2 Acids, Bases and Salts

Fastrack Revision

- **Indicators:** These are the chemical substances which give different colours in acidic and basic solutions. Litmus solution and turmeric are natural indicators. Methyl orange and phenolphthalein are synthetic indicators. Vanilla, onion and clove are used to determine the presence of acids and bases with their smell, hence they are called olfactory indicators.

Indicator	Original Colour	Acid	Base
Red litmus	Red	No change	Blue
Blue litmus	Blue	Red	No change
Turmeric	Yellow	No change	Reddish brown
Red cabbage juice	Purple	Red	Greenish yellow
Phenolphthalein	Colourless	Colourless	Pink
Methyl orange	Orange	Red	Yellow
Onion	–	No change	Smell vanishes
Vanilla	–	No change	Smell vanishes
Clove oil	–	No change	Smell vanishes

- **Universal Indicator:** It is a mixture of many different indicators (or dyes) which give different colours at different pH values to indicate the acidity and alkalinity of solutions.
- **Acids:** The substances which are sour in taste and turn blue litmus solution to red colour are called acids. Some fruits like lemon, orange, tamarind, etc. are sour in taste due to presence of acid in them. According to Arrhenius, acids are hydrogenous substances and releases hydrogen ions (H^+) in aqueous solution, *e.g.*, HCl (Hydrochloric acid), H_2SO_4 (Sulphuric acid), HNO_3 (Nitric acid), CH_3COOH (Acetic acid), H_2CO_3 (Carbonic acid), H_2SO_3 (Sulphurous acid), etc.
- **Chemical Properties of Acids**
  - **Reaction with Metals:** When acids react with metals, they produce a salt and hydrogen gas. Most metals react with acids, but not all.

    For example,
    - $Zn(s) + H_2SO_4(aq) \longrightarrow ZnSO_4(aq) + H_2(g)$
    - $Mg(s) + 2HCl(aq) \longrightarrow \underset{\text{Salt}}{MgCl_2(aq)} + H_2(g)$
  - **Reaction with Metal Carbonates:** All metal carbonates and hydrogen carbonates react with acids to give a corresponding salt, carbon dioxide and water.

    For example,
    - $\underset{\text{Acid}}{2HCl(aq)} + \underset{\text{Metal carbonate}}{Na_2CO_3(s)} \longrightarrow \underset{\text{Salt}}{2NaCl(aq)} + CO_2(g) + H_2O(l)$
    - $\underset{\text{Hydrogen carbonate}}{NaHCO_3(s)} + HCl(aq) \longrightarrow NaCl(aq) + CO_2(g) + H_2O(l)$
  - **Neutralisation Reaction:** It is the reaction between an acid and a base to give salt and water.

    For example,

    $\underset{\text{Acid}}{HCl(aq)} + \underset{\text{Base}}{NaOH(aq)} \longrightarrow \underset{\text{Salt}}{NaCl(aq)} + \underset{\text{Water}}{H_2O(l)}$
  - **Reaction with Metal Oxides:** An acid reacts with a metal oxide/hydroxide to form salt and water.

    For example,

    $\underset{\text{Metal oxide}}{CuO(s)} + \underset{\text{Acid}}{2HCl(aq)} \longrightarrow \underset{\text{Salt}}{CuCl_2(aq)} + \underset{\text{Water}}{H_2O(l)}$
- **Bases:** The substances which are soapy to touch, bitter in taste and turn red litmus solution to blue colour are called bases. According to Arrhenius, they give hydroxide (OH^-) ions in aqueous solution, *e.g.*, NaOH, KOH, etc. All water-soluble bases are called **alkalies.** All alkalies are bases but all bases may not be alkalies.
- **Chemical Properties of Bases**
  - **Reaction with Metals:** Only reactive metals (such as sodium and potassium) react with bases to form salt and hydrogen gas.

    For example,

    $\underset{\text{Base}}{2NaOH(aq)} + \underset{\text{Metal}}{Zn(s)} \longrightarrow \underset{\text{Salt}}{Na_2ZnO_2(s)} + \underset{\text{Gas}}{H_2(g)}$
  - **Reaction with Non-metallic Oxides:** Non-metallic oxides are acidic in nature. Thus, they will react with bases to form salt and water. They do not react with acids.

    For example,

    $\underset{\text{Base}}{Ca(OH)_2(s)} + \underset{\text{Non-metallic oxide}}{CO_2(g)} \longrightarrow \underset{\text{Salt}}{CaCO_3(s)} + \underset{\text{Water}}{H_2O(l)}$
- **pH Scale:** It is a scale used to measure the concentration of H^+ ions in a solution. One can measure pH from zero (very acidic) to fourteen (very alkaline) on this scale. Higher the value of hydrogen ion, lower will be its pH value. Also, as pH increases, the concentration of OH^- ions also increases and therefore the strength of the base also increases. 7 indicates neutral pH.
- **Importance of pH in Everyday Life**
  - Our body works in the pH range of 7.0 to 7.8.
  - Change in pH (less than 5.6) of rain causes acid rain, which has harmful effects on aquatic life.
  - Plants require a specific pH range for their healthy growth.
  - Tooth decay starts when pH of mouth is lower than 5.5.

- **pH of Salts**
  - Salt of a strong acid and a strong base is neutral in nature with pH value of 7.
  - Salt of a strong acid and a weak base is acidic in nature with pH value less than 7.
  - Salt of a strong base and a weak acid is basic in nature with pH value more than 7.
- **Common Salt:** Sodium chloride obtained from sea is also known as common salt. The large crystals of common salt found in underground deposits are called rock salt.
- **Some Compounds Obtained from Common Salt**
  - **Sodium Hydroxide (NaOH):** When electricity is passed through an aqueous solution of sodium chloride (brine), the salt undergoes decomposition to produce sodium hydroxide solution near the cathode, chlorine gas at the anode and hydrogen gas at the cathode. This process is called chlor-alkali process because of the products formed-chlor for chlorine and alkali for NaOH.

$$2NaCl(aq) + 2H_2O(l) \xrightarrow{\text{Electricity}} 2NaOH(aq) + Cl_2(g) + H_2(g)$$

  - **Bleaching Powder ($CaOCl_2$):** When chlorine gas is passed through dry slaked-lime [$Ca(OH)_2$], bleaching powder ($CaOCl_2$) is obtained.

$$\underset{\text{Slaked lime}}{Ca(OH)_2} + Cl_2 \longrightarrow \underset{\text{Bleaching powder}}{CaOCl_2} + H_2O$$

Bleaching powder is used to manufacture chloroform and as a disinfectant.

  - **Baking Soda ($NaHCO_3$):** It is used for making baking powder and as an ingredient of antacids. It is also used in soda-acid fire extinguishers.

$$NaCl + H_2O + CO_2 + NH_3 \longrightarrow \underset{\text{Ammonium chloride}}{NH_4Cl} + \underset{\text{Sodium hydrogen-carbonate}}{NaHCO_3}$$

The following reaction takes place when baking soda is heated during cooking.

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

  - **Washing Soda ($Na_2CO_3 \cdot 10H_2O$):** Washing soda is obtained by recrystallisation of sodium carbonate. It is a basic salt.

$$\underset{\text{Sodium carbonate}}{Na_2CO_3} + 10H_2O \longrightarrow \underset{\text{Washing soda}}{Na_2CO_3 \cdot 10H_2O}$$

It is used in soap, glass and paper industries.

- **Plaster of Paris ($CaSO_4 \cdot \frac{1}{2}H_2O$):** It is prepared by heating gypsum ($CaSO_4 \cdot 2H_2O$) at 373K causing it to lose water molecules and becoming calcium sulphate hemihydrate.

$$\underset{\text{Gypsum}}{CaSO_4 \cdot 2H_2O} \xrightarrow[373\,K]{\text{Heat}} \underset{\text{Plaster of Paris}}{CaSO_4 \cdot \frac{1}{2}H_2O} + \underset{\text{Water}}{\frac{3}{2}H_2O}$$

It is used for making toys, materials for decoration and for making smooth surfaces.

- **Water of Crystallisation:** It is the fixed number of water molecules present in one formula unit of a salt. The salts which contain water of crystallisation are called hydrated salts.

For example, Gypsum crystals contain two molecules of water of crystallisation. It has the chemical formula, $CaSO_4 \cdot 2H_2O$.

When hydrated salts are heated strongly, they lose their water of crystallisation. The salts which have lost their water of crystallisation are called anhydrous salts.

Practice Exercise

Multiple Choice Questions

Q 1. Select from the following statement which is true for bases. *(CBSE 2021 Term-1)*

a. Bases are bitter and turn blue litmus red.
b. Bases have a pH less than 7
c. Bases are sour and change red litmus to blue
d. Bases turn pink when a drop of phenolphthalein is added to them.

