

Practical Notebook

# Chemistry

Grade X

Web Version of PCTB Textbook

**giz**



**Punjab Curriculum and  
Textbook Board, Lahore**

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Certified that:

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School \_\_\_\_\_

has completed the practical work of Chemistry X for  
session \_\_\_\_\_ as per syllabus.

\_\_\_\_\_  
Signature  
Science Teacher

\_\_\_\_\_  
Signature  
Head of the Department

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# Learning Outcomes of Practical Work

Students are required to carry out practical work as an integral part of the course. They are advised to maintain a laboratory record book in which they record all their practical work, the experimental arrangements used, the observations made and the analysis of these observations. Through experimental work the students are expected to develop the following skills.

- Adopt safety procedures in Chemistry laboratory
- Handle chemical apparatus and use compounds and reagents etc.
- Keep and store poisonous compounds properly.
- Control explosive reactions.
- Identify sodium, calcium, strontium, barium, copper and potassium ions by flame test.
- Determine the molarity of the given solution volumetrically.
- Standardize the given HCl solution volumetrically.
- Classify substances as acidic, basic or neutral.
- Use litmus paper, pH paper and other indicators for measuring pH of solutions.
- Identify carboxylic acids and phenols in the laboratory.
- Distinguish between saturated and unsaturated compounds using potassium per manganate solution.
- Test water quality by checking its hardness.

# CHAPTER Acids, Bases and Salts

# 10



## Experiment 10.1

Identify sodium, calcium, strontium, barium, copper and potassium ions by flame test.

Date \_\_\_\_\_



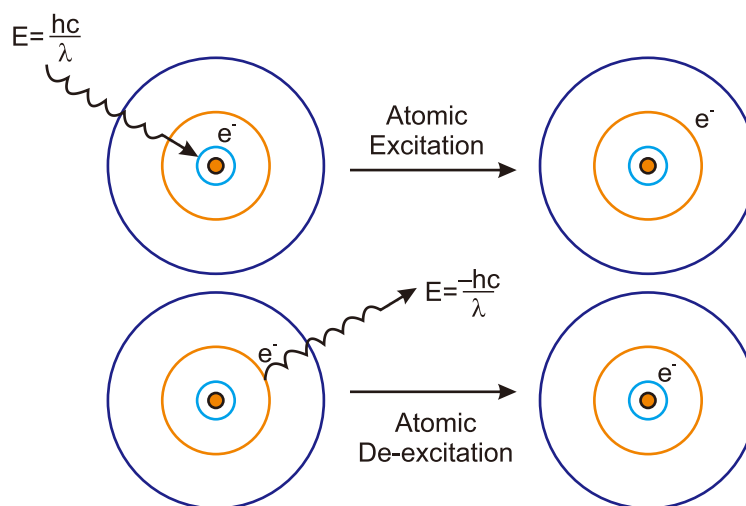
## Background Information

Flame test is used to identify the presence of some metal ions in a compound. It is a very quick way to identify these ions. Not all the metal ions impart colour to the flame.

The alkali and alkaline earth metals have loosely bound valence electrons that are capable of being excited at the temperature of the Bunsen flame. In the flame, the volatile salts evaporate and dissociate into ions. Electrons, which are plentiful in the flame, fall from outside the cations into the valence sub-shells with the emission of energy in the form of visible light. The colour of the emitted light is characteristics of the element. The bright orange spectral lines of sodium in the visible region are associated with the transition of this outermost electron from the 3p sub-shell (excited state) back to 3s sub-shell.

Chloride salts of metals are usually preferred for performing flame test because these are generally more volatile than the other salts and hence easily impart a characteristic colour to the flame.

Spectrum of elements can also be taken when they are enclosed in the form of a gas in the discharge tube. When the atoms present in the gaseous state are supplied with energy, an electron is raised from a low energy level to a higher level. When the same electron drops back, energy equal to the difference between the two levels is emitted in the form of light radiations. If these radiations fall in the visible range, they can be seen as colours in the form of spectrum.





## Materials Required

Watch glass, platinum wire, burner/ spirit lamp, glass rod, beaker.



NaCl, KCl,  $\text{SrCl}_2$ ,  $\text{BaCl}_2$ ,  $\text{CuCl}_2$ ,  $\text{CaCl}_2$ , Concentrated HCl

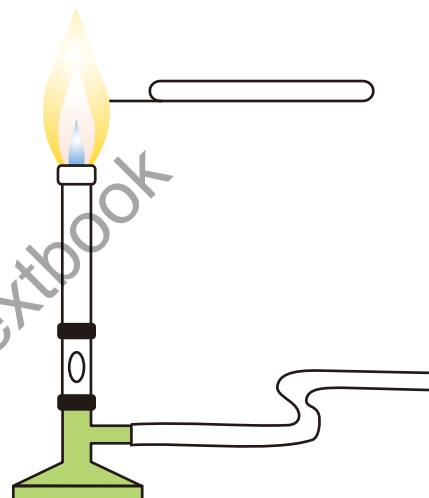


### FOR YOUR INFORMATION

In laboratory nichrome wire is often used instead of expensive platinum wire. Nichrome is an alloy of Ni and Cr. It is also used in electric heaters.

Watch glass

Paste of salt  
in conc. HCl



## Procedure

### CAUTIONS

- Paste of the salt should be thick
- Flame should be oxidizing.
- The conc. HCl is highly volatile and its vapours are corrosive. It attacks the eyes and respiratory systems so the process of moistening with the acid must be done quickly and carefully.

- 1 Take the platinum or nichrome wire and make a small loop of it.
- 2 Dip it in concentrated  $\text{HNO}_3$  and then heat it in an oxidizing blue flame till the wire imparts no colour.
- 3 Take a small amount of a salt on the watch glass with the help of spatula and add a few drops of concentrated HCl on it. Stir it with a glass rod to make a uniform thick paste. Wait until the given salt is converted into its chloride.
- 4 Take a little of this paste on the loop of the nichrome wire and hold it in an oxidizing / blue flame. The wire should be heated at the top of the flame. HCl paste is required only if the salt used is other than chloride.
- 5 Note the characteristic colour of the flame imparted by the metal ion.
- 6 Wash the nichrome wire with concentrated HCl and heat it on the flame till no characteristic colour is imparted to the flame.
- 7 Repeat the experiment with other salts in the same manner.
- 8 Record the **colour** of the flame imparted by a particular metallic ion in the following table.



## Observations

| Metallic ion                 | Sodium ion | Calcium ion | Strontium ion | Barium ion | Copper ion | Potassium ion |
|------------------------------|------------|-------------|---------------|------------|------------|---------------|
| Colour imparted to the flame |            |             |               |            |            |               |

## Result



-----

## Post Lab Activities



1. What is the reason of different colours you observe in the sky usually at the time of sun set?

\_\_\_\_\_  
\_\_\_\_\_

2. Why sodium vapour lamps are used as street lights instead of simple white tube lights?

\_\_\_\_\_  
\_\_\_\_\_

3. How the presence of certain elements is confirmed in distant stars?

\_\_\_\_\_  
\_\_\_\_\_



### DO YOU KNOW?

- If the entire incident light is absorbed by a substance then the colour of the substance appears **BLACK**.
- If light of certain wavelength is absorbed only, the compound will appear **COLOURED**.
- If whole of the incident light is transmitted through a substance, it will appear colourless.
- If all the incident light is reflected then the colour of the substance appears **WHITE**.

### Think

1. Why do different atoms emit different colours of light?
2. Why do you think the salts have to be heated in the flame before the coloured light is emitted?
3. Colourful light emissions are applicable to everyday life. Where else have you observed these emissions? Are these light emission applications related? Explain.
4. Why certain metals do not impart colour to the flame?



### BRAIN TEASER

How do you think **FIRE WORKS** are made? Where do the following colours come from?

Blue \_\_\_\_\_

Green \_\_\_\_\_

Purple \_\_\_\_\_

Red \_\_\_\_\_

Golden \_\_\_\_\_

White \_\_\_\_\_



## Standardize the given NaOH solution volumetrically.

Date \_\_\_\_\_



Volumetric analysis is used to find the concentrations of solutions by means of a technique known as titration. In this technique a solution of unknown concentration is combined slowly and carefully with a known volume of a standard solution until a colour change shows the completion of the reaction. The substance which indicates the completion of reaction by the change in its colour is called an indicator. The moment at which the indicator changes colour is called the end point. Either solution can be taken in a burette with the other solution taken in a conical or a titration flask. With the help of this technique we can check the purity of the products produced in industry or are available in the market.

A large number of substances are available as acid base indicators, which undergo a change in colour according to the pH of the solution (colour change interval). The chief characteristic of these indicators is that the change in colour is not sudden but takes place within a small interval of pH termed as the colour change interval. For most acid base titrations we can, therefore, select an indicator which shows a distinct colour change at a pH close to that which is obtained at the end point.

Colour change and pH range of certain indicators

| Indicator        | pH range/<br>colour change<br>interval | Colour in acidic<br>solution | Colour in<br>alkaline solution |
|------------------|----------------------------------------|------------------------------|--------------------------------|
| Phenolphthalein  | 8.3 – 10.0                             | Colourless                   | Red or pink                    |
| Methyl Orange    | 3.1 -4.4                               | Red                          | Pale yellow                    |
| Litmus           | 5.0-8.0                                | Red                          | Blue                           |
| Bromothymol Blue | 6.0 – 7.6                              | Yellow                       | Blue                           |

**Titrand:** The solution which is taken into the conical flask is called titrand or titrate.

**Titrant:** The solution taken in the burette during titration is called titrant.

**Concordant Readings:** The burette readings which do not differ by more than  $0.1 \text{ cm}^3$ .

**Meniscus:** The curved surface of a liquid in a narrow tube (e.g, burette or pipette) is called meniscus. Note down the reading corresponding to the lower level of the meniscus for the transparent liquids and the straight level for coloured liquids. Avoid parallex error by noting down the reading at eye level.



