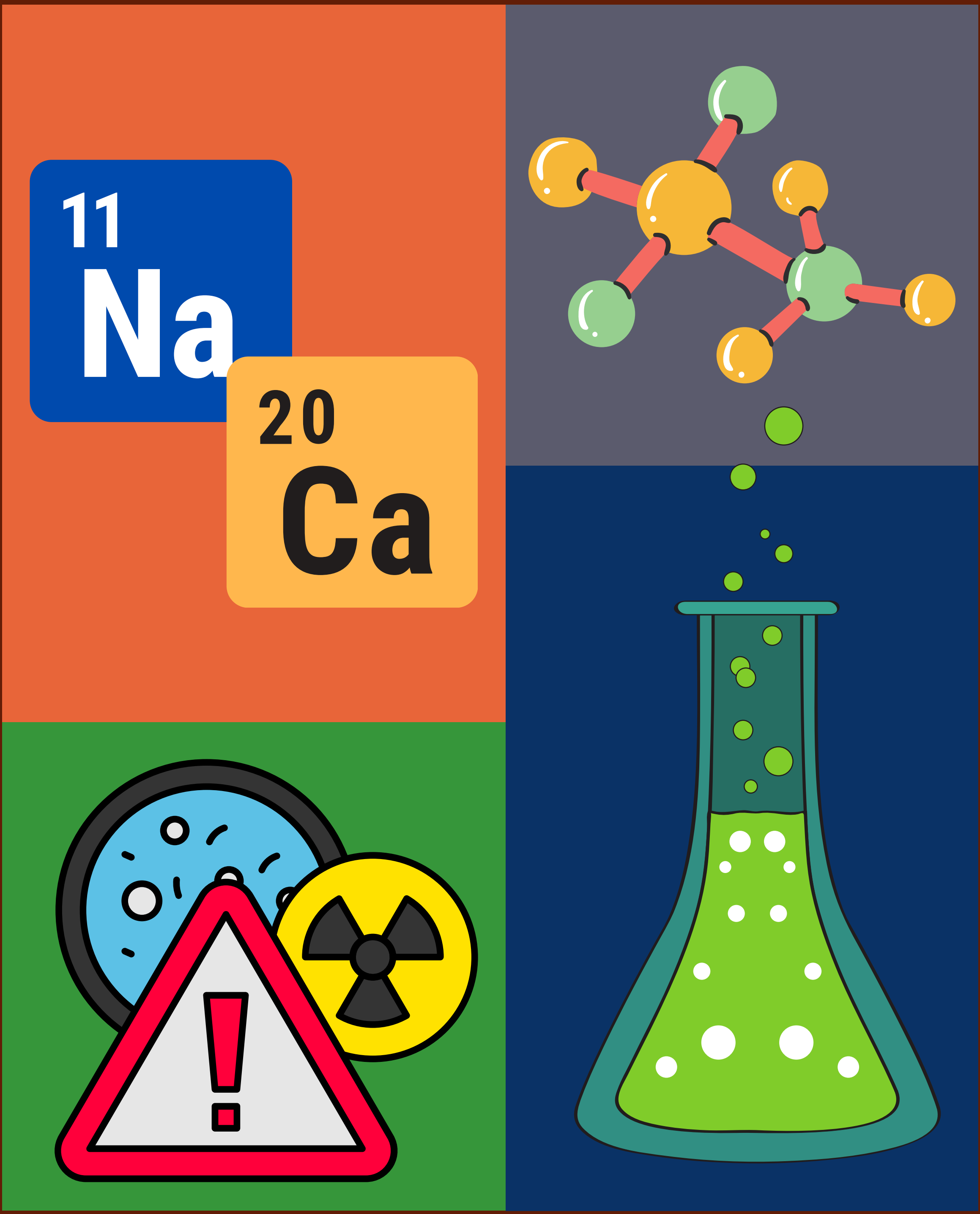


CLASS 10 NOTES

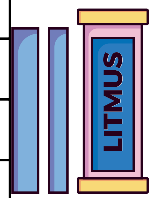
SCIENCE

Acid, Bases and Salts

PRASHANT KIRAD

Acids, Bases and Salts

Acids	Bases
Sour in tasteDerived from Greek word' ACIDUS'	Bitter in taste
Changes blue litmus into red	Changes red litmus into blue
e.g. Hydrochloric acid HCl	e.g. Sodium hydroxide NaOH
Sulphuric acid	Potassium hydroxide KOH
Nitric acid	Calcium hydroxide
Acetic acid	Ammonium hydroxide



Acid-Base Indicators:

Exam me aayega

Natural indicators like litmus, turmeric, red cabbage leaves, and colored petals from flowers like Hydrangea, Petunia, and Geranium can show acidity or alkalinity. On the other hand, synthetic indicators such as methyl orange and phenolphthalein are also used for the same purpose.

