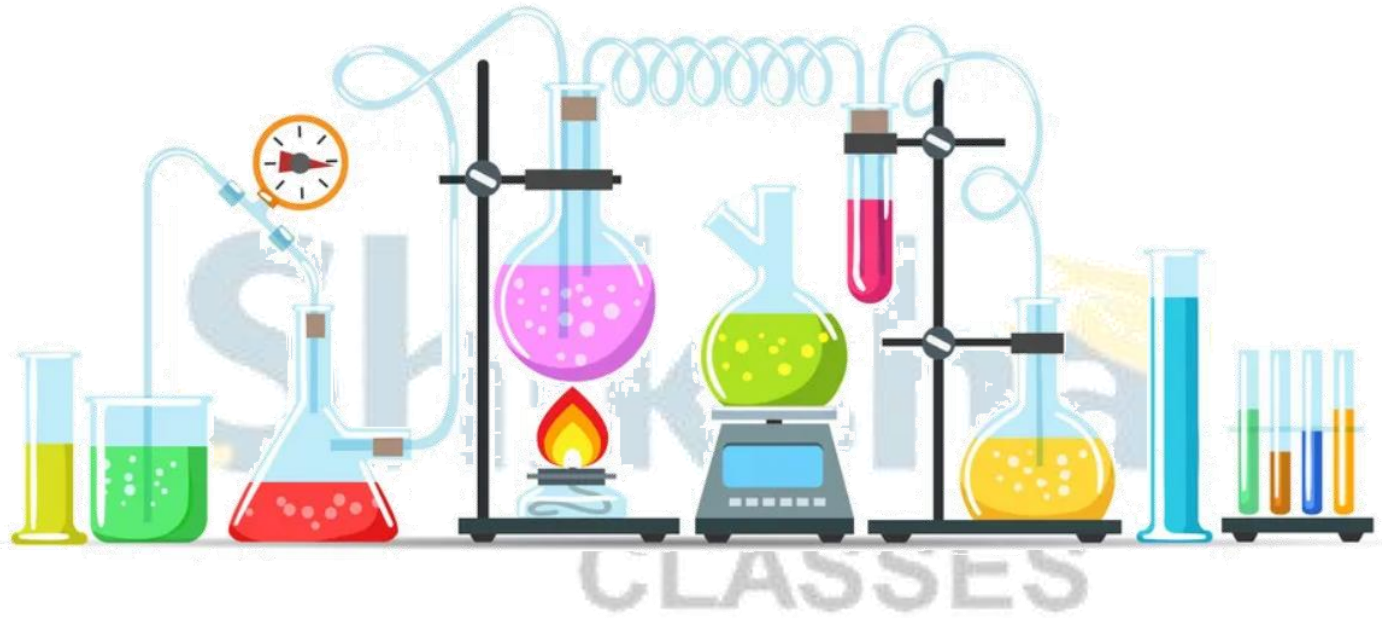
Shiksha CLASSES

SCIENCE

(Chemistry)

Chapter 2: Acids, Bases & Salts



Acids, Bases & Salts

Three different theories have been put forth in order to define acids and bases.

- The Arrhenius theory of acids and bases states that “an acid generates H+ ions in a solution whereas a base produces an OH– ion in its solution”.
- The Bronsted-Lowry theory defines “an acid as a proton donor and a base as a proton acceptor”.
- Finally, the Lewis definition of acids and bases describes “acids as electron-pair acceptors and bases as electron-pair donors”.

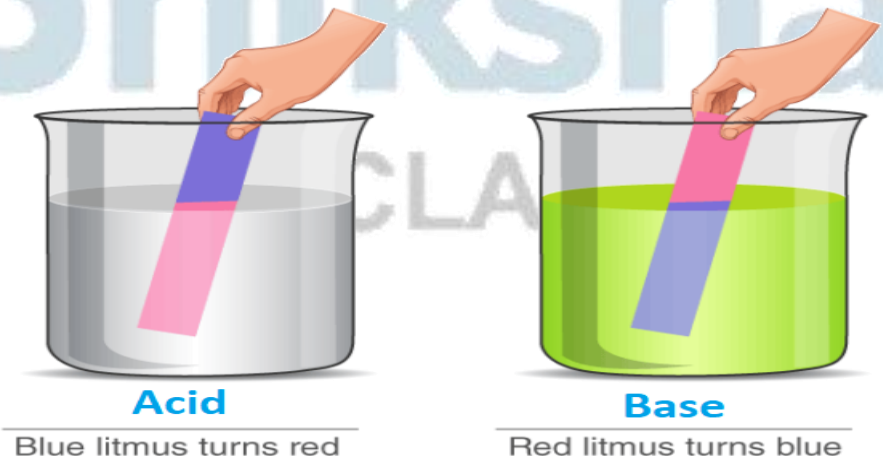
Acids and Bases in the Laboratory

Indicators

An indicator tells us whether a substance is acidic or basic in nature, by the change in colour.

Common Indicators

- An acid turns blue litmus red and a base turns red litmus blue.
- Methyl orange indicator gives a red colour in an acidic solution and gives a yellow colour in a basic solution.
- Phenolphthalein is colourless in an acidic solution and gives a pink colour in a basic solution.



Olfactory Indicators

- Those substances whose odour changes in acidic or basic media are called olfactory indicators. For example: onion, vanilla and clove oil.
- On adding sodium hydroxide solution to a cloth strip treated with onion, the smell of the onion is not detected. An acidic solution does not eliminate the smell of the onion.

Reaction of Acids & Bases with Metals

Acids react with metals to produce salt by displacing hydrogen.

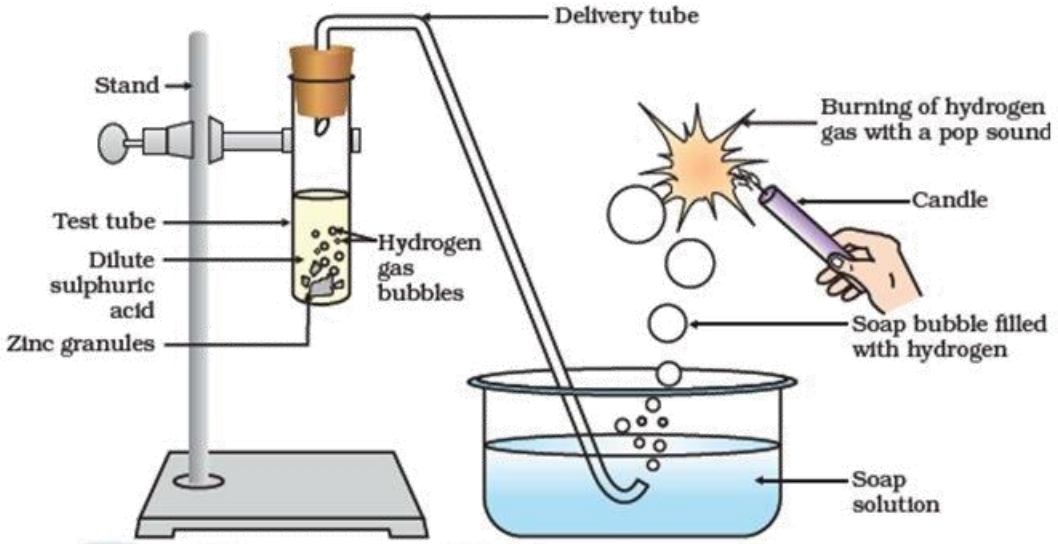
For Example:

1. When dilute sulphuric acid reacts with the metal zinc, zinc sulphate is formed with the evolution of hydrogen gas.

   $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

2. Zinc is the only metal which reacts with sodium hydroxide to form sodium zincate with the release of hydrogen gas.

   $Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2$



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

Reaction of Metal Carbonates & Bicarbonates with Acids

Acids react with metal carbonates or bicarbonates to form salt and water with the evolution of carbon dioxide gas.

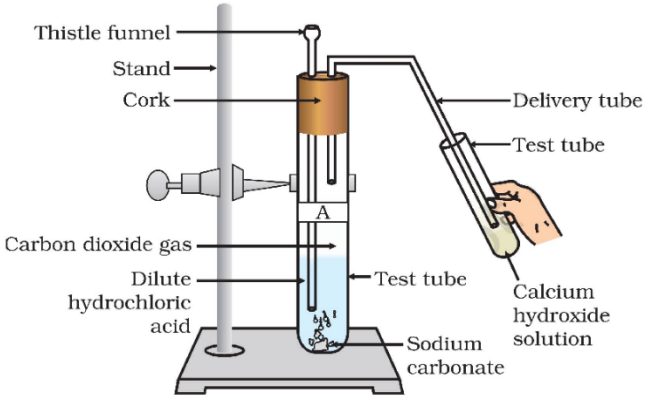
For Example:

1. Hydrochloric acid reacts with sodium carbonate to form sodium chloride and water with the release of carbon dioxide gas.

   $Na_2CO_{3(s)} + 2\ HCl_{(aq)} \rightarrow 2NaCl_{(aq)} + CO_{2(g)} + H_2O_{(l)}$

2. Similarly, sodium bicarbonate also reacts with hydrochloric acid to form sodium chloride and water with the release of carbon dioxide gas.

   $NaHCO_{3(s)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + CO_{2(g)} + H_2O_{(l)}$



Passing carbon dioxide gas through calcium hydroxide solution

Acids and Bases React with each other

The reaction between an acid and a base to form salt and water is called a neutralisation reaction.

For example:

Hydrochloric acid reacts with sodium hydroxide to form sodium chloride and water.

$NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$

In general, a neutralisation reaction can be written as:

Base + Acid ⟶ Salt + Water

Reaction of Metallic Oxides with Acids

Acids react with metallic oxides to form salt and water.

For Example:

Copper oxide (II), a black metal oxide reacts with dilute hydrochloric acid to form a blue-green coloured copper chloride (II) solution.

$CuO + 2HCl \longrightarrow CuCl_{2(aq)} + H_2O$

Reaction of Non-Metallic Oxides with Base

Bases react with non-metallic oxides to form salt and water.

For Example:

Calcium hydroxide reacts with non-metallic oxides like carbon dioxide to form calcium carbonate salt and water.

$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$

Acids and Bases in Water

Acids

An acid is a substance which dissociates (or ionises) when dissolved in water to release hydrogen ions.

For Example:

An aqueous solution of hydrochloric acid dissociates to form hydrogen ions. Since hydrogen ions do not exist as H^+ in solution, they combine with polar water molecules to form hydronium ions [H_3O^+].

$HCl_{(aq)} \longrightarrow H^+_{(aq)} + Cl^-_{(aq)}$

$H^+ + H_2O \longrightarrow H_3O^+$

The presence of hydrogen ions [H^+] in hydrochloric acid solution makes it behave like an acid.

Bases

A base is a substance which dissolves in water to produce hydroxide ions [OH- ions]. Bases which are soluble in water are called alkalis.

For Example:

Sodium hydroxide dissolves in water to produce hydroxide and sodium ions.

$NaOH_{(aq)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$

The presence of hydroxide ions [OH^-] in sodium hydroxide solution makes it behave like a base.

pH Scale

- pH of a solution: pH of a solution is the negative logarithm to the base 10 of the hydrogen ion concentration expressed in mole per litre.

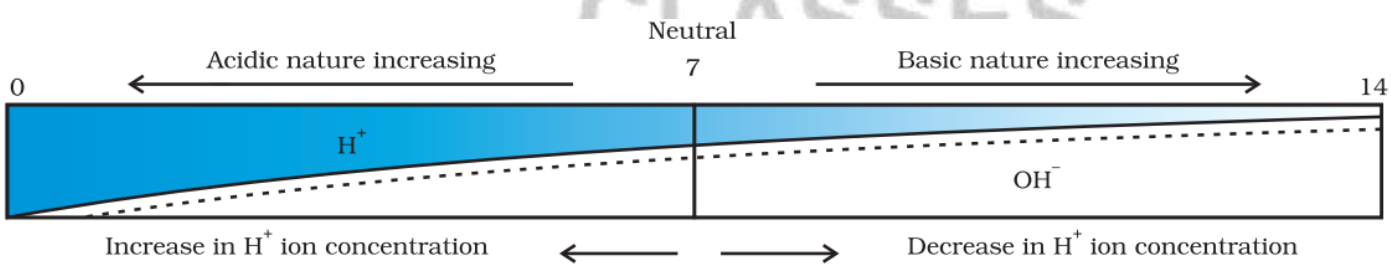
  $pH = -\log_{10}(H^+)$

p H = 7 - Neutral	$[H^+] = [OH^-]$
pH less than 7 - **Acidic**	$[H^+]$ more than $[OH^-]$
pH more than 7 - **Basic**	$[OH^-]$ more than $[H^+]$

Universal Indicator

In case of a colourless liquid, the accurate pH can be obtained by adding a universal indicator.