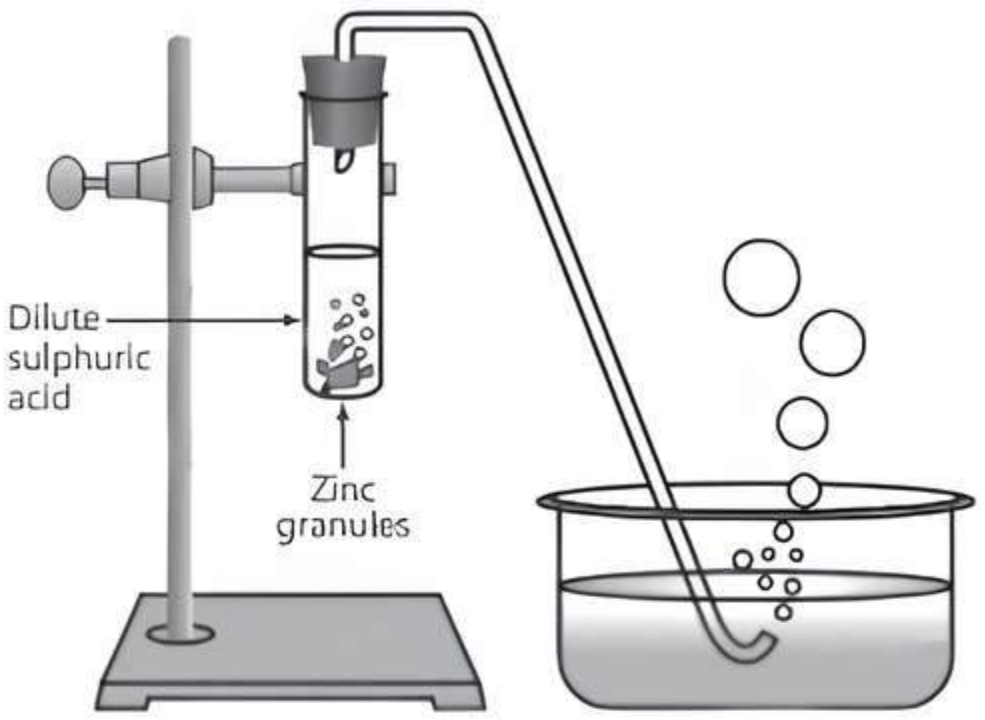
Q 2. Vinay observed that the stain of curry on a white shirt becomes reddish-brown when soap is scrubbed on it, but it turns yellow again when the shirt is washed with plenty of water. What might be the reason for his observation?
(i) Soap is acidic in nature
(ii) Soap is basic in nature
(iii) Turmeric is a natural indicator which gives reddish tinge in bases
(iv) Turmeric is a natural indicator which gives reddish tinge in acids *(CBSE SQP 2021 Term-1)*

a. (i) and (ii)
b. (ii) and (iii)
c. (i) and (iv)
d. (ii) and (iv)

Q 3. An aqueous solution 'A' turns phenolphthalein solution pink. On addition of an aqueous solution 'B' to 'A', the pink colour disappears. Which of the following statement is true for solution 'A' and 'B'? *(CBSE 2020)*

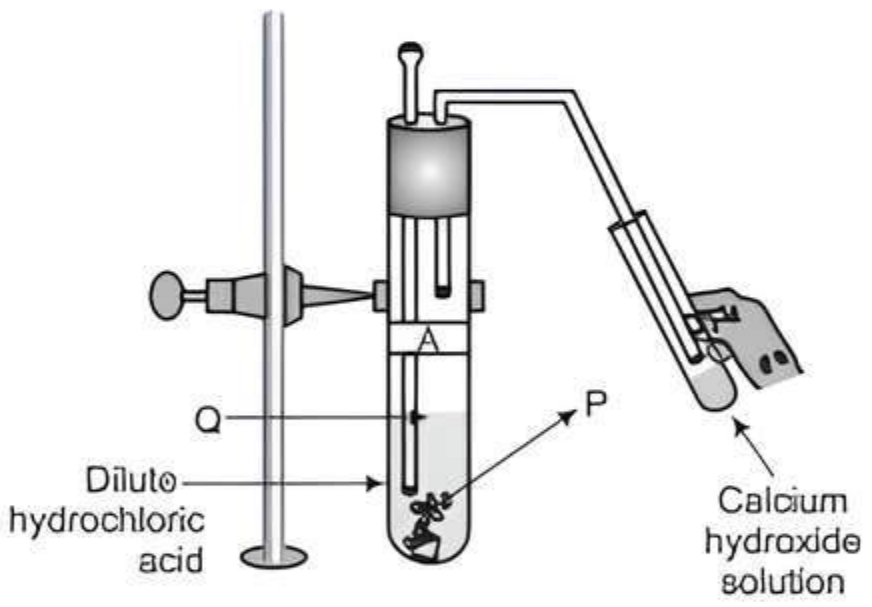
a. A is strongly basic and B is a weak base.
b. A is strongly acidic and B is a weak acid.
c. A has pH greater than 7 and B has pH less than 7.
d. A has pH less than 7 and B has pH greater than 7.

Q 4. Study the diagram given below and identify the gas formed in the reaction. *(CBSE 2021 Term-1)*



a. Carbon dioxide which extinguishes the burning candle.
b. Oxygen due to which the candle burns more brightly.
c. Sulphur dioxide which produces a suffocating smell
d. Hydrogen which while burning produces a popping sound.

Q 5. Study the experimental set up shown in given figure and choose the correct option from the following: *(CBSE 2021 Term-1)*

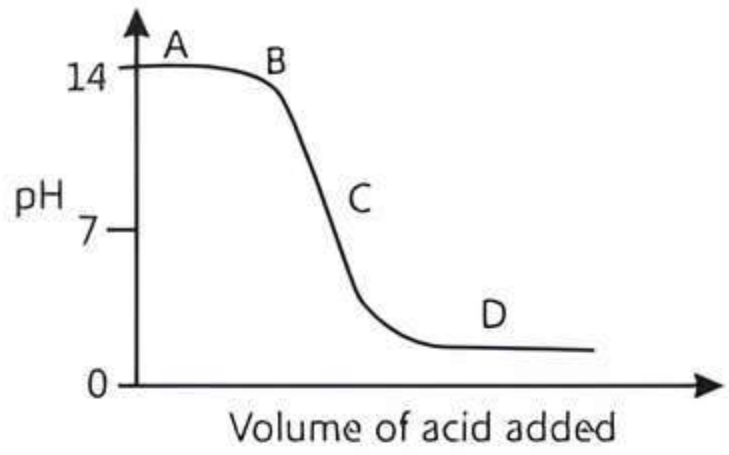


	P	Q	Change observed in calcium hydroxide solution
a.	K_2CO_3	Cl_2 gas	No change
b.	$KHCO_3$	CO_2 gas	No change
c.	$KHCO_3$	H_2 gas	Turns milky
d.	K_2CO_3	CO_2 gas	Turns milky

Q 6. When sodium bicarbonate reacts with dilute hydrochloric acid, the gas evolved is: *(CBSE 2023)*

a. Hydrogen: it gives pop sound with burning match stick.
b. Hydrogen: it turns lime water milky.
c. Carbon dioxide: it turns lime water milky.
d. Carbon dioxide: it blows off a burning match stick with a pop sound.

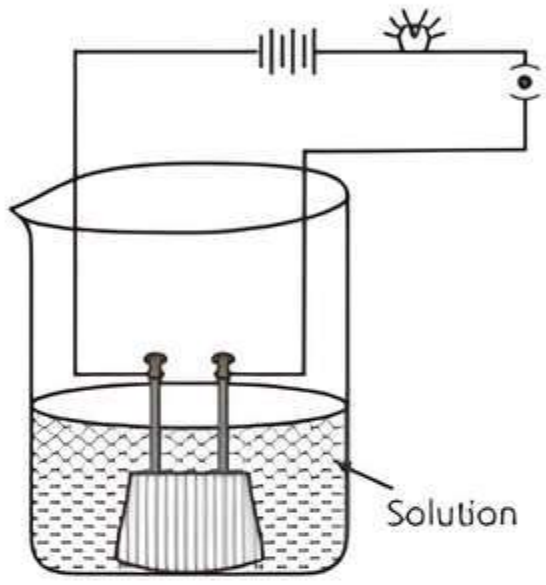
Q 7. The graph given ahead depicts a neutralisation reaction (acid + Add alkali ⟶ salt + Add water). The pH of a solution changes as we add excess of acid to an alkali.



Which letter denotes the area of the graph where both acid and salt are present? *(CBSE SQP 2021 Term-1)*

a. A b. B c. C d. D

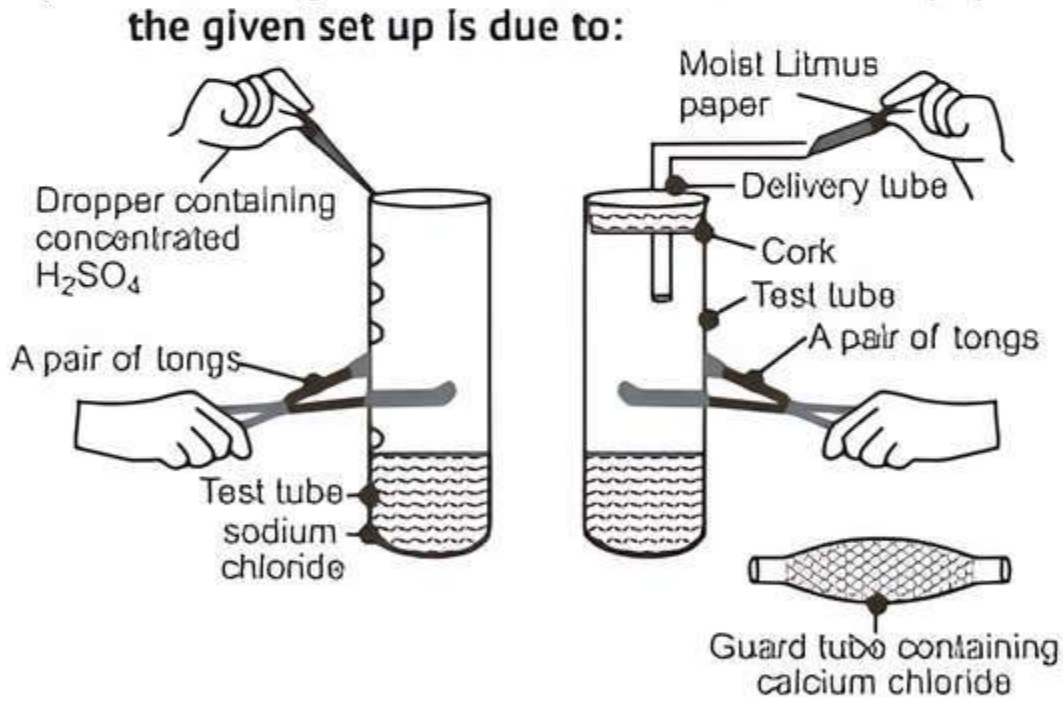
Q 8. In the given experimental set-up, if the experiment is carried out separately with each of the following solutions the cases in which the bulb will glow is/ are: *(CBSE 2023)*



(i) Dilute hydrochloric acid
(ii) Dilute sulphuric acid
(iii) Glucose solution
(iv) Alcohol

a. Only (i) b. Only (ii)
c. (i) and (ii) d. (ii), (iii) and (iv)

Q 9. The change in colour of the moist litmus paper in the given set up is due to:



(i) presence of acid
(ii) presence of base
(iii) presence of $H^+(aq)$ in the solution
(iv) presence of Litmus which acts as an indicator *(CBSE SQP 2022-23)*

a. (i) and (ii) b. Only (ii)
c. Only (iii) d. Only (iv)

Q 10. Sodium hydroxide is termed an alkali while Ferric hydroxide is not because: *(CBSE 2023)*

a. Sodium hydroxide is a strong base, while Ferric hydroxide is a weak base.
b. Sodium hydroxide is a base which is soluble in water while Ferric hydroxide is also a base but it is not soluble in water.

c. Sodium hydroxide is a strong base while Ferric hydroxide is a strong acid.
d. Sodium hydroxide and Ferric hydroxide both are strong base but the solubility of Sodium hydroxide in water is comparatively higher than that of Ferric hydroxide.