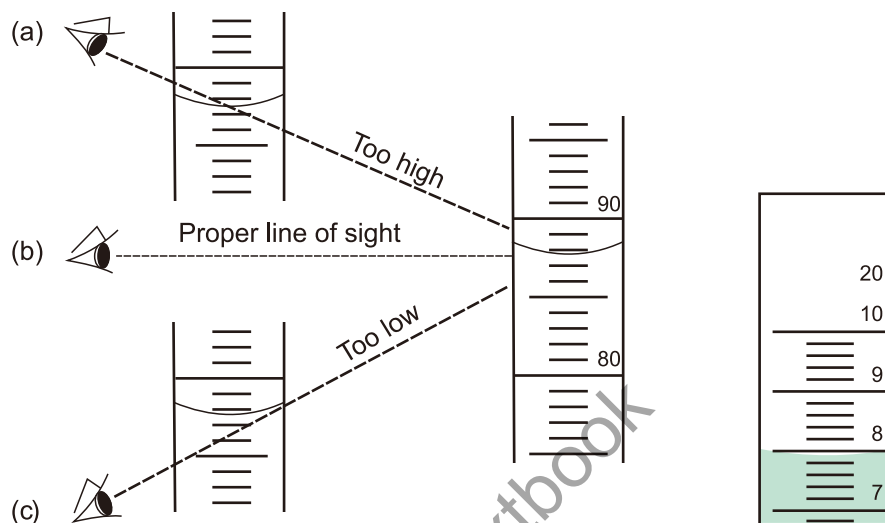
#### FOR YOUR INFORMATION

Phenolphthalein solution is prepared by adding one gram of the indicator in 500 cm<sup>3</sup> of 50% ethanol. Use only one to two drops in 10 cm<sup>3</sup> of the solution to be titrated. The colour change is from pink to colourless as the pH decreases. The light pink colour which marks the end point tends to fade gradually due to the interference of atmospheric carbon dioxide which slowly dissolves in the solution.



#### Materials Required

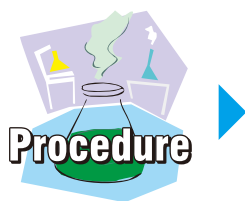
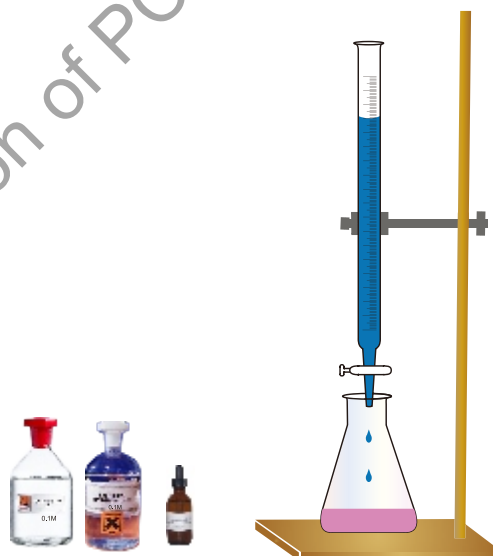
**Anti parallellex card or paper:** A piece of card or paper placed behind the burette and used to eliminate the error due to parallex is called an anti parallellex card/paper.



Beakers, burette, pipette, funnel, conical flask, iron stand.

Distilled water, 0.1M HCl solution, NaOH solution, phenolphthalein.

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#### Procedure

- 1 Rinse the pipette first with distilled water and then with the given NaOH solution.
- 2 Rinse the conical flask with distilled water only.
- 3 Pipette out 10 cm<sup>3</sup> of NaOH solution into a conical flask.
- 4 Add one to two drops of phenolphthalein indicator into it. The solution turns pink.



## CAUTIONS

- Before using conical flask and burette, these should be washed with distilled water.
- During titration, place the conical flask on a white tile / white paper under the burette to see the colour change of the indicator clearly.
- Check that the burette does not leak.

## Think

1. Calculate the mass of NaOH in 1dm<sup>3</sup> of 0.1 molar solution.
2. Why is a rough titration carried out?
3. What is a standard solution.



5. Rinse the burette first with distilled water and then with the given HCl solution.
6. Fix the burette on a clamp stand in an upright position.
7. Fill it with the given HCl solution with the help of a funnel. Remove funnel from the burette.
8. Using the tap at the base of the burette, allow the acid to flow into a beaker to remove any air bubble present in the nozzle.
9. Note the burette reading as an initial reading using an anti parallax card or a white paper.
10. Carry out a rough titration by adding hydrochloric acid solution from the burette in approximately 1 cm<sup>3</sup> portion to the conical flask.
11. The contents of the flask must be swirled after each addition of acid for thorough mixing.
12. Keep on adding acid till the colour of solution becomes light pink and then check whether this pink colour disappears by adding one more drop of the acid.
13. This will be the end point of the reaction.
14. Again note down the burette reading, this will be the final reading.
15. The difference of final and initial readings of burette will give the volume of the acid used.
16. Repeat the titration for accurate reading. For this purpose add hydrochloric acid solution from the burette to the conical flask rapidly to within 2 cm<sup>3</sup> of the end point and then add drop by drop till the end point is reached.
17. Take three concordant readings which agree with one another within 0.1 cm<sup>3</sup>.

| Titration number                    | Rough Reading | 1 | 2 | 3 |
|-------------------------------------|---------------|---|---|---|
| Final reading                       | x             |   |   |   |
| Initial reading                     | y             |   |   |   |
| Volume of acid used/cm <sup>3</sup> | (x-y)         |   |   |   |

Mean volume = \_\_\_\_\_ cm<sup>3</sup>

Volume of HCl solution used \_\_\_\_\_ cm<sup>3</sup>



Find out the molarity of NaOH solution by using the following molarity equation



## Calculations



$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

$M_1$  molarity of acid solution

$V_1$  volume of the acid solution

$n_1$  no. of moles of the acid in the balanced chemical equation

$M_2$  molarity of base solution

$V_2$  volume of the base solution used

$n_2$  no. of moles of the base in the balanced chemical equation

$$M_2 = \frac{M_1 V_1}{n_1} \times \frac{n_2}{V_2}$$

## Result



Molarity of the given NaOH solution is \_\_\_\_\_ M.

## Post Lab Activities



1. You are provided with two test tubes labeled A and B containing an acid solution and an alkaline solution. Using only the indicator phenolphthalein identify which test tube contains an acid and which contains an alkali.

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2. When a drop of universal indicator is dropped into calcium hydroxide what colour change will you observe?

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3. What volume of  $0.25 \text{ mol dm}^{-3}$  HCl solution neutralizes  $25 \text{ cm}^3$  of  $0.1 \text{ mol dm}^{-3}$  NaOH solution?

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4. Why do we need distilled water in preparation of sodium hydroxide solution, sodium carbonate and oxalic acid solutions?

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### BRAIN TEASERS

1. People working in the biology laboratory give proper concentration of an anaesthetic chemicals to the lab. animals. What technique do you think they use to have a proper concentration?
2. Which is a good indicator for the titration of a weak acid with a strong base?



## Experiment 10.3

# Standardize the given HCl solution volumetrically.

Date \_\_\_\_\_



### Background Information

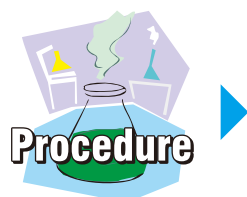
Standardization of HCl solution involves the determination of its exact concentration with the help of a standard solution of NaOH. This process helps to check the purity of acid available in the market.



### Materials Required

**APPARATUS:** Pipette, burette, funnel, conical flask, beaker.

**CHEMICALS:** Solution of HCl, standard solution of NaOH, phenolphthalein.



### Procedure

- 1 Set up the apparatus like that used in the previous experiment 10.2.
- 2 Take the given HCl solution in the burette using a plastic or glass funnel. Remove any air bubble present in the nozzle of the burette.
- 3 Note down the initial reading of the burette.
- 4 Pipette out  $10\text{cm}^3$  of standard NaOH solution in the conical flask.
- 5 Add a drop of phenolphthalein indicator. It would turn the solution pink.
- 6 Run down the HCl solution from the burette drop by drop into the conical flask containing NaOH solution with continuous shaking. Take a rough reading like that in experiment 10.2. The end point is light pink colour to colourless. Note down the final reading.
- 7 Repeat the titration for accurate reading by adding the hydrochloric acid solution from the burette rapidly to within  $2\text{cm}^3$  of the end point and then drop by drop till the end point is reached.
- 8 Take three concordant readings.



### CAUTIONS

- While sucking the solution using pipette, be careful that the solution should not reach the mouth.
- The apparatus must be appropriately washed and rinsed before starting the experiment.
- Burette should be fixed vertically.



### DO YOU KNOW?

1. Concentrated HCl solution is highly corrosive and poisonous. If ingested, it corrodes mucous membranes, oesophagus and stomach causing dysphagia, nausea, circulatory failure and some times death may occur.
2. NaOH is a caustic, strongly alkaline compound used in drain cleaners. NaOH if ingested will cause vomiting, prostration and collapse.



| Titration number                    | Rough Reading | 1 | 2 | 3 |
|-------------------------------------|---------------|---|---|---|
| Final reading                       |               |   |   |   |
| Initial reading                     |               |   |   |   |
| Volume of acid used/cm <sup>3</sup> |               |   |   |   |

Mean volume = \_\_\_\_\_ cm<sup>3</sup>  
 Volume of HCl solution used \_\_\_\_\_ cm<sup>3</sup>



Find out the molarity of HCl solution by using the following molarity equation

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

- $M_1$  molarity of acid solution  
 $V_1$  volume of the acid solution  
 $n_1$  no. of moles of the acid in the balanced chemical equation  
 $M_2$  molarity of base solution  
 $V_2$  volume of the base solution used  
 $n_2$  no. of moles of the base in the balanced chemical equation

$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

**Think**

- Why does the change in colour of NaOH solution in the flask take place on adding HCl in it?
- What does strength of the solution mean?
- What is the name of reaction between an acid and a base?
- Give the net ionic equation for the reaction between an acid and a base.



