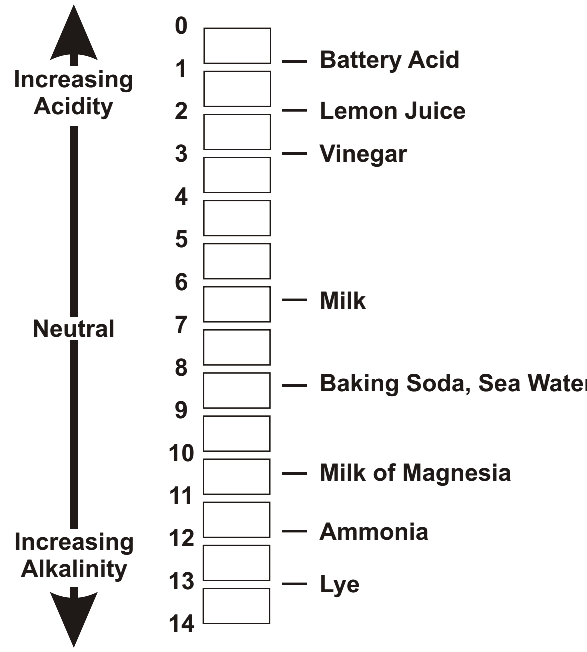
ACTIVITY 1 Measuring pH

After completing this activity, you should be able to:

- measure the approximate pH of chemicals in water using a pH indicator
- acquire a basic understanding of the pH scale
- learn the pH of some common substances



Introduction

A pH scale is used to measure the amount of acid in a liquid (like water). Because acids release hydrogen ions, the acid content of a solution is based on the concentration of hydrogen ions and is expressed as "pH." This scale is used to measure the acidity of rain samples.

The smaller the number on the pH scale, the more acidic the substance is. (The larger the number, the less acidic, or more alkaline or basic.) Rain measuring between 0 and 5 on the pH scale is acidic and therefore called "acid rain." Small number changes on the pH scale actually mean large changes in acidity.

For example, a change in just one unit from pH 6.0 to pH 5.0 would indicate a tenfold increase in acidity. Clean rain has a pH of 5.6. It is slightly acidic because of carbon dioxide which is naturally present in the atmosphere.

Here the pH of some common substances, as well as natural water, will be measured.

If pH indicator paper is not available in your science lab, it may be purchased at some beer- and wine-making supply stores, pharmacies and hair salons. If you do not have distilled water in your lab, you can find it in some pharmacies, or grocery, department, hardware or speciality stores.

Materials Needed

- pH paper and colour chart (pH range 3 to 12)
- distilled water
- white vinegar
- household ammonia (or baking soda)
- 4 small, clear cups or glasses
- 4 stirring spoons
- measuring cups and spoons (1/2 cup; 1/8 and 1/2 teaspoon)
- notebook and pencil
- labels

Procedure

Rinse one cup with distilled water, shake out excess water, and label "natural water". Locate a stream, river, lake, or pond. Scoop some of the surface water into this cup. (A plastic collection bottle can be used to transfer the water back to your lab, but this must be first rinsed with distilled water as well.)

Rinse each of the other three cups with distilled water as above. Label one cup "vinegar", one "ammonia" (or "baking soda"), and one "distilled water". Pour 1/2 cup distilled water into each of these 3 cups. Add 1/2 teaspoon white vinegar to the vinegar cup and stir with a clean spoon. Add 1/2 teaspoon ammonia to the ammonia cup (or 1/2 tsp. baking soda) and stir with another clean spoon. Do not add anything to either of the water cups.

Dip an unused, clean strip of pH paper in the vinegar cup for about 2 seconds and immediately compare with the colour chart. Write down the approximate pH value and set the cup aside. Likewise, dip an unused, clean strip of pH paper in the ammonia (or baking soda) cup for about 2 seconds and immediately compare with the colour chart. Write down the approximate pH value and set the cup aside. Repeat this process for the distilled water and natural water cups.

Discussion

1) Is vinegar an acid or a base?

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2) What is the approximate pH of vinegar?

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3) Is ammonia (or baking soda) an acid or a base?

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4) What is the pH of distilled water?

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5) What is the pH of your natural water sample?

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6) Based on where you live and what you have learned about acid rain, are you surprised by the result?

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7) Discuss the findings with your teacher. How does the measured pH compare to the pH levels that affect plants and animals in aquatic habitats? (See the chart explaining how acid rain affects organisms living in the water.)