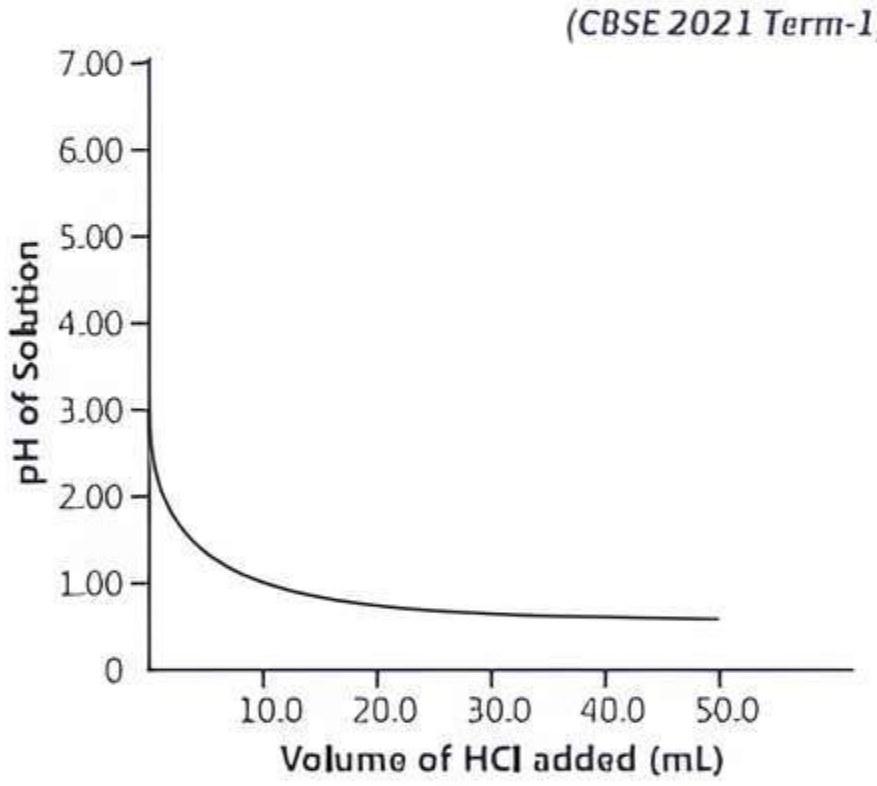
Q 11. Consider the pH value of the following acidic samples:

S. No.	Sample	pH Value
1.	Lemon Juice	2.2
2.	Gastric Juice	1.2
3.	Vinegar	3.76
4.	Dil. Acetic acid	3.0

The decreasing order of their H^+ ion concentration is: *(CBSE 2021 Term-1)*

a. 3 > 4 > 1 > 2 b. 2 > 1 > 3 > 4
c. 2 > 1 > 4 > 3 d. 3 > 4 > 2 > 1

Q 12. 50.0 mL of tap water was taken in a beaker. Hydrochloric acid was added drop by drop to water. The temperature and pH of the solution was noted. The following graph was obtained. Choose the correct statements related to this activity. *(CBSE 2021 Term-1)*



(i) The process of dissolving an acid in water is highly endothermic.
(ii) The pH of the solution increases rapidly on addition of acid.
(iii) The pH of the solution decreases rapidly on addition of acid.
(iv) The pH of tap water was around 7.0

a. (i) and (ii) b. (i) and (iii)
c. (iii) and (iv) d. (ii) and (iv)

Q 13. Anita added a drop each of diluted acetic acid and diluted hydrochloric acid on pH paper and compared the colours. Which of the following is the correct conclusion? *(CBSE SQP 2022-23)*

a. pH of acetic acid is more than that of hydrochloric acid.
b. pH of acetic acid is less than that of hydrochloric acid.
c. Acetic acid dissociates completely in aqueous solution.
d. Acetic acid is a strong acid.

Q 14. Which of the following gives the correct increasing order of acidic strength?

a. Sodium chloride < Acetic acid < Hydrochloric acid
b. Sodium chloride < Hydrochloric acid < Acetic acid
c. Acetic acid < Sodium chloride < Hydrochloric acid
d. Hydrochloric acid < Sodium chloride < Acetic acid

Q 15. Calcium phosphate is present in tooth enamel. Its nature is: *(NCERT EXEMPLAR)*

a. basic b. acidic
c. neutral d. amphoteric

Q 16. Acid present in tomato is: *(CBSE 2023)*

a. Methanoic acid b. Acetic acid
c. Lactic acid d. Oxalic acid

Q 17. Study the following table and choose the correct option. *(CBSE 2021 Term-1)*

Salt	Parent Acid	Parent base	Nature of salt
a. Sodium Chloride	HCl	NaOH	Basic
b. Sodium Carbonate	H_2CO_3	NaOH	Neutral
c. Sodium Sulphate	H_2SO_4	NaOH	Acidic
d. Sodium Acetate	CH_3COOH	NaOH	Basic

Q 18. Common salt besides being used in kitchen can also be used as the raw material for making: *(NCERT EXEMPLAR)*

(i) washing soda (ii) bleaching powder
(iii) baking soda (iv) slaked lime.

a. (i) and (ii) b. (i), (ii) and (iv)
c. (i) and (iii) d. (i), (iii) and (iv)

Q 19. Mild non-corrosive basic salt is: *(CBSE SQP 2023-24)*

a. $Ca(OH)_2$ b. NaOH
c. NaCl d. $NaHCO_3$

Q 20. The name of the salt used to remove permanent hardness of water is: *(CBSE 2023)*

a. Sodium hydrogen carbonate ($NaHCO_3$)
b. Sodium chloride (NaCl)
c. Sodium carbonate decahydrate ($Na_2CO_3 \cdot 10H_2O$)
d. Calcium sulphate hemihydrate ($CaSO_4 \cdot \frac{1}{2}H_2O$)

Q 21. Which of the following salts do not have the water of crystallisation? *(CBSE 2021 Term-1)*

(i) Bleaching Powder (ii) Plaster of Paris
(iii) Washing soda (iv) Baking soda

a. (ii) and (iv) b. (i) and (iii)
c. (ii) and (iii) d. (i) and (iv)

Assertion & Reason Type Questions

Directions (Q. Nos. 22-30): *Each of the following questions consists of two statements, one is Assertion (A) and the other is Reason (R). Give answer:*

a. Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
b. Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).
c. Assertion (A) is true but Reason (R) is false.
d. Assertion (A) is false but Reason (R) is true.

Q 22. **Assertion (A):** Bases change red litmus solution into blue litmus solution.
Reason (R): Bases give hydroxide ions in aqueous solution.

Q 23. **Assertion (A):** Clove oil is an olfactory indicator.
Reason (R): Smell of clove can be characterised in acidic medium, but it cannot be recognised in basic medium.

Q 24. **Assertion (A):** Non-metallic oxides react with bases to form salt and water.
Reason (R): Non-metallic oxides are acidic in nature.

Q 25. **Assertion (A):** Hydrochloric acid is a stronger acid than acetic acid.
Reason (R): On dissociation, hydrochloric acid yields lesser hydrogen ions for the same concentration as compared to acetic acid.

Q 26. **Assertion (A):** Strength of acid or base decreases with dilution.
Reason (R): Ionisation of an acid or a base increase with dilution.

Q 27. **Assertion (A):** To dilute concentrated sulphuric acid, water is added to the acid slowly.
Reason (R): A lot of heat energy will be given out in the dilution of concentrated sulphuric acid.

Q 28. **Assertion (A):** Sodium hydrogen carbonate is used as an ingredient in antacids.
Reason (R): $NaHCO_3$ is a mild non-corrosive basic salt.

Q 29. **Assertion (A):** During electrolysis of concentrated aqueous solution of sodium chloride, chlorine gas is given off at the cathode and hydrogen gas at the anode.
Reason (R): Ions in electrolytes are attracted to the oppositely charged electrodes.

Q 30. **Assertion (A):** Plaster of Paris should be stored in a moisture proof container.
Reason (R): Plaster of Paris is a powdery mass that absorbs water to form a hard solid, gypsum.

Answers

1. (d) Bases turn pink when a drop of phenolphthalein is added to them.

2. (b) (ii) and (iii)

3. (c) A has pH greater than 7 and B has pH less than 7.

4. (d) Hydrogen which while burning produces a popping sound.
$Zn(s) + H_2SO_4(aq) \longrightarrow ZnSO_4(aq) + H_2(g)$

5. (d) K_2CO_3 CO_2 gas Turns milky
$K_2CO_3 + 2HCl \longrightarrow 2KCl + CO_2 + H_2O$
$KHCO_3 + HCl \longrightarrow KCl + CO_2 + H_2O$
In both cases, CO_2 is produced which turns lime water milky.

6. (c) Carbon dioxide: it turns lime water milky.
$NaHCO_3 + HCl \longrightarrow NaCl + H_2O + CO_2$
Sodium bicarbonate
We know that CO_2 turns lime water milky.

7. (d) D
When both acid and salt are present, the pH of the solution becomes less than 7. From the graph, pH is less than 7 at only D.