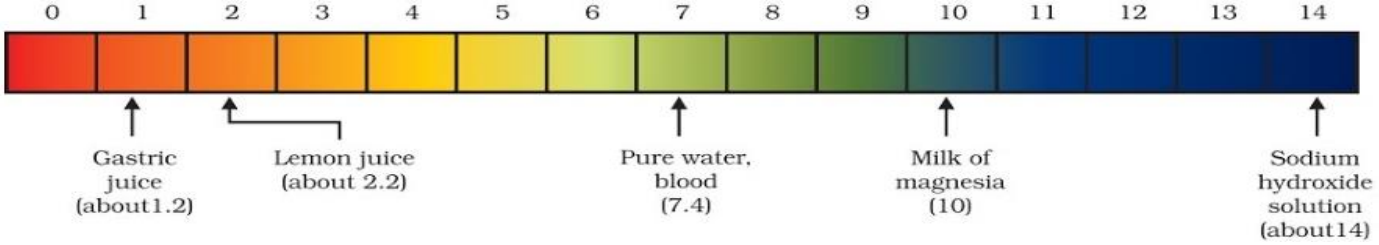
It is a mixture of several indicators and shows different colours at different concentration of hydrogen ions in a solution.



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

For Example:

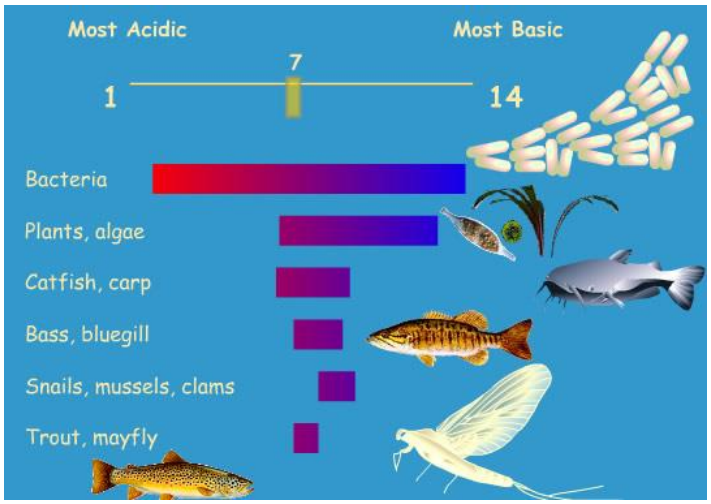
i. A universal indicator produces green colour in a neutral solution, pH = 7.
ii. The colour changes from blue to violet as pH increases from 7 to 14.
iii. The colour changes from yellow to pink and then to red as pH decreases from 7 to 1.



pH of some common substances shown on a pH paper (colours are only a rough guide)

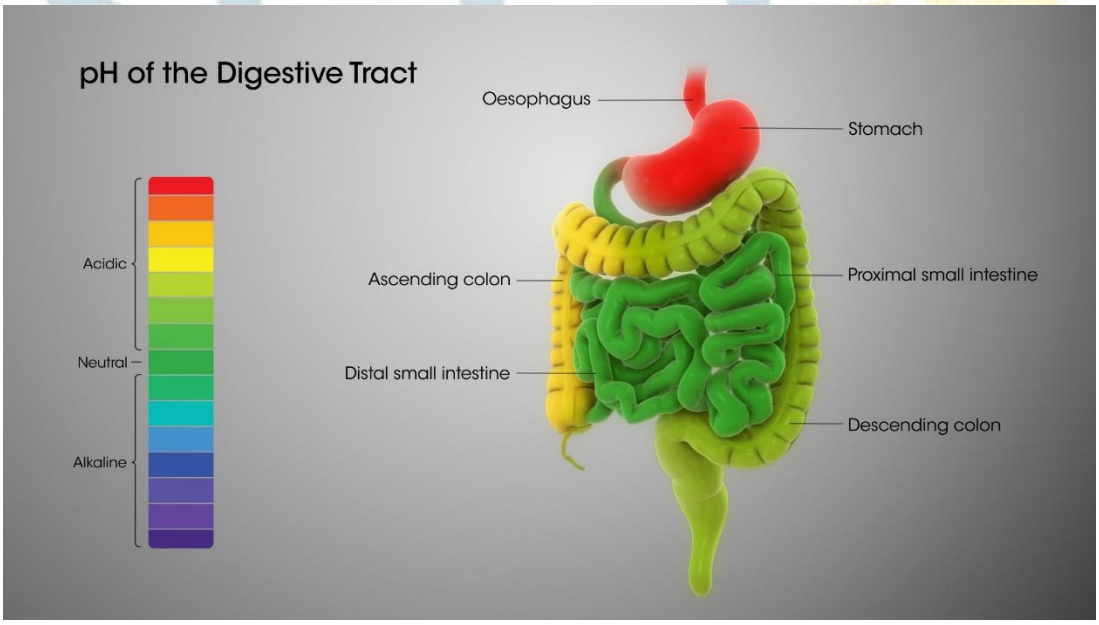
Importance of pH in everyday life

pH change and survival of animals



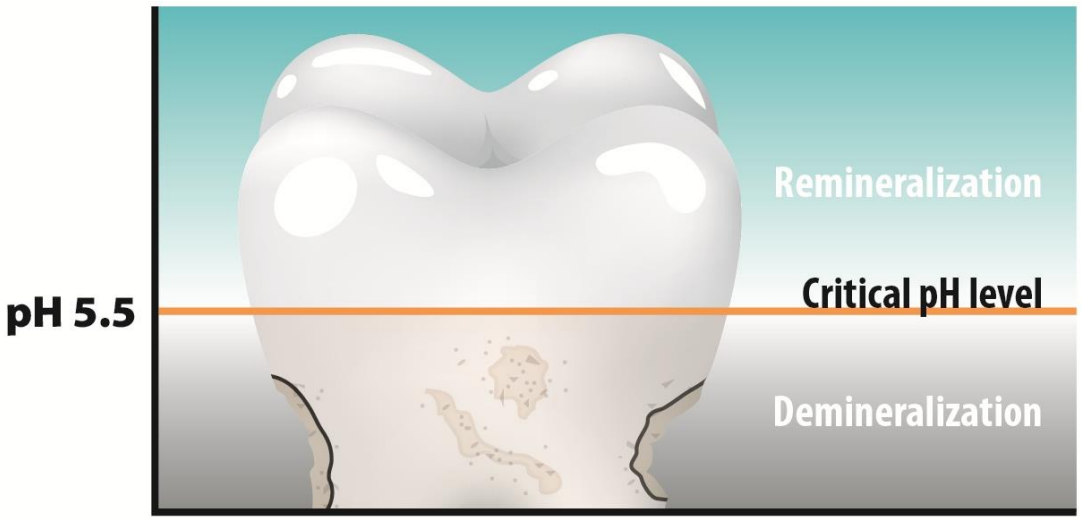
- Our body works well within a narrow pH range of 7.0 to 7.8.
- When the pH of rain water is less than 5.6, it is known as acid rain.
- When this acid rain flows into rivers, it lowers the pH of the river water making the survival of aquatic life difficult.

