Chemistr

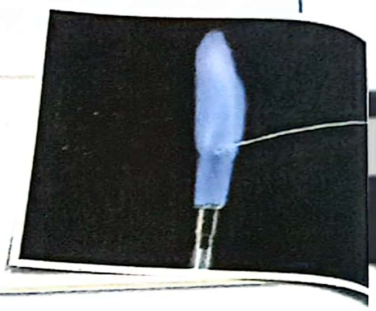
PBA SLOs:

- Standardize the given NaOH solution Volumetrically
- Standardize the given HCl solution Volumetrically
- Determine the exact molarity of the Na_2CO_3 solution Volumetrically
- Determine the exact molarity of Oxalic acid solution Volumetrically
- Identify saturated and unsaturated organic compounds by $KMnO_4$ test
- Demonstrate that sugar decomposes into elements or other compounds
- Demonstrate softening of water by removal of calcium ions from hard water
- Identify sodium, calcium radicals by flame test
- Identify carboxylic acids using sodium carbonate test
- Classify substances as acidic, basic or neutral

Date / /20

EXPERIMENT **24**

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

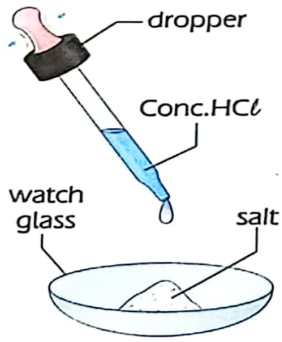


Apparatus: ⊙ Platinum wire ⊙ matches ⊙ spatula ⊙ watch glass ⊙ burner ⊙ glass rod

Chemicals: ▶ salt each of: sodium ▶ strontium ▶ barium ▶ copper ▶ concentrated HCℓ ▶ calcium ▶ potassium ▶ Conc. HNO_3

Procedure

1. Take the platinum or nichrome wire and make a small loop of it.
2. Dip it in concentrated HNO_3 and then heat it in the oxidizing blue flame of the burner till wire imparts no colour the flame.
3. Take a small amount of the salt on a 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 for a minute until the given salt is converted into its chloride.
4. Now take a little of this paste on the loop of the nichrome wire and hold it in the oxidizing flame (blue flame). The wire should be heated at the top of the flame (HCℓ paste is required only if the salt used is not a chloride).
5. Note the characteristic colour of the flame imparted by the metal ion.



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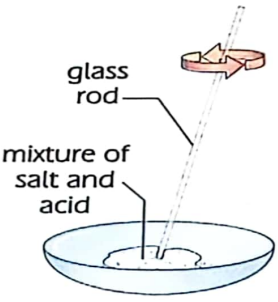

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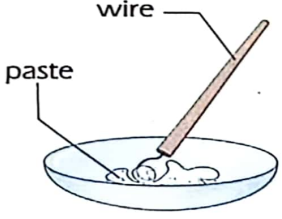

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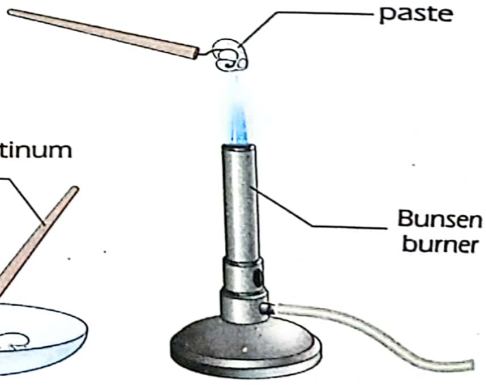


step (4)

6. Now wash the nichrome or platinum wire with concentrated $HC\ell$ and heat it again 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 table.

Do You Know ?

The Dead Sea is the lowest part on Earth, almost 400 m below sea level in the rift valley which runs from East Africa to Syria. Sea water in most oceans of the world contains around 40 g dm^{-3} of dissolved salts (mainly common salt, sodium chloride). In the Dead Sea, the amount of dissolved salts reaches to more than 350g dm^{-3} ($MgC\ell_2$ 140g dm^{-3}, $NaC\ell$ 80 g dm^{-3} $CaC\ell_2$ 40 g dm^{-3}, $KC\ell$ 13 g dm^{-3} $MgBr_2$ 6 g dm^{-3}, etc).

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 give colour to the flame.

The alkali and alkaline earth metals have loosely bound valence electrons which become excited at the temperature of the Bunsen flame. In the flame, the volatile salts evaporate and dissociate into ions. Consequently the electrons which are in great number 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. For example 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.

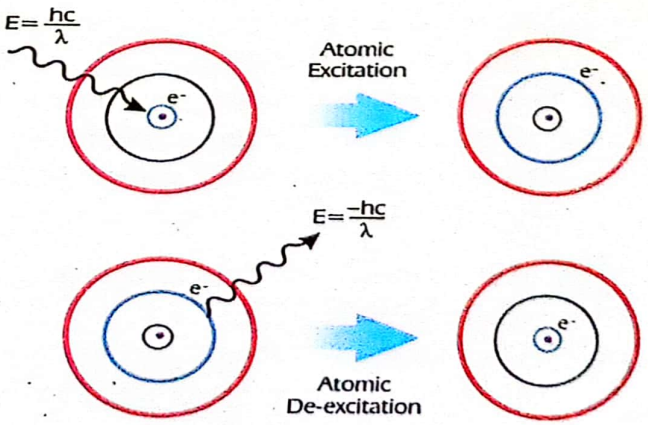
Metal Chlorides are usually preferred for performing flame test because these are more volatile than the other salts and hence easily impart a characteristic colour to the flame.

We can get spectrum of elements when they are enclosed in the form of a gas in the discharge tube. When the atoms in the gaseous state are supplied with energy then 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 region they can be seen as colours in the form of spectrum.

In the flame test few drops of conc. Hydrochloric acid are dropped on the salt which converts them into chlorides. Chlorides are more volatile and easily impart characteristics colour to the Bunsen flame. By noting the colour of the flame, we can identify the metal ion.

We use only Conc $HC\ell$ in the flame test because chlorides are easily converted into vapours than any other types of salt.



Observations

S. No.	Colour of flame through naked eye	Inference
1.	Blusih green	Cu^{+2}
2.	Brick red	Ca^{+2}
3.	Crimson red	Sr^{+2}
4.	Grassy green	Ba^{+2}
5.	Persistent golden yellow	Na^{+1}
6.	Violet	K^{+1}

Result

The chlorides of different metals impart different flame colour to the flame of Bunsen burner.

Precautions

1. Always add few drops of Conc. HCℓ on the salt to make a paste.
2. Never touch the paste with your finger otherwise acid will harm your skin.
3. Platinum wire must be clean and free from any impurity.
4. Before using the platinum wire for another salt, dip it many times in Conc HCℓ and heat it again in the oxidizing flame till it imparts no colour to the flame.
5. Concentrated HCℓ is highly volatile and its vapours are corrosive. It attacks the eyes and respiratory system. Therefore the process of moistening must be done quickly and carefully.

Viva Voce 24 — Q&A — Short Questions and Answers

Answer the following Questions.

Q.1. **What is the reason of different colours you observe in the sky usually at the time of sunset?**

Ans. At sunrise and sunset, the sun is closer to horizon, the sunlight passes through more air and the particles in the air before reaching our eyes, scatter the shorter waves that appear blue and the longer ones appear red, orange and yellow.

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

Ans. They are very efficient and provide high intensity light suitable for illuminating large open areas e.g. streets.

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

Ans. The presence of certain elements in distant stars is confirmed by absorption spectrum.

Q.4. **Why do different atoms emit different colours of light?**

Ans. When the element is subjected to flame, the electrons are excited to high energy state and when they come back down to stable state, energy is released in the form of light. The colour emitted depends on the amount of energy released which is the characteristics of the element. The different colours of light emitted are caused by different quantities of electrons losing energy in different elements.

Q.5. **Why do you think the salts have to be heated in the flame before the coloured light is emitted?**

Ans. The loosely bound valence electrons become excited to higher energy level, after sometime they come back to ground state by emitting energy in the form of visible light. The colour of the emitted light is the characteristics of the element. If we do not heat them, they will not go to higher energy state and hence no coloured flame will be produced.

Q.6. **Colourful light emission are applicable to every day life where else you have observed these emissions? Are these emissions application related? Explain.**

Ans. In flame test neon signs, sodium vapoulamp and in fireworks colourful light emissions are observed. These colurful light emission are the characteristics of the elements present in fireworks. Yes, these emission are applications related.

Q.7. **Why certain metals do not impart colour to flame?**

Ans. Certain metals do not give colour to the flame because they do not impart characteristic wave lengths to the flame in other words their valence electrons are tightly bounded.

Q.8. **How do you think FIRE WORKS are made? Where do the following colours come from?**

Blue _____ **Green** _____

Purple _____ **Red** _____

Golden _____ **White** _____

Ans. Various components of fire works used in its making are black powder which consists of carbon black, sugar or starch, metals like iron, Al, Mg, Sr, Zn oxidizing agents like potassium nitrate, potassium per chlorate and sulphur powder,

Blue: copper — Green: Barium

Purple: strontium + copper — Red: Lithium carbonate or Li powder. or Strontuim

Golden: charcoal — White: Aluminium or magnesium

Q.9. What are the damaging effects of vaporus of conc. HCℓ?

Ans. Conc. HCℓ vapours are corrosive and attacks eyes and respiratory systems.

Q.10. When does a substance appear black?

Ans. When the whole of the incident light is absorbed.

Q.11. When does a substance appear white?

Ans. When all the incident light is reflected, the substance appears white.

Q.12. When does a substance appears colourless?

Ans. When whole of the incident light is transmitted through a substance then the substance appears colourless.

Q.13. When does a certain object appear coloured, say red?

Ans. An object appears coloured if it reflects say red colour only and absorb all other colours. Thus a substance appears coloured if it absorbs all colour except the one which is reflected.

Q.14. What is the use of nichrome wire and of which metals it is made of?

Ans. Nichrome wire is used in flame test and is an alloy of nickel and chromium metals.

Q.15. Name the acid used in the flame test?

Ans. Conc. Hydrochloric acid.

Q.16. Why the platinum wire must be cleaned before performing flame test?

Ans. Because a properly cleaned platinum wire will have no impurity, so it will not impart any colour to the flame.

Q.17. Can we use copper wire in the flame test?

Ans. No, Because copper wire imparts bluish green colour to the flame which will interfere with the flame of other salts.

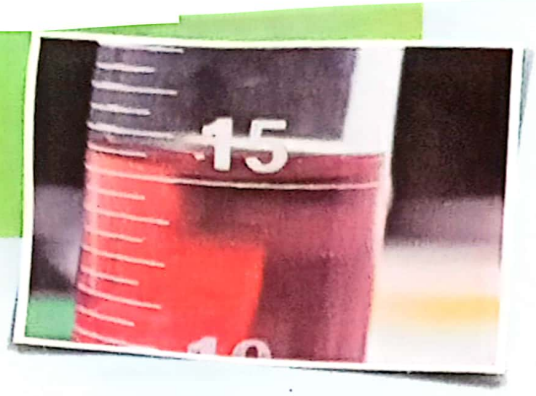
Q.18. Why do we use Conc HCℓ in the flame test?

Ans. Because it converts metallic salts to chlorides, chlorides being volatile impart the characteristic colour of the metal to the flame.

Q.19. What is the purpose of using blue glass in the flame test?

Ans. Blue glass absorbs a part of light. Therefore blue glass produces a characteristic change in the colour of the flame of basic radicals having similar flame. For example, Ca and Sr have brick red and crimson colour and they appear green and purple through blue glass respectively.

Introduction to Volumetric Analysis



1. **Volumetric analysis**
   Volumetric analysis is used to find the concentration of solution by means of titration.
2. **Acid-Base titration**
   It is the process of determining exact volume of one solution (say acid) which reacts completely with a definite volume of another solution (say base).
3. **Titration**
   The process of finding the volume practically of a solution which completely reacts with a definite volume of an other solution is called titration. With the help of this technique we can find the purity of the products in industry or which are available in the market.
4. **Titrant**
   The solution which is taken in the burette in titration is called titrant.
5. **Titrand or Titrate**
   The solution which is taken in conical flask in titration is called titrand or titrate.
6. **Rinsing**
   The washing of the apparatus for wetting its inner surface with the given solution is called rinsing.
7. **Indicator**
   It is the substance which indicates the completion of a chemical reaction by the appearance or disappearance of a colour:

Colour change and pH range of certain indicators

Indicator	pH range/colour change interval	Colour in acidic solution	Colour in 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

In acid base titration, a large number of indicators are available which undergo a change in colour according to the pH of the solution (colour change interval). The main characteristic of these indicators is that the change in colour is not sudden but takes place within a small interval of pH known as the colour change

interval. For an acid base titrations we can, select an indicator which shows a distinct colour change at a pH close to that which is obtained at the end point.

8. End Point

The moment at which the indicator changes colour is called end point.

