Teacher packs in Experimental Science

CHE Pack 6

Preparation of Natural Indicators from plants

Pack contents:

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Curriculum areas covered:

Acids, bases; pH, preparation of solutions at different concentrations

Produced as part of DelPHE-funded collaboration between University of Cape Coast and The Open University, UK

Title: Preparation of Natural Indicators from plant parts e.g. flowers and leaves

Target group: DBE students

Also suitable for: SHS students

Time Required: One hour

Learning outcomes:

These are the learning outcomes expected after students have gone through this Pack

1. **Knowledge and understanding**

   KN1 explain the stages involved in the preparation of natural indicators from plant parts.
   KN2 outline the steps involved in the extraction of indicators from the plant
   KN3 explain the cause of the colour changes in each of the solutions

2. **Cognitive skills**

   CS1 apply the knowledge and understanding of extracting natural indicators from natural sources to everyday life experiences.

3. **Key Skills**

   KS1 implement the procedure for the extraction of natural indicators from natural source
   KS2 identify and describe some everyday uses of indicators, including the testing of soil acidity/basicity

4. **Practical skills**

   PS1 set up and use appropriate equipment for weighing, dissolving, filtration, and evaporation
   PS2 record experimental results

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A. Teacher's Guide

Preparation of test solutions

⇒ Lemon juice: squeeze out and filter the juice from the lemon fruit.
⇒ 0.1M Hydrochloric acid (HCl) solution: measure 1.7ml of concentrated HCl into 100ml of distilled water.
⇒ Dissolve 20g of Baking soda in 50ml distilled water
⇒ 0.1M NaOH solution (NaOH is available as lye from the market and from soap makers; dissolve 4.0g NaOH in enough distilled water to make 100ml of solution)
⇒ Distilled water

Sample collection and treatment

Collect enough samples of colored flowers
For the sake of time, prepare Waakye leaf extract for the students

Sample Assessment Questions

1. What caused the colour changes in each of the solutions? (KN)
2. Outline the steps involved in the extraction of indicator from the plant. (KN)
3. How do indicators from the different flowers differ from each other?
4. Explain what caused the colour changes in each of the solutions (KN)
5. Mention the principles involved in extracting natural indicators from natural sources (C)
6. Describe some everyday uses of indicators including the testing of soil acidity/basicity (KS)

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B. Student Guide

Purpose:

⇒ This experiment explores the extraction of natural indicators from plant parts like flowers and leaves
⇒ To observe the colour changes of these natural indicators in different acid-base solutions
⇒ To compare natural indicators to commercial indicators.

Background to the experiment

Many flowers, fruits, leaves and roots contain chemical substances that change colour in solutions of different pHs. These chemicals are known as indicators. Indicators are chemical substances that change colours when they come into contact with an acid or a base. In this experiment, some of these indicators will be extracted. The pH's at which the indicators change colour will be investigated.

Indicators are mostly used by scientists to test substances to see whether they are acidic or basic. This is a safe way to determine whether a substance is an acid or a base. One example of an indicator is litmus paper, which will simply tell you whether a substance is an acid or a base. But what if we had two acidic substances? How could we tell which one was more acidic than the other? Litmus paper will not work since it can only tell you that they are both acids. A universal indicator can be used in this situation.

A universal indicator will undergo a variety of colour changes in different pH solutions
It changes colour according to the pH of the material it is in. It is so useful because the colour also tells you how strong the substance is. e.g. if you were to put a few drops of the indicator in water it would turn green. A few drops of it in detergent and it would turn a deep purple.

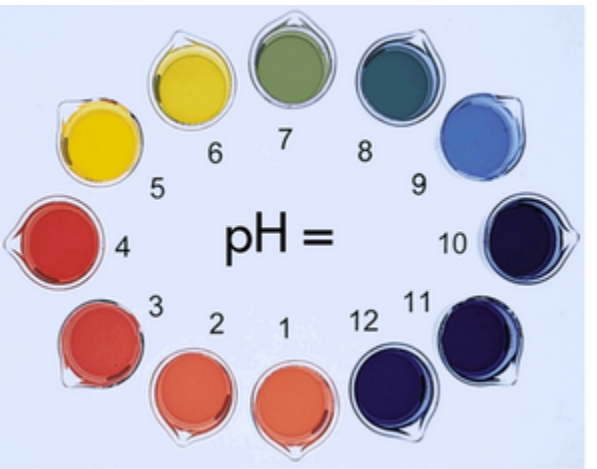

Figure 1: A Universal Indicator

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Equipment/ Materials

Chemicals

1. White vinegar/lemon juice
2. 0.1M hydrochloric acid (HCl) solution
3. Baking soda solution
4. 0.1 M sodium hydroxide (NaOH) solution
5. Distilled water
6. Flowers: red Hibiscus, purple periwinkle and *Hibiscus sabdariffa* (bisap/zobo)
7. Leaves: *waakye* leaves (husks of millet) - dark colours are preferred
8. clean, washed sea sand

Equipment

- 5 Test tubes
- 5 disposable plastic cups (50ml)
- Stirring rods/plastic coffee stirrers
- 10-ml measuring cylinder/ graduated plastic cup
- Medicine droppers
- Miniature mortar and pestle/earthenware bowl and its pestle *('tapore')*
- Funnel
- filter paper/white clean cloth
- source of heat
- heating pan

Other requirements

Working bench/table, open space, laboratory coat, eye goggles, nose mask, hand gloves.