pH in our digestive system



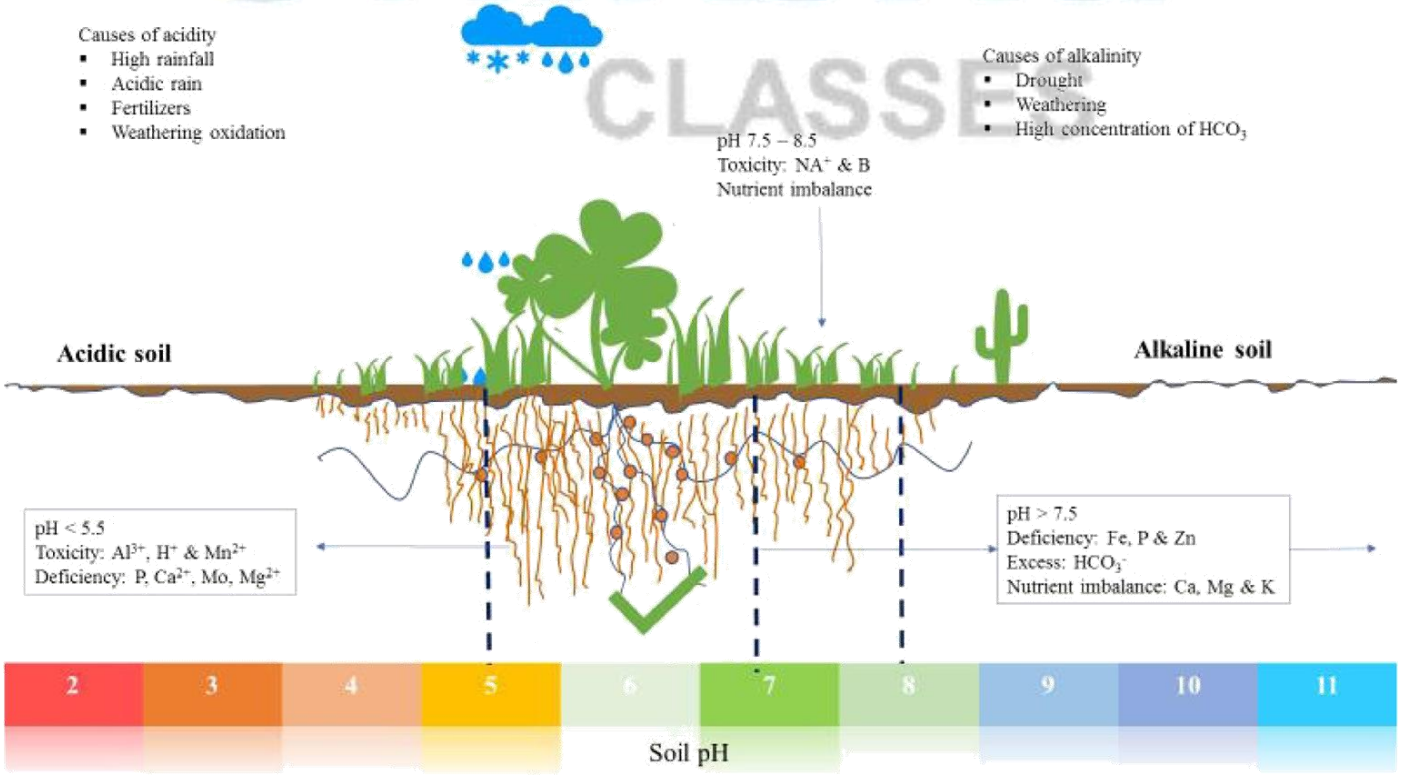
- Our stomach produces hydrochloric acid which helps in the digestion of food without harming the stomach.
- Sometimes excess acid is produced in the stomach which causes indigestion.
- To get rid of this pain, bases called antacids are used.
- Antacids are a group of mild bases which react with the excess acid and neutralise it.
- Commonly used antacids are magnesium hydroxide [$Mg(OH)_2$] & sodium bicarbonate [$NaHCO_3$]

pH change - Cause of tooth decay



- Tooth decay starts when the pH in the mouth falls below 5.5.
- Tooth enamel is made up of calcium phosphate which is the hardest substance in the body.
- It is insoluble in water but gets corroded when the pH in the mouth falls below 5.5.
- The bacteria present in the mouth produce acids due to the degradation of sugar and food particles after eating.
- Hence, to prevent tooth decay, the mouth should be rinsed after eating food and toothpastes which are basic should be used cleaning teeth to neutralise the excess acid.

Soil of pH and plant growth



Most of the plants have a healthy growth when the soil has a specific pH (close to 7) range

which should be neither alkaline nor highly acidic. Therefore,

- Compound 'X' is Sodium hydroxide (NaOH).
- Compound 'A' is Zinc sulphate (ZnSO4).
- Compound 'B' is Sodium chloride (NaCl).
- Compound 'C' is Sodium acetate (CH3COONa)

More about Salts

A salt is a combination of an anion of an acid and a cation of a base.

Examples: KCl, $NaNO_3$,$CaSO_4$, etc.

Salts are usually prepared by the neutralisation reaction of an acid and a base.

Family of salts

Salts having same positive ions (or same negative ions) are said to belong to a family of salts. For example, NaCl, KCl, LiCl.

pH of Salts

- Salts of strong acid and a strong base are neutral, with a pH value of 7.

  For Example: NaCl, Na_2SO_4
- Salts of strong acid and weak base are acidic, with a pH value less than 7.

  For Example: Ammonium chloride solution has pH value of 6.
- Salts of weak acid and strong base are basic, with a pH value more than 7.

  For Example: Sodium carbonate solution has a pH value of 9.

Common Salt

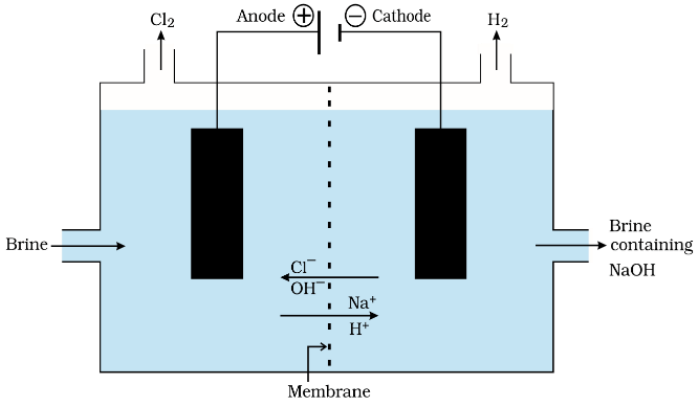
- Common salt is a neutral salt and can be prepared in the laboratory by the reaction of sodium hydroxide and hydrochloric acid.

  $NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H2O_{(aq)}$
- It is an important raw material for products of daily use such as NaOH, baking soda, washing soda and bleaching powder.

Sodium Hydroxide

- Sodium hydroxide is produced by the electrolysis of an aqueous solution of sodium chloride (called brine).
- The process is called the chlor-alkali process because of the products formed, i.e. 'chlor' for chlorine and 'alkali' for sodium hydroxide.