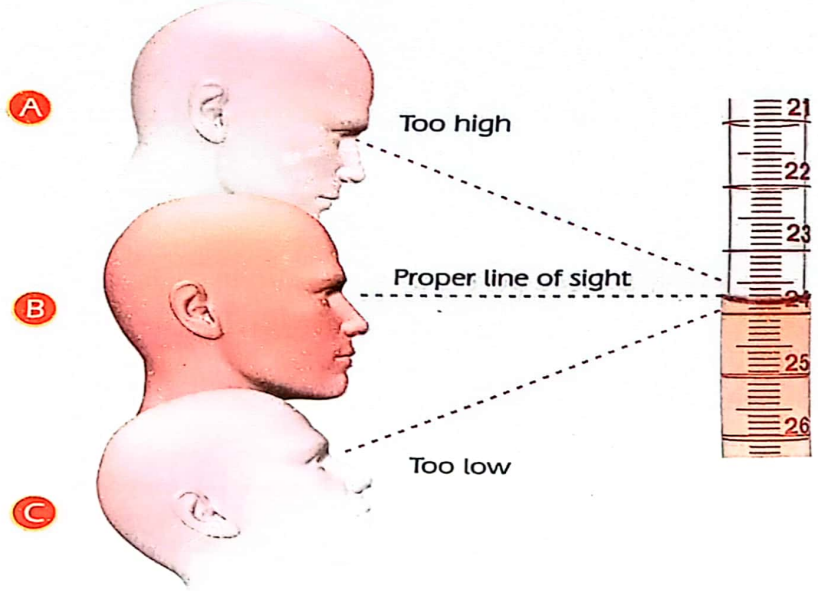
9. Meniscus

The curved surface of a liquid in a narrow test tube (burette or pipette) in called meniscus

Note the lower level of meniscus for transparent (colourless) liquids and the straight level for coloured liquids. Avoid parallex error by nothing down the reading at eye level.

10. Anti parallex 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 parallex card/paper.



11. Concentrated Solution

A solution which contains a large amount of solute in it is called a concentrated solution.

Example

A solution which contains 40 g of sodium hydroxide per litre of its solution is more concentrated than a solution which contains 10 g of sodium hydroxide per litre of its solution.

12. Standard Solution

A solution whose concentration or molarity is known.

13. Mole

Molecular weight of a substance expressed in grams is called a mole e.g.

1 mole of NaOH = molecular weight of NaOH = 23 + 16 + 1 = 40 grams.

Similarly

1 mole of Na_2CO_3 = molecular weight of Na_2CO_3 = $2 \times 23 + 12 + 3 \times 16$ = 106 grams.

14. Molar Solution

A solution which contains 1 gram mole of a solute per litre of its solution is called a molar solution. A molar solution is represented by M.

Example

1 molar solution of NaCℓ is prepared by dissolving 58.5 g (1 mole of NaCℓ) in water and is called a molar solution.

15. Molarity

Moles of solute per litre of a solution is called molarity. It is also represented by M.

$$\text{Molarity (M)} = \frac{\text{No. of moles of solute}}{\text{Litres of solution}}$$

OR

$$\text{Molarity (M)} = \frac{\text{Concentration (g/litre)}}{\text{Formula mass (g/mole)}}$$

Example

Find the molarity of sodium hydroxide solution which contains 2.0 g per litre in it.

Formula mass of NaOH = 23 + 16 + 1 = 40

$$\therefore \text{ Molarity} = \frac{\text{Concentration (g/litre)}}{\text{Formula mass (g/mole)}}$$

$$= \frac{2.0}{40} = \frac{1}{20} = 0.05 \text{ M}$$

16. Molarity Equation

$$\frac{\text{Acid}}{\frac{M_1V_1}{n_1}} = \frac{\text{Base}}{\frac{M_2V_2}{n_2}}$$

Where

M_1 = molarity of acid

V_1 = Volume of acid used

n_1 = No. of moles of acid reacted according to balanced chemical equation.

M_2 = Molarity of base

V_2 = Volume of base taken for each titration.

N_2 = No. of moles of base reacted according to balanced chemical equation.

17. Apparatus used in a volumetric experiment

Burette, burette stand, two beakers, pipette, white tile, glass funnel, glass rod, titration flask.

i. Burette

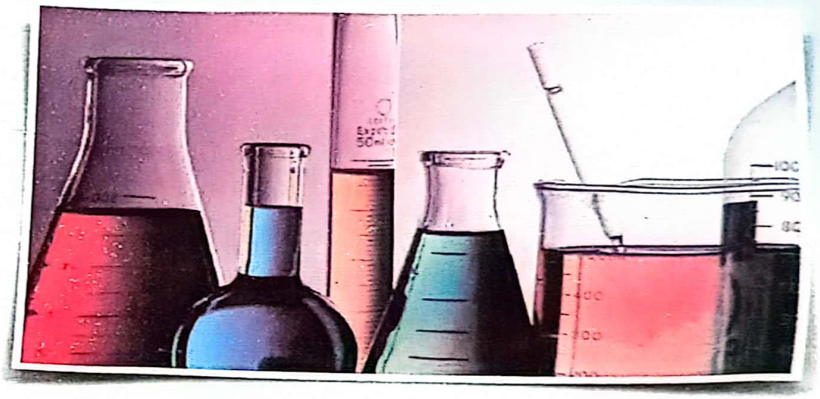
It is a long graduated tube which has generally the capacity of 50.0 cm^3. It is graduated to read 0.1 cm^3 of a liquid.

ii. Pipette

It is a glass tube having a bulb in its middle and its lower end is in the form of a jet. Pipettes are of different capacity but generally 10 cm^3 is used.

iii. Titration flask

It is also called conical flask and has a flat bottom. Its usual capacity is 250 cm^3.



Precautions

1. The acid should always be taken in the burette and the burette should be filled with the help of a glass funnel which should be removed before taking the readings.
2. The burette must be held vertically and eye should be in level with the surface of the solution. The solution will form a half moon shape called meniscus which shows a double line. Lower surface of meniscus (for colourless liquids) should be recorded.
3. Use phenolphthalein for titrating a strong acid against a strong base.
4. Only one or two drops of the indicator should be used.
5. Always pour acid from the burette drop wise and shake the flask constantly.
6. Take three concordant readings.

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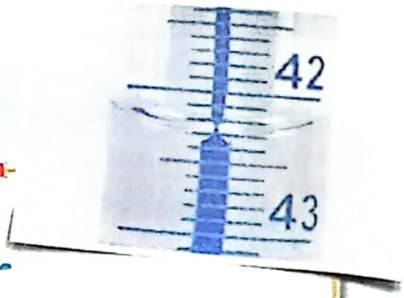
EXPERIMENT 25

Standardize the given NaOH solution volumetrically.



Apparatus: ⊙ pipette ⊙ burette ⊙ conical flask ⊙ funnel ⊙ beakers ⊙ iron stand

Chemicals: ▶ standard solution of 0.1 M $HC\ell$ ▶ solution of NaOH ▶ phenolphthlein ▶ distilled water

Chemical equation

$$NaOH + HC\ell \longrightarrow NaCl + H_2O$$

$n_1 = 1$ mole $n_2 = 1$ mole

Molar ratio

$HC\ell$	:	NaOH
1	:	1

Standard solution

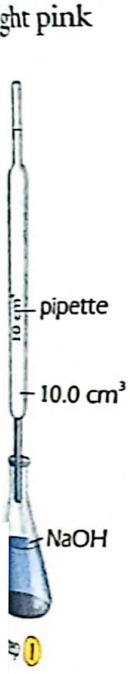
0.1M hydrochloric acid

Indicator

Phenolphthalein

End point

Light pink



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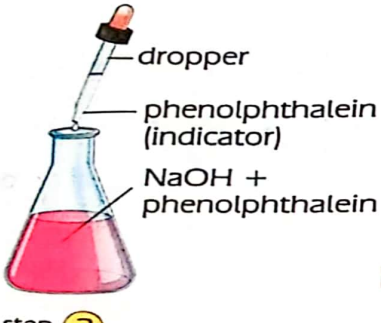
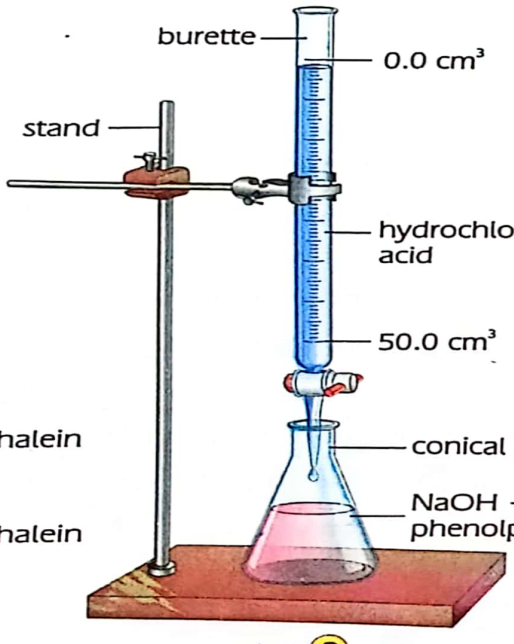
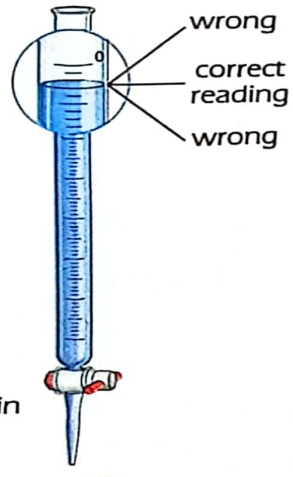


step (2)



step (3)
Neutralization takes place



step (4)
How to take burette reading

Procedure

1. Rinse the pippet with distilled water and then with the given NaOH solution.
2. Now rinse the conical flask with distilled water only.
3. Pipette out 10 cm^3 of NaOH solution into a conical flask and then add one to two drops of phenolphthalein indicator into it. The solution will turn pink.
4. Rinse the burette first with distilled water and then with the given $HC\ell$ solution.
5. Fix the burette on a clamp stand in an upright position.
6. Fill it with the given $HC\ell$ solution with the help of a funnel and remove the funnel from the burette.
7. Put the beaker at the base of the burette and allow the acid to flow into a beaker in order to remove any air bubble present in the nozzle.
8. Now note the burette readings as an initial reading by the help of an anti parallax card or a white paper.
9. Carry out a rough titration by adding hydrochloric acid solution from the burette in approximately 1 cm^3 portion to the conical flask.
10. Swirl the contents of the flask after each addition of acid for thorough mixing.
11. Keep on adding acid till the colour of solution becomes light pink then check whether this pink colour disappears by adding one more drop of acid.
12. This is the end point of the reaction. Now note down this burette reading. It is the final reading.
13. The difference of final and initial readings of burette gives the volume of the acid used.
14. 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^3 of the end point and then add drop by drop till the end point is reached.
15. Take three concordant readings which agree with one another within 0.1 cm^3. Record your observation in the table given below.

Precautions

1. Before using conical flask and burette, these must be washed with distilled water.
2. During titration, place the conical flask on a white tile or white paper under the burette to see the colour change of the indicator clearly.
3. Make sure that the burette does not leak.
4. Always take acid in the burette.
5. Fill the acid in the burette by the help of glass funnel which must be removed before taking readings.
6. Fill in the burette upto zero mark.
7. Always keep the burette in vertical position.
8. Take lower meniscus for reading.
9. Use two drops of phenolphthalein indicator for each titration.
10. Pour acid from the burette dropwise and shake the flask constantly.
11. Always take three concordant readings.

Observations

1. Volume of NaOH taken for each titraiton = 10.0 cm^3
2. Molairty of hydrochloric acid = 0.1M
3. Volume of acid used = ?

No. of obs.	Initial Reading	Final Reading	Volume of acid used in cm^3
1.	0.00 cm^3	10.0 cm^3	10.0 cm^3
2.	10.0 cm^3	20.0 cm^3	10.0 cm^3
3.	20.0 cm^3	30.0 cm^3	10.0 cm^3

Mean volume of hydrochloric acid used = 10.0 cm^3

Calculations

Calculations for finding the molarity of NaOH

Molarity equation

Acid Base

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

M_1 molarity of acid solution = 0.1M

V_1 volume of the acid solution = 10.0 cm^3

n_1 no. of moles of the acid in the balanced chemical equation = 1 mole

M_2 molarity of base solution = ?

V_2 volume of the base solution used = 10.0 cm^3

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

putting the values in the molarity equation

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

$$\therefore \frac{0.1 \times 10}{1} = \frac{M_2 \times 10}{1}$$

$$\therefore M_2 = \frac{0.1 \times 10 \times 1}{1 \times 10}$$

$$\therefore M_2 = 0.1M$$

$\therefore$ Molarity of NaOH = 0.1M

Learn about it

Standardization of NaOH solution involves the determination of its exact concentration with the help of standard solution of HCl. The process helps us to find the purity of NaOH avaiable in the market.

Result The molarity of the given NaOH is 0.1M.

Viva Voce 25 Q&A Short Questions and Answers

Answer the following Questions.

Q.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.**

Ans. Phenolphthalein will be colourless in test tube containing acid. Phenolphthalein will turn pink or red in alkaline solution.

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

Ans. Greenish blue.

Q.3. **Which volumn of 0.25 mole dm^{-3} HCℓ solution neutralizes 25 cm^3 of 0.1 mole dm^{-3} NaOH solution?**

Ans. Molarity equation

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

putting the values

$$\frac{0.25 \times V_1}{1} = \frac{0.1 \times 25}{1}$$

$$\therefore \quad V_1 = \frac{0.1 \times 25 \times 1}{1 \times 0.25}$$

$$= 10.0 \text{ cm}^3$$

Chemical Equation

$HC\ell + NaOH \longrightarrow NaC\ell + H_2O$

$n_1 = 1$ mol $\quad n_2 = 1$ mol

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

Ans. Because distilled water does not contain any impurity in it which can react with these (NaOH, Na_2CO_3, oxalic acid solution) substances and hence molarity will not change.

Q.5. **What is a good indicator for the titration of a weak acid with a strong base?**

Ans. Phenolphthalein indicator.

Q.6. **Calculate the mass of NaOH in one dm^3 of 0.1 molar solution.**

Ans. Molar mass of NaOH = 23 + 16 + 1 = 40 amu.
40 g of NaOH in 1 dm^3 has molarity = 1 Molar
∴ 1 Molar solution of NaOH has = 40
0.1 molar solution of NaOH = 40 × 0.1
= 4 g/dm^3

Q.7. **Why is a rough titration carried out?**

Ans. To find approximate end point. This information enables the subsequent titrations to be carried out more quickly.