8. (c) (i) Dilute hydrochloric acid
(ii) Dilute sulphuric acid
Bulb will glow in the case of acids (HCl, H_2SO_4, etc.) and will not glow in case of glucose and alcohol solution.

9. (c) Only (iii).

10. (b) Sodium hydroxide is a base which is soluble in water while Ferric hydroxide is also a base but it is not soluble in water.

11. (c) 2 > 1 > 4 > 3

TiP
Lower is the pH value, higher is the H° ion concentration.

12. (c) (iii) and (iv)

13. (a) pH of acetic acid is more than that of hydrochloric acid.

14. (a) Sodium chloride < Acetic acid < Hydrochloric acid
HCl is a strong acid, Acetic acid is a weak acid and sodium chloride is a salt.
Thus, correct order of acidic strength is sodium chloride < Acetic acid < Hydrochloric acid.

15. (a) basic

16. (d) Oxalic acid

17. (d) Sodium Acetate CH_3COOH NaOH Basic
Sodium chloride is a neutral salt, sodium carbonate is a basic salt, sodium sulphate is a neutral salt and sodium acetate is a basic salt.

18. (c) (i) and (iii)

19. (d) $NaHCO_3$

20. (c) Sodium carbonate decahydrate ($Na_2CO_3 . 10H_2O$)
Washing soda, *i.e.*, sodium carbonate decahydrate ($Na_2CO_3 . 10H_2O$) is used for removing permanent hardness of water.

21. (d) (i) and (iv)

22. (b) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

23. (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

24. (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

25. (c) Reason (R) is false because on dissociation, HCl yields more hydrogen ion for the same concentration as compared to acetic acid.

26. (b) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

TiP
Mixing an acid/base with water results decrease in the concentration of H_3O^+/OH^- ions per unit volume.
Degree of ionisation increases with dilution.

27. (d) Assertion (A) is false because to dilute concentrated sulphuric acid, acid must always be added slowly to water with constant stirring.

28. (b) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

29. (d) Assertion is false because in this process, chlorine is given off at anode and hydrogen gas at cathode.

30. (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

Case Study Based Questions

Case Study 1

The pH scale measures how acidic or basic a substance is by making use of hydrogen ion concentrations in them.

Substance	pH	Colour shown by universal indicator
A	6	Greenish yellow
B	10	Navy blue
C	0	Dark red
D	8.5	Greenish blue
E	2.5	Orange

Based on the above table, answer of the following questions:

Q 1. Which of the following is/are true about substance B?

I. It is the strongest base among the given substance.
II. It is used in antacids.
III. It turns blue litmus paper to blue.
IV. None of the above.

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

Q 2. What happens when a solution of substance D is mixed with a solution of substance E in a test tube?

I. Salt formation takes place
II. Temperature of solution remains the same
III. Temperature of solution decreases
IV. Temperature of solution increases

a. Only (I)
b. (I) and (II)
c. (II) and (IV)
d. (I) and (IV)

Q 3. Arrange the substances *A*, *C* and *E* in increasing order of their acidic strength.

a. $C < E < A$
b. $A < E < C$
c. $A < C < E$
d. $E < C < A$

Q 4. Equal volumes of hydrochloric acid and sodium hydroxide solutions of same concentration are mixed and the pH of the resulting solution is checked with a pH paper. What would be the colour obtained?

a. Blue
b. Red
c. Yellowish green
d. Orange

Q 5. Study the table given below and select the row that has the incorrect information.

S.No.	Indicators	A, C and E	B and D
1.	Action with methyl orange	They turn methyl orange red.	They turn methyl orange yellow.
2.	Action with litmus paper	They turn blue litmus paper red.	They turn red litmus paper blue.
3.	Action with phenolphthalein	No change.	They turn phenolphthalein purple.
4.	Action with turmeric	No change.	They turn turmeric reddish brown.

Answers

1. (a) I and II
2. (d) (I) and (IV)
   Base (*D*) + Acid (*E*) ⟶ salt + water.
   During this reaction, temperature of the solution increases.
3. (b) $A < E < C$
4. (c) Yellowish green
5. (c) Action with phenolphthalein No change. They turn phenolphthalein purple.

TiP

Learn and understand the action of different indicators and make a list of how each one differs from the other one. It is the best way to avoid confusions and mistakes.

Case Study 2

The teacher while conducting practicals in the laboratory divided the students into three groups and gave them various solutions to find out their pH and classify them into acidic, basic and neutral solutions.

Group A – Lemon juice, vinegar, colourless aerated drink.

Group B – Tomato juice, coffee, ginger juice.

Group C – Sodium hydroxide, sodium chloride, lime water.

Read the above passage carefully and give the answer of the following questions:

Q 1. For the solutions provided, which group is/are likely to have pH value (i) less than 7, (ii) greater than 7?

Q 2. List two ways of determining pH of a solution.

Q 3. Explain, why the sour substances such as lemon juice are effective in cleaning the tarnished copper vessels?

Or

"pH has great importance in our daily life." Justify this statement by giving two examples. *(CBSE 2023)*

Answers

1. (I) Group A (II) Group C
2. (i) using litmus paper
   (ii) using universal indicator
3. Copper reacts with moist carbon dioxide in air to form copper carbonate and as a result, copper vessel loses its shiny brown surface forming a green layer of copper carbonate. The citric acid present in the

lemon juice neutralises the basic copper carbonate and dissolves the layer. That is why, tarnished copper vessels are cleaned with sour substances like lemon juice to give the surface of the copper vessel its characteristic lustre.

OR

(I) Tooth decay starts when the pH of the mouth is lower than 5.5.

(ii) Our body works within the pH range of 7.0 to 7.8.

Case Study 3

The Salt Story From: The New Indian Express 9 March, 2021.

The salt pans in Marakkanam, a port town about 120 km from Chennai are the third largest producer of salt in Tamil Nadu. Separation of salt from water is a laborious process and the salt obtained is used as raw materials for manufacture of various sodium compounds.

One such compound is sodium hydrogen carbonate, used in baking, as an antacid and in soda acid fire extinguishers.

The table shows the mass of various compounds obtained when 1 litre of sea water is evaporated.

Compound	Formula	Mass of Solid Present/g
Sodium Chloride	NaCl	28.0
Magnesium Chloride	$MgCl_2$	8.0
Magnesium Sulphate	$MgSO_4$	6.0
Calcium Sulphate	$CaSO_4$	2.0
Calcium Carbonate	$CaCO_3$	1.0
Total Amount of salt obtained		45.0

(CBSE SQP 2021 Term-1)

Read the above passage carefully and give the answer of the following questions:

Q 1. Which compound in the table reacts with acids to release carbon dioxide?

a. NaCl b. $CaSO_4$ c. $CaCO_3$ d. $MgSO_4$

Q 2. How many grams of magnesium sulphate are present in 135g of solid left by evaporation of sea water?

a. 6 g b. 12 g c. 18 g d. 24 g

Q 3. What is the saturated solution of Sodium Chloride called?

a. Brine b. Lime water
c. Slaked lime d. Soda water

Q 4. What is the pH of the acid which is used in the formation of common salt?

a. Between 1 to 3 b. Between 6 to 8
c. Between 8 to 10 d. Between 11 to 13

Answers

1. (c) $CaCO_3$
2. (c) 45 g of salt contains 6 g magnesium sulphate

$\Rightarrow$ 1 g of salt contains $\frac{6}{45}$ g of magnesium sulphate

$\therefore$ Amount of magnesium sulphate in 135 g salt

$= \frac{6}{45} \times 135 = 18$ g.

3. (a) Brine
4. (a) Between 1 to 3

Case Study 4

Mrs. Tomar uses a compound of sodium '*X*' to make pakoras crispy. It is a mild non-corrosive basic salt, also used as an ingredient in antacids. It is produced using sodium chloride as one of the raw materials.

Read the above passage carefully and give the answer of the following questions:

Q 1. Identify the compound of sodium '*X*'.

Q 2. Is the pH value of '*X*' solution lower than or higher than 7?

Q 3. Write the chemical equation of preparation of '*X*'.

Q 4. Write the chemical reaction involved when '*X*' is heated.

Q 5. How would you test the presence of gas which is evolved on heating '*X*'?

Answers

1. The compound is sodium hydrogen carbonate ($NaHCO_3$). commonly known as baking soda.
2. pH value of baking soda (*X*) is higher than 7.
3. The chemical equation is:

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

4. The following reaction takes place when '*X*' is heated :

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

5. When the evolved gas is passed through lime water, it turns milky. This shows that the gas evolved is CO_2.

Case Study 5

A girl met with an accident and her leg got fractured. She went to an orthopedician for treatment. On examination, the doctor mixed a white powder in water and applied it to her leg along with the cotton and gauze. After a while, it turned into white, solid, hard mass. The doctor said that it would support her fractured bone and help it to join in the right position.

Read the above passage carefully and give the answer of the following questions:

Q 1. What is 'white powder' and 'white hard solid mass' called as?

Q 2. Write the chemical name of 'white powder' and 'white hard solid mass'.

Q 3. After treatment, the doctor repacked the white powder back into moisture proof, airtight container. Why?

Q 4. Write a chemical equation to show the reaction between white powder and water.

Q 5. Find the difference in water molecules of white hard solid mass and white powder.

Answers

1. The 'white powder' is called as Plaster of Paris and 'white hard solid mass' is called as Gypsum.
2. The chemical name of white powder, *i.e.*, Plaster of Paris is calcium sulphate hemihydrate and that of white hard solid mass, *i.e.*, Gypsum is calcium sulphate dihydrate.
3. This is because the presence of moisture can cause the slow setting of powder (Plaster of Paris) into hard mass by bringing out its hydration. This makes Plaster of Paris useless after some time.
4. $\underset{\text{Plaster of Paris}}{CaSO_4 \cdot \frac{1}{2}H_2O} + 1\frac{1}{2}H_2O \longrightarrow \underset{\text{Gypsum}}{CaSO_4 \cdot 2H_2O}$
5. White hard solid mass, *i.e.*, Gypsum is $CaSO_4 . 2H_2O$ and white powder, *i.e.*, Plaster of Paris is $CaSO_4 \cdot \frac{1}{2}H_2O$.