Molarity of the given HCl solution is \_\_\_\_\_ M.



- Standardize the given vinegar solution (acetic acid) using standard NaOH solution.

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2. Standardize the given lemon juice using standard NaOH solution.

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3. A 1:1 mixture of HCl and NaOH does not cause any poisonous symptoms if ingested, Explain why?

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#### BRAIN TEASER

Why is phenolphthalein and no other indicator used in titration involving a strong acid and a strong base?

## Experiment 10.4

# Determine the exact molarity of $\text{Na}_2\text{CO}_3$ solution volumetrically.

Date \_\_\_\_\_

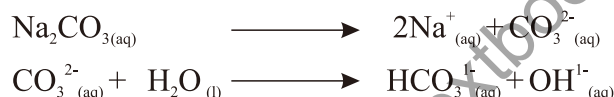
## Background Information



### DO YOU KNOW?

When plants are dried and burned, the sodium and potassium they contain are left behind, making the ashes rich in sodium and potassium carbonates.

Sodium carbonate ( $\text{Na}_2\text{CO}_3$ ) is available as washing soda ( $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ ) and soda ash ( $\text{Na}_2\text{CO}_3$ ) also called anhydrous sodium carbonate. The aqueous solution of sodium carbonate is alkaline in nature. In water sodium carbonate dissociates into sodium ions and carbonate ions. The carbonate ions react with water in a reaction called hydrolysis and release hydroxide ions. Released hydroxide ions, being a strong alkali, makes the solution alkaline.



The molarity of the given sodium carbonate solution is determined by titrating it against a standard solution of hydrochloric acid using methyl orange as an indicator. The choice of the indicator is determined by the pH of the solution at the end point. In this strong acid – weak base titration, the end point lies in the acidic medium, therefore, methyl orange indicator is the best choice because it changes from orange-yellow (at pH 4.4) to red (at pH 3.1).

## Materials Required

**APPARATUS:** Pipette, burette, funnel, conical flask, beaker.

**CHEMICALS:** Standard solution of HCl, solution of  $\text{Na}_2\text{CO}_3$ , methyl orange.

## Procedure

- ① Rinse the burette with HCl solution and clamp it vertically in the burette stand.
- ② Using a funnel, add small amount of hydrochloric acid solution to rinse the burette.
- ③ Fill the burette with hydrochloric acid solution. Remove the funnel.
- ④ Using the tap at the base of the burette, allow the acid to flow freely into a beaker to remove any air bubble present in the nozzle.
- ⑤ Note down the initial reading.
- ⑥ Rinse the pipette with some distilled water and then with some of the sodium carbonate solution.
- ⑦ Rinse the conical flask with distilled water only.
- ⑧ Pipette out  $10\text{ cm}^3$  of the given sodium carbonate solution into the

## CAUTIONS

- Ensure that there are no air bubbles in the nozzle of the burette.
- Hold a piece of white card behind the burette in order to see the level of liquid more clearly.
- Remember to record the lower level of the meniscus at eye level.
- During the titration, any solution adhering to the sides of the conical flask should be washed down with distilled water.
- First titration is only a rough titration and gives the approximate volume of acid used.

clean conical flask.

- Then add 2-3 drops of methyl orange indicator.
- The solution will turn orange. A white tile underneath the conical flask will make the colour look more vivid.
- Carry out a rough titration by adding hydrochloric acid solution from the burette in approximately  $1\text{ cm}^3$  portions to the conical flask, swirl the flask continuously, until the colour of the solution in the conical flask just changes to red.
- Note down the final reading.
- Repeat the titration for accurate reading, by adding the hydrochloric acid solution from the burette rapidly to within  $2\text{ cm}^3$  of the end point and then drop by drop till the end point is reached.
- Repeat the titration until three readings agree within  $0.1\text{ cm}^3$ .

## Think

- Why is a conical flask, rather than a beaker, used in the experiment?
- In using a burette, why is it important (a) to rinse it with a little of the solution which is to be used (b) to clamp it vertically (c) to remove the air bubbles present in the nozzle?
- The following procedures were carried out during the titration:
  - The sides of the conical flask were washed down with distilled water.
  - The conical flask was frequently swirled or shaken.
 Give one reason for carrying out each of these procedures.
- Why is more than one accurate titration carried out?

## Chemical Equation



## Observations

| Titration number                   | Rough Reading | 1 | 2 | 3 |
|------------------------------------|---------------|---|---|---|
| Final reading                      | $x$           |   |   |   |
| Initial reading                    | $y$           |   |   |   |
| Volume of acid used/ $\text{cm}^3$ | $(x-y)$       |   |   |   |

Mean volume = \_\_\_\_\_  $\text{cm}^3$

Volume of HCl solution used \_\_\_\_\_  $\text{cm}^3$



Find out the molarity of  $\text{Na}_2\text{CO}_3$  solution by using the following equation:

$$\begin{array}{ccc} \text{Base} & & \text{Acid} \\ \frac{M_1 V_1}{n_1} & = & \frac{M_2 V_2}{n_2} \\ M_1 & = & \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1} \end{array}$$



Molarity of the given  $\text{Na}_2\text{CO}_3$  solution is \_\_\_\_\_ M.



1. Design any other method to determine the exact molarity of sodium carbonate solution in the laboratory.

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2. Make a list of weak acids and bases available in your school laboratory?

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3. Which indicator will you choose for the titration of a weak acid and a strong base. Support your answer with reason.

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#### BRAIN TEASER

What is the main use of sodium carbonate in industry?





## Experiment 10.5

# Determine the exact molarity of a solution of oxalic acid $(\text{COOH})_2 \cdot 2\text{H}_2\text{O}$ volumetrically.

Date \_\_\_\_\_



### Background Information

A substance which can be obtained in a state of high purity is called a primary standard substance and it is suitable for the preparation of a standard solution. A solution of definite molarity of a primary standard is prepared simply by weighing out the desired amount and dissolving it in the solvent usually water. Oxalic acid being a crystalline solid, is treated as a primary standard.

A secondary standard is a substance which may be used for standardization and whose content of the active substance has been found by comparison against a primary standard.



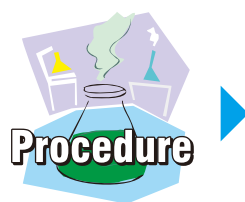
### Materials Required

#### APPARATUS

Top loading balance, watch glass, spatula, measuring flask ( $100 \text{ cm}^3$ ), beakers ( $250 \text{ cm}^3$ ), funnel, pipette, burette

#### CHEMICALS

Phenolphthalein indicator,  $0.1 \text{ M NaOH}$  solution, glass rod, distilled water, oxalic acid.



### Procedure

#### CAUTIONS

- Use only one to two drops of phenolphthalein indicator.
- Note down the reading from the burette keeping your eye parallel to the lower meniscus.
- The apparatus must be appropriately washed and rinsed before starting the experiment.

- 1 Weigh exactly  $1.26 \text{ g}$  of oxalic acid on a watch glass with the help of a top loading balance.
- 2 Dissolve the above acid in about  $50 \text{ cm}^3$  distilled water taken in a beaker.
- 3 Transfer the above solution to a measuring flask ( $100 \text{ cm}^3$ ). Wash the beaker with a small amount of water and transfer the washings to the same measuring flask.
- 4 Add water in the measuring flask to make up the volume upto the etched mark. Mix the solution thoroughly.
- 5 To find out its exact molarity, titrate it with the standard  $\text{NaOH}$  solution.
- 6 For this purpose take oxalic acid solution in a burette.
- 7 After removing the air bubbles from the nozzle of the burette note down the initial reading
- 8 Pipette out  $10 \text{ cm}^3$  of the given solution of  $\text{NaOH}$  in a conical flask and add two drops of phenolphthalein indicator with the help of a glass tube or a dropper. The solution turns pink.
- 9 Add oxalic acid solution to the alkaline solution taken in the conical flask dropwise with constant stirring. Take a rough reading following



the procedure in experiment No. 10.2. The end point is light pink colour to colourless. Note down the final reading.

- ⑩ Repeat the titration for accurate reading by adding the oxalic acid solution to the conical flask rapidly to within 2 cm<sup>3</sup> of the end point and then drop by drop till the end point is reached.
- ⑪ Note down the final reading from the burette.
- ⑫ Take three concordant readings.

## Think

1. A student adds 50cm<sup>3</sup> H<sub>2</sub>O to 25 cm<sup>3</sup> 0.881 M NaOH. What is the concentration of the diluted solution?
2. A sample of gastric juices (HCl present in the stomach) having a volume of 5 cm<sup>3</sup> required 11 cm<sup>3</sup> of 0.01 M NaOH solution for neutralization in a titration. Find out the molar concentration of HCl in the gastric juices.



| Titration number                               | Rough Reading | 1 | 2 | 3 |
|------------------------------------------------|---------------|---|---|---|
| Final reading                                  | x             |   |   |   |
| Initial reading                                | y             |   |   |   |
| Volume of the oxalic acid used/cm <sup>3</sup> | (x-y)         |   |   |   |

Mean volume = \_\_\_\_\_ cm<sup>3</sup>

Volume of oxalic acid used \_\_\_\_\_ cm<sup>3</sup>



Calculate the exact molarity of oxalic acid solution using the following molarity equation.

$$\frac{M_1 V_1}{n_1} = \frac{M_2 V_2}{n_2}$$

M<sub>1</sub> molarity of oxalic acid

V<sub>1</sub> volume of the oxalic acid used

n<sub>1</sub> no. of moles of the oxalic acid (from balanced chemical equation)

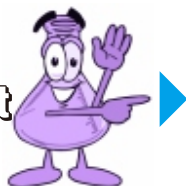
M<sub>2</sub> molarity of NaOH

V<sub>2</sub> volume of the NaOH taken in the conical flask

n<sub>2</sub> no. of moles of NaOH (from balanced chemical equation)

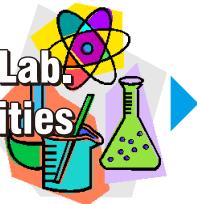
$$M_1 = \frac{M_2 V_2}{n_2} \times \frac{n_1}{V_1}$$

## Result



The exact molarity of oxalic acid solution is ---- M.