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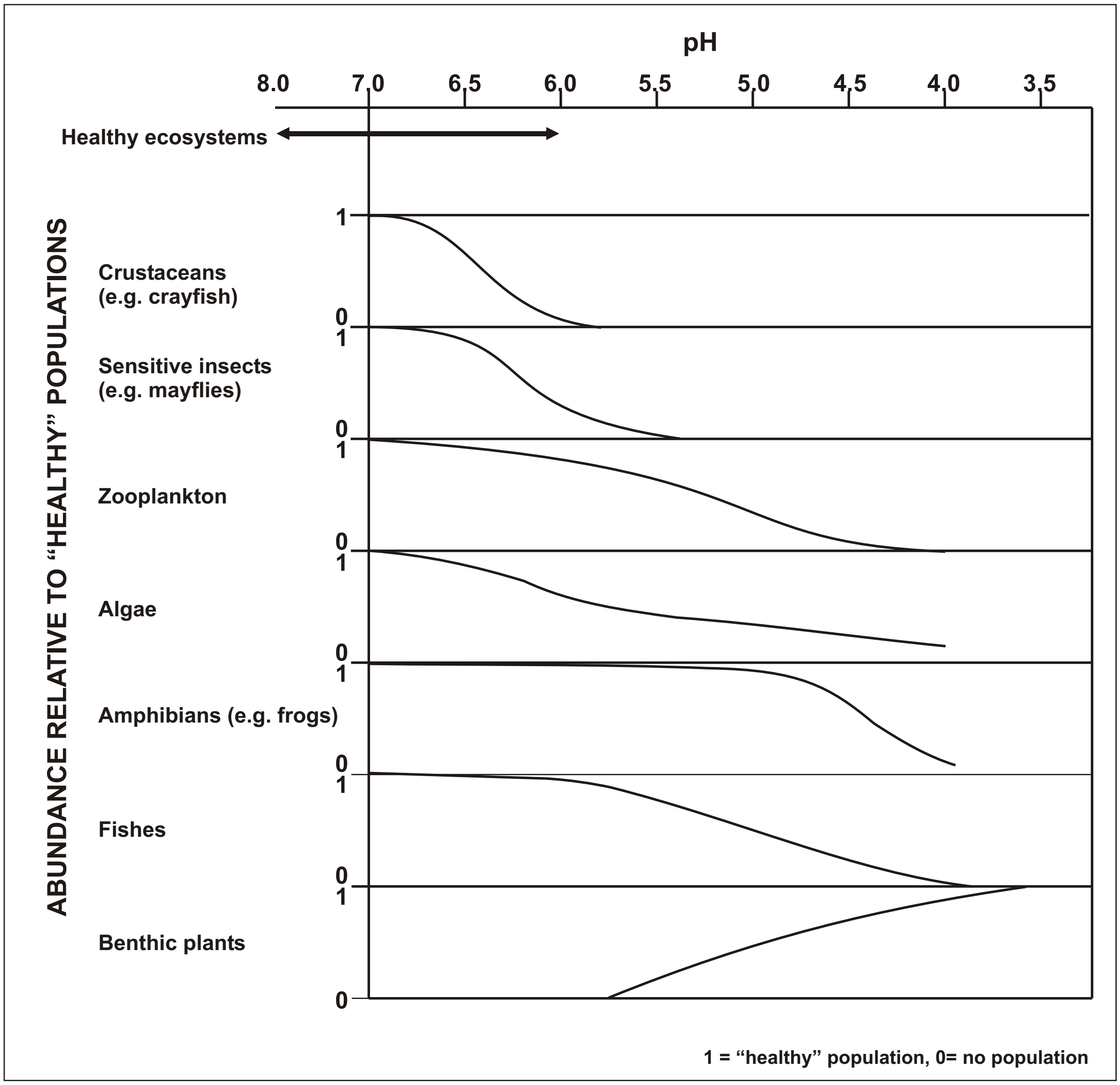

Aquatic life forms vary in their tolerance to acidity. Acidification primarily reduces the variety of life inhabiting a lake and alters the balance among the surviving populations.

ACTIVITY 2 Making a Natural pH Indicator

After completing this activity, you should be able to:

- prepare a natural pH indicator
- determine whether substances are acidic or basic using this indicator
- acquire a greater understanding of the pH scale and neutralization

Introduction

In this experiment you will make your own pH indicator from red cabbage. Red cabbage contains a chemical that turns from its natural deep purple colour to red in acids and blue in bases. Litmus paper, another natural pH indicator, also turns red in acids and blue in bases. The red cabbage pH indicator can be obtained by boiling the cabbage.

Materials Needed

- sliced red cabbage
- stainless steel or enamel pan or microwave casserole dish
- 1 litre water
- stove, microwave, or hotplate
- white vinegar
- ammonia or baking soda
- clear, non-cola beverage
- 3 glass cups (preferably clear)
- measuring spoons
- 3 clean teaspoons for stirring
- measuring cup (1/4 cup)
- notebook and pencil

Procedure

Boil cabbage in a covered pan for 30 minutes or microwave for 10 minutes. (Don't let water boil away.) Let cool before removing the cabbage.