Q.8. **What is a standard solution?**

Ans. A solution whose molarity or concentration is known.

Q.9. **How is phenolphthalein solution prepared?**

Ans. It is prepared by adding one gram of indicator in 500 cm^3 of 50% ethyl alcohol.

Q.10. **How many drops of indicator are used in each titration?**

Ans. One or two drops of indicator in 10 cm^3 of the solution are used for each titration.

Q.11. **What is the colour change of phenolphthalein in acid base titration and why the colour fades after sometime?**

Ans. 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 action of atmospheric carbon dioxide which slowly dissolves in the solution.

Q.12. **What is neutralization?**

Ans. The process in which, an acid reacts with a base to form salt and water is called neutralization.

Q.13. **Some stings are basic e.g. nettle stings and wasp stings. They contain a basic substance histamine. How will you treat a person bitten by a wasp?**

Ans. On the sting place acid will be applied to neutralize the base present in the sting.

Q.14. **What will you do if the soil of an area is too much acidic?**

Ans. We will add powdered lime stone (calcium carbonate) or slaked lime in the soil to raise its pH to the right value.

Q.15. **Name two strong acids.**

Ans. Sulphuric acid, nitric acid.

Q.16. **Define primary standard.**

Ans. A substance which is 100% pure or of a known purity. Other substances may be compared with it.

Q.17. **What is meant by concordant readings?**

Ans. Readings which do not differ by more than 0.1 cm^3.

Q.18. **What is the volume of the burette?**

Ans. It is 50.0 cm^3.

Q.19. **Define indicator.**

Ans. A substance usually organic in nature which is used to tell about the end point of a chemical reaction by sudden change in colour is called indicator.

Q.20. **What is the colour of phenolphthalein in acid medium?**

Ans. Just colourless.

Q.21. **Name a salt which we almost use everyday in our diet.**

Ans. Sodium chloride.

Q.22. **Can we take upper meniscus for colourless liquids?**

Ans. No.

Q.23. **We usually take some antacid (anti–acids) to ease our stomach ache. What do you mean by antacid?**

Ans. If there is excess of acid in our stomach due to food or other reason, then we use substances to neutralize the excess of acid. These substances are called antacids or antiacids e.g. milk of magnesia.

Q.24. **Why NaOH or KOH are not primary standard?**

Ans. Because they absorb CO_2 and moisture or water from air during weighing.

Date 20

EXPERIMENT 26

Standardize the given HCℓ solution volumetrically.

Apparatus: ⊙ beaker ⊙ funnel ⊙ pipette ⊙ conical flask ⊙ burette

Chemicals: ▶ 0.1M sodium hydroxide ▶ solution of HCℓ ▶ phenolphthlein

Chemical equation

$$HC\ell + NaOH \longrightarrow NaC\ell + H_2O$$

$n_1 = 1$ mole $n_2 = 1$ mole

Molar ratio

HCℓ : NaOH

1 : 1

Standard solution

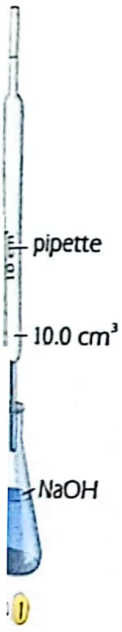
0.1M hydrochloric acid

Indicator

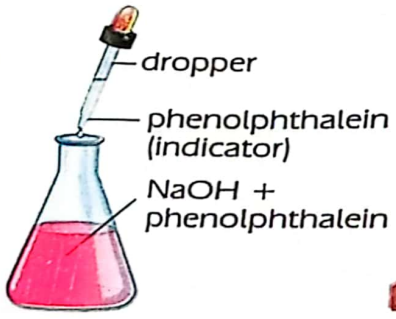
Phenolphthalein

End point

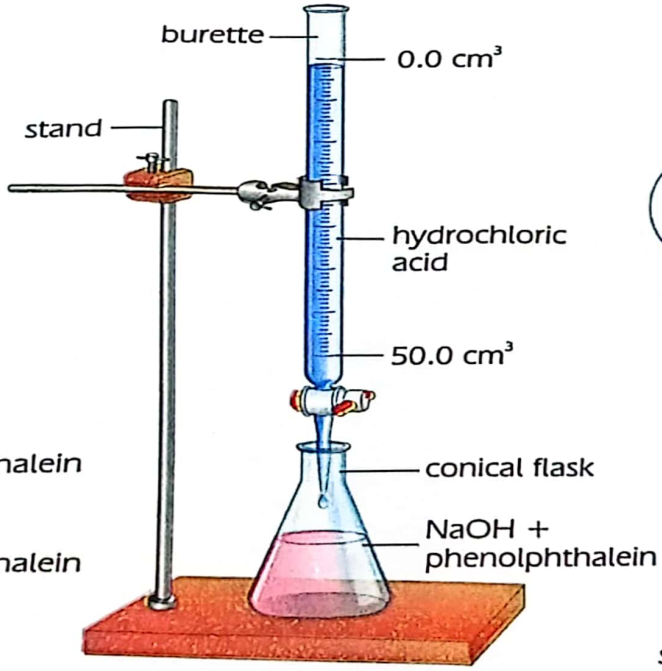
Light pink



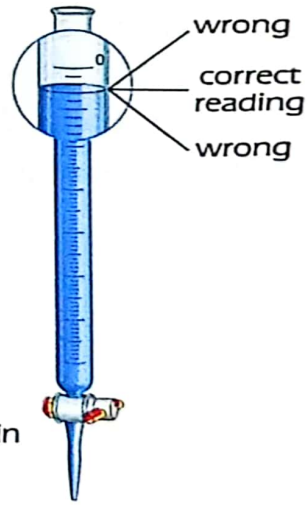
step (1)



step (2)



step (3)
Neutralization takes place



step (4)
How to take burette reading

Procedure

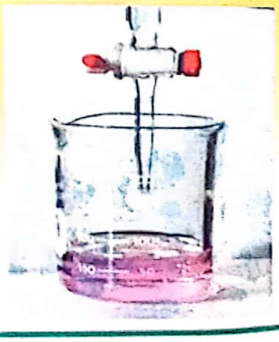
1. Clamp a clean burette stand vertically and fill it with hydrochloric acid up to zero mark using a glass funnel. Remove any air bubble present in the nozzle of the burette.
2. Take 10.0 cm^3 of 0.1M NaOH solution by the help of pipette in a conical flask.
3. Then add two drops of phenolphthalein in it as an indicator, sodium hydroxide solution turns pink.
4. Note the initial reading of the acid in the burette (slip a piece of white paper behind the graduation of the burette). This will help you to note correct reading.
5. Run down the acid drop by drop in NaOH solution by pressing the pinch cork.
6. Carry out a rough titration by adding hydrochloric acid from the burette in approximately 1 cm^3 portion to the conical flask.
7. Swirl the content of the flask after each addition of the acid for thorough mixing.
8. Keep on adding acid till the colour of the solution becomes light pink. Now check whether pink colour disappears by adding one more drop of acid.
9. This is the end point of the reaction. Note down this reading. This is the final reading.
10. The difference between final and intial reading will be the volume of acid used to neutralize 10.0 cm^3 of NaOH.
11. Repeat the same experiment to get the three concordant readings.

Precautions

1. While sucking the solution, be careful that the solution does not reach the mouth.
2. The apparatus must be washed and rinsed before starting the experiment.
3. Always take acid in the burette.
4. Fill the burette up to zero mark.
5. Keep the burette in vertical position.
6. Use two drops of phenolphthalein indicator for each titration.
7. Always take lower meniscus for reading.
8. Pour acid from the burette drop less wise and shake the flask continuously.
9. Always take three concordant readings.

Learn about it

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. Hydrochloric acid is also present in our stomach.



Observations and Calculations

1. Volume of NaOH taken for each titration = 10.0 cm^3
2. Molarity of NaOH = 0.1M
3. Molarity of $HC\ell$ = ?
4. Volume of $HC\ell$ used = ?

No. of observations	Initial Reading	Final Reading	Volume of acid used in cm^3
1.	0.00 cm^3	10.0 cm^3	10.0 cm^3
2.	10.0 cm^3	20.0 cm^3	10.0 cm^3
3.	20.0 cm^3	30.0 cm^3	10.0 cm^3

Mean Volume of hydrochloric acid used = 10.0 cm^3

Calculations

$$\frac{\text{Acid}}{M_1 \times V_1} = \frac{\text{Base}}{M_2 \times V_2}$$
$$n_1 \qquad\qquad n_2$$

Where

M_1 = Molarity of $HC\ell$ = ?

V_1 = Volume of $HC\ell$ used = 10.0 cm^3

n_1 = number of moles of $HC\ell$ = 1

M_2 = Molarity of NaOH = 0.1M

V_2 = Volume of NaOH used = 10.0 cm^3

n_2 = Number of moles of NaOH = 1

Putting these values in the molarity equation, we get

$$\frac{M_1 \times 10}{1} = \frac{0.1 \times 10}{1}$$

$$\therefore \quad M_1 \times 10 \times 1 = 0.1 \times 10 \times 1$$

$$\therefore \quad M_1 = \frac{0.1 \times 10}{10}$$

$$\mathbf{M_1 = 0.1M}$$

Result

The molarity of given hydrochloric acid is 0.1M.

Viva Voce 26 — Q&A — Short Questions and Answers

Answer the following Questions.

Q.1. **Standardize the given vinegar solution (acetic acid) using standard NaOH solution.**

Ans. Take vinegar solution in the burette up to zero mark and titrate it against 0.1M, 10 cm^3 of NaOH using two drops of phenolphthalein as an indicator. Drop acid in it dropwise till end point light pink in colour is obtained. Note down the reading. Take three concordant readings. Find the volume of acid used and calculate molarity of vinegar from molarity equation

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

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

Ans. Take 25ml of freshly squeezed lemon juice, add 75ml of water in conical flask, add 2 drops of phenolphthalene indicator and titrate with 0.01M NaOH using the following chemical equation (end point is light pink in colour):

$$\underset{\text{citric acid}}{C_6H_8O_{7(aq)}} + 3NaOH_{(aq)} \longrightarrow \underset{\text{sodium citrate}}{Na_3C_6H_5O_{7(aq)}} + 3H_2O_{(\ell)}$$

Molarity equation:

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

Q.3. **A1:1 mixture of HCℓ and NaOH does not cause any poisonous symptoms if ingested, Explain why?**

Ans. This mixture is neutral due to formation of a normal salt (sodium chloride) which is not poisonous.

Q.4. **Why is phenolphthalein and no other indicator used in titration involving a strong acid and a strong base?**

Ans. Phenolphthalein has a more distinct colour change than other indicators because a colour change suddenly appears with change in pH with it.

Q.5. **Why does the change in colour of NaOH solution in the flask take place on adding HCℓ in it?**

Ans. Neutralization of base will occur with acid forming salt (NaCℓ) and water. Consequently pH of solution falls rapidly toward acidic side resulting in a change in colour.

Q.6. **What does strength of solution means?**

Ans. It is the amount of a substance (solute) contained in one dm^3 of the solution.

Q.7. **What is the name of the reaction between an acid and a base?**

Ans. The reaction between an acid and a base is called neutralization reaction.

Q.8. **Give the net ionic equation for the reaction between an acid and a base.**

Ans. $\underset{\text{Acid}}{H^+A^-_{(aq)}} + \underset{\text{Base}}{M^+OH^-_{(aq)}} \longrightarrow \underset{\text{Salt}}{M^+A^-_{(aq)}} + \underset{\text{Water}}{H_2O_{(\ell)}}$ OR

$H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}$

It is a general equation for reaction between acid and a base. For example in case of hydrochloric acid and sodium hydroxide, it is

$H^+Cl^-_{(aq)} + Na^+OH^-_{(aq)} \longrightarrow Na^+Cl^-_{(aq)} + H_2O_{(l)}$

Q.9. What are the harmful effect of ingesting concentrated HCl solution?

Ans. Concentrated HCl solution is highly corrosive and poisonous. If it is ingested, it corrodes mucous membranes, oesophagus and stomach causing dysphagia, nausea, circulatory failure and sometimes death may occur.

Q.10. What are the harmful effects of ingesting NaOH solution.

Ans. NaOH if ingested causes vomiting, prostration and collapse.

Q.11. Do you think that sodium hydroxide can be used in drain cleaners.

Ans. Yes. NaOH being caustic, strongly alkaline compound, can be used in drain cleaners.

Q.12. What is neutralization?

Ans. The process in which, an acid reacts with a base to form salt and water is called neutralization.

Q.13. What is the volume of the burette?

Ans. It is 50.0 cm^3

Q.14. Can we take upper meniscus for colourless liquids?

Ans. No.

Q.15. Define indicator?

Ans. A substance usually organic in nature which is used to tell about the end point of a chemical reaction by sudden change in colour is called indicator.

Q.16. What will you do if the soil of an area in too much acidic?

Ans. We will add powdered lime stone (calcium carbonate) or slaked lime in the soil to raise its pH to the right value.

Date
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EXPERIMENT
27

Determine the exact molarity of the Na_2CO_3 solution volumetrically.

Apparatus: ⊙ pipette ⊙ burette ⊙ beaker ⊙ funnel ⊙ conical flask

Chemicals: ▶ standard solution of 0.1M $HC\ell$ ▶ solution of Na_2CO_3 ▶ methyl orange

Chemical equation

$$Na_2CO_3 + 2HC\ell \longrightarrow 2NaC\ell + H_2O + CO_2$$

n_1 = mole n_2 = 2 mole

Molar ratio

Na_2CO_3	:	$HC\ell$
1		2

Standard solution

0.1M $HC\ell$

Indicator

Methyl orange

Procedure

1. Rinse the burette with $HC\ell$ 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. Now fill the burette with hydrochloric acid solution and remove the funnel.
4. Using the tap at the base of the burette, allow the acid to flow freely into a beaker in order to remove any air bubble present in the nozzle and note down the initial reading.
5. Now rinse the pipette with some distilled water and then with sodium carbonate solution. Similarly rinse the conical flask with distilled water only.
6. Take 10.0 cm_3 of Na_2CO_3 solution by the help of pipette from the beaker and transfer it into a clean conical flask.
7. Add two drops of methyl orange as an indicator. The colour of the solution changes to yellow. Use white tile underneath the conical flask to note the vivid colour of solution.
8. Carry out a rough titration by adding hydrochloric acid solution from the burette in approximately 1 cm^3 portions to the conical flask and swirl the flask

continuously tell the colour of the solution in the conical flask just changes to red.