Red litmus solution	Blue litmus solution	Phenolphthalein solution	Methylorgane solution
Acid - No change Base - Blue	Acid - Red Base - No change	Acid - Colorless Base - Pink	Acid - Red Base - Yellow

Some naturally occurring acids

Vinegar	Acetic Acid
Orange	Citric Acid
Lemon	Citric Acid
Tamarind	Tartaric Acid
Tomato	Oxalic Acid
Sour milk (Curd)	Lactic Acid
Ant and Nettle sting	Methanoic Ac

Do You Know?

Litmus solution is a purple dye, which is extracted from lichen, a plant belonging to the division Thallophyta, and is commonly used as an indicator. When the litmus solution is neither acidic nor basic, its colour is purple. There are many other natural materials like red cabbage leaves, turmeric, coloured petals of some flowers such as *Hydrangea*, *Petunia* and *Geranium*, which indicate the presence of acid or base in a solution. These are called acid-base indicators or sometimes simply indicators.

What Is an Acid and a Base? E.M.A

Ionisable and Non-Ionisable Compounds

An ionizable compound, when in water or molten form, breaks down into ions almost completely. Examples include NaCl, HCl, KOH, and others.
In contrast, a non-ionizable compound does not separate into ions when dissolved in water or in its molten state. Examples of such compounds are glucose and acetone.

Acids and Bases

An acid is a substance that contains hydrogen and can donate a proton (hydrogen ion) to another substance. On the other hand, a base is a molecule or ion capable of accepting a hydrogen ion from an acid. Typically, acidic substances are recognized by their sour taste.

Arrhenius' Theory of Acids and Bases

An Arrhenius acid is a substance that, when dissolved in water, breaks apart to yield H^+ (aq) or H_3O^+ ions.
An Arrhenius base is a substance that, when dissolved in water, dissociates to produce OH^- ions.

Acids	Bases
Hydrochloric acid (HCl)	Sodium hydroxide (NaOH)
Sulphuric acid (H_2SO_4)	Potassium hydroxide (KOH)
Nitric acid (HNO_3)	Calcium hydroxide ($Ca(OH)_2$)

Bronsted Lowry Theory

A Bronsted acid is an H^+ (aq) ion donor.
A Bronsted base is an H^+ (aq) ion acceptor.

examples:
In the reaction: HCl (aq) + NH_3 (aq) → NH_4^+(aq) + Cl^- (aq)
HCl – Bronsted acid and Cl^- : its conjugate acid
NH_3 – Bronsted base and NH_4^+ : its conjugate acid

potential physical tests for identifying an acid or a base are:

- Taste

Acids typically have a sour taste, while bases often taste bitter. However, relying on taste to identify acids or bases is not recommended due to the risk of contamination or corrosiveness.
For instance, substances like curd, lemon juice, orange juice, and vinegar exhibit a sour taste because they contain acids. On the other hand, baking soda, despite having a somewhat sour taste, serves as an example of a base. It is essential to use proper testing methods rather than relying on taste alone.

- Effect on Indicators by Acids and Bases

An indicator is a chemical substance that exhibits a change in its physical properties, particularly in color or odor, upon contact with an acid or a base.
Common indicators and the colors they display are as follows:

a) Litmus:
Neutral solution – purple
Acidic solution – red
Basic solution – blue
Litmus is provided in paper strip forms as red litmus and blue litmus.

Acid transforms moist blue litmus paper to red.
Base transforms moist red litmus paper to blue.

b) Methyl Orange:
Neutral solution – orange
Acidic solution – red
Basic solution – yellow

c) Phenolphthalein:
Neutral solution – colorless
Acidic solution – remains colorless
Basic solution – exhibits a pink color.

Acid-Base Reactions ← E.M.A

A neutralization reaction takes place when an acid interacts with a base, resulting in the formation of salt and water as the final products. In this conventional approach, an acid-base neutralization reaction is expressed as a double-replacement reaction.

Reactions of Acids and Bases

a) Reaction of acids and bases with metals

Acids, in general, react with metals to produce salt and hydrogen gas. Bases, in general, do not react with metals and do not produce hydrogen gas.
Acid + active metal → salt + hydrogen + heat
$2HCl + Mg \rightarrow MgCl_2 + H_2 (\uparrow)$
Hydrochloric acid + Magnesium → Magnesium chloride + Hydrogen
Base + metal → salt + hydrogen + heat
$2NaOH + Zn \rightarrow Na_2ZnO_2 + H_2 (\uparrow)$
Sodium hydroxide + Zinc → Sodium zincate + Hydrogen
A more reactive metal displaces the less reactive metal from its base.
$2Na + Mg(OH)_2 \rightarrow 2NaOH + Mg$
Sodium + Magnesium hydroxide → Sodium hydroxide + Magnesium

b. Acid Interaction with Metal Carbonates and Bicarbonates:

When acids engage with metal carbonates or bicarbonates, the resulting reaction generates carbon dioxide, metal salts, and water. For example, the reaction between hydrochloric acid and sodium carbonate produces sodium chloride, carbon dioxide, and water. Notably, if the evolved carbon dioxide is passed through lime water, it causes the lime water to exhibit a milky appearance.