  $2NaCl_{(aq)} + 2H_2O_{(aq)} \rightarrow 2NaOH_{(aq)} + H_{2(g)} + Cl_{2(g)}$



Important products from the chlor-alkali process

Bleaching Powder

- It is produced by the action of chlorine on dry slaked lime [$Ca(OH)_2$].

  $Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$

- It is represented as $CaOCl_2$

Uses

- 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 oxidising agent in many chemical industries; and
- to make drinking water free from germs.

Baking Soda

- Chemical formula: $NaHCO_3$
- It is produced on a large scale by treating cold and concentrated solution of sodium chloride (brine) with ammonia and carbon dioxide.

  $NaCl + H_2O + CO_2 + NH_3 \rightarrow \underset{\text{(Ammonium chloride)}}{NH_4Cl} + \underset{\text{(Sodium hydrogen carbonate)}}{NaHCO_3}$

- On heating, it decomposes to give sodium carbonate with the evolution of carbon dioxide.

  $\underset{\text{(Sodium hydrogen carbonate)}}{2NaHCO_3} \xrightarrow{Heat} \underset{\text{(Sodium carbonate)}}{Na_2CO_3} + H_2O + CO_2$

Uses

- For making baking powder, which is a mixture of baking soda (sodium hydrogen carbonate) and a mild edible acid such as tartaric acid. When baking powder is heated or mixed in water, the following reaction takes place:

  $NaHCO_3 + H^+ \rightarrow CO_2 + H_2O +$ Sodium salt of acid

  Carbon dioxide produced during the reaction can cause bread or cake to rise making

them soft and spongy.

- Sodium hydrogen carbonate is also an ingredient in antacids. Being alkaline, it neutralizes excess acid in the stomach and provides relief.
- It is also used in soda-acid fire extinguishers.

Washing Soda

- Chemical formula: $Na_2CO_3.10H_2O$
- Sodium hydrogen carbonate, on heating decomposes to give sodium carbonate with the release of hydrogen gas. Re-crystallisation of sodium carbonate produces washing soda.

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

$Na_2CO_3 + 10H_2O \longrightarrow Na_2CO_3.10H_2O$
(Sodium carbonate)

Uses

- Sodium carbonate (washing soda) is used in glass, soap and paper industries.
- It is used in the manufacture of sodium compounds such as borax.
- Sodium carbonate can be used as a cleaning agent for domestic purposes.
- It is used for removing permanent hardness of water.

Water of Crystallisation

- Water molecules which form a part of the structure of a crystal are called water of crystallisation.
- The salts which contain water of crystallisation are called hydrated salts.
- Every hydrated salt has a fixed number of molecules of crystallisation in its one formula unit.

For Example: $CuSO_4.5H_2O$, $Na_2CO_3.10H_2O$, $CaSO_4.5H_2O$, and $FeSO_4.7H_2O$

- Copper sulphate crystals ($CuSO_4.5H_2O$) are blue in colour, and on heating strongly they lose all the water of crystallisation and form anhydrous copper sulphate, which is white. On adding water to anhydrous copper sulphate, it gets hydrated and turns blue.

$CuSO_4.5H_2O \xrightarrow{Heat} CuSO_4 + 5H_2O$

$CuSO_4 + 5H_2O \longrightarrow CuSO_4.5H_2O$

Plaster of Paris

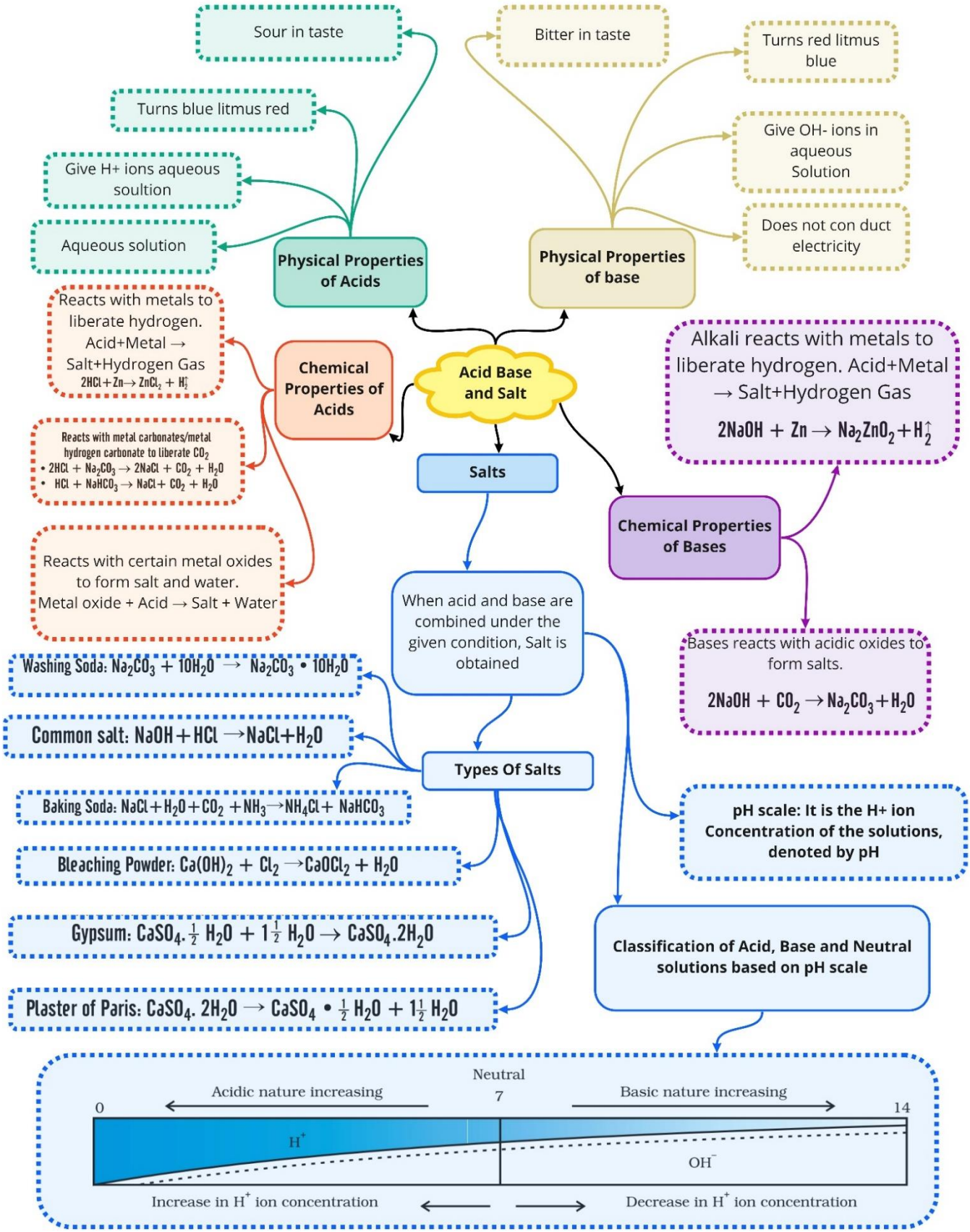
Plaster of Paris is prepared by heating gypsum at 373 K. On heating, it loses water molecules and becomes calcium sulphate hemihydrate ($CaSO_4.\frac{1}{2}H_2O$) which is called Plaster of Paris.