9. Note down the final reading.
10. Repeat the titration to get accurate reading. For this purpose add $HC\ell$ solution form burette rapidly within 2 cm^3 of the end point and then drop by drop till the end point is reached.
11. The difference between initial and final reading in each titration gives the volume of acid used to neutralize 10.0 cm^3 of Na_2CO_3.
12. Repeat the experiment to get three concordant readings which should agree with one another with in 0.1 cm^3

Observations and Calculations

1. Volume of Na_2CO_3 used = 10.0 cm^3
2. Molarity of Na_2CO_3 = ?
3. Molarity of $HC\ell$ = 0.1M
4. Volume of $HC\ell$ used = ?

No. of observations.	Initial Reading	Final Reading	Volume of acid used cm^3
1.	0.0 cm^3	10.0 cm^3	10.0 cm^3
2.	10.0 cm^3	20.0 cm^3	10.0 cm^3
3.	20.0 cm^3	30.0 cm^3	10.0 cm^3

Precautions

1. There should be no air bubbles in the nozzle of the burette.
2. Hold a piece of white card behind the burette in order to see the level of liquid more clearly.
3. During the titration, any solution adhering to the sides of the conical flask must be washed down with distilled water.
4. Always take acid in the burette.
5. Fill the burette up to zero mark.
6. Keep the burette in vertical position.
7. Use two drops of methyl orange as an indicator for each titration.
8. Always take lower meniscus for reading.
9. Always take three concordant readings.

odium carbonate is known as washing soda ith chemical formula ($Na_2CO_3.10H_2O$) while oda ash (Na_2CO_3) is called anhydrous sodium rbonate. The aqueous solution of sodium rbonate is alkaline in nature due to hydrous. In ter sodium carbonate dissociates into sodium s and carbonate ions. The carbonate ions ct with water in a reaction called hydrolysis to lease hydroxide ions. Released hydroxide ions, g a strong alkali, makes the solution alkaline.

$$Na_2CO_{3(aq)} \longrightarrow 2Na^+_{(aq)} + CO_3^{2-}{}_{(aq)}$$

$$CO_3^{2-}{}_{(aq)} H_2O_{(l)} \longrightarrow HCO_3^{1-}{}_{(aq)} + OH^{1-}{}_{(aq)}$$

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. Since in this strong acid – weak base titration, the end point lies in the acidic medium, therefore, methyl orange is used as an indicator because it changes from orange–yellow (at pH 4.4) to red (at pH 3.1).

The determination of molarity of Na_2CO_3 is an acid – base titration. By this titration we can also find the amount of impurity present in the samples of washing soda and soda ash.

Calculations

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

Where

1. No. of moles of Na_2CO_3 reacting = $n_1 = 1$ mole
2. No. of moles of $HC\ell$ reacting = n_2 = 2 moles
3. Volume of Na_2CO_3 solution = V_1 = 10.0 cm^3 taken for each titration.
4. Molarity of Na_2CO_3 solution = $M_1 = ?$
5. Molarity of $HC\ell$ solution = $M_2 = 0.1$
6. Molarity of $HC\ell$ solution = $V_2 = 1.0\ cm^3$

Putting these values in molarity equation, we get

$$\frac{M_1 \times 10}{1} = \frac{0.1 \times 10}{1}$$

$$\therefore M_1 \times 2 \times 10 = 0.1 \times 10 \times 1$$

$$\therefore M_1 = \frac{0.1 \times 10 \times 1}{2 \times 10}$$

$$\mathbf{M_1 = 0.05M}$$

Result

The molarity of the given Na_2CO_3 solution is 0.05M.

Viva Voce 27 — Q&A — Short Questions and Answers

Answer the following Questions.

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

Ans. Titrate the given solution of sodium carbonate with a standard solution of oxalic acid using methyl orange indicator and calculate its molarity using molarity equation.

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

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

Ans. Weak acids : Acetic acid,
Weak bases : Ammonium hydroxide, calcium hydroxide

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

Ans. Phenol[illegible] it is in alkaline medium. It is red if pH is 9 or above.

Q.4. **What are the uses of sodium carbonate in industry?**

Ans. Sodium carbonate is used as a cleaning agent for domestic use. In industry it is used for the manufacture of caustic soda, borax, glass and soaps etc..

Q.5. **Which important compounds are present in the ashes of plants?**

Ans. When plants are dried and burned, the sodium and potassium they contain are left behind in the form of ashes which are rich in sodium carbonate potassium carbonate.

Q.6. **Why is a conical flask, rather than a beaker, used in the experiment?**

Ans. Because by using a beaker, some of the substance will splash out affecting our measurement.

Q.7. **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?**

Ans.
a. To remove any water sticking to the inner walls of the burette.
b. In order to measure the correct level of the meniscus in the burette.
c. Presence of air bubbles in nozzle will result in inaccurate volume reading.

Q.8. **The following procedure were carried out during the titration:**
a. The sides of the conical flask were washed down with distilled water.
b. The conical flask was frequently swirled or shaken.
Give one reason for carrying out each of these procedures.

Ans.
a. To wash out any chemical sticking with the wall of the burette which may change the volume of acid used in titration.
b. This is done to mix titrand and titrate completely for completion of the reaction.

Q.9. **Why is more than one accurate titration carried out?**

Ans. In order to minimise error by getting accurate reading within 0.1 cm^3 of each other.

Q.10. **Which indicator is used for titrating metal carbonates with strong acid?**

Ans. Methyl orange.

Q.11. **What is the colour of methyl orange in basic medium?**

Ans. Yellow.

Q.12. **What is the colour of methyl orange in acidic medium?**

Ans. Pink or red.

Q.13. **What is the chemical formula of washing soda?**

Ans. $Na_2CO_3.10H_2O$

Date
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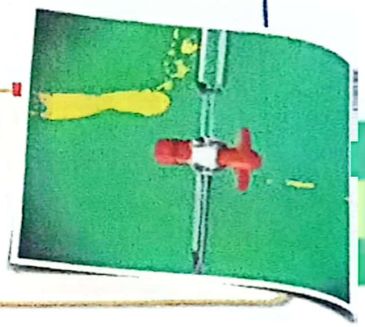
EXPERIMENT 28

Determine the exact molarity of a solution of oxalic acid volumetrically.



Apparatus: ⊙ pipette ⊙ burette ⊙ funnel ⊙ beaker ⊙ measuring flask 100 cm^3 ⊙ watch glass ⊙ top loading balance ⊙ spatula

Chemicals: ▶ standard solution of NaOH (0.1M) ▶ oxalic acid ▶ phenolphthalein

Chemical equation

$$\begin{matrix}COOH \\ | \\ COOH\end{matrix} .2H_2O + 2NaOH \longrightarrow \begin{matrix}COONa \\ | \\ COONa\end{matrix} + 4H_2O$$

n_1 = 1 mole n_2 = moles sodium oxalate

The following equation may also be used which is without water of crystallization

$$\underset{\text{oxalic acid}}{(COOH)_{2\,(aq)}} + 2NaOH_{(aq)} \longrightarrow \underset{\text{sod. oxalate}}{(COONa)_2} + 2H_2O_{(l)}$$

Molar ratio

$$\begin{matrix}COOH \\ | \\ COOH\end{matrix} \quad : \quad NaOH$$

1 : 2

Standard solution

0.1M NaOH

Indicator

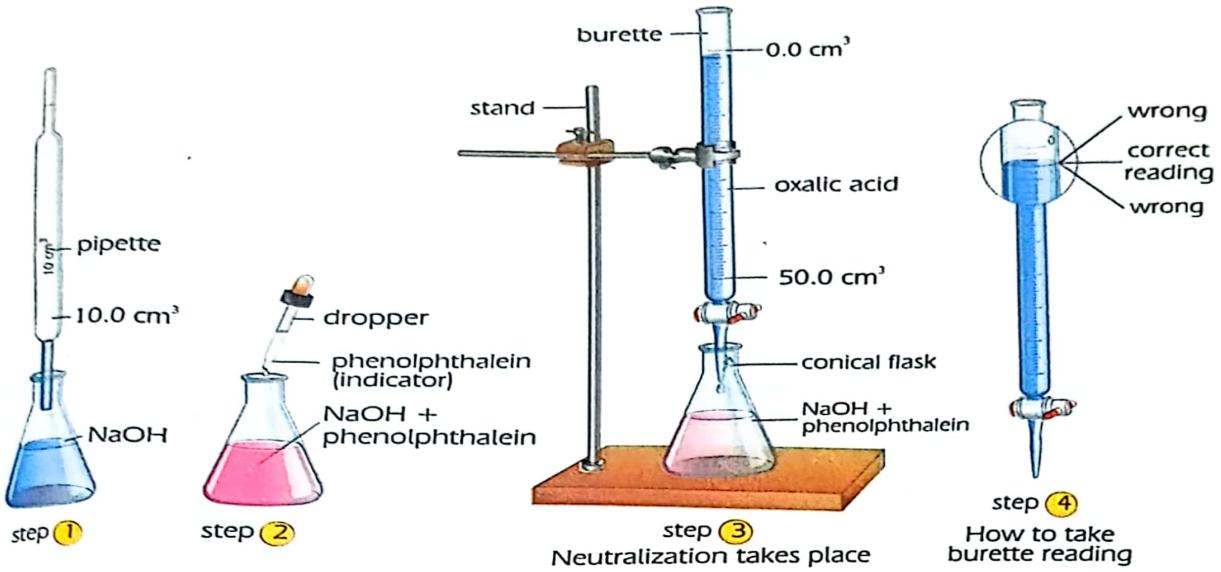
Phenolphthalein

End point

Light pink

Procedure

1. Weigh exactly 1.26g of oxalic acid on a watch glass with the help of a top loading balance.
2. Dissolve the above acid in a about 50 cm^3 distilled water taken in a beaker.
3. Now transfer the above solution to a measuring flask (100 cm^3). Wash the beaker with a small amount of water and transfer the washings to the same measuring flask.



4. Now add water in the measuring flask to make up the volume upto the mark and shake throughly.
5. Take oxalic acid solution in a burette. Remove the air bubbles from the nozzle of the burette and note down the initial reading.
6. Pipette out 10 cm^3 of the given solution of NaOH in a conical flask and add two drops of phenolphthalein indicator with the help of a dropper. The solution turns pink.
7. Now add oxalic acid solution to the alkaline solution taken in the conical flask dropwise with constant stirring. Take a rough reading till the end point, light pink in colour is reached.
   Note down the final reading.
8. Repeat the titration for accurate reading by adding the oxalic acid solution to the conical flask rapidly to within 2 cm^3 of the end point and then drop by drop till the end point is reached. The difference of initial and final reading gives the volume of acid used for this titration.
9. Repeat the experiment to get three concordant readings.

Precautions

1. Always take acid in the burette.
2. Fill the burette upto zero mark.
3. Always Keep the burette in vertical position.
4. Use two drops of phenolphthalein indicator for each titration.
5. Always take lower meniscus for reading.
6. Always take three concordant readings.
7. The apparatus must be washed and rinsed properly before and after the experiment.

Learn about it

A substance which can be obtained in a state of high purity is called a primary standard substance. Such a substance is suitable for the preparation of a standard solution.

A solution of definite molarity of a primary standard is prepared simply by weighting out the desired amount and dissolving it in the solvent (usually water). Oxalic acid is a crystalline solid and is used as a primary standard.

Secondary standard

A substance which is used for standardization of other substances and whose content of the active substance is found by comparing against a primary standard is called secondary standard. Oxalic acid is dibasic acid because it has two replaceable hydrogen atoms in it ($\begin{matrix}COOH\\COOH\end{matrix}.2H_2O$). It can be titrated against a base i.e. NaOH solution.

Observations and Calculations

1. Molarity of oxalic Acid $= M_1 = ?$
2. Molarity of NaOH $= M_2 = ?$
3. Volume of NaOH solution taken $= V_2 = 10.0\ cm^3$
4. Volume of Oxalic acid $= V_1 = ?$

No. of observations.	Initial Reading	Final Reading	Volume of acid used in cm^3
1.	0.0 cm^3	10.0 cm^3	10.0 cm^3
2.	10.0 cm^3	20.0 cm^3	10.0 cm^3
3.	20.0 cm^3	30.0 cm^3	10.0 cm^3

Mean volume of acid used = 10.0 cm^3

Calculations

$$\frac{\text{Acid}}{M_2V_2} = \frac{\text{Base}}{M_1V_1}$$
$$\overline{n_2} \quad = \quad \overline{n_1}$$

Where

Molarity of oxalic Acid $= M_1 = ?$

Volume of NaOH solution taken $= V_2 = 10.0\ cm^3$

Number of moles of oxalic acid $= n_1 = 1$ (from balanced chemical equation)

Molarity of NaOH $= M_2 = 0.1M$

Volume of NaOH $= V_2 = 10.0\ cm^3$

Number of moles of NaOH $= n_2 = 2$ (from balanced chemical equation)

Putting these values in molarity equation we get:

$$\frac{M_1 \times 10}{1} = \frac{0.1 \times 10}{1}$$

$M_1 \times 10 \times 2 = 0.1 \times 10 \times 1$

$$M_1 = \frac{0.1 \times 10 \times 1}{10 \times 2}$$

$M_1 = 0.05M$

Result So the molarity of oxalic acid is 0.05M.