Acid + metal carbonate or bicarbonate → salt + water + carbon dioxide.
$2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$
$H_2SO_4 + Mg(HCO_3)_2 \rightarrow MgSO_4 + 2H_2O + 2CO_2$
Effervescence indicates the liberation of CO_2 gas.

SECRET QUESTIONS

1. Which gas is generally liberated when an acid reacts with a metal? Illustrate with a suitable ex. How will you identify and test for the presence of this gas?

Hydrogen gas is liberated when an acid reacts with a metal. For example: Take some pieces of zinc granules in a test tube and add H_2SO_4 to it. Shake it and pass the gas evolved into a soap solution. Bubbles are formed in the soap solution. These soap bubbles contain hydrogen gas. The chemical equation of the reaction is:

$H_2SO_4 + Zn \rightarrow ZnSO_4 + H_2 \uparrow$

Identification test- Hydrogen gas is identified by bringing a burning candle near the soapy bubbles. The candle will burn with a pop sound.

2. Explain why Plaster of Paris should be stored in a moisture-proof container. Give reasons.

Plaster of Paris should be stored in a moisture-proof container because moisture can affect the plaster of Paris by slowing down the setting of the dressing application because of hydration. It will turn the plaster useless.

Explanations: Plaster of Paris (POP) should be stored in a moisture-proof container because it is a powdery mass that can absorb water or moisture to form a hard solid mass known as gypsum. The reaction takes place as follows:

$CaSO_4.\frac{1}{2}H_2O$ +	$1\frac{1}{2}H_2O$	$\rightarrow CaSO_4.2H_2O$
Plaster Of Paris	water	gypsum(hard solid)

3. What do you understand by olfactory indicators?

Some indicators show a change in their odor in the presence of acids or bases. Such indicators are called olfactory indicators. They are very useful for visually challenged students because such students cannot use other indicators.
Clove, vanilla, and onion are examples of olfactory indicators.

4. What is meant by the term water of crystallization? How would you show that copper sulphate crystals contain water of crystallization?

The molecules of water associated with a crystalline substance are called water of crystallization.
When hydrated copper sulphate is heated its color changes from blue to dirty white and water droplets are formed.
$CuSO_4.5H_2O \rightarrow CuSO_4 + 5H_2O$.
If we add little water to anhydrous $CuSO_4$, we get blue color again. It is the presence of molecules of water of crystallization that was lost on heating.
$CuSO_4 + 5H_2O \rightarrow CuSO_4.5H_2O$

c) Reaction of Acid with Base

1. Metal Oxides and Hydroxides with Acids:
   Metal oxides or metal hydroxides exhibit basic properties.
   Acid + Base→Salt + Water + Heat
   Acid + Base→Salt + Water + Heat
   Examples: $H_2SO_4 + MgO \rightarrow MgSO_4 + H_2O$
   $2HCl + Mg(OH)_2 \rightarrow MgCl_2 + 2H_2O$

2. Non-Metal Oxides with Bases:
   Non-metal oxides demonstrate acidic properties.
   Base + Nonmetal Oxide→Salt + Water + Heat
   Base + Nonmetal Oxide→Salt + Water + Heat
   Example: $2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

3. Reaction of acids and base
   A very common acid is hydrochloric acid. The reaction between strong acid, says hydrochloric acid and strong base say sodium hydroxide, forms salt and water. The complete chemical equation is shown below.
   HCl (strong acid) + NaOH (strong base) → NaCl (salt) + H_2O (water)

Acids and Bases in Water

When added to water, acids and bases dissociate into their respective ions and help in conducting electricity.
Base:
Neutralization Reaction: Bases participate in neutralization reactions with acids.
Composition: Composed of metal oxides, metal hydroxides, metal carbonates, and metal bicarbonates.
Solubility in Water: Most bases are insoluble in water.

Alkali:
Nature: An alkali is an aqueous solution of a base, predominantly metallic hydroxides.
Dissociation in Water: It dissolves in water and dissociates to yield OH^- ions.
Relationship with Bases: All alkalis are bases, but it is important to note that not all bases are alkalis.

The **hydronium ion** is created through the acceptance of a lone pair of electrons from the oxygen atom of a water molecule by a hydrogen ion, resulting in the formation of a coordinate covalent bond.

Dilution

Dilution involves decreasing the concentration of a solution by incorporating additional solvent, typically water. This process is highly exothermic. When diluting acid, it is essential to add the acid to water and not vice versa.