Experimental Procedure

Extraction of the indicator

1. Grind 20g of the petals of 'bisap' flower with ½ teaspoonful of sea sand with mortar and pestle.
2. Stir in about 10 ml of tap water and filter into one of the disposal flasks.
3. Label and allow to stand
4. Repeat steps 1-3 for the rest of the samples except the *waakye* leaves
5. Slice the 'waakye' leaves and boil in water for 20 minutes

Testing the colour of the natural indicators in different acid – base solutions

1. Label the test tubes
2. Transfer 5ml of each test solution into a test tube.

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Test solutions

⇒ White vinegar/lemon juice
⇒ 0.1M hydrochloric acid (HCl) solution
⇒ Baking soda solution
⇒ 0.1 M sodium hydroxide (NaOH) solution
⇒ Distilled water

3. Add a drop or two of the red hibiscus indicator to each test solution.
4. Observe and record the colour change in the table below
5. Discard the content in the test tubes and wash with enough water.
6. Repeat steps 2-5 with the rest of the natural indicators

Test solution	Indicator Colour change			
	Hibiscus rosa-sinensis (Red)	Purple periwinkle	*Hibiscus sabdariffa* (bisap/zobo)	Waakye leaves
White vinegar /lemon juice				
0.1M hydrochloric acid (HCl) solution				
Baking soda solution				
0.1 M sodium hydroxide (NaOH) solution				
Distilled water				

Reflection on the experiment

Discuss the differences in colour change of all the indicators in the test solutions.

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C. Assessment – Student's sheet

On completion of the experiment, you should answer the following questions:

1. What caused the colour changes in each of the solutions? (KN1)

2. Outline the steps involved in the extraction of indicators from the plants. (KN2)

3. How do indicators from different coloured flowers of the same species differ? (CS1)

4. Describe some everyday uses of indicators including the testing of soil acidity/basicity (CS1/KS2)

5. Mention the principles involved in extracting natural indicators from natural sources (CS1)

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D. Extensions to experiment

1. a. Design an experiment to determine what particular combinations of natural indicators would result in an effective universal indicator.
   b. Can the individual components of an extract be effectively isolated through the use of chromatography?
2. How do scientists test for acidic and basic solutions?

E. Useful links/references

- http://studentorgs.vanderbilt.edu/vsvs/
- http://www.woodrow.org/teachers/ci/1986/exp23.html
- Phanstiel, O. J. (1985). *Chem. Ed*. 62, 322.
- Summerlin, L.R. (1986). *Chemistry of Common Substances*. New York: Silver Burdett.

F. Health and Safety

HAZARDS

Caution should be used when working with solutions of hydrochloric acid and sodium hydroxide. Both can be irritating to the skin.
Goggles must be worn throughout the experiment.
If it is necessary to heat the extract in order to concentrate the indicator, do not heat those containing the flammable solvents, 2-propanol or acetone, over an open flame. Use a water bath or hot plate.

BASIC SAFETY RULES:

a. Do not eat, drink or chew whilst doing the experiment.

b. Keep your face at a safe distance from open flames and heated solutions. Never look into a heated solution from above.

c. Avoid breathing in dust or vapour. When smelling solutions, gently wave the air above the solution towards your nose with your hand.

d. Wash any spilled solutions from your skin with plenty of water, and notify the instructor.

e. Report any accident, no matter how minor, to the instructor/report the nearest health post.

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Compulsory rules

You will not be allowed to do the experiment unless you are wearing the following items:

a. Long-sleeved overcoat that is long enough to cover the hips, worn closed at all times.
b. Safety glasses. Please note that contact lenses do not provide eye protection and in some cases may complicate an emergency (caustic liquids which splash into the eye can be trapped behind the contact lens). It is recommended that you avoid wearing contact lenses in the laboratory, if possible.
c. Closed, flat-heeled shoes (no open sandals).
d. Long hair and loose scarves must be tucked away or tied up.
e. Wear protective gloves when you are using toxic or corrosive chemicals. .

Tidy working

Keep your working area tidy. A cluttered bench is a common contributory factor to accidents.
Cleaning the glassware after use should be done immediately. This prevents the organic tarry material from attacking the surface of the glass.
Always clean up a chemical spill without delay
Clean up and dispose of your unknown substances according to your teacher's instructions.
Flush down all of the solutions prepared into the drain with plenty of water or throw into a gutter

G. Evaluation

a. Was it difficult/easy to have access to the experimental materials listed?
b. Were the experimental procedures easy to follow? Explain
c. Suggest other methods and materials which can be included in this pack

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