Lab: Indicators of Acids and Bases

FOR THE TEACHER

Summary
In this lab, students will use various indicators to identify unknown (clear) solutions as acidic, basic, or neutral.

Grade Level
High or Middle School

AP Chemistry Curriculum Framework
This laboratory experiment supports the following units, topics and learning objectives.

- **Unit 4: Chemical Reactions**
  - Topic 4.8: Introduction to Acid-Base Reactions
    - TRA-2.B: Identify species as Brønsted-Lowry acids, bases, and/or conjugate acid-base pairs, based on proton-transfer involving those species.

- **Unit 8: Acids and Bases**
  - Topic 8.1: Introduction to Acids and Bases
    - SAP-9.A: Calculate the values of pH and pOH, based on Kw and the concentration of all species present in a neutral solution of water.

Objectives
By the end of this lab, students should be able to

- Explain that substances can be identified as acidic, basic, or neutral using indicators.
- Identify the colors associated with a specific indicator when signifying either an acidic, basic, or neutral solution.

Chemistry Topics
This lab supports students’ understanding of

- Acids and bases
- Indicators
- Identifying an unknown

Time
**Teacher Preparation:** 20-30 minutes
**Lesson:** 45 minutes

Materials
(Per group)

- A well plate with at least 16 wells
- Red and blue litmus paper
- Phenolphthalein indicator in a dropper bottle
- Red cabbage juice in a dropper bottle
  (To share amongst class)
- Eight clear solutions labeled 1-8 (suggestions below)
- Acids
  - 0.5 M HCl
  - clear soda

Submitted by
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Thanks to:
Dow Chemistry Teacher Summit
- vinegar
- Bases
  - 0.5 M NaOH
  - baking soda solution
  - ammonia
  - bleach
- Neutral
  - water

Safety
- Always wear safety goggles when handling chemicals in the lab.
- Students should wash their hands thoroughly before leaving the lab.
- When students complete the lab, instruct them how to clean up their materials and dispose of any chemicals.
- When working with acids, if any solution gets on students’ skin, they should immediately alert you and thoroughly flush their skin with water.

Teacher Notes
- On the student lab sheet I created a grid that matches the 24 well plates I use during the lab. I have them label it 1-8 (twice) so that they can use it as a guide while doing the lab.
- Preparations:
  - Litmus (I give each group a vial of red and a vial of blue)
  - Phenolphthalein (in a dropper bottle)
  - Red cabbage juice (in a dropper bottle - you can make this yourself or buy the prepared powder)
  - Labeled the acidic, basic and neutral solutions 1-8 (make sure you know the identity of each solution!)
- Indicators:
  - Litmus paper is red in acids and blue in bases
  - Phenolphthalein is colorless in acids (and neutral) and pink in bases
  - Cabbage juice is red/pink in acids and blue/green in bases
  - You could use any indicators you have on hand. The point is for them to see that we have several different indicators at our disposal and they all can be used to identify substances as long as you know the colors they turn.
- When finished, the students need to rinse their well plates REALLY WELL with water. This is to make sure no indicator is left in wells before the next class.
- I create one station on my desk for students to come up to when filling their wells. Eight Erlenmeyer flasks labeled 1-8 with pipets for dispensing. I like to watch them do this because they often fill wells too much or not enough. Also, I monitor to make sure their solutions are not turning colors as they put them in (this would be a result of a lab group not rinsing their well plate REALLY WELL). This step is what makes the lab take a while. If you are fine not monitoring them getting the solutions, then make multiple stations for them to obtain them and it will go much quicker.
- You should figure they will need about 1-2 ml of each solution for each well. So for a class with twelve lab groups (groups of two) you would need around 50 ml max of each solution. If your wells are smaller use less, if bigger use more.
- I have my students use the internet to answer the pre-lab questions as I always do this lab on the very first day of the acids and bases unit. It is fun!
FOR THE STUDENT

Lesson

Indicators of Acids and Bases

Objective
In this lab you will identify solutions as acidic, basic, or neutral using various indicators.

Pre-lab Questions
1. What is an indicator?

2. What are the three indicators being used in this lab?

3. Acids will turn red litmus paper ________ and blue litmus paper ________. Bases will turn red litmus paper ________ and blue litmus paper ________.

4. What color will red cabbage juice turn in an acid? A base? A neutral substance?
5. What color will phenolphthalein turn in an acid? A base? A neutral substance?

Safety
• Always wear safety goggles when handling chemicals in the lab.
• Wash your hands thoroughly before leaving the lab.
• Follow your teacher’s instructions for clean-up of materials and disposal of any chemicals.
• When working with acids and bases, if any solution gets on your skin immediately rinse the area with water.

Procedure
1. Obtain and wear safety goggles and lab apron.
2. Label the plate below for your reference BEFORE getting the solutions!!! Using a 24-well plate, add each of eight solutions to their own unique well (you will need to add each solution to two wells (total of 16 wells) – only fill about halfway).
Part 1: Litmus Paper
3. Obtain four strips of each color of litmus paper, then tear them in half to make a total of eight strips. Using the blue litmus first, test each of the eight solutions by quickly dipping the litmus paper into one well. Record the color on your data table. Repeat with the red litmus paper.

Part 2: Red Cabbage Juice Indicator
4. After completing Part 1, add a couple drops of red cabbage juice indicator to one well for each of the eight solutions. Record the color of each solution in your data table.

Part 3: Phenolphthalein
5. After completing Part 1 and Part 2, add a couple drops of phenolphthalein to the other well (not the one you added red cabbage juice indicator) for each of the eight solutions. Record the color of each solution in your data table.

Part 4: Clean-Up
6. Put all litmus in the trash. Thoroughly rinse the solutions out of your 24-well plate (repeatedly rinse each well with water). It is very important that you remove ALL of the solutions COMPLETELY from the wells. Left over residue of solutions and indicators will cause incorrect data for future users. Shake the water out and dry the wells of the plate using a paper towel.

Observations

<table>
<thead>
<tr>
<th>Solution</th>
<th>Blue Litmus</th>
<th>Red Litmus</th>
<th>Red Cabbage Juice</th>
<th>Phenolphthalein</th>
<th>Acid, Base, or Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
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**Post-lab Questions**

1. Which of the solutions are acids? How do you know? Repeat for bases and neutral solutions. You must reference every indicator you used in your explanation as to why you know a solution is an acid, base, or neutral. Do not be general! Give an explanation for EACH solution #1 thru #8. Put your final answer in the last column of the data table.

   **Example:** I know solution #2 is a(n) ____ because the red litmus turned ____ , the blue litmus turned ____ , the cabbage juice was ____ , the phenolphthalein was ____ .

2. Choose two of the following substances to research. You must:
   - Write the chemical name of the substance and identify the substance as an acid or base.
   - List safety precautions associated with the substance.
   - List uses for the substance.

   **Options (choose 2):**
   
<table>
<thead>
<tr>
<th>HCl</th>
<th>H₂SO₄</th>
<th>NH₃</th>
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<tbody>
<tr>
<td>HNO₃</td>
<td>NaOH</td>
<td>HC₂H₃O₂</td>
</tr>
<tr>
<td>HF</td>
<td>Ca(OH)₂</td>
<td>CH₅N</td>
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</tbody>
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