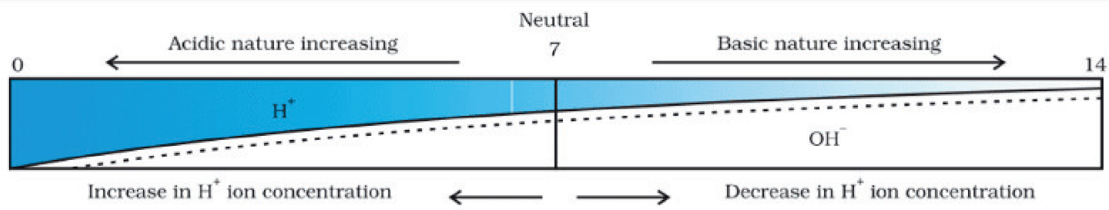
Strength of Acids and Bases:
Strong Acid or Base: In the case of a strong acid or base, every molecule in a given quantity undergoes complete dissociation in water, resulting in the formation of their respective ions ($H^+(aq)$ for acids and $OH^-(aq)$ for bases).
Weak Acid or Base: Contrastingly, with weak acids or bases, only a few molecules from a given amount undergo partial dissociation in water, producing their respective ions ($H^+(aq)$ for acids and $OH^-(aq)$ for bases).

Dilute acid: contains less number of H+(aq) ions per unit volume.
Concentrated acid: contains more number of H+(aq) ions per unit volume.

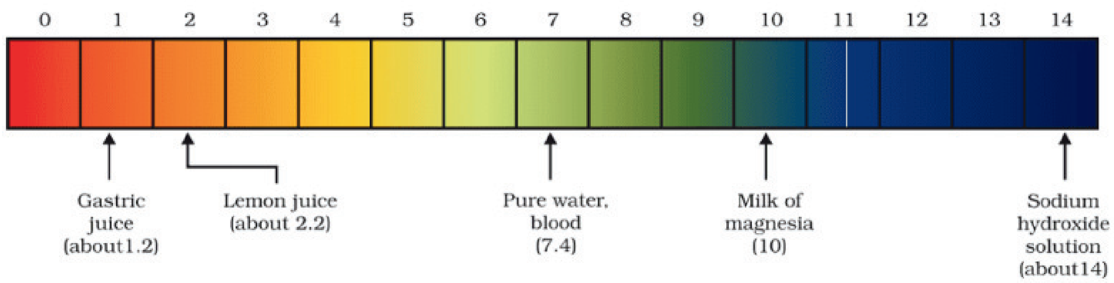
A universal indicator spans a pH range of 0 to 14, providing information about the acidity or alkalinity of a solution. A solution is considered neutral when it has a pH of 7.

pH Scale ← E.M.A

- The pH scale, developed for measuring hydrogen ion concentration in a solution, derives the "p" from the German term 'potenz,' meaning power.
- On the pH scale, readings range generally from 0 (indicating strong acidity) to 14 (indicating strong alkalinity).
- pH is a numerical representation of the acidic or basic nature of a solution.
- A lower pH value corresponds to a higher concentration of hydronium ions.
- A neutral solution has a pH of 7.
- Values below 7 on the pH scale represent an acidic solution.
- As the pH value increases from 7 to 14, it signifies a rise in the concentration of OH^- ions, indicating an increase in the strength of the alkali.
- The pH scale is often measured using paper impregnated with a universal indicator.



Variation of pH with the change in concentration of H+ (aq) and OH– (aq) ions



Importance of pH in everyday life
Are plants and animals pH sensitive?
Our body works within the pH range of 7.0 to 7.8.
When pH of rainwater is less than 5.6, it is called acid rain.
When acid rain flows into the rivers, it lowers the pH of the river water. The survival of aquatic life in such rivers becomes difficult.

pH in our digestive system

It's fascinating to observe that our stomach naturally produces hydrochloric acid, aiding in the digestion of food without causing harm to the stomach lining. However, in instances of indigestion, an excess of stomach acid can lead to discomfort and irritation. To alleviate this pain, individuals often turn to bases known as antacids. These antacids work by neutralizing the surplus acid. Magnesium hydroxide, commonly known as Milk of Magnesia, is a mild base frequently employed for this purpose.

pH change as the cause of tooth decay

- Tooth decay starts when the pH of the mouth is lower than 5.5.
- Tooth enamel, made up of calcium hydroxyapatite (a crystalline form of calcium phosphate) is the hardest substance in the body.
- Bacteria present in the mouth produce acids by degradation of sugar and food particles remaining in the mouth after eating.
- The best way to prevent this is to clean the mouth after eating food.
- Using toothpaste, which is generally basic, for cleaning the teeth can neutralize the excess acid and prevent tooth decay.

Self-defense by animals and plants through chemical warfare

Bee-sting leaves an acid that causes pain and irritation. The use of a mild base like baking soda on the stung area gives relief. Stinging hair of nettle leaves injects methanoic acid causing burning pain.