   Difference in number of water molecules

   $$= 2 - \frac{1}{2} = \frac{3}{2}.$$

Very Short Answer Type Questions

Q 1. What are acid-base indicators? Give two examples.

Ans. Acid-base indicators are dyes or mixtures of dyes which are used to indicate the presence of acids and bases.
Examples: Phenolphthalein and methyl orange.

Q 2. What is the colour of litmus in a solution of ammonium hydroxide?

Ans. Red litmus turns blue in ammonium hydroxide solution.

Q 3. Identify the products formed when 1 mL of dil. hydrochloric acid is added to 1 g of sodium metal. *(CBSE 2017)*

Ans. The products are hydrogen gas and sodium chloride solution.

Q 4. How will you test for the gas which is liberated when hydrochloric acid reacts with an active metal?

Ans. When HCl reacts with an active metal like Zn, the gas liberated burns with a pop sound which indicates that it is hydrogen gas.

$$Zn(s) + 2HCl(l) \longrightarrow ZnCl_2(s) + H_2(g)$$

Q 5. Give reason why acids are not stored in metal containers?

Ans. Acids are not stored in metal containers because they react vigorously with most metals to liberate hydrogen gas.

Q 6. Write a balanced chemical equation for a neutralisation reaction, mentioning the physical state of the reactants and the products.

Ans. The balanced chemical equation is:

$$NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l)$$

Q 7. Why does HCl not conduct electricity when dissolved in toluene?

Ans. This is because HCl cannot ionise in organic solvents like toluene.

Q 8. What effect does an increase in concentration of H^+ in a solution have on the pH of solution?

Ans. Higher the concentration of H^+ in a solution, lower will be the pH of solution.

Q 9. Arrange the following in an increasing order of their pH values: NaOH solution, blood, lemon juice.

Ans. Lemon juice < Blood < NaOH solution.

Q 10. Write the name and chemical formula of the product formed by the action of chlorine on slaked lime.

Ans. The product formed is $CaOCl_2$ (Bleaching powder).

Q 11. Write the chemical name and chemical formula of the salt used to remove permanent hardness of water. *(CBSE 2018)*

Ans. Sodium carbonate (washing soda) is used to remove permanent hardness of water. Its chemical formula is Na_2CO_3.

Short Answer Type-I Questions

Q 1. Blue litmus solution is added to two test tubes *A* and *B* containing dilute HCl and NaOH solution respectively. In which test tube a colour change will be observed? State the colour change and give its reason. *(CBSE 2019)*

Ans. Colour change will be observed in test tube '*A*' containing dilute HCl.
The colour of test tube '*A*' changes from blue to red because HCl is an acid and acid turns blue litmus to red.

Q 2. (i) What happens when an acid reacts with a metal carbonate? Give chemical equation involved.
(ii) Which gas is usually liberated when an acid reacts with a non-metal?

Ans. (i) When an acid reacts with a metal carbonate, salt and water are formed and brisk effervescence is observed due to the evolution of carbon dioxide gas.

Metal carbonate + Acid ⟶ Salt + Water + Carbon dioxide

e.g., $ZnCO_3 + 2HCl \longrightarrow ZnCl_2 + H_2O + CO_2\uparrow$

(ii) Hydrogen gas is usually liberated when an acid reacts with a non-metal.

Q 3. A student took a small amount of copper oxide in a conical flask and added dilute hydrochloric acid to it with constant stirring. He observed a change in colour of the solution.
(i) Write the name of the compound formed and its colour.
(ii) Write a balanced chemical equation for the reaction involved. *(CBSE 2023)*

Ans. (i) The compound formed in this reaction is copper (II) chloride. It is blue-green in colour.

(ii) $\underset{\text{Copper Oxide}}{CuO(s)} + \underset{\text{Hydrochloric acid}}{2HCl(aq)} \longrightarrow \underset{\text{Copper (II) chloride}}{CuCl_2(aq)} + \underset{\text{Water}}{H_2O(l)}$

Q 4. What are strong and weak acids? In the following list of acids, separate strong acids from weak acids. Hydrochloric acid, citric acid, acetic acid, nitric acid, formic acid, sulphuric acid.

Ans. Acids that give rise to more H^+ ions are said to be strong acids. and acids that give less H^+ ions are said to be weak acids.

Strong acids: Hydrochloric acid. nitric acid. sulphuric acid.

Weak acid: Citric acid. acetic acid. formic acid.

Q 5. You have four solutions *A*, *B*, *C* and *D*. The pH of solution *A* is 6, *B* is 9, *C* is 12 and *D* is 7.

(i) Identify the most acidic and most basic solutions.

(ii) Arrange the above four solutions in the increasing order of H^+ ion concentration.

Ans. (i) '*A*' is the most acidic and '*C*' is the most basic solution.

(ii) C (10^{-12}) < B (10^{-9}) < D (10^{-7}) < A (10^{-6})

TiP

Practice a number of questions based on increasing and decreasing order of H^+ ion concentration.

Q 6. Name the acid present in ant sting and give its chemical formula. Also give the common method to get relief from the discomfort caused by the ant sting.

Ans. The acid present in ant sting is methanoic acid (formic acid). The chemical formula is HCOOH.

To get relief from ant sting, one should apply a mild base like baking soda ($NaHCO_3$) on the stung area.

Q 7. A milkman adds a very small amount of baking soda to fresh milk.

(i) Why does he shift the pH of the fresh milk from 6 to slightly alkaline?

(ii) Why does this milk take a long time to set as curd?

Ans. (i) Milk is made slightly alkaline so that it may not get sour easily.

(ii) The alkaline milk takes a longer time to set into curd because the lactic acid formed has to first neutralise the alkali present in it.

Q 8. The industrial process used for the manufacture of caustic soda involves electrolysis of an aqueous solution of compound '*X*'. In this process, two gases '*Y*' and '*Z*' are liberated. '*Y*' is liberated at cathode and '*Z*', which is liberated at anode, on treatment with dry slaked lime forms a compound '*B*'. Name *X*, *Y*, *Z* and *B*. *(CBSE 2023)*

Ans. When electricity is passed through an aqueous solution of sodium chloride (*X*). it decomposes to form caustic soda. hydrogen gas (*Y*) and chlorine gas (*Z*).

$$\underset{(X)}{2NaCl\,(aq)} + 2H_2O\,(l) \longrightarrow \underset{\text{Caustic Soda}}{2NaOH\,(aq)} + \underset{(Z)}{Cl_2(g)} + \underset{(Y)}{H_2(g)}$$

X = Sodium Chloride (NaCl)

Y = Hydrogen gas (H_2)

Z = Chlorine gas (Cl_2)

$$\underset{\text{Dry Slaked lime}}{Ca(OH)_2} + \underset{(Z)}{Cl_2} \longrightarrow \underset{(B)}{CaOCl_2} + H_2O$$

∴ B is bleaching powder or calcium hypochlorite.

Q 9. Chlorine gas was prepared using electrolysis of brine solution. Write the chemical equation to represent the change. Identify the other products formed in the process and give one application of each. *(CBSE SQP 2023-24)*

Ans. $2NaCl(aq) + 2H_2O(l) \longrightarrow \underset{\text{Sodium hydroxide}}{2NaOH\,(aq)} + Cl_2(g) + \underset{\text{Hydrogen gas}}{H_2(g)}$

Application of Sodium Hydroxide:

(i) It is used in manufacture of soaps and detergents.

(ii) It is used in making paper and artificial fibres. (Any one)

Application of Hydrogen Gas:

(i) It is used to manufacture ammonia which in turn is used to make fertilizers.

(ii) It is used in the production of margarine.

Q 10. How would you distinguish between baking powder and washing soda by heating?

Ans. Sodium hydrogen carbonate on heating gives CO_2 gas which will turn lime water milky whereas no such gas is obtained from sodium carbonate.

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

$$Na_2CO_3.10H_2O \xrightarrow{\text{Heat}} Na_2CO_3 + 10H_2O$$

Q 11. Complete the following table:

	Plaster of Paris	Bleaching Powder
Chemical equation for its preparation	(i)	(ii) .....
Use	(iii)	(iv) .....

Ans. (i) $CaSO_4 \cdot 2H_2O \longrightarrow CaSO_4 \cdot \frac{1}{2}H_2O + \frac{3}{2}H_2O$

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

(iii) It is used for making toys.

(iv) It is used as disinfectant.

COMMON ERROR

Mostly students commit errors in writing the chemical equation of reactions involved in preparation of different salts.

Q 12. Explain the following giving chemical equation in each case:

(i) Baking soda is heated.

(ii) Gypsum is heated at 373K.

Ans. (i) Baking soda (sodium hydrogen carbonate. $NaHCO_3$) on heating gives Na_2CO_3 salt and CO_2 gas which will turn lime water milky.

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

(II) When gypsum is heated at 373K, it loses water molecules and becomes calcium sulphate hemihydrate ($CaSO_4.1/2H_2O$). This is called Plaster of Paris.

$$\underset{\text{Gypsum}}{CaSO_4.2H_2O} \xrightarrow{\Delta} \underset{\substack{\text{Plaster}\\\text{of Paris}}}{CaSO_4.\frac{1}{2}H_2O} + \frac{3}{2}H_2O$$

Q 13. Give suitable reason for the following statements:

(i) We feel burning sensation in the stomach when we overeat.

(ii) The crystals of washing soda change to white powder on exposure to air.

Ans. (i) Due to overeating, excess of hydrochloric acid is produced in stomach which causes burning sensation.

(II) Washing soda is sodium carbonate decahydrate ($Na_2CO_3.10H_2O$) but when it is exposed to air, it loses its water of crystallisation and changes to white powder (Na_2CO_3).

Short Answer Type-II Questions

Q 1. (i) Define olfactory indicators. Name two substances which can be used as olfactory indicator.

(ii) Choose strong acids from the following: $CH_3COOH, H_2SO_4, H_2CO_3, HNO_3$ *(CBSE 2015)*

Ans. (i) Olfactory indicators are the substances whose smell changes in acidic or basic solution *e.g.* onion and clove.