Viva Voce 28 Q&A Short Questions and Answers

Answer the following Questions.

Q.1. **What is the difference between:**

a. a strong acid and a weak acid

Ans. Acids which ionizes completely to give H^+ ions are called strong acids e.g. H_2SO_4, HCl, HNO_3.

Acids which ionizes to a small extent are called weak acids e.g. HF, CH_3COOH, H_2CO_3

b. a concentrated acid and a dilute acid

A concentrated acid is more in acidity and has hundred percent strength. A dilute acid contain small amount of acid in a large amount of solvent (water) or dilute acid is a solvant added acid and is less in acidity.

Q.2. **What do you expect to be the pH of the solution obtained after the end point has reached in titration.**

Ans. pH will be about 9.0.

Q.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.**

Ans. No. It will not be the same.

Q.4. **Do you expect a weak acid like acetic acid reacts with a weak base like NH_4OH.**

Ans. Yes.

Q.5. **A chemist dissolved enough HCl to prepare 250cm^3 of an aqueous solution which contains 0.10g of H^+ in the solution. Calculate molarity of H^+ in the solution.**

Ans.

$$\text{Molarity} = \frac{\text{mass}}{\text{molar mass}} \times \frac{1}{\text{vol in dm}^3}$$

$$\therefore \text{Volume} = \frac{250}{1000} = 0.25 \text{ dm}^3$$

Molar mass of $H^+ = 1g$

$$\therefore \text{Molarity} = \frac{0.10g}{1g} \times \frac{1}{0.25\text{dm}^3} = \boxed{0.4M}$$

$\therefore$ Molarity of H^+ = **0.4M**

Q.6. **A student adds 50 cm^3 H_2O to 25 cm^3 0.881 M NaOH. What is the concentration of the diluted solution?**

Ans.

Diluted solution		Concentrated solution	
M_1V_1	=	M_2V_2	[Total new volume 25 + 50 = 75cm^3]
$M_1 \times 75$	=	0.881×25	
$\therefore M$	=	$\frac{0.881 \times 25}{75}$	

$\therefore$ Molarity of diluted solution = **0.293 M**

Q.7. **A sample gastric juices (HCl present in the stomach) having a volume of 5cm^3 required 11 cm^3 of 0.01 M NaOH solution for neutralization in a titration. Find out the molar concentration of HCl in the gastric juices.**

Ans. Using molarity equation

$$HCl_{(g)} + NaOH_{(g)} \longrightarrow NaCl_{(g)} + H_2O_{(l)}$$
$$n_1 \text{ mole} \quad n_2 = 1 \text{ mole}$$

Acid = Base

$M_1V_1 = M_2V_2$

$M \times 5 = 0.01 \times 11$

$\therefore M = \frac{0.01 \times 11}{5} =$ **0.022 M**

Molarity of HCl = **0.022 M**

Q.8. **Name the vegetables which contains small amount of oxalic acid.**

Ans. Spinach, cabbage and tomatoes contain small amount of oxalic acid.

Q.9. **Which plants contain large amount of oxalic acid in their leaves and should not be eaten?**

Ans. The leaves of rhubarb plants and house plants such as philodendron and dieffenbachia contain much higher concentrations of the oxalic acid and therefore, should not be eaten.

Q.10. **What is the colour of Phenelphthalein in basic medium?**

Ans. It is Pink.

Q.11. **Name the indicator used for titrating a strong acid with a strong base. What will be its colour in acidic medium?**

Ans. Phenelphthalein is used to titrate a strong acid with a strong base. Phenolphthalein has light–pink colour in acid medium.

Q.12. **How many water molecules are present in crystals of oxalic acid?**

Ans. Oxalic acid has two water molecules as water of crystallization.

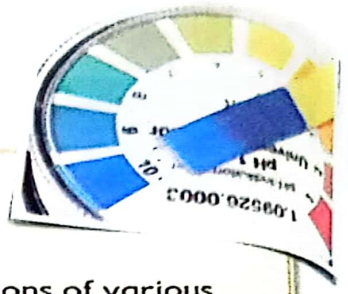
Q.13. **What is the colour of phenolphthalein in a mixture of solution of oxalic acid and sodium oxalate?**

Ans. Since the solution is acidic, therefore Phenolphthalein will be colourless.

Date
/ /20

EXPERIMENT 30

Classify substances as acidic, basic or neutral.

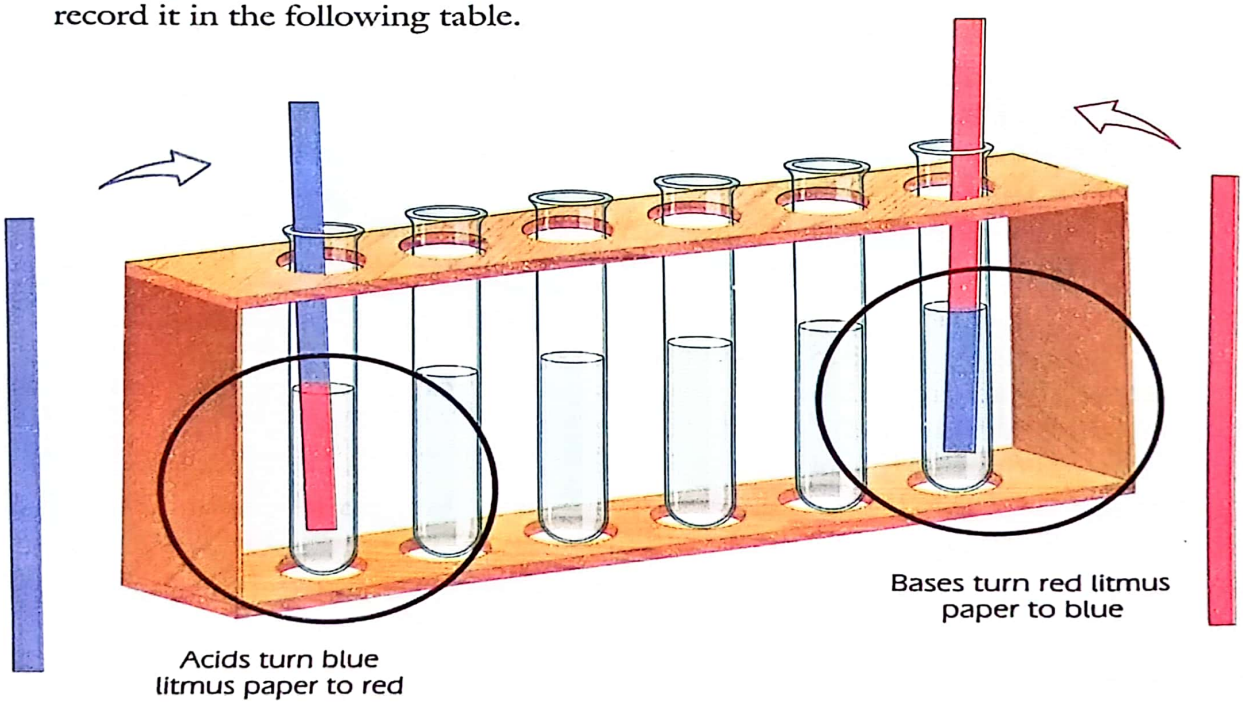


Apparatus: ⊙ six 100 cm^3 beakers ⊙ test tubes ⊙ red and blue litmus papers ⊙ safety goggles

Chemicals: ▶ 0.1% Bromothymol blue ▶ 0.1M solutions of various acids (▶ hydrochloric acid ▶ nitric acid ▶ sulphuric acid ▶ acetic acid) ▶ hydroxides of sodium ▶ potassium ▶ calcium ▶ ethanol ▶ methanol ▶ magnesium ▶ sodium chloride ▶ distilled water

Procedure

1. Take the given solutions in small quantities in different test tubes. Write the names of the solutions on test tubes with marking pencil. Dip red blue litmus paper turn by turn in each of solutions. The solution which turns the blue litmus paper into red is acidic in nature. The others which turn red litmus paper into blue are alkaline. Those having no effect on blue and red litmus paper are neutral.
2. 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.



According to Arhemins, acids are the compounds which give hydrogen ions (H^+) or hydroxonium ions (H_3O^+) when they are dissolved in water. Bases are the compound which give hydroxide ions (OH^-) in water. The presence of (H^+ and OH^-) ions can be indicated with the help of a compound i.e. the indicator which usually changes its colour in the presence of these ions. Many indicators are dyes which have been extracted from natural sources. For example, litmus is a purple dye which is 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 indicator changes into yellow in acidic solution but remains blue in an alkaline solution.

Many acids are present in our body, in plants, oil and food. Bases are also very important for us. Sodium bicarbonate is used as an antacid.

Caustic soda is used in the manufacture of soaps and for removing grease. Tooth paste is mildly alkaline. It neutralizes the acids which attach the teeth. Milk of magnesia (a suspension of magnesium hydroxide in water) is used to cure stomach upset. It neutralizes some of the acids in the stomach if it is too much. Ammonia is commonly added to house hold cleaners to remove oily and greasy diet.

The following table shows some acids with their source.

Acid	Source
Formic acid	Ants
Acetic acid	Vinegar
Butanoic	Butter
Lactic acid	Sour milk
Citric acid	Citrus fruits
Tartaric acid	Grapes

Observations

Substance	Action on Red litmus paper	Action on Blue Litmus paper	Action on 0.1% Bromothymol Blue	Inference
lydrchloric acid				
itric acid				
ulphuric acid				
cetic acid	No effect	Turns red	Yellow	acidic
odium hydroxide				
otassium hydroxide				
lagnesium hydroxide				
ethanol				
thanol				
odium chloride				
p Water				

Result

The change in colour of litmus paper or 0.1 % bromothymol blue is become of the nature of a substance to be acidic, basic or neutral.

Precautions

1. Test the reagent in their solution form.
2. Always use reagents and solution in small quantities.
3. Use distilled water for preparing the solutions.
4. Wet the litmus paper before it is dipped in the solution.
5. Do not touch acids or basis with bare fingers.

Viva Voce 30 — Q&A — Short Questions and Answers

Answer the following Questions.

Q.1. If gaseous HCℓ is cooled to about −84°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 HCℓ?

Ans. Liquid HCℓ is covalent in nature and does not conduct electricity due to the absence of ions in it.

Q.2. How would the electrical conductivity of a solution of $Ba(OH)_2$ (a strong base) change as a solution of H_2SO_4 (a strong acid) is added slowly to it?

Ans. Insoluble $BaSO_4$ and water are gradually produced when H_2SO_4 is slowly added to $Ba(OH)_2$. There is a gradual decrease in electrical conductivity due to decrease in the number of ions present due to neutralization process. $BaSO_4$ is sparingly soluble in water, so almost few ions are present and hence less is the conductivity.

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

Ans. Saliva before meal is basic and may change its pH after a meal (may be acid depending on food). The normal pH range of saliva is 6.5 – 7.5.

Q.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.

Ans. Students to collect samples of water and check their acidic or basic character with the help of litmus paper.

Q.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).

Ans. Student should prepare juice as hinted above and then determine which substance can be used as acid base indicator using ammonia solution and vinegar separately.

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

Ans. Lime scales from kettle are removed by treating them with vinegar when a soluble salt e.g. calcium acetate etc is obtained. Then kettle is washed with sufficient water.

Q.7. Ammonia (NH_3) does not contain any hydroxide group yet it produces hydroxide ions in water. Explain.

Ans. Water (H_2O) acts as an acid when it reacts with NH_3 as shown below:

$$H_2O_l + NH_{3(aq)} \rightleftharpoons N^+H_{4(aq)} + OH^-_{(aq)}$$

Ion pair of nitrogen forms dative bond with proton of water to release OH^- ions.

Q.8. Both methanol and sodium hydroxide contain a hydroxyl group. Why sodium hydroxide is basic while methanol is neutral in character?

Ans. Sodium hydroxide is an ionic compound and releases hydroxide ions and hence is basic in character. Methanol is a covalent organic compound and cannot release H^+ or OH^- ions, therefore it is neutral in character.

Q.9. Define the term neutralization. Which products are formed as a result of this process?

Ans. The reaction in which an acid reacts with a base is called neutralization reaction. The products are salt and water.

$$\underset{\text{Acid}}{HCl_{(aq)}} + \underset{\text{Base}}{NaOH_{(aq)}} \longrightarrow \underset{\text{salt}}{NaCl_{(aq)}} + \underset{\text{water}}{H_2O_{(l)}}$$

Q.10. How would you differentiate between a base and an alkali?

Ans. Base is a metallic oxide e.g. CuO, FeO etc.

A base soluble in water is called alkali e.g. Na_2O is soluble in water to produce alkali called sodium hydroxide NaOH.

Q.11. 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.

Ans. Both these compounds i.e. Na_2CO_3 and citric acid are solids. They must be in ionic form to react. It is possible only when water is added to the mixture, they dissolve and then react.

Q.12. Explain why fluoride ion in drinking water work to prevent tooth decay?

Ans. Fluoride works by stopping or even reversing the tooth decay process. It

keeps the enamel of the tooth healthy strong and solid by preventing the loss of important minerals.
The fluoride ions reduce the ability of plaque bacteria to produce acid. This is a major factor in the prevention of tooth decay. It results from the ability of plaque bacteria to concentrate the low levels of fluoride at tooth surface which inhibits function of some enzymes which are essential for bacteria's ability to produce acid.

Q.13. What is the difference between the terms neutral and amphoteric? Is water a neutral or amphoteric substance?