Manufacture of Acids and Bases

Manufacture of acids and bases

a) Nonmetal oxide + water → acid
$SO_2(g) + H_2O(l) \rightarrow H_2SO_3(aq)$
$SO_3(g) + H_2O(l) \rightarrow H_2SO_4(aq)$
$4NO_2(g) + 2H_2O(l) + O_2(g) \rightarrow 4HNO_3(aq)$
Non-metal oxides are thus referred to as acid anhydrides.

b) Hydrogen + halogen → acid
$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$
$HCl(g) + H_2O(l) \rightarrow HCl(aq)$

c) Metallic salt + conc. sulphuric acid → salt + more volatile acid
$2NaCl(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2HCl(aq)$
$2KNO_3(aq) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + 2HNO_3(aq)$

e) Metal + water → base or alkali + hydrogen
$Zn(s) + H_2O(steam) \rightarrow ZnO(s) + H_2(g)$

f) Few metallic oxides + water → alkali
$Na_2O(s) + H_2O(l) \rightarrow 2NaOH(aq)$

g) Ammonia + water → ammonium hydroxide
$NH_3(g) + H_2O(l) \rightarrow NH_4OH(aq)$

Salts ← E.M.A

Salt is formed through the combination of an anion derived from an acid and a cation derived from a base.
Examples of salts include KCl, $NaNO_3$, $CaSO_4$, and others.
Typically, salts are produced through the neutralization reaction between an acid and a base.

Commonly known as common salt, Sodium Chloride (NaCl) is extensively utilized globally in cooking.

Salts sharing the same cation or anion are considered part of the same **salt family**. Examples include NaCl, KCl, LiCl.

pH of Salts

Salts of a strong acid and a strong base are neutral with a pH value of 7.
Salts of a strong acid and weak base are acidic with a pH value of less than 7.
Those of a strong base and weak acid are basic in nature with a pH value of more than 7.

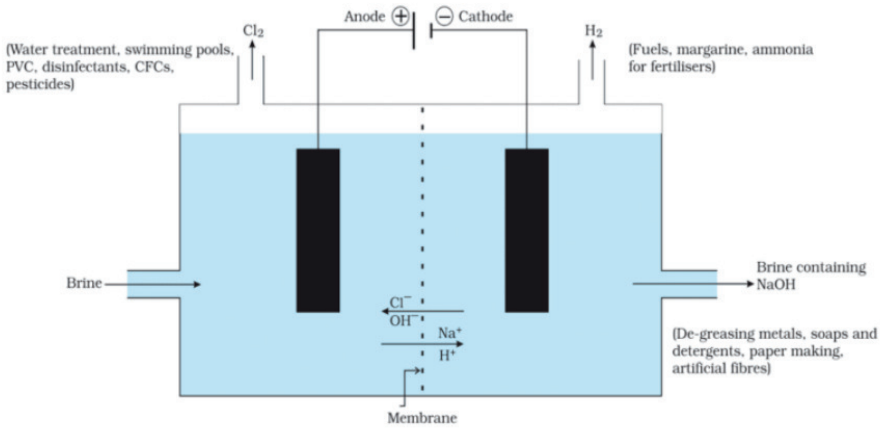
Chemicals From Commal Salt

The salt formed by the combination of hydrochloric acid and sodium hydroxide solution is called sodium chloride (NaCl)/Common Salt.
The common salt thus obtained is an important raw material for various materials of daily use, such as sodium hydroxide, baking soda, washing soda, bleaching powder, and many more.

- Sodium hydroxide or lye or caustic soda
- Baking soda or sodium hydrogen carbonate, or sodium bicarbonate
- Washing soda or sodium carbonate decahydrate
- Bleaching powder or calcium hypochlorite

1.Sodium Hydroxide

- When electricity is passed through salty water (brine), it breaks down to make sodium hydroxide. This process is called the chlor-alkali process because it produces chlorine and alkali (sodium hydroxide).
- $2NaCl\ (aq) + 2H_2O\ (l) \rightarrow 2NaOH\ (aq) + Cl_2\ (g) + H_2\ (g)$
- At one end (anode), chlorine gas is released, and at the other end (cathode), hydrogen gas is given off. Close to the cathode, we get a solution of sodium hydroxide.



Bleaching Powder

- Chlorine gas is utilized in the manufacturing process of bleaching powder.
- The production of bleaching powder involves the interaction of chlorine with dry slaked lime [$Ca(OH)_2$].
- While bleaching powder is often represented as $CaOCl_2$, its actual composition is more complex.
- $Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$.

Bleaching powder is used –

- for bleaching cotton and linen in the textile industry, for bleaching wood pulp in paper factories, and for bleaching washed clothes in laundry;
- as an oxidizing agent in many chemical industries; and
- to make drinking water free from germs.

Baking Soda

Sodium bicarbonate, commonly known as baking soda or bicarbonate of soda, has the chemical formula $NaHCO_3$ and is recognized by the IUPAC name sodium hydrogen carbonate. This salt is created by the combination of a sodium cation (Na^+) and a bicarbonate anion (HCO_3). Found as a fine powder, sodium bicarbonate is a white, crystalline substance. Its taste is mildly salty and alkaline, resembling that of washing soda (sodium carbonate).

Chemical name – Sodium hydrogen carbonate
Chemical formula – $NaHCO_3$

Water of Crystallization

The water of crystallization is the fixed number of water molecules present in one formula unit of salt. Five water molecules are present in one formula unit of copper sulphate. The chemical formula for hydrated copper sulphate is CuSO4.5H2O.