(II) H_2SO_4 and HNO_3 are strong acids.

Q 2. Answer the following questions:

(i) State the colour of phenolphthalein in soap solution.

(ii) Name the by-product of chlor-alkali process which is used for the manufacture of bleaching powder.

(iii) Name one indicator which specifies the various levels of H^+ ion concentration. *(CBSE 2016)*

Ans. (i) The colour of phenolphthalein is pink in soap solution.

(II) Chlorine gas is used for manufacturing bleaching powder.

TiP

While studying the chlor-alkali process, lay stress on the uses of three important by-products obtained in this process.

(iii) Universal indicator specifies the various levels of H^+ ion concentration.

Universal indicator is a mixture of different indicators. It shows different colours on different hydrogen ion concentrations in a solution.

Q 3. 2 mL of sodium hydroxide solution is added to a few pieces of granulated zinc metal taken in a test tube. When the contents are warmed, a gas evolves which is bubbled through a soap solution before testing. Write the equation of the chemical reaction involved and the test to detect the gas. Name the gas which will be evolved when the same metal reacts with dilute solution of a strong acid. *(CBSE 2018)*

Ans. Chemical Equation Involved:

$$2NaOH + Zn \longrightarrow \underset{\substack{\text{Sodium}\\\text{zincate}}}{Na_2ZnO_2} + H_2\uparrow$$

Test for Detection: The hydrogen gas can be tested by putting burning matchstick over the solution. The burning matchstick will extinguish with a pop sound.

Gas Evolved: When Zn metal reacts with a dilute solution of strong acid such as HCl, it will give zinc chloride and hydrogen gas is evolved.

$$2HCl + Zn \longrightarrow ZnCl_2 + \underset{\text{Hydrogen gas}}{H_2\uparrow}$$

Q 4. Explain the action of dil. HCl on the following using chemical equations:

(i) Magnesium ribbon.

(ii) Sodium hydroxide.

(iii) Crushed egg shells. *(CBSE 2015)*

Ans. (I) Hydrogen gas is formed.

$$Mg(s) + 2HCl\,(dil) \longrightarrow MgCl_2(aq) + H_2(g)$$

(ii) Sodium chloride and water will be formed.

$$NaOH(aq) + HCl(aq) \longrightarrow NaCl(s) + H_2O(l)$$

(iii) Crushed egg shells are made up of $CaCO_3$ which reacts with dil. HCl to give brisk effervescence due to evolution of CO_2.

$$CaCO_3(s) + 2HCl\,(aq) \longrightarrow CaCl_2\,(aq) + H_2O\,(l) + CO_2\,(g)$$

COMMON ERROR

Most students don't know that egg shells are made up of calcium carbonate and find 3rd part difficult to answer.

Q 5. Complete and balance the following chemical equations:

(i) $NaOH\,(aq) + Zn\,(s) \rightarrow$

(ii) $CaCO_3(s) + H_2O\,(l) + CO_2(g) \rightarrow$

(iii) $HCl(aq) + H_2O\,(l) \rightarrow$ *(CBSE 2020)*

Ans. (I) $2NaOH(aq) + Zn(s) \longrightarrow \underset{\text{Sodium zincate}}{Na_2ZnO_2(s)} + \underset{\text{Hydrogen}}{H_2(g)}$

(II) $CaCO_3(s) + H_2O(l) + CO_2(s) \longrightarrow \underset{\substack{\text{Calcium hydrogen carbonate}\\\text{or Calcium bicarbonate}}}{Ca(HCO_3)_2(aq)}$

(iii) $HCl(aq) + H_2O(l) \rightarrow \underset{\text{Hydronium ion}}{H_3O^+(aq)} + \underset{\text{Chloride ion}}{Cl^-(aq)}$

Q 6. What is a neutralisation reaction? Give two examples.

Ans. A reaction in which an acid and a base react with each other to give salt and water is termed as neutralisation reaction. In this reaction, energy is evolved in the form of heat.

For example,

(I) $NaOH + HCl \longrightarrow NaCl + H_2O + Heat$

(ii) During indigestion an antacid like milk of magnesia, neutralises the excess of acid produced in stomach and thus gives relief from indigestion.

$$Mg(OH)_2 + 2HCl \longrightarrow MgCl_2 + 2H_2O$$

Q 7. (i) Why is acidified water considered to be a good conductor of electricity?

(ii) Write a chemical equation showing the ionic products formed on dissolving potassium hydroxide in water.

(iii) Care must be taken while diluting concentrated nitric acid with water. Why? *(CBSE 2023)*

Ans. (i) Acidified water produce hydrogen ions, $H^+(aq)$ in solution, which allow electric current to pass through it. Hence, acidified water is considered a good conductor of electricity.

(ii) $KOH(s) \xrightarrow{H_2O} K^+(aq) + OH^-(aq)$

(iii) Care must be taken while diluting conc. nitric acid with water because the process of dissolving an acid in water is highly exothermic and the heat generated may cause the mixture to splash out and cause burns. Therefore, conc. nitric acid must always be added slowly to water with constant stirring.

Q 8. (i) Suggest a safe procedure of diluting a strong concentrated acid.

(ii) Name the salt formed when sulphuric acid is added to sodium hydroxide and write its pH.

(iii) Dry HCl gas does not change the colour of dry blue litmus paper. Why?

Ans. (i) Large amount of heat is generated on mixing a strong concentrated acid with water. Hence, acid must always be added slowly to water with constant stirring.

(ii) $H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$

Sulphuric acid — Sodium hydroxide — Sodium sulphate

Name of salt: Sodium sulphate

pH : 7 (it is a neutral salt formed by reaction between strong acid and strong base).

(iii) Dry HCl gas does not undergo dissociation to form ions, because of the absence of an aqueous medium. Since, in this case neither HCl is in the aqueous form nor litmus paper is wet. Therefore, colour of the litmus paper does not change.

Q 9. "pH has a great importance in our daily life". Explain by giving three examples. *(CBSE 2017)*

Ans. Examples of pH in our daily life:

(i) Plants and Animals are pH Sensitive: Our body works within the pH range of 7.0 to 7.8. Change in pH (less than 5.6) of rain water leads to acid rain, which makes the survival of aquatic life difficult.

(ii) Change in pH Causes Tooth Decay: Tooth decay starts when the pH of the mouth is lower than 5.5 because tooth enamel (hardest substance in the body) starts corroding when the pH in the mouth is below 5.5.

(iii) pH of the Soil: Plants require a specific pH range for their healthy growth.

Q 10. Discuss the role of pH in:

(i) Digestive system, and

(ii) Causes of tooth decay.

Ans. (i) Our stomach produces HCl which helps in the digestion of food without harming the stomach. During indigestion, the stomach produces too much acid which causes pain and irritation that can be combated by the intake of an antacid. These antacids neutralise the excess acid. Example. $Mg(OH)_2$ (Milk of magnesia).

(ii) Tooth decay starts when the pH of the mouth is lower than 5.5. Tooth enamel *i.e.,* calcium phosphate is corroded when the pH in the mouth is below 5.5. Bacteria present in the mouth produce acids by degradation of sugar and food particles that are left in the mouth after eating.

Using toothpaste (which are generally basic in nature) for cleaning the teeth, can neutralise the excess acid and prevent tooth decay.

Q 11. (i) Write the name given to bases that are highly soluble in water. Give an example.

(ii) How is tooth decay related to pH? How can it be prevented?

(iii) Why does bee sting cause pain and irritation? Rubbing of baking soda on the sting area gives relief. How?

Ans. (i) The name given to bases that are highly soluble in water is alkali, *e.g.,* NaOH (sodium hydroxide).

(ii) Tooth decay starts when the pH of the mouth is lower than 5.5 because tooth enamel starts corroding when the pH in the mouth is below 5.5.

Tooth decay can be prevented by brushing teeth with a basic toothpaste after every meal.

(iii) Bee sting causes pain and irritation due to the injection of methanoic acid. Rubbing of baking soda (sodium hydrogen carbonate) on the stung area neutralises methanoic acid and provides relief.

Q 12. Consider the following salts:

(i) *Y*Cl (ii) NH_4X (iii) ZCO_3

(a) What would be the pH of the salt solution if in *Y*Cl, *Y* is sodium? Give reason for your answer.

(b) If in salt NH_4X, *X* is nitrate, then its solution will give what colour with universal indicator? Why?

(c) What would be the change in colour in blue litmus solution if ZCO_3 is added to it and *Z* is potassium? *(CBSE 2023)*

Ans. (a) YCl = NaCl when Y is sodium.
We know that NaCl is a neutral salt.
∴ pH of NaCl (YCl) = Z

(b) $NH_4X = NH_4NO_3$ when X is nitrate.
Solution of NH_4NO_3 will give yellowish-orange colour with universal indicator because NH_4NO_3 is an acidic salt formed by reaction between a weak base (ammonium hydroxide) and strong acid (nitric acid).

(c) $ZCO_3 = K_2CO_3$ when Z is potassium.
K_2CO_3 is a basic salt and will produce a basic aqueous solution. We know that. blue litmus solution does not change colour in basic solution.
So, K_2CO_3 does not affect blue litmus solution.