## Post Lab. Activities



1. 1. What is the difference between
  - a. a strong acid and a weak acid
  - b. a concentrated acid and a dilute acid

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### DO YOU KNOW?

Oxalic acid is a toxic compound. The human body has little difficulty in processing the small amounts of oxalic acid present in natural foods such as spinach, cabbage and tomatoes. The leaves of rhubarb plants and house plants such as philodendron and dieffenbachia contain much higher concentrations of the oxalic acid and should not be eaten.

2. What do you expect to be the pH of the solution obtained after the end point has reached in titration.
3. Do you expect the end point or the volume of the acid used will be the same or different if methyl orange is used as an indicator instead of phenolphthalein in this exercise.
4. Do you expect a weak acid like acetic acid reacts with a weak base like  $\text{NH}_4\text{OH}$ .

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### BRAIN TEASER

A chemist dissolved enough HCl to prepare  $250\text{cm}^3$  of an aqueous solution which contains 0.10g of  $\text{H}^+$  in the solution. Calculate molarity of  $\text{H}^+$  in the solution.



## Demonstrate that some natural substances are weak acids.

Date \_\_\_\_\_



Many natural substances are classified as acids and bases. Acids are sour in taste so it can be concluded that all natural substances that are sour in taste contain acids. For instance, lemon, orange, strawberry and tomatoes are all acidic in nature. Some natural substances are comparatively stronger acids while others are weaker.

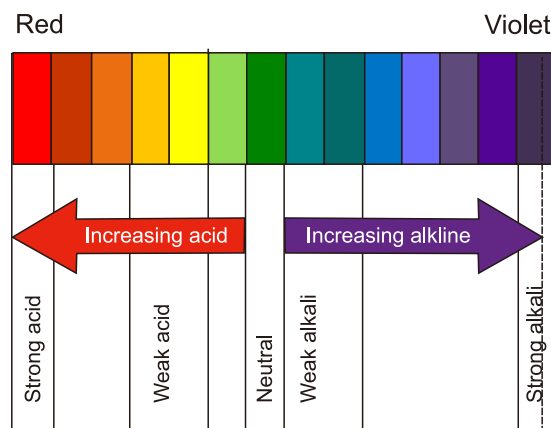
Litmus can tell if a substance is acidic, basic or neutral. A universal indicator is a mixture of many indicators. It can be used to know not only whether a substance is acidic or alkaline, but also whether it is a strong or a weak acid or a base. A universal indicator does so by having different colours in the range of red and violet (e.g. orange, yellow, green, blue, and indigo). Each colour is associated with a particular pH value.

A pH paper consists of a strip of filter paper which has been soaked in a universal indicator. A strip of pH paper is immersed in an unknown solution, and the resulting colour is matched with a colour on the chart with a specific pH value.

pH is a log of inverse of the concentration of hydrogen ion ( $H^+_{(aq)}$ ). A pH value higher than seven indicates a base, while a pH value less than seven indicates an acid. A pH of seven indicates a neutral substance. The stronger the acid the lower is its pH value while the stronger the base the higher is its pH value.

The following table lists some common substances with their pH values.

| $H^+$ Ion concentration (mol/dm <sup>3</sup> ) | pH Value | Examples                 | $OH^-$ Ion concentration (mol/dm <sup>3</sup> ) |
|------------------------------------------------|----------|--------------------------|-------------------------------------------------|
| 1                                              | 0        | Hydrochloric acid        | $10^{-14}$                                      |
| $10^{-1}$                                      | 1        | Stomach acid             | $10^{-13}$                                      |
| $10^{-2}$                                      | 2        | Lemon juice              | $10^{-12}$                                      |
| $10^{-3}$                                      | 3        | Vinegar, Coca Cola, beer | $10^{-11}$                                      |
| $10^{-4}$                                      | 4        | Tomatoes                 | $10^{-10}$                                      |
| $10^{-5}$                                      | 5        | Black coffee             | $10^{-9}$                                       |
| $10^{-6}$                                      | 6        | Urine                    | $10^{-8}$                                       |
| $10^{-7}$                                      | 7        | Pure water               | $10^{-7}$                                       |
| $10^{-8}$                                      | 8        | Sea water                | $10^{-6}$                                       |
| $10^{-9}$                                      | 9        | Baking soda              | $10^{-5}$                                       |
| $10^{-10}$                                     | 10       | Great Salt lake          | $10^{-4}$                                       |
| $10^{-11}$                                     | 11       | Household ammonia        | $10^{-3}$                                       |
| $10^{-12}$                                     | 12       | Bicarbonate of soda      | $10^{-2}$                                       |
| $10^{-13}$                                     | 13       | Oven cleaner             | $10^{-1}$                                       |
| $10^{-14}$                                     | 14       | Sodium hydroxide (NaOH)  | 1                                               |





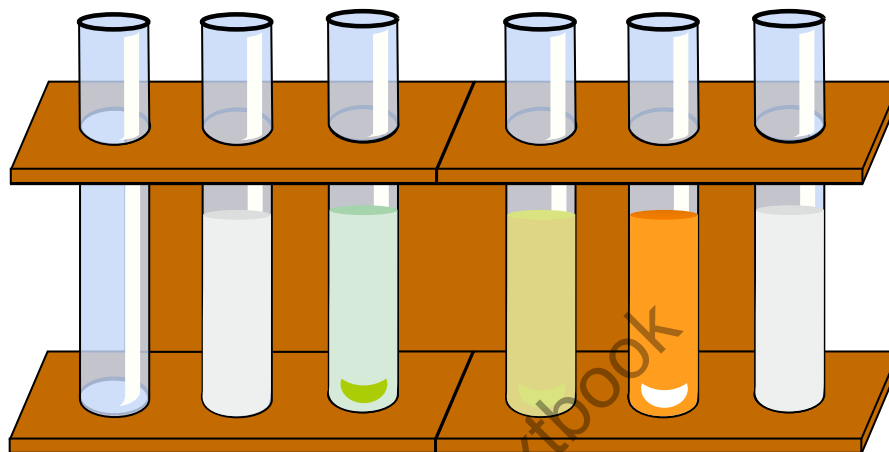
## Materials Required

**APPARATUS:** Six Test tubes, test tube stand, pH paper strip and pH chart, knife.

**CHEMICALS:** Hydrochloric acid, lemon, orange and apple juices, vinegar.

## CAUTIONS

- Use dry piece of pH paper
- Do not touch the end of pH paper to be dipped in the solution.
- Comparison of pH strip with pH chart should be made carefully.



## Procedure

## Think

1. Which substances are used to prepare pH paper strips?
2. Name some natural substances which behave like bases.

- 1 Fill  $\frac{1}{4}^{\text{th}}$  of the test tube with the juice provided. Add equal volume of distilled water to dilute the juice.
- 2 Take the given dilute hydrochloric acid in a separate test tube and dilute it further by adding equal volume of distilled water.
- 3 Take a pH paper strip, dip one end of the strip in hydrochloric acid solution.
- 4 Match the pH paper strip with the colour band of pH chart. Note down the pH from the pH chart.
- 5 Repeat the same procedure with the given samples of juices.
- 6 Record the observations in the following table.



## Observations

| Sample | Dilute Hydrochloric acid solution | Lemon juice | Orange Juice | Apple juice | Vinegar |
|--------|-----------------------------------|-------------|--------------|-------------|---------|
| pH     |                                   |             |              |             |         |

## Result





#### DO YOU KNOW?

- Due to excessive use of soft cola drinks that are acidic in nature tooth decay is accelerated.
- If we don't brush our teeth at night then bacteria present in our mouth produce acid that damages our teeth.
- The pH of the fluid in your stomach is about 1, which is much more acidic than the foods you eat. The acidity level of the contents of your stomach is primarily controlled by the formation of HCl, which is believed to be in stomach as an antibacterial agent and possibly as a predigestion agent for some foods. Under some conditions, such as when you ingest certain foods and beverages, the acidic solution in your stomach can pass into the esophagus, the tube that carries food into your stomach. When this happens you experience a burning sensation in chest known as heartburn.

1. Design an experiment to check the character of the following substances used.

- |                          |                     |
|--------------------------|---------------------|
| a) Sea water/River water | b) Soft cola drinks |
| c) Black coffee          | d) Rain water       |
| e) Toothpaste            | f) Cow's milk       |
| g) Tomato juice          |                     |
- \_\_\_\_\_
- \_\_\_\_\_

2. Our stomach produces hydrochloric acid for the hydrolysis of proteins present in our food in the presence of enzyme. Why only proteins present in the food are hydrolyzed but not the walls of the stomach that are also made up of proteins?

\_\_\_\_\_

\_\_\_\_\_

3. What role does water play when acids and bases are dissolved in it?

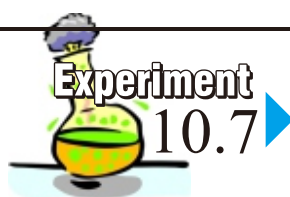
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#### BRAIN TEASER

1. Water coming out of a coal mine is found to be acidic in nature. When this acidic water mixes with fresh water streams or lakes it can cause major environmental problem by killing aquatic life. Name the acid present in mine drainage causing this disaster.
2. Suggest a method to neutralize the acidic water of streams and lakes to save aquatic life.