Ans. A neutral substance has no action on blue or red litmus paper and cannot act as an acid or a base. Amphotaric substance can behave both as an acid and as a base. Water is an amphotaric substance. It can behave as an acid as well as a base as shown below.
Water acts as a base when it reacts with Hcl.

$$\underset{\text{Acid}}{HCl_{(aq)}} + \underset{\text{Base}}{H_2O_{(aq)}} \rightleftharpoons H_3O^+_{(aq)} + Cl^-_{(aq)}$$

Water acts as an acid when it reacts with ammonia.

$$\underset{\text{Acid}}{H_2O_{(l)}} + \underset{\text{Base}}{NH_{3(aq)}} \rightleftharpoons NH^+_{4\,(aq)} + OH^-_{(aq)}$$

Q.14. What is the nature of bee's sting?

Ans. It is basic in nature.

Q.15. What is the pH range of litmus?

Ans. Litmus contains many substances and changes colour over a broad range from pH 5 to pH 8.

Q.16. Why sodium chloride is neutral?

Ans. NaCl is a neutral salt because NaCl on hydrolysis produces a strong acid HCl and a strong base NaOH. Hence the resulting solution of NaCl is neutral.

Q.17. What are phenolphthalein and bromthymol in nature?

Ans. Both phenolphthalein and bromthymol are dyes and are used as indicators. They give different colours in acidic or alkaline medium.

Q.18. What do you know about acidic and basic salts.

Ans. 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.

Q.19. What is the action of acidic and basic substances on hair?

Ans. Acidic substances cause hair cuticles to shrink and harden, making them lie flat. This gives the hair a smooth and shiny appearance. Vinegar helps in dissolving basic soap scum, and hence increases the luster of hair. A base causes hair to swell and soften.

Q.20. **How is the message "sour" sent to the brain by food drinks with low pH?**

Ans. 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.

Q.21. **What is the colour of 0.1% Bromthymol Blue in hydrochloric acid?**

Ans. It is yellow in colour.

Q.22. **Name an essential salt of our food which is of daily use?**

Ans. Sodium Chloride.

Q.23. **What is the basic difference between acid and a base?**

Ans. Acid gives H^+ ions when dissolved in water whereas a base is a substance which provides hydroxyl ion. (OH^-) in solution.

Q.24. **What are the chemical names of common salt and vinegar?**

Ans. Sodium chloride and acetic acid.

Q.25. **What is the action of an acid on red and blue Litmus paper?**

Ans. An acid turns blue litmus paper red. But there is no action of acid on red litmus paper.

Q.26. **What is the action of a base on red and blue litmus paper?**

Ans. A base turns red litmus blue and there is no action of base on blue litmus paper.

Date
/ /20

EXPERIMENT

33

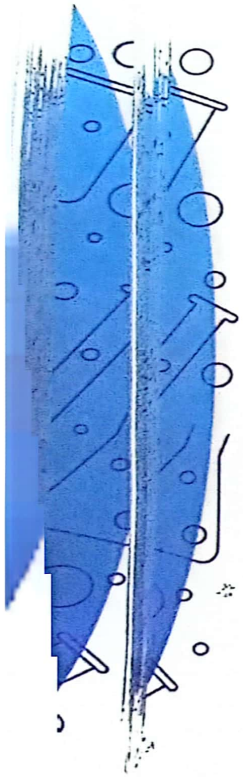
Identify carboxylic acids using sodium carbonate test.

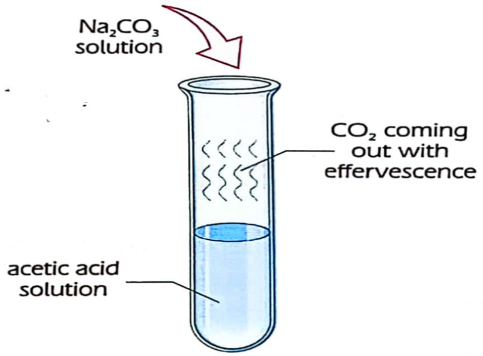
Apparatus: ⊙ test tubes ⊙ test tube holder ⊙ test tube rack ⊙ spatula ⊙ burner ⊙ match box ⊙ delivery tube ⊙ corks

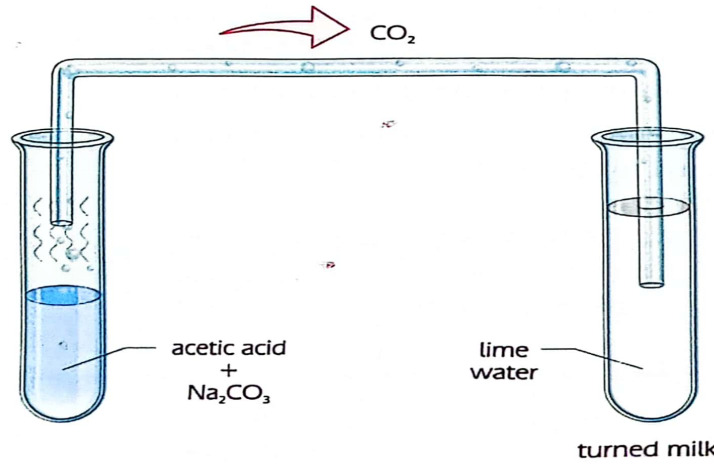
Chemicals: ▶ acetic acid solution ▶ solid sodium carbonate ▶ distilled water ▶ lime water

Chemical reaction

$$CH_3COOH_{(aq)} + Na_2CO_{3(aq)} \longrightarrow CH_3COONa_{(aq)} + H_2O_{(\ell)} + CO_{2(g)}$$







The organic compounds containing carboxylic group – COOH as a functional group are called carboxylic acid.

Some important carboxylic acids with their formulas are :

Formic acid HCOOH (found in ants)

Acetic acid CH_3COOH (found in vinegar)

Oxalic acid $\begin{matrix}COOH\\|\\COOH\end{matrix} \cdot 2H_2O$ (found in spinich)

Similarly citric acid is found in lemon (citrus fruits), tartaric acid in grape juice and malic acid in apples and pears.

The most important organic acid is ethanoic acid. It is commonly called acetic acid. It is made by the oxidation of ethyl alcohol with air. In the air are tiny micro-organisms called bacteria which help in this oxidation.

Ethyl alcohol + air $\xrightarrow{Heat}$ acitic acid + water

$C_2H_5OH_{(l)} + O_{2\,(g)} \longrightarrow CH_3COOH_{(aq)} + H_2O_{(l)}$

Vinegar made in this way contains 5% ethanoic acid. It is because of this oxidation by the air that wines and beers turn sour and taste vinegary if left exposed to the air. Vinegar is used with food as a preservative and flavourirng agent.

Acetic acid is also an important industrial chemical. Ethanoic acid is used with other chemicals in the manufacture of drugs, dyes, paints, insecticides and plastics. It is also used to make useful organic compounds called esters.

Procedure

1. Take about 5 cm^3 of dilute acetic acid in a test tube and add a few crystals of solid sodium carbonate in it.
2. Now pass the gas which is evolved in the above reaction through lime water and record your observation.

Precautions

1. Do not taste any chemical or solution.
2. Use freshly prepared lime water solution.

Observations

e water turns milky.

Further Observation

Experiment	Observations
d solid Na_2CO_3 to acetic acid ution.	A colourless odourless gas with effervescence came out which extinguished a burning splinter and turned lime water milky.

Carboxylic acids produce CO_2 gas when they react with Na_2CO_3.

Viva Voce 33 Q&A Short Questions and Answers

Answer the following Questions.

Q.1. **Identify the carboxylic acids present in tamarind (imli).**

Ans. Tamarind contains many acids such as Tartaric acid, citric acid, malic acid etc..

Q.2. **How will you change aspirin to make it water soluble?**

Ans. By treating aspirin sodium hydroxide or sodium bicarbonate, water soluble aspirn is produced.

Q.3. **Which carboxylic acid is responsible for the odour and taste of vinegar?**

Ans. Vinegar is a dilute solution of a acetic acid (CH_3–COOH). Its odour and taste is due to acetic group in it.

Q.4. **What are the products when carboxylic acids react with bicarbonates?**

Ans. Metal carboxylate, carbon dioxide gas and water, for example when sodium bicarbonate reacts with a acetic acid, sodium acetate, CO_2 and water are produced.

$$CH_3COOH_{(aq)} + NaHCO_{3\,(aq)} \longrightarrow CH_3COONa_{(aq)} + CO_{2\,(g)} + H_2O_{(l)}$$

Q.5. **Where does carbon dioxide come from?**

Ans. From bicarbonates.

Q.6. **Which two functional groups are joined together to give a carboxylic acid group?**

Ans. The two functional groups which are joined together to give a carboxylic acid group $-\overset{\overset{O}{\|}}{C}-OH$ are:

i. carboxyl group $-\overset{\overset{O}{\|}}{C}-$

ii. hydroxyl group $-\overset{|}{C}-OH$

Q.7. **Name some commonly used carboxylic acids?**

Ans.
1. Acetic acid
2. Oxalic acid
3. Succinic acid
4. Tartaric acid
5. Citric acid
6. Cinnamic acid

Q.8. **While preparing cakes and cookies why the flour swells up on the addition of baking soda in it?**

Ans. It swells up due to the evolution of carbon dioxide gas.

Q.9. **Which is more basic, Na_2CO_3 or $NaHCO_3$?**

Ans. Na_2CO_3

Q.10. **What is the cause of distinctive tangy taste of sourdough (khameri roti)?**

Ans. 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, which give sourdough bread a sour taste.

Q.11. **Which acid is injected when red ants bites and what is their aim behind it?**

Ans. Many insects, including the red ant, inject formic acid which they use as a defensive chemical weapon, a communication system and for protection against their enemies.

Q.12. **What is aspirin chemically?**

Ans. Chemically aspirin is acetyl salicylic acid which is a carboxylic acid.

Q.13. **What is vinegar?**

Ans. Dilute solution of acetic acid (about 5%) is called vinegar.

Q.14. **What is the use of vinegar (Dilute acetic acid) in food?**

Ans. It is used as a preservative and flavouring agent for food.

Q.15. **What are the other uses of acetic acid?**

Ans. It is used in the manufacture of drugs, dyes, paints, insecticides and plastics.

Q.16. **What is the action of acetic acid on blue litmus?**

Ans. Acetic acid turns blue litmus red.

Q.17. **Name the gas produced when acetic acid reacts with Na_2CO_3 solution.**

Ans. Caron dioxide gas.

Hydrocarbons

Date 20

EXPERIMENT 35

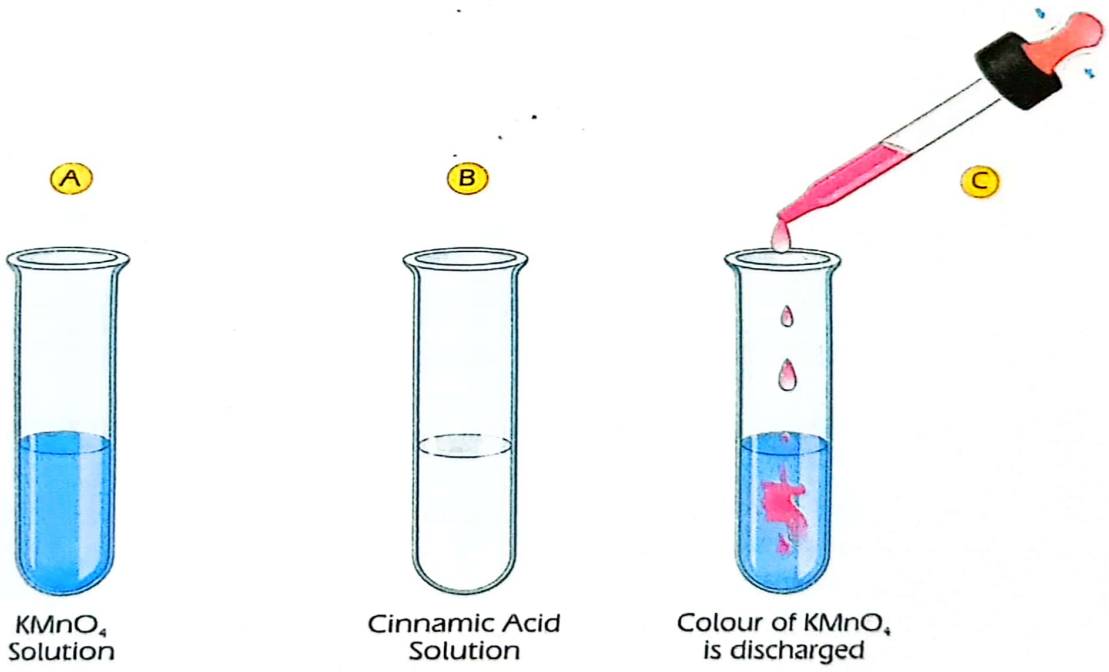
Identify saturated and unsaturated organic compounds by $KMnO_4$ test.

Apparatus: ⊙ test tubes ⊙ test tube holder ⊙ test tube rack ⊙ dropper

Chemicals: ▶ cinnamic acid ▶ ether or alcohol ▶ acidified $KMnO_4$ solution ▶ distilled water ▶ tartaric acid solution ▶ bromine water

Procedure

1. Take 5 cm^3 water in a test tube A and add a few crystals of $KMnO_4$. Stir with glass rod to dissolve $KMnO_4$. Then add a few drops of dilute H_2SO_4 to acidify $KMnO_4$ solution.
2. Take 5 cm^3 water in another test tube B and add a few crystals of cinnamic acid and stir with a glass rod. Cinnamic acid being insoluble will form a suspension in H_2O.



3. Now add a few drops of acidified $KMnO_4$ solution to cinnamic acid with the help of a dropper and record your observation.
4. Take about 5 cm^3 water in a test tube C and add a few crystals of tartaric acid. Stir well to dissolve the acid then add a few drops of acidified $KMnO_4$ solution to this solution and see what happens.
5 Record your observations.