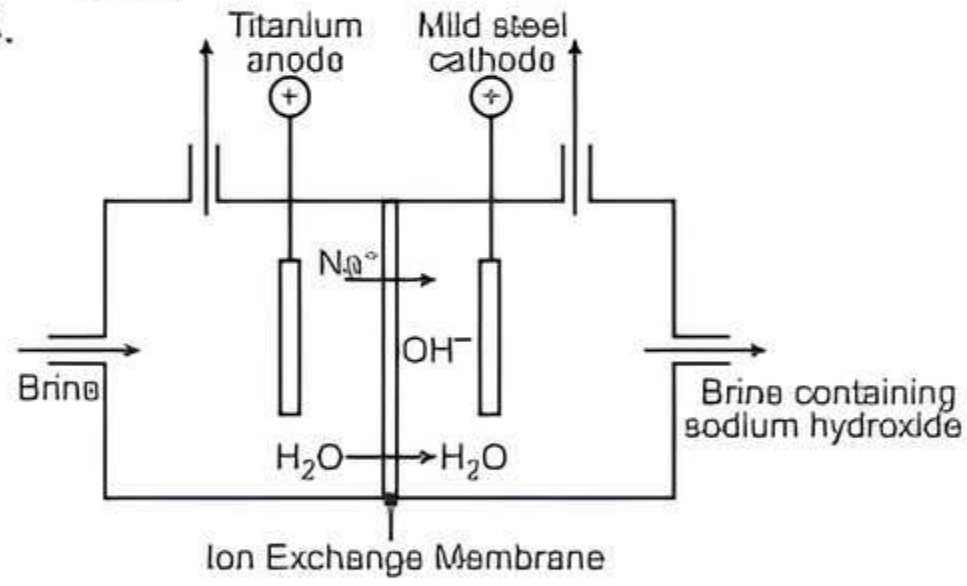
Q 13. Identify the acid and base which form sodium hydrogen carbonate. Write chemical equation in support of your answer. State whether this compound is acidic, basic or neutral. Also write its pH value. *(CBSE 2019)*

Ans. Sodium hydroxide (base) and carbonic acid combine to form sodium hydrogen carbonate.

$$2NaOH + H_2CO_3 \longrightarrow Na_2CO_3 + 2H_2O$$

The compound is basic in nature because NaOH is a strong base and H_2CO_3 is a weak acid. Its pH value is 8.3.

Q 14.



(i) Identify the gases evolved at the anode and cathode in the above experimental set up.
(ii) Name the process that occurs. Why is it called so?
(iii) Illustrate the reaction of the process with the help of a chemical equation. *(CBSE SQP 2022-23)*

Ans. (i) Chlorine gas is given off at the anode and hydrogen gas at the cathode.

(ii) The process is called chlor-alkali process because of the products formed chlor for chlorine and alkali for sodium hydroxide.

(iii) $2NaCl(aq) + 2H_2O(l) \xrightarrow{\text{Electric current}} 2NaOH(aq) + Cl_2(g) + H_2(g)$

COMMON ERROR
Students usually get confused between the gas liberated at anode and cathode during electrolysis of brine.

Q 15. What happens when chlorine is passed over slaked lime at 313 K? Write chemical equation of the reaction involved and state two uses of the product obtained.

Ans. When chlorine is passed over slaked lime, bleaching powder is formed.

$$Ca(OH)_2 + Cl_2 \xrightarrow{313\,K} CaOCl_2 + H_2O$$

Uses:
(i) It is used as a bleaching agent in paper and textile industries.
(ii) It is used as a disinfectant in purification of drinking water.

Q 16. (i) Give the constituents of baking powder.
(ii) Why does cake or bread swell on adding baking powder? Write chemical equation.

Ans. (i) Baking powder consists of sodium hydrogen carbonate and tartaric acid.

(ii) Cake or bread swell on adding baking powder due to the formation of carbon dioxide.

$$2\,NaHCO_3(s) \xrightarrow{\Delta} Na_2CO_3(s) + CO_2(g) + H_2O(l)$$

Q 17. A white powder is used by doctors to support fractured bones.
(i) Write the name and chemical formula of the powder.
(ii) How is this powder prepared?
(iii) What special precaution should be taken during the preparation of this compound?

Ans. **(i) Name of White Powder:** Calcium sulphate hemihydrate (Plaster of Paris).

Chemical formula: $CaSO_4 . \frac{1}{2}H_2O$.

(ii) It is prepared by heating gypsum at 373 K.

$$\underset{\text{Gypsum}}{CaSO_4 . 2H_2O} \xrightarrow{373\,K} \underset{\substack{\text{Plaster}\\\text{of Paris}}}{CaSO_4 . \frac{1}{2}H_2O} + \frac{3}{2}H_2O$$

(iii) Gypsum should not be heated above 373 K otherwise it will form $CaSO_4$.

Long Answer Type Questions

Q 1. State reasons for the following statements:
(i) Stain of curry on a white cloth becomes reddish-brown when soap is scrubbed on it and turns yellow again when the cloth is washed with plenty of water.
(ii) Curd should not be kept in copper or brass vessels. What is done to protect it? *(CBSE 2016)*

Ans. (i) Turmeric, a natural indicator, present in the stain of curry reacts with sodium hydroxide (base) present in soap to form a reddish-brown compound. This colour changes to yellow again because sodium hydroxide becomes dilute when the cloth is washed with a plenty of water.

(ii) Curd contains lactic acid that reacts with copper or brass vessels and forms poisonous or toxic substances which may prove harmful for human body. So, curd should be kept in glass, steel or ceramic containers which does not react with lactic acid present in it.

Q 2. Equal length of magnesium ribbon are taken in two test tubes '*A*' and '*B*'. H_2SO_4 is added to test tube '*A*' and H_2CO_3 to the test tube '*B*' in equal amounts:

(i) Identify the test tube showing vigorous reaction.

(ii) Give reason to support your answer.

(iii) Name the gas liberated in both the tubes. How will you prove its liberation?

(iv) Write chemical equations for both reactions.

(v) Out of the two acids taken above:

(a) Which one will have lower pH value?

(b) Which one will have lower H^+ concentration?

Ans. (i) Test tube 'A' will show vigorous reaction.

(ii) This is because H_2SO_4 is a strong acid.

(iii) H_2 gas is liberated in both the tubes. When a burning splinter is brought near the gas, it will burn with a 'pop' sound. This shows that gas liberated is hydrogen.

(iv) $Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2\uparrow$

$Mg + H_2CO_3 \longrightarrow MgCO_3 + H_2\uparrow$

(v) (a) H_2SO_4 will have lower pH value.

(b) H_2CO_3 will have lower concentration of H^+.

Q 3. Write the main difference between an acid and a base. With the help of suitable examples explain the term neutralisation and the formation of:

(i) Acidic salts (ii) Basic Salts (iii) Neutral Salts

(CBSE 2019)

Ans. Acids are the substances that produce H^+ ion in aqueous solution and turn blue litmus to red whereas bases are the substances that produce OH^- ion in aqueous solution and turn red litmus to blue. Neutralisation is a type of reaction between an acid and a base to give salt and water with evolution of heat.

$$\text{Base} + \text{Acid} \longrightarrow \text{Salt} + \text{Water}$$

(i) Acidic Salts: These are formed by the neutralisation of a strong acid with a weak base.

For example, $HCl + NH_4OH \longrightarrow NH_4Cl + H_2O$

(ii) Basic Salts: These are formed by the neutralisation of a strong base with a weak acid.

For example,

$$NaOH + H_2CO_3 \longrightarrow Na_2CO_3 + H_2O$$

(iii) Neutral Salts: These are formed by the neutralisation of strong acid with a strong base.

For example, $HCl + NaOH \longrightarrow NaCl + H_2O$

COMMON ERROR

Students often write irrelevant answer as they are unaware of the concept of acidic, basic and neutral salts.

Q 4. State reason for the following statements:

(i) Tap water conducts electricity whereas distilled water does not.

(ii) Dry hydrogen chloride gas does not turn blue litmus red whereas dil. HCl does.

(iii) During summer season, a milkman usually adds a very small amount of baking soda to fresh milk.

(iv) For dilution of acid, acid is added to water and not water into acid.

(v) Ammonia is a base but does not contain hydroxyl group. *(CBSE 2015)*

Ans. (i) Tap water conducts electricity as it contains ions but distilled water does not contain ions so it does not conduct electricity.

(ii) Dry HCl does not turn blue litmus red as it does not form ions but dil. HCl does since it forms H^+ and Cl^- ions.

(iii) During summer season, a milkman adds a very small amount of baking soda to fresh milk because it does not allow milk to change to lactic acid that makes milk sour.

TiP

The concept of dilution of acids should be kept in mind.

(iv) When we add water to acid, so much heat is generated that the solution may splash out of the container. On the other hand, when acid is added to water, small amount of heat is released and the solution will not splash out.

(v) Ammonia does not contain hydroxyl group but when it is dissolved in water, it forms OH^-, so it is basic in nature.

$$NH_3 + H_2O \longrightarrow NH_4^+ + OH^-$$

Q 5. (i) The pH of soil *A* is 7.5 while that of soil *B* is 4.5. Which of the two soils *A* or *B* should be treated with powdered chalk to adjust its pH and why?

(ii) Name the chemical which is injected into the skin of a person.

(a) During an ant's sting.

(b) During the nettle leaf sting.

(iii) Explain how the pH change in the river water can endanger the lives of aquatic animals like fish. *(CBSE 2016)*

Ans. (i) Soil '*B*' should be treated with powdered chalk which is basic in nature as this soil is acidic. In order to maintain the pH as plants grow well in the pH range of 6-8.

(ii) (a) Methanoic acid (HCOOH).

(b) Methanoic acid (HCOOH).

The effect of these stings is neutralised by rubbing the skin with a mild base such as baking soda ($NaHCO_3$).

(iii) Lowering of pH of the river water due to acid rain decreases the amount of oxygen dissolved in water, which makes the survival of aquatic animals like fish difficult in such rivers.

Q 6. (i) A metal compound '*X*' reacts with dil. H_2SO_4 to produce effervescence. The gas evolved extinguishes a burning candle. If one of the compounds formed is calcium sulphate, then what is '*X*' and the gas evolved? Also write a balanced chemical equation for the reaction which occurred.

(ii) Name one antacid. How does it help to relieve indigestion in stomach?

(iii) A farmer treats the soil with quicklime or calcium carbonate. What is the nature of soil? Why does the farmer treat the soil with quicklime?

Ans. (i) '*X*' is $CaCO_3$ (Calcium carbonate). The gas evolved is CO_2.

$$CaCO_3 + H_2SO_4(dil) \longrightarrow CaSO_4 + H_2O + CO_2\uparrow$$

(ii) Magnesium hydroxide (Milk of Magnesia) is an antacid. It neutralises the effect of excess acid in the stomach and relieves us from indigestion.

(iii) The soil is acidic in nature. The farmer makes the soil neutral by treating it with quicklime, which is good for crops and maintains its pH.