## CLASSIFY SUBSTANCES AS ACIDIC, BASIC OR NEUTRAL

Date \_\_\_\_\_



According to Arrhenius concept acids are the compounds which give hydrogen ions ( $H^+$ ) or hydroxonium ions ( $H_3O^+$ ) when they are dissolved in water. Similarly bases are the compounds which give hydroxide ions ( $OH^-$ ) in water. The presence of these ions ( $H^+$  and  $OH^-$ ) can be indicated with the help of a compound which usually changes its colour in the presence of these ions. This compound is called an indicator. Many indicators are dyes which have been extracted from natural sources. For example, litmus is a purple dye which has been extracted from lichens. Blue litmus paper turns red when it is added to an acid and red litmus paper turns blue when added to an alkali. In neutral solution the litmus has a purple colour. Bromothymol blue is another such indicator. It changes into yellow colour in acidic solution while it remains blue in an alkaline solution.

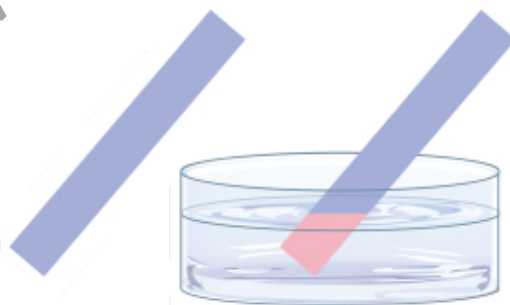


**APPARATUS:** Six 100 cm<sup>3</sup> beakers, red and blue litmus papers, safety goggles, test tubes.

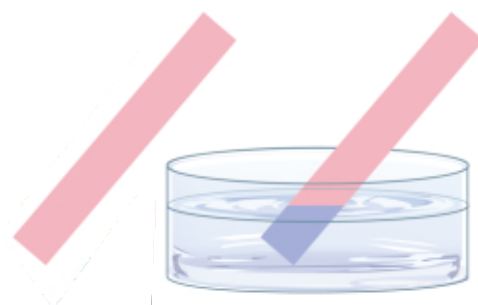
**CHEMICALS:** 0.1% Bromothymol blue, 0.1M solutions of various acids (hydrochloric acid, nitric acid, sulphuric acid and acetic acid), hydroxides of sodium, potassium, calcium and magnesium, methanol, ethanol, sodium chloride and distilled water.

### CAUTIONS

- Do not touch acids or bases with bare fingers
- Wear safety goggles
- Use moist strip of litmus paper



Acids turn blue litmus paper to red



Bases turn red litmus paper to blue



- ❶ Fill half the test tube with the above compounds one by one . Test the liquid in each test tube separately with a strip of red litmus paper and a strip of blue litmus paper. Observe the colour change in the litmus paper and record it in the following table.
- ❷ Similarly fill half the test tube with all the above compounds one by one. Add a few drops of 0.1 % bromthymol blue solution. Observe the colour change and record it in the following table.



| Substance           | Action on Red litmus paper | Action on Blue litmus paper | Action on 0.1% Bromothymol Blue | Inference |
|---------------------|----------------------------|-----------------------------|---------------------------------|-----------|
| Hydrochloric acid   |                            |                             |                                 |           |
| Nitric acid         |                            |                             |                                 |           |
| Sulphuric acid      |                            |                             |                                 |           |
| Acetic acid         |                            |                             |                                 |           |
| Sodium hydroxide    |                            |                             |                                 |           |
| Potassium hydroxide |                            |                             |                                 |           |
| Magnesium hydroxide |                            |                             |                                 |           |
| Methanol            |                            |                             |                                 |           |
| Ethanol             |                            |                             |                                 |           |
| Sodium chloride     |                            |                             |                                 |           |
| Tap water           |                            |                             |                                 |           |




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### Think

1. Both methanol and sodium hydroxide contain a hydroxyl group. Why sodium hydroxide is basic while methanol is neutral in character?
2. Define the term neutralization? Which products are formed as a result of this process?
3. How would you differentiate between a base and an alkali?



1. If gaseous  $\text{HCl}$  is cooled to about  $-84^\circ\text{C}$ , it condenses to a liquid that does not conduct electricity. Why is it so? Do you expect ions to be present in pure liquid  $\text{HCl}$ ?

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2. How would the electrical conductivity of a solution of  $\text{Ba}(\text{OH})_2$  (a strong base) change as a solution of  $\text{H}_2\text{SO}_4$  (a strong acid) is added slowly to it?

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3. Is your saliva acidic or basic before and after having a meal?

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4. Collect water samples from a nearby river or a lake or a pond and check acidic or basic character with the help of a litmus paper.

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5. Using vinegar and ammonia solutions determine which substances in the list given below can be used as acid base indicators.

Beet juice, plum juice, turmeric solution.

(Hint: To extract juice, cut or shred one quarter cup of fruit or vegetable and add a small amount of alcohol)

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6. Why does the application of vinegar remove the scales from a kettle?

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7. Ammonia ( $\text{NH}_3$ ) does not contain any hydroxide group yet it produces hydroxide ions in water. Explain.

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### DO YOU KNOW?

1. Acid base indicators like phenolphthalein and bromthymol blue are dyes which give different colours in acidic or alkaline medium.
2. Litmus contains several substances and changes colour over a broad range, from about pH 5 to pH 8.
3. Sodium chloride is a neutral salt because the ions it forms in water do not react with water.
4. An acidic salt contains a cation that releases a proton after reacting with water and a basic salt contains an anion that abstracts a proton from water.
5. Acidic substances cause hair cuticles to shrink and harden, making them lie flat. This gives the hair a smooth, shiny appearance. Vinegar helps dissolve basic soap scum, thereby, increasing the luster of hair. A base, on the other hand, causes hair to swell and soften.
6. Food drinks with low pH taste sour to us because the  $H^+$  ions react temporarily with molecules on the side of tongue, causing them to change shape somewhat, an action which sends the message "sour" to our brain.



### BRAIN TEASERS

1. Health salt is a mixture of sodium bicarbonate and citric acid. Explain why these compounds do not react with each other until water is added in the salt.
2. Explain why fluoride ions in drinking water work to prevent tooth decay.
3. What is the difference between the terms neutral and amphoteric? Is water a neutral or amphoteric substance?
4. What is the nature of bee's sting?



## Experiment 11.1

## Identify aldehydes using Fehling's test and Tollen's test.

Date \_\_\_\_\_



### Background Information



### DO YOU KNOW?

1. Fehling's test is sensitive enough that even 1mg of glucose produces the characteristic red colour of the compound copper (I) oxide.
2. Fehling's test is used to identify the presence of reducing sugar (glucose) in the urine of diabetic patient.
3. Due to reflective nature of the deposited silver at the glass surface Tollen's reagent is used to produce ordinary mirrors.

Organic compounds which contain an aldehydic functional group ( $\text{R}-\overset{\text{O}}{\parallel}\text{C}-\text{H}$ ) are called aldehydes. This family of organic compounds can be identified with both Fehling's and Tollen's tests. Fehling's test is commonly used to detect reducing sugars like glucose. It may be mentioned that glucose molecule has an aldehydic group present in it. Both Fehling's and Tollen's tests are regarded as specific tests for the identification of aldehydes.

### Fehling's Reagent:

Fehling's solution is always prepared fresh in the laboratory. It is made initially as two separate solutions known as Fehling's **A** and Fehling's **B**.

Fehling's **A** is a blue aqueous solution of copper (II) sulphate pentahydrate  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  crystals, while Fehling's **B** is a clear aqueous solution of potassium, sodium tartrate in sodium hydroxide. To identify an aldehyde, the two solutions are mixed in equal quantities and the given aldehyde is added in it.

### TOLLEN'S Reagent:

Tollen's reagent is a colourless, basic, aqueous solution containing silver ions attached to ammonia. It is prepared by using the following procedure.

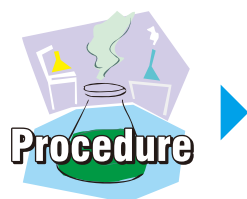
Sodium hydroxide is added dropwise to an aqueous solution of silver nitrate ( $\text{AgNO}_3$ ). A white precipitate will appear which will dissolve by adding aqueous ammonia. This is called ammonical silver nitrate or Tollen's reagent.



### Materials Required

**APPARATUS:** Test tubes, test tube holder, burner, water bath, match box, dropper, safety goggles

**CHEMICALS:** Fehling's reagent, Tollen's reagent, glucose solution.



### Procedure

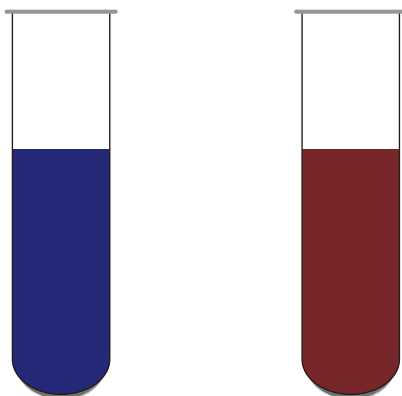
### PROCEDURE FOR FEHLING'S TEST

1. Mix  $3\text{ cm}^3$  of Fehling's solution A with  $3\text{ cm}^3$  of Fehling's solution B in an empty test tube.
2. Dissolve a few crystals of glucose in  $3\text{ cm}^3$  water.

## Think

1. What is the colour of copper(II) oxide?
2. Which can be easily oxidized an aldehyde or a ketone?

3. Mix the two solutions.
4. Heat the test tube containing the above mixture.



| Experiment                                             | Observation |
|--------------------------------------------------------|-------------|
| Mix glucose solution with Fehling's solution and heat. |             |

## CAUTIONS

1. Use distilled water to prepare solution.
2. Copper (II) sulphate pentahydrate is toxic if ingested.
3. The reagents should be freshly prepared and stored refrigerated in a dark glass container.
4. Tollen's reagent has an approximate shelf-life of 24 hours when stored in this way.
5. After the test has been performed, the resulting mixture of Tollen's test should be acidified with dilute acid before disposal. These precautions are to prevent the formation of the highly explosive silver nitride ( $\text{Ag}_3\text{N}$ ).