$CaSO_4.2H_2O \xrightarrow{Heat} CaSO_4.\frac{1}{2}H_2O + 1\frac{1}{2}H_2O$
(Gypsum) (Plaster of Paris)

Uses

- Used in hospitals as plaster for supporting fractured bones in the right position.
- Used as a fire-proofing material.

Class : 10th Chemistry
Chapter-2 : Acid Base and Salt



Important Questions

➢ Multiple Choice Questions:

1. What happens when a solution of an acid is mixed with a solution of a base in a test tube?

(i) Temperature of the solution decreases

(ii) Temperature of the solution increases

(in) Temperature of the solution remains the same

(iv) Salt formation takes place

(a) (i) and (iv)

(b) (i) and (iii)

(c) (ii) only

(d) (ii) and (iv)

2. When hydrogen chloride gas is prepared on a humid day, the gas is usually passed through the guard tube containing calcium chloride. The role of calcium chloride taken in the guard tube is to

(a) absorb the evolved gas

(b) moisten the gas

(c) absorb moisture from the gas

(d) absorb Cl– ions from the evolved gas

3. Which one of the following salts does not con-tain water of crystallisation?

(a) Blue vitriol

(b) Baking soda

(c) Washing soda

(d) Gypsum

4. In terms of acidic strength, which one of the following is in the correct increasing order?

(a) Water < Acetic acid < Hydrochloric acid

(b) Water < Hydrochloric acid < Acetic acid

(c) Acetic acid < Water < Hydrochloric acid

(d) Hydrochloric acid < Water < Acetic acid

5. What is formed when zinc reacts with sodium hydroxide?

(a) Zinc hydroxide and sodium

(b) Sodium zincate and hydrogen gas

(c) Sodium zinc-oxide and hydrogen gas

(d) Sodium zincate and water

6. Tomato is a natural source of which acid?

(a) Acetic acid

(b) Citric acid

(c) Tartaric acid

(d) Oxalic acid

7. Brine is an

(a) aqueous solution of sodium hydroxide

(b) aqueous solution of sodium carbonate

(c) aqueous solution of sodium chloride

(d) aqueous solution of sodium bicarbonate

8. $Na_2CO_3.\ 10H_2O$ is

(a) washing soda

(b) baking soda

(c) bleaching powder

(d) tartaric acid

9. At what temperature is gypsum heated to form Plaster of Paris?

(a) 90°C

(b) 100°C

(c) 110°C

(d) 120°C

10. How many water molecules does hydrated calcium sulphate contain?

(a) 5

(b) 10

(c) 7

(d) 2

➢ Very Short Question:

1. Write a balanced chemical equation for the reaction between sodium carbonate and hydrochloric acid indicating the physical state of the reactants and products.

2. During summer season, a milkman usually adds a small amount of baking soda to fresh milk. Give reason.

3. What is the difference between slaked lime and lime water?

4. Which acid is present in sour milk or curd?

5. Why is potassium iodide added into common salt to use it as table salt?

6. What are the pH values of distilled water and common salt solution

7. A dry pellet of a common base B, when kept in open absorbs moisture and turns sticky. The compound is also a by-product of 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.

8. Which bases are called alkalies? Give an example of an alkali.

9. A knife, which is used to cut a fruit, was immediately dipped into water containing drops of blue litmus solution. If the colour of the solution is changed to red, what inference can be drawn about the nature of the fruit and why?

10. How do H^+ ions exist in water?

➢ Short Questions:

1. How will you find pH of lemon juice?

2. A sample of bleaching powder was kept in an air tight container. After a month, it lost some of its chlorine content. How will you account for it?

3. An aqueous solution of sodium carbonate is basic and not acidic. Assign reason.

4. An old person complained of acute pain in the stomach. Doctor gave him a small antacid tablet and he got immediate relief. What actually happened?

5. A milkman adds very small amount of baking soda to fresh milk. What happens to its pW?

6. A few drops of phenolphthalein indicator were added to an unknown solution A. It acquired pink colour. Now another unknown solution B was added to it dropwise and the solution ultimately became colourless. Predict the nature of the solutions A and B.

7. A compound which is prepared from gypsum has the property of hardening when mixed with proper quantity of water. Identify the compound. Write chemical equation to prepare the compound. Mention one important use of the compound.

8. The oxide of a metal M was water soluble. When a blue litmus strip was dipped in this solution, it did not undergo any change in colour. Predict the nature of the oxide.

➢ Long Questions:

1. (a) A solution has a pH of 7. Explain how you would you:

(i) increase its pH

(ii) decrease its pH

(b) If a solution changes the colour of the litmus from red to blue, what can you say about its pH?

(c) What can you say about the pH of a solution that liberates carbon dioxide from sodium carbonate?

2. Explain why:

(i) Common salt becomes sticky during the rainy season

(ii) Blue vitriol changes to white upon heating

(iii) If bottle full of concentrated sulphuric acid is left open in the atmosphere by accident, the acid starts flowing out of the bottle of its own.

3. (a) Name the raw materials used in the manufacture of sodium carbonate by Solvay process.

(b) How is sodium hydrogen carbonate formed during Solvay process separated from a mixture of NH_4Cl and $NaHCO_3$?

(c) How is sodium carbonate obtained from sodium hydrogen carbonate?

➢ Assertion Reason Question:

1. For question two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both A and R are true, and R is correct explanation of the assertion.
   b. Both A and R are true, but R is not the correct explanation of the assertion.
   c. A is true, but R is false.
   d. A is false, but R is true.

Assertion: The process of dissolving an acid or a base in water is highly exothermic reaction.

Reason: Water must always be added slowly to acid with constant stirring.

2. For question two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both A and R are true, and R is correct explanation of the assertion.
   b. Both A and R are true, but R is not the correct explanation of the assertion.
   c. A is true, but R is false.
   d. A is false, but R is true.

Assertion: Higher the H+ ion concentration, lower is the pH value.

Reason: The pH of a neutral solution = 7, that of a basic solution< 7 and that of an acidic solution> 7.

