your observations in the table below.

|  |  |  |
| --- | --- | --- |
|  | Tap Water | Deionized Water |
| Before Addition of Reagents |  |  |
| After Addition of 6M Ammonium Hydroxide |  |  |
| After Addition of 6M Hydrochloric Acid |  |  |

**Data Analysis and Discussion**

1. Summarize your observations on the change of tap water and deionized water upon addition of ammonium hydroxide and hydrochloric acid.
2. From the observation, what can you conclude about tap water water and deionized water? What might be contained in tap water?
3. Have you observed white residue after boiling tap water? What can you say about the residue based on this experiment? Why does boiling water form the white precipitation? To clean it out, what can you do?