## Result



## PROCEDURE FOR TOLLEN'S TEST

1. Take  $3\text{cm}^3$  aqueous silver nitrate in a neat and clean test tube.
2. Add  $3\text{cm}^3$  of dilute  $\text{NaOH}$  solution dropwise to the above solution.
3. Add aqueous ammonia solution dropwise to the above solution until the precipitate of  $\text{Ag}_2\text{O}$  formed disappears.
4. Dissolve a few crystals of glucose in  $3\text{cm}^3$  distilled water in a separate test tube.
5. Add  $3\text{cm}^3$  ammoniacal silver nitrate to the glucose solution.



Silver mirror

- ⑥ Place the test tube in a hot water bath for a few minutes and note down the observation.



| Experiment                                                                  | Observation |
|-----------------------------------------------------------------------------|-------------|
| Mix glucose solution and Ammonical silver nitrate and Heat on a water bath. |             |



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- Predict the role of sodium potassium tartarate in Fehling's solution.  
\_\_\_\_\_  
\_\_\_\_\_
- What happens to an aldehyde when it reacts with Fehling's solution or Tollen's reagent?  
\_\_\_\_\_  
\_\_\_\_\_
- Which structural feature in an aldehyde makes it an easily oxidizable molecule?  
\_\_\_\_\_  
\_\_\_\_\_



#### BRAIN TEASER

Search out what is the range of the normal level of blood sugar in the human body?



## Identify ketones using 2, 4-dinitrophenyl hydrazine test.

Date \_\_\_\_\_



2, 4-Dinitrophenylhydrazine is often abbreviated as 2, 4-DNP or 2, 4-DNPH. This reagent is prepared by dissolving 2, 4-dinitrophenylhydrazine in ethanol. Then a few  $\text{cm}^3$  of concentrated sulphuric acid are added slowly. The mixture becomes warm and the solid dissolves completely. Fructose is a carbohydrate which has a ketonic group ( $\text{R}-\overset{\text{O}}{\underset{\text{||}}{\text{C}}}-\text{R}$ ) present in it.



**APPARATUS:** Test tubes, test tube holder, burner, water bath, match box, dropper, safety goggles,

**CHEMICALS:** Fructose solution, distilled water, 2,4-DNPH, ethanol, concentrated sulphuric acid.



### Think

1. Do ketones give positive tests with Fehling's and Tollen's reagents?
2. Can you use 2, 4 DNPH reagent to test sugar in the urine of a diabetic patient?

1. Suspend 0.25g of 2,4 dinitrophenylhydrazine in  $5\text{ cm}^3$  ethanol and add 8 to 10 drops of concentrated sulphuric acid cautiously. Use this solution to test any ketone.
2. In a test tube, take  $2\text{ cm}^3$  of 95% ethanol and add a few crystals of fructose. Shake it to dissolve fructose.
3. Add  $3\text{ cm}^3$  of 2,4-dinitrophenyl hydrazine reagent in the above mixture. Shake vigorously and if no precipitate appears immediately allow the solution to stand for a few minutes. If no precipitate appears dilute the solution



### DO YOU KNOW?

1. 2, 4-Dinitrophenylhydrazine is a red, crystalline powder with a melting point of approximately  $200^\circ\text{C}$ . It is soluble in dilute inorganic acids and is used as a reagent for the identification of aldehydes and ketones. The aldehyde or ketone is converted to its hydrazone by reaction with 2,4-dinitrophenylhydrazine.
2. Acetone ( $\text{CH}_3-\text{CO}-\text{CH}_3$ ) is a commercially important ketone. It is a solvent used in manufacturing other organic chemicals, drugs and explosives. It is also used as a nail polish remover.

carefully with 1M  $\text{H}_2\text{SO}_4$ .

- ④ Occasionally, it may be necessary to heat the solution gently on a water bath to accelerate the slow reaction.
- ⑤ Record your observations.



| Experiment                                                                                                                          | Observation |
|-------------------------------------------------------------------------------------------------------------------------------------|-------------|
| Mix fructose solution with 2,4-DNPH reagent. Shake vigorously and if required dilute the solution with 1M $\text{H}_2\text{SO}_4$ . |             |



Perform 2, 4-DNPH test with glucose solution and record your result in the following table.

| Experiment                                     | Observation |
|------------------------------------------------|-------------|
| Glucose solution + 2,4-DNPH reagent and shake. |             |



#### BRAIN TEASER

Search out the shelf life of 2,4 DNPH solution in mineral acids.



## Identify carboxylic acids using sodium carbonate test.

Date \_\_\_\_\_



Organic compounds containing  $\text{-COOH}$  as a functional group are called carboxylic acids. Carboxylic acids evolve carbon dioxide gas on reacting with metal carbonates or bicarbonates. This reaction is used as an identification test for carboxylic acids.

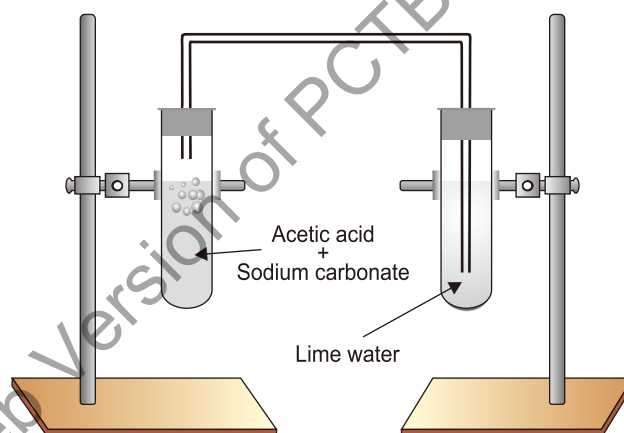


**APPARATUS:** Test tubes, test tube holder, test tube rack, spatula, burner, match box, delivery tube, corks.

**CHEMICALS:** Acetic acid solution, solid sodium carbonate, distilled water, lime water.

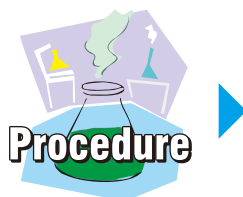
**CAUTIONS**

- Do not taste any chemical / solution.
- Use freshly prepared lime water solution.



### Think

1. What are the products when carboxylic acids react with bicarbonates?
2. Where does carbon dioxide gas come from?
3. Which two functional groups are joined together to give a carboxylic acid group?
4. Name some commonly used carboxylic acids?



- ❶ Take about  $5\text{cm}^3$  of dilute acetic acid in a test tube.
- ❷ Add a few crystals of solid sodium carbonate in the above test tube.
- ❸ Pass the gas which is evolved in the above reaction through lime water.
- ❹ Record your observation.



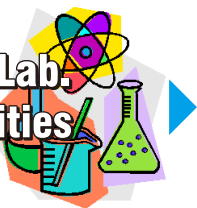
## Observations

| Experiment                                                  | Observation |
|-------------------------------------------------------------|-------------|
| Add solid $\text{Na}_2\text{CO}_3$ to acetic acid solution. |             |

## Result



## Post Lab Activities



1. Identify the carboxylic acids present in tamarind (imli).  
\_\_\_\_\_  
\_\_\_\_\_
2. How will you change aspirin to make it water soluble?  
\_\_\_\_\_  
\_\_\_\_\_
3. Which carboxylic acid is responsible for the odour and taste of vinegar.  
\_\_\_\_\_  
\_\_\_\_\_



### DO YOU KNOW?

1. The distinctive tangy taste of sourdough bread (Khameri roti) results from the work of yeast and lactobacteria. Acetic acid and lactic acid are produced during the fermentation, giving sourdough bread its sour taste.
2. Many insects, including the red ant, use formic acid as a defensive chemical weapon, a communication system and for protection against parasites.
3. Aspirin is acetylsalicylic acid which is a carboxylic acid.



### BRAIN TEASER

1. While preparing cakes and cookies why the flour swells up on the addition of baking soda in it?
2. Which is more basic,  $\text{Na}_2\text{CO}_3$  or  $\text{NaHCO}_3$ ?





## Experiment 11.4

# Identify phenol using ferric chloride test.

Date \_\_\_\_\_



### Background Information

Phenol is an aromatic compound which contains a  $\text{-OH}$  group directly attached with the carbon atom of the benzene ring. It is hygroscopic in nature and turns pink when exposed to air and light. It is moderately soluble in cold water, but is readily soluble in ethanol and ether. When treated with ferric chloride in a dilute aqueous or alcoholic solution, phenol gives a characteristic purple colour. The colour develops due to the formation of ferric phenoxide. Phenol is used as an antiseptic and disinfectant.



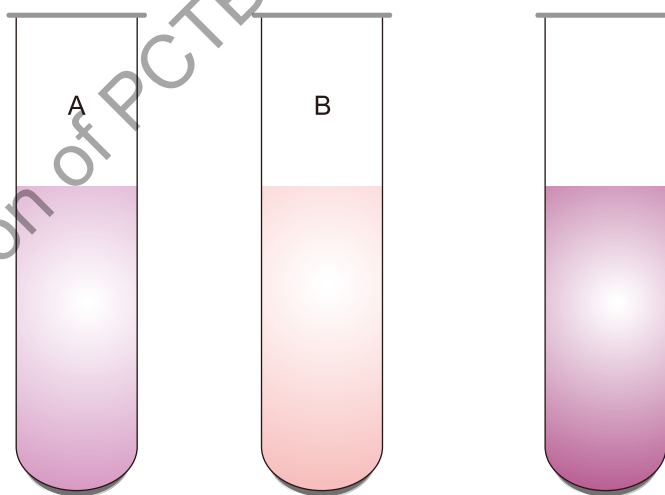
### Materials Required

**APPARATUS:** Test tubes, test tube holder, test tube rack, dropper, safety goggles.

**CHEMICALS:** Phenol solution, freshly prepared ferric chloride solution, distilled water.

**CAUTIONS**

- Phenol can cause a severe health hazard. It should be handled with extreme cautions.
- Phenol is highly corrosive. Do not allow it to come in contact with the skin..
- Use freshly prepared ferric chloride solution.