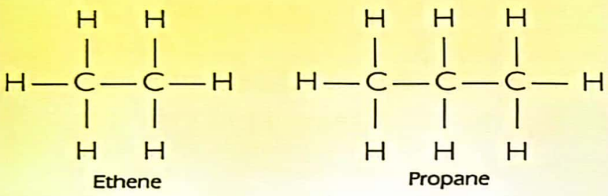
Precautions

1. Handle $KMnO_4$ with care.
2. Avoid contact of $KMnO_4$ with skin because it causes stubborn stains.

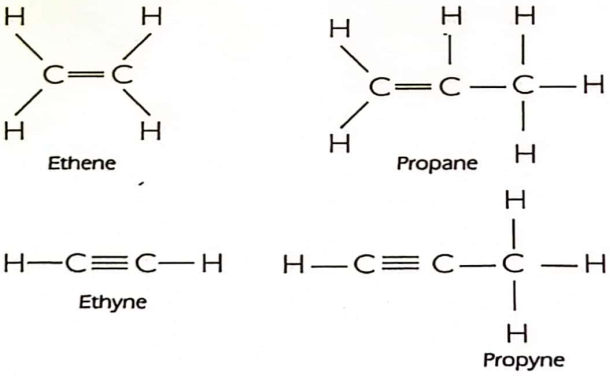
Learn about it

Saturated compounds are those organic compounds which contain only carbon–carbon single bond. Alkanes are saturated hydrocarbons.

Examples

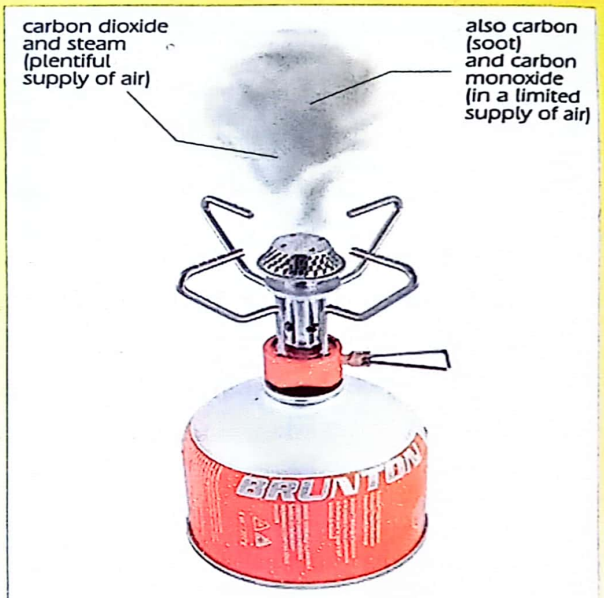


Unsaturated compounds are those organic compounds which contain carbon–carbon double bond (=) or triple (≡) bond. Alkenes and alkeyes are unsaturated hydrocarbons



Examples

Since alkanes are saturated hydrocarbons with a single covalent bond between two carbon atoms, they are not reactive.



Butane gas is commonly used as bottled gas for cooking.

Unstauration in organic compounds can be found by the following two tests:

1. Bromite water test.
2. $KMnO_4$ test

The easily available unsaturated compound in the laboratory is cinnamic acid. ($C_6H_5-CH=CH-COOH$). It decolourizes acidified $KMnO_4$ solution.

However the most important test used to differentiate between saturated and unsaturated organic compounds is acidified $KMnO_4$ solution test.

Observations

Experiment	Observation
Add acidified $KMnO_4$ solution to the aqueous suspension of cinnamic acid.	Colour of acidicied $KMnO_4$ was discharged.
Add acidified $KMnO_4$ solution to the aqueous suspension of tartaric acid.	No change in colour.

An Alternative method

The unsaturation in an organic compound can also be detected by the help of bromine water.

Experiment	Observation	Inference
Add a few drops of bromine water in cinnamic acid suspension in a test tube.	Colour of bromine water is discharged	Cinnamic acid shows saturation
Add a few drops of bromine water in tartaric acid suspension in a test tube.	No change in colour of bromine water is noted	Tartaric acid shows saturation

Cinnamic acid is an unsaturated organic compound becanse it decolourises bromine water and KM_nO_4 solution.

Precautions

Bromine being dangerous to handle, use it carefully. It causes burns on the skin.

Viva Voce 35 — Q & A — Short Questions and Answers

Answer the following Questions.

Name the main product obtained when acidified $KMnO_4$ reacts with ethane.

Ethene glycol (1,2 – ethanediol) is produced. The chemical reaction is:

$$3CH_2 = CH_2 + 2KMnO_4 + 4H_2O \longrightarrow 3 \begin{matrix} H_2C-CH_2 \\ | \quad\quad | \\ HO \quad OH \end{matrix} + 2MnO_2 + 2KOH$$

What type of reactions do unsaturated compound normally give?

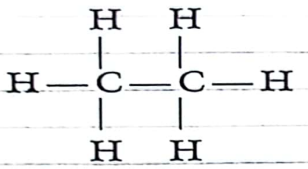
Unsaturated compounds normally give addition reaction.

Q.3. **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?**

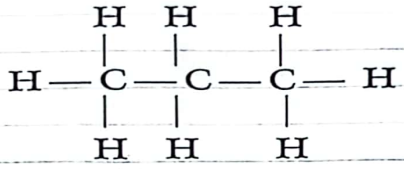
Ans. Polyunsaturated fatty acids.

Q.4. **What is the difference between a saturated and unsaturated hydrocarbon?**

Ans. A saturated hydrocarbon contain carbon – carbon single bond in it e.g.

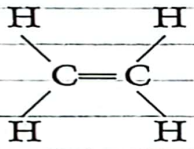


Ethane

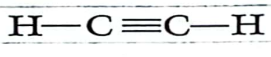


Propane

Unsaturated hydrocarbons are those hydrocarbons which contain carbon = carbon double (=) or tripple bond (≡). For example



Ethene



Ethyne

Q.5. **How hydrogenation of liquid oil takes place?**

Ans. When hydrogen is passed through vegetable oil in the presence of a catalyst (Ni), the process is called hydrogenation of oils. Margarine (Banaspati ghee) is the product.

Q.6. **Why vegetable oils are called polyunsaturated organic compounds?**

Ans. Because they contain many carbon–carbon double (C = C) bonds.

Q.7. **Why the diets rich in saturated fatty acids are unhealthy?**

Ans. Because they lead to higher level of blood cholesterol.

Q.8. **What is petroleum?**

Ans. Petroleum is a dark brown or greenish black coloured viscous liquid which is a mixture of many saturated hydrocarbons.

Q.9. **Why desi ghee is found in semi solid form?**

Ans. Due to presence of saturated and unsaturated fatty acids.

Q.10. **How many double bounds are in benzene and how does it behave?**

Ans. Benzene (C_6H_6) has three alternate double bonds in it. It behaves more like a saturated compound.

Q.11. Write two uses of ethene.

Ans. 1. It is used in manufacture of a plastic called polyethene.
2. It is used in ripening of fruits and vegetables.

Q.12. What is the use of catalytic hydrogenation?

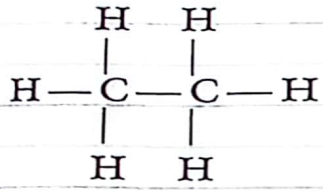
Ans. It is used to change vegetable oil (a liquid) into margarine which is a semi–solid. People prefer to spread semi–solid margarine over their bread than the liquid oil.

Q.13. Define hydrocarbons.

Ans. Organic compounds containing carbon and hydrogen only are called hydrocarbons.

Q.14. What are alkanes?

Ans. The hydrocarbons which posses a single covalent bond between two carbon atoms e.g. ethane C_2H_6.



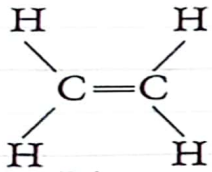
Q.15. What are paraffins?

Ans. Alkanes are also called paraffins.

Q.16. What are alkenes?

Ans. Hydrocarbons having a double covalent bond between two carbon atoms are called alkenes e.g.

Ethene C_2H_2 Structure



Ethene

Q.17. Name two alkanes which are liquid at room temperature.

Ans. n–pentane and n–hexane.

Q.18. What is the colour and physical state of potassium permanganate ($KMnO_4$). What is the colour of its solution in water?

Ans. Potassium permanganate has dark purple shining crystals which produce pink coloured solution on dissolving in water.

Q.19. Name the chemical used to test unsaturation in organic compounds.

Ans. Potassium permanganate solution.

Q.20. What is the formula for cinnamic acid?

Ans. Formula of cinnamic acid is $C_6H_5 - CH = CH - COOH$.

Biochemistry

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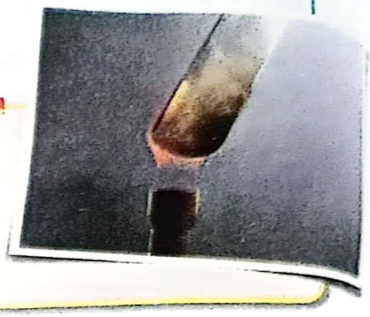
EXPERIMENT 36

Demonstrate that sugar decomposes into elements or other compounds.



Apparatus: Test tubes, cobalt chloride paper, test tube holder or clamp, bunsen, safety goggles, match box

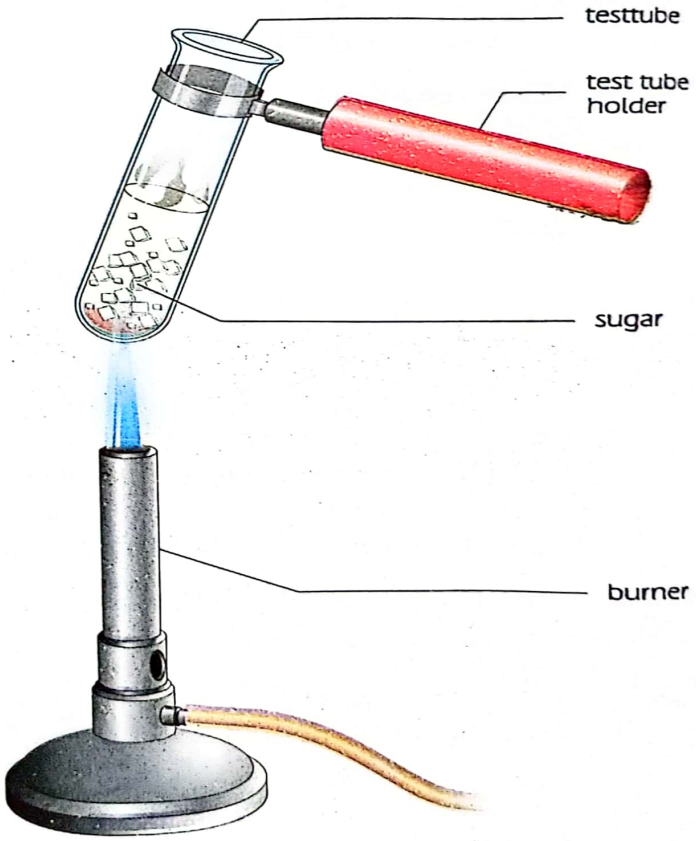
Chemicals: concentrated sulphuric acid, sugar, ethanol

Chemical equation

$$\underset{\text{Sugar}}{C_{12}H_{22}O_{11(s)}} \xrightarrow{\text{Heat}} 12C_{(s)} + 11\,H_2O_{(g)}$$

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 in the clamp of iron stand.
3. Now heat the test tube gently with a Bunsen burner by using blue flame since it is hotter and cleaner.
4. Bring dry cobalt chloride paper near the mouth of the test tube and observe the change in its colour.



Precautions

Give to and fro motion to test tube while heating to avoid spurting.

The chemical reaction in which a substance is broken down into two or more simpler substances is called decomposition reaction. It 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 either in the form of heat (thermal decomposition) or electricity (electrolytic decomposition or electrolysis). The thermal decomposition of sugar results in its decomposition into carbon and steam.

Observations

Experiment	Observations
Take common sugar in a test tube and heat it gently.	It started to make a cracking sound It also started turning brown.
Heat the above test tube strongly.	Burning smell of sugar came out. Water vapour evolved and a black residue was left.
Take cobalt chloride paper near the mouth of the above test tube.	It turned blue.

Result

On heating sugar strongly in a test tube, it decomposed to water and element carbon.

Viva Voce 36 — Q & A — Short Questions and Answers

Answer the following Questions.

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

Experiment	Before heating	After gentle heating	After strong heating
Physical state of glucose (colour)	White powder	Brown	Black residue was left and water vapours also came out.

2. What are the products of the burning wax?

Carbon dioxide and water vapours.

3. Which gas is burnt in kitchen burner and what are the products of burning of this gas?

Methane gas (sui gas or Natural gas)

$$\underset{(g)}{CH_4} + 2\underset{(g)}{O_2} \longrightarrow \underset{(g)}{CO_2} + 2\underset{(g)}{H_2O} + \text{heat}$$

Q.4. 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.

Ans. The process is called thermal decomposition

$$\underset{(g)}{CH_4} \xrightarrow{Heat} C_{(s)} + \underset{(g)}{2H_2}$$

Q.5. What name will you give to the black residue left at the end of the experiment? (13.1).

Ans. The black residue left is pure carbon.

Q.6. What is caramal and where it is used?

Ans. Caramal is a beige to dark brown confectionary product made by heating a variety of sugars. It is used in custard, pudding, ice–cream and in confectionary items.

Q.7. Name the product formed when spirit (ethanol) and some other organic compounds such as hydrocarbons are burnt.

Ans. They are changed to carbon dioxide, water vapours and lot of heat is produced.

Q.8. The ingestion of complex carbohydrates or starches has no effect on our immune system. But eating or drinking 100 grams of sugar which is equivalent of one 350 cm^3 can of fizzy drink has the effect on our immune system which starts in less than 30 minutes after ingestion and may last for five hours. What effect they have on white blood cells?