➢ Case Study Questions:

1. Read the following and answer any four questions from (i) to (v).

Bleaching powder is also known as chloride of lime. It is a solid and yellowish white in colour. Bleaching powder can be easily identified by the strong smell of chlorine. When calcium hydroxide (slaked lime) reacts with chlorine, it gives calcium oxychloride (bleaching powder) and water is formed. Aqueous solution of bleaching powder is basic in nature. The material to be bleached is first passed through solution of Na OH to remove greasy matter. Then it is passed through aqueous solution of bleaching powder and very dil. HCl solution. HCl reacts with bleaching powder to liberate nascent oxygen which bleaches material.

i. Bleaching powder is used as:
   a. Bleaching agent in textile, paper and jute industry.
   b. Disinfectant for water to make water free of germs.
   c. Oxidising agent in many industries.
   d. All of these.

ii. Bleaching powder is also known as:
   a. Calcium oxychloride.
   b. Calcium hypochlorite.
   c. Chloride of lime.
   d. All of these.

iii. Bleaching powder gives smell of chlorine because it.
   a. Is unstable.
   b. Gives chlorine on exposure to atmosphere.
   c. Is a mixture of chlorine and slaked lime.
   d. Contains excess of chlorine.

iv. Select the correct statement (s) regarding bleaching powder.
   a. It is pale yellow powder having smell of chlorine.
   b. It is sparingly soluble in water and gives milky suspension when dissolved in water.
   c. As bleaching powder gives nascent oxygen, it shows bleaching property.
   d. All of these.

v. Identify the product 'X' in the given reaction.

   $Ca(OH)_2 + Cl_2 \rightarrow X + H_2O$

   a. $CaOCl_2$

b. $CaCl_2$

c. $Ca(ClO_3)_2$

d. $CaCO_3$

2. Read the following and answer any four questions from (i) to (v).

Baking powder produces carbon dioxide on heating, so it is used in cooking to make the batter spongy. Although, baking soda also produces CO_2 on heating, but it is not used in cooking because on heating, baking soda produces sodium carbonate along with carbon dioxide. Sodium carbonate, thus, produced, makes the taste bitter. Baking powder is the mixture of baking soda and a mild edible acid. Generally, tartaric acid is mixed with baking soda to make baking powder. When baking powder is heated, $NaHCO_3$ decomposes to give CO_2 which makes bread and cake fluffy. Tartaric acid helps to remove bitter taste due to formation of sodium tartrate.

$$\underset{\text{Banking soda}}{2NaHCO_3} + \underset{\text{Tartaric acid}}{C_4H_6O_6} \longrightarrow \underset{\text{Carbon dioxide}}{2CO_2} + 2H_2O + \underset{\text{Sodium tartaric}}{Na_2C_4H_4O_6}$$

i. On passing excess CO_2 gas in aqueous solution of sodium carbonate, the substance obtained is:

a. NaOH
b. $NaHCO_3$
c. $Na_2CO_3.\ I0H_2O$
d. $Na_2CO_3.\ H_2O$

ii. When sodium hydrogen carbonate is added to acetic acid, it evolves a gas. Which of the following statements are true about the gas evolved?

I. It turns lime water milky.
II. It extinguishes a burning splinter.
III. It turns lime water milky.
IV. It has a pungent odour.

a. (I) and (II).
b. (I), (II) and (III).
c. (II), (III) and (IV).
d. (I) and (IV).

iii. Select the correct statement regarding sodium hydrogen carbonate.

a. CO and CO_2 are produced during the heating of $NaHCO_3$.
b. It is insoluble in water.
c. It is used in soda-acid fire extinguishers.
d. All of these.

iv. Acetic acid was added to a solid X kept in a test tube. A colourless and odourless gas was evolved. The gas was passed through lime water which turned milky. It was concluded that,

a. Solid X is sodium hydroxide and the gas evolved is CO_2.
b. Solid X is sodium bicarbonate and the gas evolved is CO_2.
c. Solid X is sodium acetate and the gas evolved is CO_2.
d. Solid X is sodium chloride and the gas evolved is CO_2.

v. Which of the following statements are correct regarding baking soda?

I. Baking soda is sodium hydrogen carbonate.
II. On heating, baking soda gives sodium carbonate.
III. It is used for manufacture of soap.
IV. It is an ingredient of baking powder.

a. I and IV only.
b. I, II and III only.
c. I, II and IV only.
d. I, II, III and IV.

Answer Key-

➢ Multiple Choice Answers:

1. (d) (ii) and (iv)
2. (c) absorb moisture from the gas
3. (b) Baking soda
4. (a) Water < Acetic acid < Hydrochloric acid
5. (b) Sodium zincate and hydrogen gas
6. (d) Oxalic acid
7. (c) aqueous solution of sodium chloride
8. (a) washing soda
9. (b) 100°C
10. (d) 2

➢ Very Short Answers:

1. Answer: Dilute Hydrochloric(HCl) acid reacts with sodium carbonate(Na_2CO_3) to produce sodium chloride (NaCl), carbon dioxide(CO_2), and water(H_2O). Brisk effervescence is seen due to the formation of carbon dioxide gas.

   The balanced chemical reaction is as follows:

   $2HCl(aq)+Na2CO3(aq) \longrightarrow 2NaCl(aq)+CO2(g)+H2O(l)$

2. Answer: Baking soda acts as a bit like preservative. It makes milk a bit alkaline so as to reduce the pace of bacteria acting on it ,as they add acids (e.g. lactic acid) to the milk and turn it sour. this keeps the milk from becoming sour for a long time.

3. Answer: Slaked lime is hydrated calcium hydroxide whereas lime water is a saturated solution of calcium hydroxide. Furthermore, slaked lime has calcium hydroxide in its unsaturated form while lime water has calcium hydroxide in its saturated form in the chemical nature of each these solutions. Similarly, we produce slaked lime from calcium oxide whereas we produce lime water from calcium hydroxide. Below inforgraphic presents more details on the difference between slaked lime and lime water in tabular form.

4. Answer: Lactic Acid or milk acid is an organic acid with chemical formula $C_3H_6O_3$. When milk sugar or lactose undergoes fermentation, the product obtained is lactic acid. It is found in cottage cheese, leban, sour milk, yogurt, and Koumiss.

5. Answer: Potassium iodide and potassium iodate are commonly added to table salt to prevent iodine deficiency and associated thyroid disease.

6. Answer: Normal distilled water has a pH of less than 7.0 and acidic because it dissolves carbon dioxide from the air. pH value of sodium chloride (common salt) in a solution (i.e) common salt solution is about equal to 7.

7. Answer: Sodium hydroxide is a byproduct of chloralkali process. When it is kept in open, it absorbs moisture and turns sticky.

   When sodium hydroxide is treated with carbon dioxide, it gives sodium carbonate. It is important to remember that carbon dioxide is an acidic oxide.

   $2NaOH+CO_2 \rightarrow Na_2CO_3+H_2O$

   Since this reaction is between a basic compound and an acidic compound, hence it is a neutralization reaction.