### Procedure

- 1 Take three test tubes, label them A, B, C and keep them in a test tube rack.
- 2 Take some phenol solution in test tube A, freshly prepared (1%) ferric chloride solution in test tube B and distilled water in test tube C.
- 3 Dilute the phenol solution with distilled water and then add a few drops of freshly prepared ferric chloride solution in it. Note down the observation.

### Think

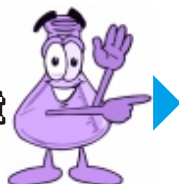
1. Why does phenol give ferric chloride test?
2. Can you carry out ferric chloride test to identify alcohols? If not why?



**Observations**

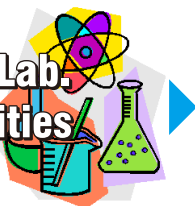
| Experiment                                                              | Observation |
|-------------------------------------------------------------------------|-------------|
| Diluted phenol solution + 1% freshly prepared ferric chloride solution. |             |

**Result**



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**Post Lab Activities**



1. Carbolic soaps contain phenol and possess characteristic smell. Design an experiment to identify the presence of phenol in different soaps available at home.

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2. With the help of a pH paper find out whether phenol is acidic, basic or neutral.

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3. Take a few crystals of phenol and keep them in an open container for half an hour. Note down your observation.

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#### BRAIN TEASER

1. Which property of phenol makes it useful to be a constituent of carbolic soaps.
2. Why can  $\text{FeCl}_2$  not be used to detect the presence of phenol?



## Experiment 12.1

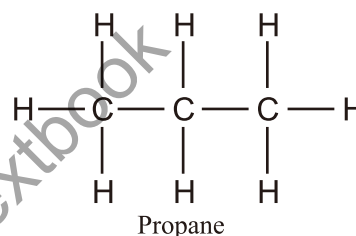
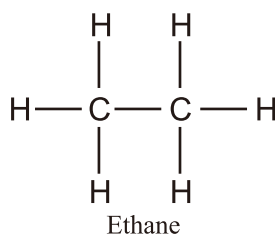
Identify the saturated and unsaturated organic compounds by potassium permanganate ( $\text{KMnO}_4$ ) test.

Date \_\_\_\_\_

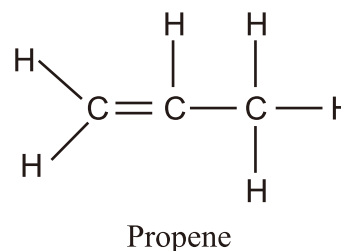
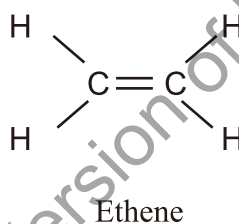


## Background Information

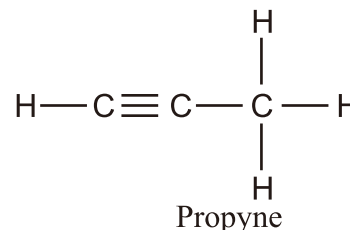
Saturated compounds are those organic compounds which contain only carbon-carbon single bond. Alkanes are saturated hydrocarbons. For example.



Unsaturated compounds are those organic compounds which contain carbon-carbon double bond (=) or triple ( $\equiv$ ) bond. Alkenes and alkynes are unsaturated hydrocarbons. For example.



Ethyne



The easily available unsaturated compound in the laboratory is cinnamic acid. ( $\text{C}_6\text{H}_5-\text{CH}=\text{CH}-\text{COOH}$ ). It decolourizes acidified  $\text{KMnO}_4$  solution.

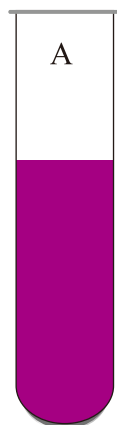
To differentiate between saturated and unsaturated organic compounds acidified  $\text{KMnO}_4$  solution is used.



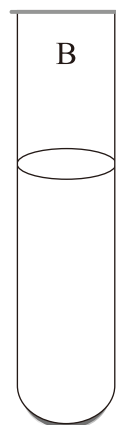
## Materials Required

**APPARATUS:** Test tubes, test tube holder, test tube rack, dropper.

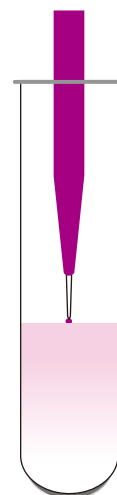
**CHEMICALS:** Cinnamic acid, acidified  $\text{KMnO}_4$  solution, tartaric acid solution, ether or alcohol, bromine water, distilled water.



KMnO<sub>4</sub> Solution



Cinnamic Acid Solution



Colour of KMnO<sub>4</sub> is discharged



## Procedure

## Think

1. What is the difference between a saturated and unsaturated hydrocarbon?
2. How hydrogenation of liquid oil takes place?

- 1 Take 5cm<sup>3</sup> water in a test tube A and add a few crystals of KMnO<sub>4</sub>. Stir with glass rod to dissolve KMnO<sub>4</sub>. Add a few drops of dilute H<sub>2</sub>SO<sub>4</sub> to acidify it.
- 2 Take 5cm<sup>3</sup> water in another test tube B and add a few crystals of cinnamic acid and stir with a glass rod. The cinnamic acid being insoluble will form a suspension in H<sub>2</sub>O.
- 3 Add a few drops of acidified KMnO<sub>4</sub> solution to cinnamic acid with the help of a dropper.
- 4 Record your observations.
- 5 Take about 5cm<sup>3</sup> water in a test tube C and add a few crystals of tartaric acid. Stir the solution to dissolve the acid.
- 6 Add a few drops of acidified KMnO<sub>4</sub> solution to the above solution with the help of a dropper.
- 7 Record your observations.



## Observations

| Experiment                                                                           | Observation |
|--------------------------------------------------------------------------------------|-------------|
| Add acidified KMnO <sub>4</sub> solution to the aqueous suspension of cinnamic acid. |             |
| Add acidified KMnO <sub>4</sub> solution to the aqueous solution of tartaric acid.   |             |

## Result





1. The unsaturation in an organic compound can also be detected by bromine water.

| No. | Experiment                                                                   | Observation | Inference |
|-----|------------------------------------------------------------------------------|-------------|-----------|
| 1.  | Add a few drops of bromine water in cinnamic acid suspension in a test tube. |             |           |
| 2.  | Add a few drops of bromine water in tartaric acid solution.                  |             |           |

**CAUTION**

- Bromine is dangerous to handle. It causes burn on the skin.

2. Name the main product obtained when acidified  $\text{KMnO}_4$  reacts with ethene.

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3. What type of reactions do unsaturated compound normally give?

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#### DO YOU KNOW?

- Catalytic hydrogenation is used to change vegetable oil, a liquid, into margarine which is a semi-solid. This is because people prefer to spread the semi-solid margarine over their bread rather than liquid oil.
- Ethene gas is not only used to produce plastic (Polythene) but it also speeds up the ripening of fruits and vegetables.
- Vegetable oil contains many carbon-carbon double bonds (=) that is why they are called poly unsaturated organic compounds.
- Diets that are rich in saturated fatty acids can be unhealthy since they lead to higher level of blood cholesterol.
- Petroleum is a mixture of saturated hydrocarbons.
- Desi ghee exists in the form of semi solid due to the presence of saturated and unsaturated fatty acids.
- Benzene ( $\text{C}_6\text{H}_6$ ) has three double bonds in it but it behaves more like a saturated compound.



#### BRAIN TEASER

Fish oils are rich in esters of certain types of unsaturated fatty acids which serve to reduce the incidence of heart disease. What name is given to such esters?



## Experiment 13.1

## Demonstrate that sugar decomposes into elements or other compounds.

Date \_\_\_\_\_



### Background Information

A chemical reaction in which a substance is broken down into two or more simpler substances is called decomposition reaction. A decomposition always involves breaking of one or more chemical bond and therefore occurs only when the required amount of energy is supplied. The energy may be supplied in any form such as heat (thermal decomposition) or electricity (electrolytic decomposition or electrolysis). By thermal decomposition sugar is converted into carbon and steam.



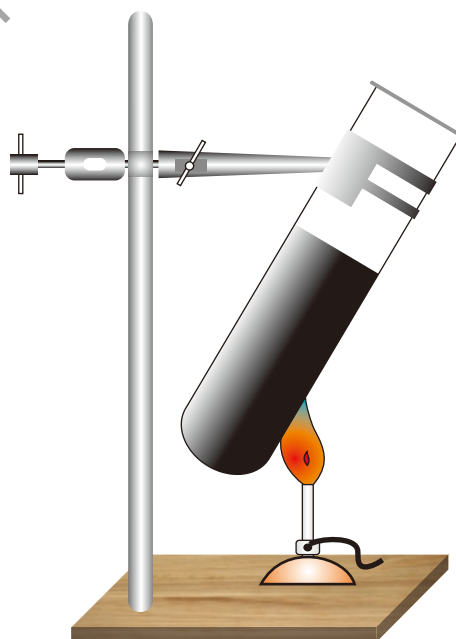
### Materials Required

**APPARATUS:** Test tubes, Bunsen burner, match box, test tube holder or clamp, cobalt chloride paper, safety goggles.

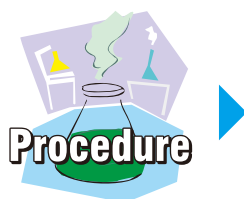
**CHEMICALS:** Sugar

**⚠ CAUTION**

- Put on your safety goggles while heating.
- Give to and fro motion to test tube while heating to avoid spurting.