Ans. The ability of white blood cells to kill bacteria is reduced by 40%.

Q.9. Do you think that taking carbohydrates or starch disturbs our immune system?

Ans. No. By taking starch or carbohydrates, there is no bad effect on our immune system.

Q.10. What is the formula of sucrose?

Ans. $Cl_{12}\ H_{22}\ O_{11}$.

Q.11. What is the commercial name of sucrose?

Ans. Sugar.

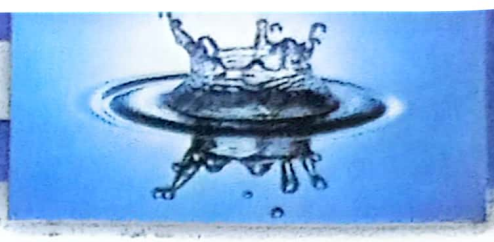
Q.12. Is burning of sugar a chemical change or physical change?

Ans. Burning of sugar is a chemical change.

Q.13. Name the products obtained by the decomposition of sugar.

Ans. Carbon and water.

Water



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EXPERIMENT 37

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

Apparatus: ⊙ test tubes ⊙ beaker ⊙ distilled water

Chemicals: ▶ Sodium bicarbonate and sodium sulphate ▶ soap solution ▶ sodium sulphate ▶ calcium chloride

Chemical equation

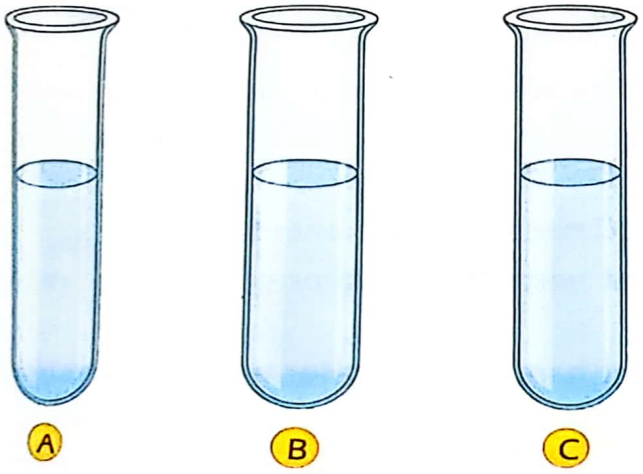
$$CaCl_{2(aq)} + Na_2CO_{3(aq)} \longrightarrow CaCO_{3(s)} + 2NaCl_{(aq)}$$

$$MgSO_{4(aq)} + Na_2CO_{3(aq)} \longrightarrow MgCO_{3(s)} + Na_2SO_{4(aq)}$$

Procedure

1. Take distilled water (10 cm^3) in three test tubes and label them as A,B and C.
2. Add 0.5g Na_2SO_4 in test tube A and shake it well to dissolve it.
3. Add a few drops of soap solution in test tube A. Shake it well and record your observation.
4. Add 1.0g $NaHCO_3$ and 0.5g $CaCl_2$ in test tube B and shake the test tube to dissolve the substances.

Now take about 5 cm^3 of the above solution in a separate test tube and add a few drops of soap solution in it. Shake it and record your observations.



Precautions

1. Boil the solution carefully in the test tube.
2. Do not taste any chemical or solution.

6. Boil the remaining solution present in test tube B. Cool it and add a few drops of soap solution. Shake well and record your observations.
7. Dissolve 0.5g $CaCl_2$ in test tube C. Add a few drops of soap solution in a portion of this solution and shake it. Record your observations.
8. Now take about 3 cm of the solution from test tube C in a separate test tube and boil it. Cool it and then add a few drops of soap solution. Shake it well and record your observations.
9. Then add 1.0 g Na_2CO_3 in the remaining solution present in test tube C. Shake it well and filter. Now add a few drops of soap solution in the filterate. Again shake it and record your observations.

Observations

S. No.	Experiments	Observations
1.	Add a few drops of soap solution in test tube A and shake.	Lather is formed
2.	Add a few drops of soap solution in a portion of solution in test tube B and shake.	Scum is produced
3.	Boil the solution present in test tube B. Add a few drops of soap solution and shake.	Lather is formed
4.	Take a portion of the solution in test tube C. Add a few drops of soap solution and shake.	Scum is produced
5.	Boil 2nd portion of solution in test tube C. Add a few drops of soap solution and shake.	Scum is produced
6.	Add Na_2CO_3 in the remaining solution in test tube C. Shake and filter. Then add a few drops of soap solution in the filterate and shake.	Lather is produced

Result

1. **Test tube contains soft water. (Experiment 1 above).**
2. **Experiment 2: Water in test tube B is temporary hard water.**
3. **Experiment 3: On boiling temporary hardness of water was removed in test tube B.**
4. **Experiment 4: Test tube C contains permanent hard water.**
5. **Experiment 5: Permanent hardness of water could not be removed by boiling test tube C.**
6. **Experiment 6: Permanent hardness of water was removed by adding Na_2CO_3 in test tube C.**

Water containing more minerals than ordinary water is called hard water.
Water may be soft water or hard water.

Soft water

Water which produces lather with soap easily is called soft water.

Hard water

Water which does not produce lather with soap easily but form a curd like precipitate is called hard water.

Hard water may be

1. **Temporary hard water**

It is due to the presence of bicarbonate of calcium and magnesium which are present in the form of ions.

$Ca(HCO_3)_{2(aq)} \rightleftharpoons Ca^{+2}_{(aq)} + 2HCO^-_{3(aq)}$

Cal. bicarbonate bicarbonate ions

$Mg(HCO_3)_{2(aq)} \rightleftharpoons Mg^{+2}_{(aq)} + 2HCO^-_{3(aq)}$

Mag. bicarbonate bicarbonate ions

2. **Permanent hard water**

This is due to the presence of chlorides and sulphates of calcium and magnesium. These salts are also water soluble and are present in the form of ions.

$Ca\,Cl_{2(aq)} \rightleftharpoons Ca^{+2}_{(aq)} + 2Cl^-_{(aq)}$

(cal. chloride)

$MgSO_{4(aq)} \rightleftharpoons Mg^{+2}_{(aq)} + SO_4^{-2}_{(aq)}$

(mag. sulphate)

or Mg^{+2} ions react with the ions present in ap to form a scum which prevents the ing action of soap. Soap normally consists ium salts of long chain organic acids d from animal fats or oils e.g. sodium e. The negative ion of the soap forms an le scum with Ca^{+2} or Mg^{+2}, which s the effectiveness of the soap for ng dirt and grease.

$Ca^{+2}\ 2C_{17}H_{35}COO \longrightarrow (C_{17}H_{35}COO)_2Ca$

Stearate ion Calcium stearate (Scum)

Temporary hardness of water can be removed by boiling it. Solube bicarbonates present in water decompose to give insoluble carbonates which come out of water in the form of precipitate and thus make it soft.

$Ca^{+2}_{(aq)}\ 2HCO^-_{3(aq)} \rightarrow CaCO_{3(s)} + CO_{2(g)} + H_2O_{(l)}$

Permanent hard water can be made soft by adding washing soda in it. Added carbonate ions (CO_3^{-2}) react with calcium or magnesium ions to form insoluble calcium or magnesium carbonate.

$Ca^{+2}_{(aq)}\ Na_2CO_{3(aq)} \rightarrow CaCO3(s) + 2Na^{+1}_{(aq)}$

Hard water is harmful for drinking as well as for use in industry. The salts present in it deposit along the inner walls of the pipes of boiler which need to be removed after regular intervals.

Water

There is no need to make water in the laboratory or in factory because there is so much of it around already. Nearly three quarters of the earth surface is covered by water.

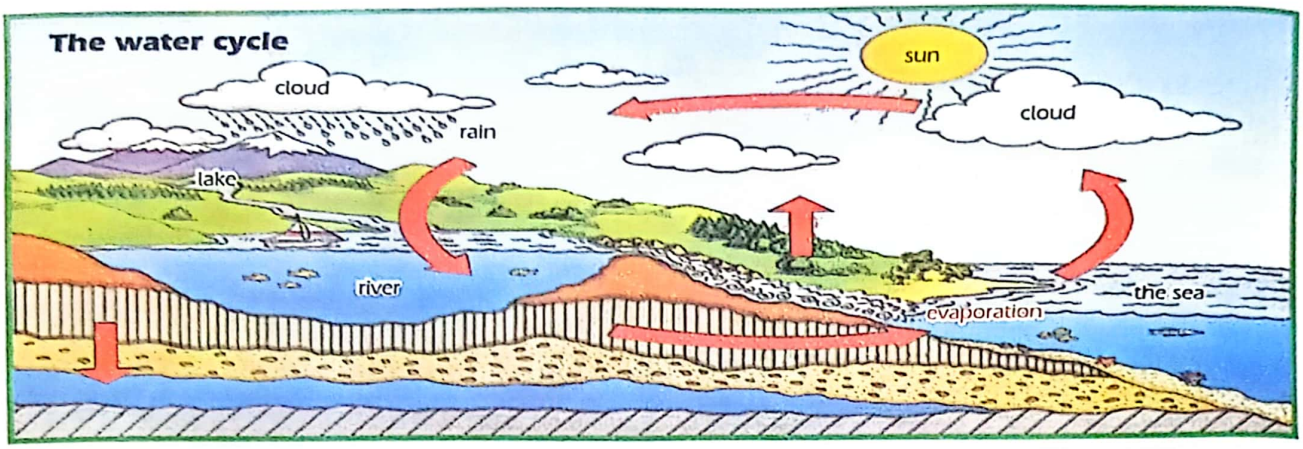
There are many types of natural water found on the surface of earth.

i. Rain water is the purest form of water and if collected it contains dissolved gases such as oxygen, nitrogen and carbon dioxide as the rain drops pass through the atmosphere.

ii. River water is impure and contains many dissolved salts from soil and gases.

iii. Spring water is the water which has made its way downward through the soil and contains many solid impurities.

iv. Sea water is the reservoir into which eventually all the impurities go, therefore it is the most impure form of water. Soft water readily produces lather with soap. Hard water does not form lather readily with soap.



Viva Voce 37 — Q&A — Short Questions and Answers

Answer the following Questions.

Q.1. **How calcium and magnesium ions are mixed in ground water and make it hard?**

Ans. The rain water absorbs CO_2 while coming down from atmosphere, passes through the beds of soil and converts insoluble carbonates of calcium and Mg into soluble bicarbonates.

Q.2. **Do the terms hard water and heavy water convey the same meaning?**

Ans. No. Hard water is H_2O containing HCO_3^- of Ca and Mg or $C\ell^-$ and SO_4^{-2} of Ca and Mg in it. While heavy water is D_2O.

Q.3. **Do you expect rain water to be hard water?**

Ans. No. Rain water is soft water. Water is made hard by dissolved calcium and magnesium ions neither of which is present in rain water until it runs over calcium or magnesium containing compounds on earth surface.

Q.4. **Collect sample of tap water and show whether it is hard or soft.**

Ans. Students should collect sample of tap water and find whether it is hard or soft.

Q.5. **Predict the effect of hard water on the growth of plants.**

Ans. Since it raises the pH level of soil, most plants are tolerant to it and survive but some may show signs of colour loss or change and a decline in overall vitality.

Q.6. **Detergents have replaced soap for many cleaning jobs at homes. Why?**

Ans. Because detergents have strong cleaning action than that of soap and can work well even in hard water while ordinary soaps first form scum in hard water and then clean, so much of the soap is wasted.

Q.7. **Regular use of hard water in the boilers reduces their heat conducting property. Why?**

Ans. Regular use of hard water deposits scales of insoluble calcium and magnesium in salts. Being bad conductor of heat, they cause more fuel to be used. Thus

they not only reduce the efficiency of boiler but also cause them to burst.

Q.8. In industry, temporary hardness in often removed by adding lime water [$Ca(OH)_2$]. It might seem odd that lime water, which itself contains Ca^{+2}, can be added to hard water to remove both HCO_3^- and Ca^{+2}. Explain.

Ans. The reason is that lime water adds 2 moles of OH^- per mole of Ca^{+2}. Two moles of OH^- neutralize 2 moles of HCO_3^- and liberate 2 moles of CO_3^{-2}, thus precipitating 2 moles of Ca^{+2}: one that was added and the one that was originally present in the hard water as shown below:

$$Ca(OH)_2 \longrightarrow Ca^{+2} + 2OH^-$$
$$2HCO_3 + 2OH \longrightarrow 2CO_3^{-2} + 2H_2O$$
$$2Ca^{+2} + 2CO_3^{-2} \longrightarrow 2CaCO_3$$

Q.9. Define hard water.

Ans. Water which does not produce lather with soap but forms precipitate is called hard water.

Q.10. What is the reason for permanent hardness of water?

Ans. It is due to the presence of dissolved chlorides and sulphates of calcium and magnesium.

Q.11. Is hard water good for drinking?

Ans. No.

Q.12. Describe three disadvantages of hard water.

Ans. i. It is harmful to the body. ii. More soap is wasted in washing.
iii. It is harmful for boilers.

Q.13. Name a reagent used to remove permanent hardness of water?

Ans. Sodium Carbonate.

Q.14. How will you remove temporary hardness of water?

Ans. i. By boiling OR ii. By adding estimated amount of limewater.

Q.15. Which is the purest form of water among the following?
Sea water, river water, rain water, spring water, canal water.

Ans. Rain water.

Q.16. A sample of water was found to contain calcium bicarbonate. What kind of hardness it has?

Ans. Temporary hardness of water.

Q.17. Can we remove permanent hardness of water by distillation?

Ans. Yes. It is the best method for removing permanent hardness of water but it is very expensive.

Q.18. Write the main sources of water pollution.

Ans. Sewage, fertilizers, industrial chemicals, pesticides, oil and detergents.