Plaster of Paris

On heating gypsum (CaSO4.2H2O) at 373 K, it loses water molecules and becomes calcium sulphate hemihydrate (CaSO4.1/2H2O). This is called Plaster of Paris.

Uses of Plaster of Paris

It is employed by medical professionals to create casts for maintaining fractured bones in the correct position.
In the realm of creativity, Plaster of Paris is utilized for crafting toys, decorative items, and achieving smooth surfaces.

Important activities

Activity 2.3

CAUTION: This activity needs the teacher's assistance.

- Set the apparatus as shown in Fig. 2.1.
- Take about 5 mL of dilute sulphuric acid in a test tube and add a few pieces of zinc granules to it.
- What do you observe on the surface of zinc granules?
- Pass the gas being evolved through the soap solution.
- Why are bubbles formed in the soap solution?
- Take a burning candle near a gas filled bubble.
- What do you observe?
- Repeat this Activity with some more acids like HCl, HNO_3 and CH_3COOH.
- Are the observations in all the cases the same or different?

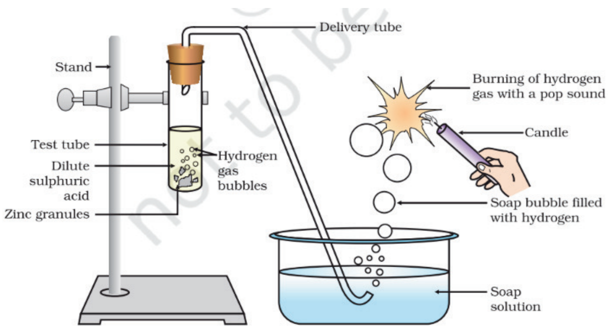


Figure 2.1 Reaction of zinc granules with dilute sulphuric acid and testing hydrogen gas by burning

- Take a few zinc granules in a boiling tube and add approximately 5 mL of dilute sulphuric acid to it.
- Observe the formation of gas bubbles on the surface of the zinc granules. Direct the gas being produced through a soap solution in a trough using a glass delivery tube. This results in the formation of gas-filled bubbles in the soap solution that rise into the air.
- Bring a burning candle close to a gas-filled soap bubble. The gas within the soap bubble ignites with a 'pop' sound, indicating a small explosion.
- This demonstration confirms that only hydrogen gas, which has the characteristic 'pop' sound when ignited, is evolved in the reaction between dilute sulphuric acid and zinc metal (present in the form of zinc granules).

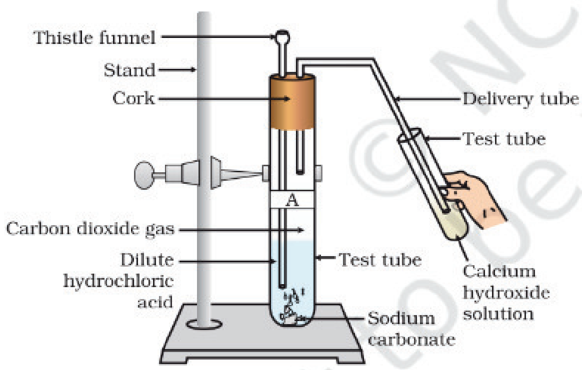


Figure 2.2
Passing carbon dioxide gas through calcium hydroxide solution

Activity 2.5

- Take two test tubes, label them as A and B.
- Take about 0.5 g of sodium carbonate (Na_2CO_3) in test tube A and about 0.5 g of sodium hydrogencarbonate ($NaHCO_3$) in test tube B.
- Add about 2 mL of dilute HCl to both the test tubes.
- What do you observe?
- Pass the gas produced in each case through lime water (calcium hydroxide solution) as shown in Fig. 2.2 and record your observations.

- Take a boiling tube and place approximately 0.5 g of sodium carbonate in it.
- Add about 2 mL of dilute hydrochloric acid to the boiling tube using a thistle funnel.
- Observe the brisk effervescence of a gas being produced.
- Pass the gas generated through lime water. Notice that the lime water turns milky, indicating the presence of carbon dioxide gas.
- Continue passing carbon dioxide gas through the milky lime water for some time. Eventually, the lime water becomes clear again.
- This demonstrates that the initially formed white precipitate of calcium carbonate dissolves when excess carbon dioxide gas is passed.
- Repeat the experiment using sodium hydrogen carbonate instead of sodium carbonate. Again, carbon dioxide gas is produced, turning the lime water milky. Upon passing an excess of carbon dioxide, the milky lime water once again becomes clear.

Activity 2.9

- Take about 1g solid NaCl in a clean and dry test tube and set up the apparatus as shown in Fig. 2.4.
- Add some concentrated sulphuric acid to the test tube.
- What do you observe? Is there a gas coming out of the delivery tube?
- Test the gas evolved successively with dry and wet blue litmus paper.
- In which case does the litmus paper change colour?
- On the basis of the above Activity, what do you infer about the acidic character of:
  (i) dry HCl gas
  (ii) HCl solution?