Thermal Decomposition of Sugar



## Procedure

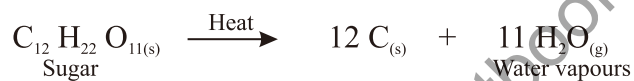
1. Fill about one third of the dry test tube with sugar crystals.
2. Fix this test tube in a test tube holder or clamp of iron stand.
3. Heat the test tube gently with a Bunsen burner.
4. A blue flame is used for heating because it is hotter and cleaner.
5. Bring dry cobalt chloride paper near the mouth of the test tube and observe the change in its colour.

## Think

1. What name will you give to the black residue left at the end of the experiment?
2. What is caramel and where is it used?



## Chemical Equation



## Observations

| Experiments                                                       | Observations |
|-------------------------------------------------------------------|--------------|
| Take common sugar in a test tube and heat it gently.              |              |
| Heat the above test tube strongly.                                |              |
| Take cobalt chloride paper near the mouth of the above test tube. |              |



## Result



## Post Lab Activities

1. Take a few crystals of glucose in a test tube. First heat gently and then strongly. Record your observations in the table below:

| Experiment                         | Before heating | After gentle heating | After strong heating |
|------------------------------------|----------------|----------------------|----------------------|
| Physical state of glucose (colour) |                |                      |                      |

2. What are the products of the burning wax?
- \_\_\_\_\_
- \_\_\_\_\_
3. Which gas is burnt in kitchen burner and what are the products of burning of this gas?
- \_\_\_\_\_
- \_\_\_\_\_



#### DO YOU KNOW?

1. Spirit (ethanol) and many other organic compounds, which do not have nitrogen in their formulae, change into carbon dioxide and water vapours when burnt in the air.
2. Eating or drinking 100 grams of sugar, the equivalent of one 350 cm<sup>3</sup> can of fizzy drink, reduces the ability of white blood cells to kill bacteria by 40%. The immune – suppress effect of sugar starts less than 30 minutes after ingestion and may last for five hours. The ingestion of complex carbohydrates, or starches, has no effect on the immune system.



#### BRAIN TEASER

By heating natural gas at high temperature in the absence of air, it breaks up into carbon and hydrogen. The carbon is used as a filler in auto-tyres and hydrogen is used either as a fuel or for the production of ammonia. What is the chemical name of this process? Write balanced equation of this reaction.



# CHAPTER Environmental Chemistry (Water)

# 15



## Experiment 15.1

**Demonstrate the softening of water by removal of calcium and magnesium ions from hard water.**

Date \_\_\_\_\_



## Background Information

Water containing more minerals than ordinary water is called hard water. Unlike soft water hard water does not produce lather easily with soap solution. Hardness in water is due to the presence of  $\text{Ca}^{+2}$  and  $\text{Mg}^{+2}$ .

Temporary hardness of water is due to the presence of  $\text{HCO}_3^-$  of calcium and magnesium while permanent hardness is due to the presence of sulphates and chlorides of  $\text{Ca}^{+2}$  or  $\text{Mg}^{+2}$ . These ions react with the ions present in the soap and form a scum which prevents the cleansing action of soap. Soap normally consists of sodium salts of long chain organic acids derived from animal fats or oils. An example is sodium stearate. The negative ion of the soap forms an insoluble scum with  $\text{Ca}^{+2}$  or  $\text{Mg}^{+2}$ , which reduces the effectiveness of the soap for removing dirt and grease.



Temporary hardness of water can be removed by simply boiling it. Soluble bicarbonates present in it decompose to give insoluble carbonates which come out of water and thus making it soft.



Permanent hard water can be made soft by adding washing soda in it. Added carbonate ions ( $\text{CO}_3^{-2}$ ) react with calcium or magnesium ions to give the insoluble calcium or magnesium carbonate.



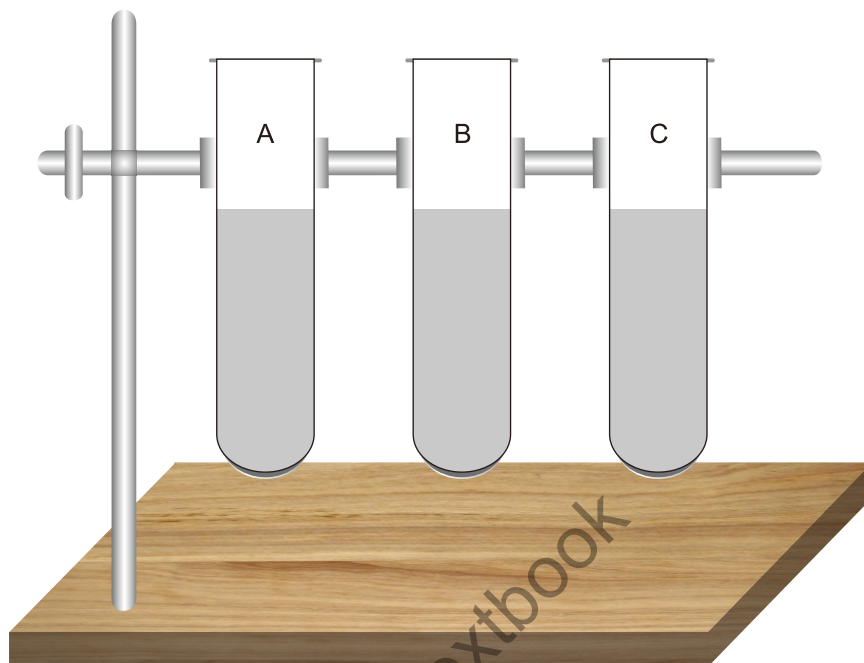
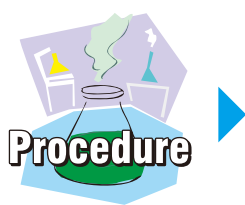
Hard water is harmful if used for drinking purpose as well in industry. The salts present in it deposit along the inner walls of the pipes of boiler requiring their removal after regular intervals.



## Materials Required

**APPARATUS:** Test tubes, beaker, distilled water.

**CHEMICALS:** Soap solution, sodium sulphate, calcium chloride, sodium bicarbonate and sodium carbonate,



- ❶ Take distilled water ( $10\text{cm}^3$ ) in three test tubes and label them as A,B and C.
- ❷ Add  $0.5\text{g Na}_2\text{SO}_4$  in test tube A and shake the test tube to dissolve it.
- ❸ Add a few drops of soap solution in the test tube A. Shake and record your observations.
- ❹ Add  $1.0\text{ g NaHCO}_3$  and  $0.5\text{ g CaCl}_2$  in the test tube B and shake the test tube to dissolve them.
- ❺ Take about  $5\text{ cm}^3$  of the above solution in a separate test tube. Add a few drops of soap solution in it. Shake and record your observations.
- ❻ Boil the remaining solution present in test tube B. Cool and add a few drops of soap solution. Shake and record your observations.
- ❼ Add  $0.5\text{ g CaCl}_2$  in the test tube C. Shake the test tube to dissolve the compound. Add a few drops of soap solution in a portion of this solution and shake. Record your observations.
- ❽ Take about  $3\text{ cm}^3$  of the solution present in test tube C in a separate test tube and boil it. Cool it and add a few drops of soap solution. Shake and record your observations.
- ❾ Add  $1.0\text{ g Na}_2\text{CO}_3$  in the remaining solution present in test tube C. Shake and filter. Now add a few drops of soap solution in the filtrate. Shake and record your observations.



| Sr. # | Experiments                                                                                                                                               | Observations |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| 1.    | Add a few drops of soap solution in test tube A and shake.                                                                                                |              |
| 2.    | Add a few drops of soap solution in a portion of solution in test tube B and Shake.                                                                       |              |
| 3.    | Boil the solution present in test tube B. Add a few drops of soap solution and shake.                                                                     |              |
| 4.    | Take a portion of the solution in test tube C. Add a few drops of soap solution and shake.                                                                |              |
| 5.    | Boil 2nd portion of solution in test tube C. Add a few drops of soap solution and shake.                                                                  |              |
| 6.    | Add $\text{Na}_2\text{CO}_3$ in the remaining solution in test tube C. Shake and filter. Then add a few drops of soap solution in the filtrate and shake. |              |




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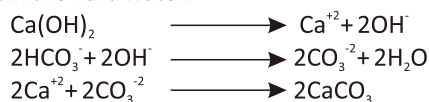


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#### DO YOU KNOW?

In industry, temporary hardness is often removed by adding lime water  $[\text{Ca}(\text{OH})_2]$ . It might seem odd that lime water, which itself contains  $\text{Ca}^{+2}$ , can be added to hard water to remove both  $\text{HCO}_3^-$  and  $\text{Ca}^{+2}$ . The point is that lime water adds 2 moles of  $\text{OH}^-$  per mole of  $\text{Ca}^{+2}$ . Two moles of  $\text{OH}^-$  neutralize 2 moles of  $\text{HCO}_3^-$  and liberate 2 moles of  $\text{CO}_3^{+2}$ , thus precipitating 2 moles of  $\text{Ca}^{+2}$  — one that was added and one that was originally present in the hard water.





1. How calcium and magnesium ions are mixed in ground water and make it hard?  
\_\_\_\_\_  
\_\_\_\_\_
2. Do the terms hard water and heavy water convey the same meaning.  
\_\_\_\_\_  
\_\_\_\_\_
3. Do you expect rain water to be hard water?  
\_\_\_\_\_  
\_\_\_\_\_
4. Collect sample of tap water and show whether it is hard or soft.  
\_\_\_\_\_  
\_\_\_\_\_
5. Predict the effect of hard water on the growth of plants.  
\_\_\_\_\_  
\_\_\_\_\_



#### BRAIN TEASERS

1. Detergents have replaced soap for many cleaning jobs at homes. Why?
2. Regular use of hard water in the boilers reduces their heat conducting property. Why?