Pour about 1/4 cup of cabbage juice into each cup. Add 1/2 teaspoon ammonia or baking soda to one cup and stir with a clean spoon. Add 1/2 teaspoon vinegar to second cup; stir with a clean spoon. Add about 1 teaspoon clear non-cola to the last cup and stir with a clean spoon.

After answering the first two questions for this experiment, pour the contents of the vinegar cup into the ammonia cup.

Discussion

1) What colour change took place when you added vinegar to the cabbage juice? Why?

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2) Did the ammonia turn the cabbage juice pH indicator red or blue? Why?

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3) What happens to the colour if you pour the contents of the vinegar cup into the ammonia cup?

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4) If you were to gradually add vinegar to the cup containing the baking soda (or ammonia) and cabbage juice, what do you think would happen to the colour of the indicator? Try it, stirring constantly.

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5) Is the non-cola soft drink acidic or basic?

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ANSWER KEY

ACTIVITY 1

1) and 2) Vinegar is an acid, and in this experiment it will display a pH of about 4. Vinegar at pH 4 turns pH paper yellow and most other pH indicators red.

3) Ammonia is a base and in this experiment it will display a pH of about 12. Bases turn most pH indicators blue. (Baking soda is a much weaker base, and should display a pH of about 8.)

4) Your distilled water may not have a neutral pH. PURE distilled water would test neutral, but pure distilled water is not easily obtained because carbon dioxide in the air around us mixes, or dissolves, in the water, making it somewhat acidic.

   The pH of distilled water is between 5.6 and 7. To neutralize slightly acidic distilled water, add about 1/8 teaspoon baking soda, or a drop of ammonia, stir well, and check the pH of the water with a pH indicator. If the water is still acidic, repeat the process until pH 7 is reached. Should you accidentally add too much baking soda or ammonia, either start over or add a drop or two of vinegar, stir, and recheck the pH.

5), 6) and 7) Answers will vary.

ACTIVITY 2

1) The vinegar and cabbage juice mixture should change from deep purple to red, indicating that vinegar is an acid.

2) The ammonia and cabbage juice mixture should change from deep purple to blue, because ammonia, like baking soda, is a base, which reacts chemically with the pH indicator, turning it blue.

3) You should find that the acid and base are neutralized, changing the colour from blue or red to purple, which is the original, neutral colour of the cabbage juice.

4) As you add more vinegar, the acid level increases and the colour becomes red.

5) It is acidic and turns the cabbage juice pH indicator red.

GLOSSARY

Acid rain - more properly called acid precipitation, it occurs when sulphur dioxide and nitrogen oxide emissions convert into such pollutants as sulphuric acid and nitric acid. Both dissolve easily in airborne water droplets.

Buffering capacity - the resistance of water or soil to changes in pH.

Critical load - a measure of how much pollution an ecosystem can tolerate.

Deposition - the processes by which chemical constituents move from the atmosphere to the earth's surface, including wet deposition (from precipitation, fog or cloud water) and dry deposition (from particles or gases).

Diffusion - the way in which freely moving particles in liquids and gases spread out to fill all the space available to them.

Dispersion - the process of reducing high concentrations of air pollutants through atmospheric motion.

Emission - a discharge or release of pollutants into the air, such as from a smokestack or automobile engine.

Fossil fuels - coal, oil, and natural gas formed from the remains of ancient plant and animal life.

Ground-level ozone - ozone that is produced at ground level when some of the chemical components of vehicle exhaust and industrial emissions react with sunlight. At ground level, ozone is a powerful and irritating pollutant. In fact, it is the main component of smog. (See also Ozone, Ozone layer.)

Neutralization - the chemical process that produces a solution that is neither acidic nor alkaline.

Nitrogen oxides - (designated NO_x) gases that form when nitrogen and oxygen in the atmosphere are burned with fossil fuels at high temperatures.

Ozone - (chemical formula O_3) a pungent-smelling, slightly bluish gas which is a close chemical cousin to oxygen. About 90 percent of the earth's ozone is located in a natural layer high above the earth in a region of the atmosphere called the stratosphere (see Ozone layer). Ironically, while stratospheric ozone is beneficial to the environment, ground-level ozone is not (see Ground-level ozone).

Ozone layer - the natural layer of ozone located in the stratosphere. Here, it protects the earth from the harmful effects of the sun's ultraviolet radiation by absorbing much of it. (See also Ozone, Ground-level ozone.)

pH - a scale ranging from 0 to 14 which measures how acidic or alkaline (basic) a substance is, defined as the common logarithm of the reciprocal of the hydrogen ion concentration.

Pollution - impurities in air, water or on land, that create an unclean environment.

Prevailing winds - the direction from which the winds blow most frequently during a given period of time. For example, the prevailing winds in Canada come from the west.

Solubility - the amount of a substance that can dissolve in a solution under a given set of conditions.

Stratosphere - the layer of air that extends from about 10 to 50 kilometres above the earth's surface.

Transport - the movement of pollutants with the wind from one region to another.