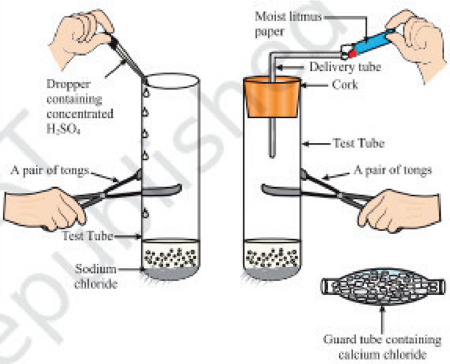


Figure 2.4 *Preparation of HCl gas*

Note to teachers: If the climate is very humid, you will have to pass the gas produced through a guard tube (drying tube) containing calcium chloride to dry the gas.

- Place 1 g of solid sodium chloride (NaCl) in a clean, dry boiling tube.
- Carefully add concentrated sulfuric acid, fitting the rubber cone over the glass tube.
- The reaction forms hydrogen chloride gas, observed escaping from the open end.
- Test the gas with a 'dry' blue litmus paper, noting no change in color, indicating HCl gas doesn't act as an acid in the absence of water.
- Test the gas with a 'moist' blue litmus paper, observing a color change to red, revealing acidic behavior of HCl gas in the presence of water.
- Conclusion: HCl gas is not acidic in the absence of water but displays acidic behavior in the presence of water.

Top Seven Questions:

1) A dry pellet of a common base B absorbs moisture and turns sticky when kept open. The compound is also a by-product of the chloralkali process. Identify B. What type of reaction occurs when B is treated with an acidic oxide? Write a balanced chemical equation for one such solution.

Solution: Sodium hydroxide (NaOH) is a commonly used base and is hygroscopic; it absorbs moisture from the atmosphere and becomes sticky. A neutralization reaction occurs when acidic oxides react with the base to give salt and water.

$$2\ NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$$

2) **Give reasons for the following:**

(i) Only one-half of the water molecule is shown in the formula of the plaster of Paris.

(ii) Sodium hydrogen carbonate is used as an antacid.

(iii) On strong heating, blue-colored copper sulfate crystals turn white. **(2020)**

Solution:

(i) Only one-half of the water molecule is shown in the formula of plaster of Paris ($CaSO_4$. $12H_2O$) as one molecule of water is being shared by two molecules of calcium sulphate ($CaSO_4$). So the effective water of crystallization for one $CaSO_4$ unit comes to half a molecule of water.

(ii) Acidity can be neutralized by a base. Sodium hydrogen carbonate can be used as an antacid solution because it is a weak base and will react with excess acid produced in the stomach due to hyperacidity and will neutralize it.

(iii) Blue colored copper sulphate crystals are hydrated copper sulphate, $CuSO_4.5H_2O$. On heating blue copper sulphate crystals lose their water of crystallization and turn into anhydrous copper sulphate which is white.

$$\underset{\text{(Blue)}}{CuSO_4.5H_2O} \xrightarrow{\text{Heat}} \underset{\text{(White)}}{CuSO_4} + 5H_2O$$

3) A white powder is added while baking cakes to make them soft and spongy. Name its main ingredients. Explain the function of each ingredient. Write the chemical reaction taking place when the powder is heated during baking. **(AI2019)**

Solution: The white powder added while baking cakes to make them soft and spongy is baking powder. Its main ingredients are sodium hydrogen carbonate and a mild edible acid like tartaric acid or citric acid. NaHCO3 decomposes to give out CO2 which causes the cake to rise and makes it soft and spongy. The function of tartaric acid or citric acid is to neutralise sodium carbonate formed during heating which can otherwise make the cake bitter. The reaction taking place when the powder is heated:

$$2NaHCO_3 \xrightarrow{Heat} Na_2CO_3 + H_2O + CO_2\uparrow$$

4) The pH of a salt used to make tasty and crispy pakoras is 14. Identify the salt and write a chemical equation for its formation. List its two uses. **(2018)**

Solution: Salt used to make tasty and crispy pakoras is sodium bicarbonate (NaHCO3), pH = 9. On a large scale, sodium bicarbonate is prepared as:

$$\underset{\text{Sodium chloride}}{NaCl} + \underset{\text{Water}}{H_2O} + \underset{\text{Carbon dioxide}}{CO_2} + \underset{\text{Ammonia}}{NH_3} \longrightarrow \underset{\text{Ammonium chloride}}{NH_4Cl} + \underset{\text{Sodium bicarbonate}}{NaHCO_3}$$

5) A white-colored powder is used by doctors to support fractured bones. **(a)**Write the chemical name and formula of the powder. **(b)**When this white powder is mixed with water a hard solid mass is obtained. Write the balanced chemical equation for this change. **(Board Term I, 2016)**

Solution: (a) Chemical name of the powder is calcium sulphate hemihydrate. The chemical formula of the powder is CaSO4. 12 ApH2O.