   B is sodium hydroxide.

8. Answer: Alkalis can be defined as bases that are soluble in water. All alkalis are bases, but all bases are not Alkalis. Example: Sodium hydroxide. They are recognized to comprise of high pH value, i.e., above 7.

9. Answer: A knife, which is used to cut a fruit, was immediately dipped into water containing drops of blue litmus solution. If the colour of the solution is changed to red, what inference can be drawn about the nature of the fruit and why?

10. Answer: H+ ions do not exist independently, it gains the unshared electron pairs on the oxygen in the water molecule to form a hydronium ion.

    $H^+ + H_2O \longrightarrow H_3O^+$

    Hence H^+ ions in water are found as hydronium ions.

➢ Short Answer:

1. Answer:

   (a) Take about 5mL of the given sample of lemon juice in a test tube.

   (b) Dip a strip of the universal pH paper in the tube.

(c) Take out the strip and note its colour. It will acquire a orange red colour.

(d) On comparison with pH paper chart, the pH of the solution falls in the range between 2 and 3.

2. Answer: Bleaching powder if kept even in an airtight container, will slowly decompose of its own and form calcium chlorate and calcium chloride. The reaction is called auto-oxidation. This will result in decrease in its chlorine contents.

$$\underset{\text{Bleaching powder}}{6CaOCl_2} \longrightarrow \underset{\text{Calcium chlorate}}{Ca(ClO_3)_2} + \underset{\text{Calcium chloride}}{5CaCl_2}$$

3. Answer: Sodium carbonate reacts with water to form sodium hydroxide and carbonic acid.

$$Na_2CO_3 + 2H_2O \longrightarrow \underset{\text{[Strong base)}}{2NaOH} + \underset{\text{(Weak acid)}}{H_2CO_3}$$

Since the base is strong while acid is weak, the solution is basic and not acidic.

4. Answer: The old person was suffering from acute acidity. Antacid tablet contains sodium hydrogen carbonate ($NaHCO_3$). It reacts with the acid (HCl) formed because of acidity and neutralizes its effect. That is how the old person got relief.

5. Answer: The pH of fresh milk is nearly 6. Baking soda is sodium hydrogen carbonate ($NaHCO_3$). On adding it to fresh milk, the medium becomes alkaline and its pH therefore, increases.

6. Answer: The solution A is basic in nature and phenolphthalein has imparted pink colour to it. The solution B is of an acid which has ultimately made solution A colourless by neutralising its basic effect.

7. Answer: The compound is Plaster of Paris ($CaSO_4.½\ H_2O$). It is formed from Gypsum ($CaSO_2.2H_2O$) upon heating to a temperature of 373 K and also changes back to Gypsum on adding water. Plaster of Paris is used for setting fractured bones.

$$\underset{\text{Gypsum}}{CaSO_4.2H_2O} \longrightarrow \underset{\text{Plaster of Paris}}{CaSO_4½H_2O} + {}^3/_2H_2O$$

$$CaSO_4.½H_2O + {}^3/_2H_2O \longrightarrow CaSO_4.2H_2O$$

8. Answer: The metal oxide (MO) is of basic in nature. It dissolves in water to form metal hydroxide as follows:

$MO + H_2O \rightarrow M(OH)_2$

A blue litmus does not undergo any change in colour in the basic medium.

➢ Long Answer:

1. Answer:

(a) The solution with pH 7 is neutral. Its pH can be increased by adding a small amount of base like sodium hydroxide. Basic solutions have pH more than 7.

Similarly, pH can be decreased by adding small amount of acid like hydrochloric acid. Acidic solutions have pH less than 7.

(b) The change in colour of litmus from red to blue indicates that the solution is of basic nature with pH more than 7.

(c) Carbon dioxide can be liberated by reacting sodium carbonate solution with acid like dilute hydrochloric acid. This shows that the solution is of acidic nature with pH less than 7.

2. Answer:

(i) Common salt contains the impurity of magnesium chloride ($MgCl_2$) which is of deliquescent nature. When exposed to atmosphere, it becomes moist. Therefore, common salt becomes sticky during the rainy reason.

(ii) Blue vitriol ($CUSO_4.5H_2O$) upon heating changes to anhydrous copper sulphate ($CUSO_4$) which is white in colour.

(iii) Concentrated sulphuric acid is highly hygroscopic. It absorbs moisture from air and gets diluted. Since the volume increases, the acid starts flowing out of the bottle.

3. Answer:

(a) The raw materials used are: NaCl, lime stone or $CaCO_3$ and NH_3.

(b) Sodium hydrogen carbonate ($NaHCO_3$) is sparingly soluble or less soluble in water and gets separated as a preciptate while NH_4Cl remains in solution. The precipitate is removed by filtration.

(c) Sodium hydrogen carbonate is converted to sodium carbonate upon heating.

$$2NaHCO_3 \xrightarrow{\text{heat}} Na_2CO_3 + H_2O + CO_2$$

➢ Assertion Reason

1. (c) A is true, but R is false.

Explanation:

The process of dissolving an acid or a base in water is highly exothermic reaction. Acid must always be added slowly to water with constant stirring.

2. (c) A is true, but R is false.

Explanation:

Higher the H^+ ion concentration, lower is the pH value. The pH value less than 7 represents an acidic solution and value more than 7 represents a basic solution.

➢ Case Study Answer:

1.

i. (d) All of these.

ii. (d) All of these.

iii. (b) Gives chlorine on exposure to atmosphere.

Explanation:

Bleaching powder gives chlorine on exposure to air by reacting with CO_2.

$$CaClO_2 + CO \longrightarrow CaCO + Cl_2$$

iv. (d) All of these.

v. (a) $CaOCl_2$

Explanation:

$$Ca(OH)_2 + Cl_2 \longrightarrow CaOCl_2 + H_2O$$

2.

i. (b) $NaHCO_3$

Explanation:

$$Na_2CO_3 + H_2O + CO_2 \longrightarrow 2NaHCO_3$$

ii. (b) (I), (II) and (III).

Explanation:

$$NaHCO_3 + CH_3COOH \longrightarrow CH_3COONa + CO_2\uparrow + H_2O$$

Carbon dioxide gas is evolved which turns lime water milky. It extinguishes a burning splinter since it is not a supporter of combustion. It dissolves in sodium hydroxide solution and it is an odourless gas.

iii. (c) It is used in soda-acid fire extinguishers.

Explanation:

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

$NaHCO_3$ is soluble in water.

iv. (b) Solid X is sodium bicarbonate and the gas evolved is CO_2.

Explanation:

$$NaHCO_3 + CH_3COOH \longrightarrow CH_3COONa + CO_2 + H_2O$$

v. (c) I, II and IV only.

Explanation:

It is not used in manufacture of soap.