(b) When water is added to the plaster of Paris, it sets into a hard mass in about half an hour. The setting of the plaster of Paris is due to its hydration to form crystals of gypsum which set to form a hard, solid mass.

$$\underset{\text{Plaster of Paris}}{CaSO_4 \cdot \frac{1}{2}H_2O} + \underset{\text{Water}}{1\frac{1}{2}H_2O} \rightarrow \underset{\text{Gypsum (sets as hard mass)}}{CaSO_4 \cdot 2H_2O}$$

6) List the important products of the Chlor-alkali process. Write one important use of each. **(2020)**

Solution: Sodium hydroxide is prepared by electrolysis of an aqueous solution of sodium chloride (brine). The complete reaction can be represented as:

The process of electrolysis of sodium chloride solution is called chlor-alkali process because of the

$$2NaCl_{(aq)} + 2H_2O_{(l)} \xrightarrow[\text{electricity}]{\text{On passing}} 2NaOH_{(aq)} + Cl_{2(g)} + H_{2(g)}$$

products formed : chlor for chlorine and alkali for sodium hydroxide. The three very useful products obtained by the electrolysis of sodium chloride solution are sodium hydroxide, chlorine, and hydrogen.

At anode: Cl_2 gas is liberated At cathode: H_2 gas is liberated.
Uses of sodium hydroxide: In the manufacture of soaps and detergents.
Uses of chlorine: As a germicide and disinfectant for sterilization of drinking water and for water of swimming pools.
Uses of hydrogen: In the manufacture of ammonia which is used for the preparation of various fertilizers like urea, ammonium sulphate, etc.

7) How is washing soda prepared from sodium carbonate? Give its chemical equation. State the type of this salt. Name the type of hardness of water which can be removed by it. **(2020)**

Solution: Washing soda is prepared by recrystallization of sodium carbonate:

$$\underset{\text{Anhydrous sodium carbonate}}{Na_2CO_{3(s)}} + 10H_2O_{(l)} \longrightarrow \underset{\text{Washing soda}}{Na_2CO_3.10H_2O_{(s)}}$$

It is used to remove the permanent hardness of water. Hard water is treated with a calculated amount of washing soda when chlorides and sulfates of calcium and magnesium present in hard water get precipitated as insoluble calcium and magnesium carbonates which can be easily filtered off. The water thus becomes soft.

$$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3\downarrow + 2NaCl$$

$MgSO_4$ + Na_2CO_3 → MgCOsub>3↓ + Na_2SO_4

Competency-Based Question:

1. A compound, X of sodium forms a white powder. It is a constituent of baking powder and is used in some antacids. When heated it gives a compound, Y which is anhydrous and absorbs water to become a hydrated salt. When this salt is kept in open air, it loses water molecules in a process called efflorescence. When dissolved in water it forms a strong base and a weak acid, Z.

(i) What is the compound, X?
(a) NaHCO3 (b) Na2CO3 (c) NaOH (d) NaCl

(ii) The compound, Y is
(a) NaHCO3 (b) Na2CO3 (c) Na2CO3. 10H2O (d) NaCl

(iii) What is the nature of the solution formed by dissolving Y in water?
(a) Alkaline (b) Acidic (c) Neutral (d) It remains insoluble.

(iv) Identify the compound, Z.
(a) CO2 (b) H2CO3 (c) NaOH (d) H2O

(v) Sodium carbonate is a basic compound because it is a salt of a
(a) strong acid and strong base (b) weak acid and weak base (c) strong acid and weak base
(d) weak acid and strong base.

2. Chemically, Plaster of Paris (POP) is calcium sulphate hemihydrate, i.e., containing half molecule of water of crystallization. It is represented by the formula, CaSO4-1/2H2O. Half molecule of water of crystallisation means that one water molecule is shared by two formula units of CaSO4. Hence, we also represent its formula as (CaSO4)2 H2O. The name, plaster of Paris, was given to this compound because for the first time, it was made from gypsum which was mainly found in Paris.

(i) The difference of water molecules in gypsum and plaster of Paris is
(a) 5/2 (b) 2 (c) 1/2 (d) 3/2

(ii) Plaster of Paris hardens by
(a) giving off CO2 (b) changing into CaCO3 (c) combining with water (d) giving out water

(iii) Which of the following statements is incorrect?
(a) Plaster of Paris is used to ornate designs on walls and ceilings.
(b) On heating gypsum above 373 K, CaSO4 is obtained.
(c) Dead burnt plaster is CaSO4.2H2O.
(d) Setting of plaster is due to its hydration into gypsum.

(iv) Select the incorrect statement with respect to gypsum.
(a) It is slightly soluble in water.
(b) It is also known as alabaster.
(c) On heating gypsum at 373 K, it loses water molecules and becomes calcium sulphate hemihydrate.
(d) Chemical formula of gypsum is CaSO4 $1/2H_2O$.

(v) Plaster of Paris is obtained by
(a) adding water to calcium sulphate
(b) adding sulphuric acid to calcium hydroxide
(c) heating gypsum to a very high temperature
(d) heating gypsum to 100° C.