Q 7. Match the pH values 1, 7, 10, 13 to the solutions given below:

(i) Milk of magnesia

(ii) Gastric juices

(iii) Brine

(iv) Aqueous Sodium hydroxide.

Amit and Rita decided to bake a cake and added baking soda to the cake batter.

Explain with a balanced reaction, the role of the baking soda. Mention any other use of baking soda.

(CBSE SQP 2020-21)

Ans. (i) pH of Milk of magnesia : 10

(ii) pH of Gastric juices : 1

(iii) pH of Brine : 7

(iv) Aqueous Sodium hydroxide : 13

Baking soda undergoes thermal decomposition to form Na_2CO_3, CO_2 and H_2O. The CO_2 gas produced makes the cake fluffy and soft.

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

Uses of Baking Soda:

(i) It is used in fire extinguishers.

(ii) It is used as an antacid to neutralise excess acid in stomach.

(iii) It is used to neutralise the effect of acid in insect sting. (Any two)

Q 8. (i) Identify the acid and the base whose combination forms the common salt that you use in your food. Write its formula and chemical name of this salt. Name the source from where it is obtained.

(ii) What is rock salt? Mention its colour and the reason due to which it has this colour.

(iii) What happens when electricity is passed through brine? Write the chemical equation for it.

Ans. (i) Acid, HCl and base, NaOH combine to form the common salt, NaCl (Sodium chloride). It is obtained from sea water.

(ii) Rock salt is a mineral or natural form of sodium chloride and is the common name for the mineral 'halite'. These large crystals are brown due to impurities present in them.

(iii) When electricity is passed through brine, NaOH is obtained and H_2 and Cl_2 gases are liberated.

$$2NaCl(aq) + 2H_2O(l) \xrightarrow{\text{Electrolysis}} 2NaOH(aq) + H_2(g) + Cl_2(g)$$

Q 9. (i) Dry pellets of a base '*X*' when kept in open absorbs moisture and turns sticky. The compound is also formed by chlor-alkali process. Write chemical name and formula of *X*. Describe chlor-alkali process with balanced chemical equation. Name the type of reaction that occurs when *X* is treated with dil. HCl. Write the chemical equation.

(ii) While diluting an acid, why is it recommended that the acid should be added to water and not water to the acid?

Ans. (i) '*X*' is sodium hydroxide, NaOH.

When sodium chloride solution (brine solution) is electrolysed, sodium hydroxide solution is formed and H_2 and Cl_2 gases are liberated. This is called chlor-alkali process.

$$2NaCl(aq) + 2H_2O(l) \xrightarrow{\text{Electrolysis}} 2NaOH(aq) + H_2(g) + Cl_2(g)$$

$$NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l)$$

'*X*'

This reaction is called neutralisation reaction.

(ii) Dilution of acid is an exothermic process. If water is added to acid, the heat generated may cause the mixture to splash out and cause burns. But, when acid is added to water, the mixture will not splash out as heat is evolved gradually and easily absorbed by the large amount of water.

Q 10. A metal carbonate *X* on reacting with an acid gives a gas which when passed through a solution *Y* gives the carbonate back. On the other hand, a gas *G* that is obtained at anode during electrolysis of brine is passed on dry *Y*, it gives a compound *Z* used for disinfecting drinking water. Identify *X*, *Y*, *G* and *Z*.

Ans.

TiP

Practice such questions in which identification of compounds is based on chemical reactions.

The gas evolved at anode during electrolysis of brine is chlorine (*G*). When chlorine gas is passed through dry $Ca(OH)_2$ *i.e.*, *Y* produces bleaching powder (*Z*) used for disinfecting drinking water.

$$Ca(OH)_2 + Cl_2 \xrightarrow[(G)]{} CaOCl_2 + H_2O$$
Slaked lime (Y) — Bleaching powder (Z)

Since, Y and Z are calcium salts, therefore X is also a calcium salt known as calcium carbonate.

$$\underset{X}{CaCO_3} + 2HCl \longrightarrow CaCl_2 + CO_2\uparrow + H_2O$$

$$Ca(OH)_2 + CO_2 \longrightarrow \underset{Y}{CaCO_3} + H_2O$$

Q 11. (i) State the chemical properties on which the following uses of baking soda are based:
(a) as an antacid.
(b) as a soda fire extinguisher.
(c) to make bread and cake soft and spongy.
(ii) How is washing soda obtained from baking soda? Write balanced chemical equation.
(CBSE 2015)

Ans. (i) (a) Baking soda is weakly basic in nature and hence neutralises hyperacidity.
(b) Baking soda liberates CO_2 with H_2SO_4 that extinguishes fire.
(c) Baking soda makes bread and cake soft and spongy as it liberates CO_2 on heating.

(ii) Baking soda on heating gives sodium carbonate which on crystallisation forms hydrated washing soda.

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

$$Na_2CO_3 + 10H_2O \longrightarrow \underset{\text{Hydrated washing soda}}{Na_2CO_3 \cdot 10H_2O}$$

Q 12. For making cake, baking powder is taken. If at home your mother uses baking soda instead of baking powder in cake then:
(i) How will it affect the taste of the cake and why?
(ii) How can baking soda be converted into baking powder?
(iii) What is the role of tartaric acid added to baking soda?

Ans. (i) Baking soda is sodium hydrogen carbonate. On heating, it is converted into sodium carbonate which is bitter in taste.

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

(ii) Baking soda can be converted into baking powder by the addition of appropriate amount of tartaric acid to it.

(iii) The role of tartaric acid is to neutralise sodium carbonate so that the cake will not taste bitter.

Q 13. (i) Four samples A, B, C and D change the colour of pH paper or solution to green, reddish-pink, blue and orange. Their pH was recorded as 7, 2, 10.5 and 6 respectively. Which of the samples has the highest amount of hydrogen ion concentration? Arrange the four samples in the decreasing order of their pH.
(ii) Rahul found that the Plaster of Paris, which he stored in a container, has become very hard and lost its binding nature. What is the reason for this? Also, write a chemical equation to represent the reaction taking place.
(iii) Give any one use of Plaster of Paris other than for plastering or smoothening of walls.
(CBSE 2016)

Ans. (i) (a) B has the highest amount of hydrogen ion (H^+) concentration.
(b) C, A, D, B is the required order of their pH.

(ii) Due to the presence of moisture in the container, Plaster of Paris is converted into gypsum, which is hard in nature.

$$\underset{\text{Plaster of Paris}}{CaSO_4 \cdot \frac{1}{2}H_2O} + \frac{3}{2}H_2O \longrightarrow \underset{\text{Gypsum}}{CaSO_4 \cdot 2H_2O}$$

(iii) Plaster of Paris is used for:
(a) making toys, dolls or statues.
(b) making decorative materials. (Any one)

Q 14. (i) Crystals of a substance changed their colour on heating in a closed test tube but regained it after sometime when they were allowed to cool down. Name the substance, write its formula and explain the phenomenon involved.
(ii) Name the compound whose one formula unit is associated with 10 water molecules. How is it prepared? Give equations of related reactions. Give two uses of the compound. *(CBSE 2015)*

Ans.

TiP
Understand the concept of water of crystallisation with proper examples.

(i) The substance is hydrated copper sulphate. Its formula is $CuSO_4.5H_2O$. It becomes white on heating due to loss of water molecules.

$$\underset{\substack{\text{Copper sulphate}\\\text{pentahydrate}\\\text{(Blue)}}}{CuSO_4.5H_2O} \longrightarrow \underset{\substack{\text{Anhydrous}\\\text{copper sulphate}\\\text{(Dirty White)}}}{CuSO_4} + 5H_2O$$

It regains its blue colour by absorbing water from atmosphere.

$$CuSO_4 + 5H_2O \longrightarrow \underset{\text{Blue}}{CuSO_4.5H_2O}$$

(ii) The compound whose one formula unit is associated with 10 water molecules is $Na_2CO_3.10H_2O$. It is called sodium carbonate decahydrate or washing soda.

Preparation: It is prepared by heating baking soda and then recrystallising the product so obtained.

Equations:

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

$$Na_2CO_3 + 10H_2O \longrightarrow \underset{\text{Washing soda}}{Na_2CO_3.10H_2O}$$

Uses:

(i) It is used for removing permanent hardness of water.

(ii) It is used in glass, soap and paper industries.

Q 15. (i) Write the chemical formula of hydrated copper sulphate and anhydrous copper sulphate. Giving an activity illustrate how these are interconvertible?

(ii) Write chemical names and formula of plaster of Paris and gypsum. *(CBSE 2015)*

Ans. (i) $CuSO_4 \cdot 5H_2O$ is hydrated copper sulphate and $CuSO_4$ is anhydrous copper sulphate.

Activity:

Aim: To show that hydrated copper sulphate and anhydrous copper sulphate are interconvertible.

Apparatus Required: $CuSO_4 \cdot 5H_2O$ (Blue vitriol), burner, boiling tube, delivery tube, test tube.

Procedure:

(a) Heat a few crystals of copper sulphate in a dry boiling tube.

(b) After heating, water is removed and salt turns white.

(c) Add 2-3 drops of water on the sample of copper sulphate obtained after heating.

(d) When crystals are moistened again with water, blue colour reappears.

Chemical Reaction:

$$\underset{\text{Blue vitriol}}{CuSO_4 \cdot 5H_2O} \xrightarrow{\Delta} \underset{\text{White}}{CuSO_4} + 5H_2O$$

Result: Crystalline substances have water of crystallisation which is lost on heating. When hydrated copper sulphate is heated, it converts into anhydrous copper sulphate. When water is added again to it, it gets converted into hydrated copper sulphate. This shows that both are interconvertible.

(ii) (a) **Plaster of Paris:**

Chemical Name: Calcium sulphate hemihydrate.

Formula: $CaSO_4 \cdot \frac{1}{2}H_2O$

(b) **Gypsum:**

Chemical Name: Calcium sulphate dihydrate.

Formula: $CaSO_4 \cdot 2H_2O$.

Chapter Test

Multiple Choice Questions

Q 1. During the preparation of hydrogen chloride gas 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:

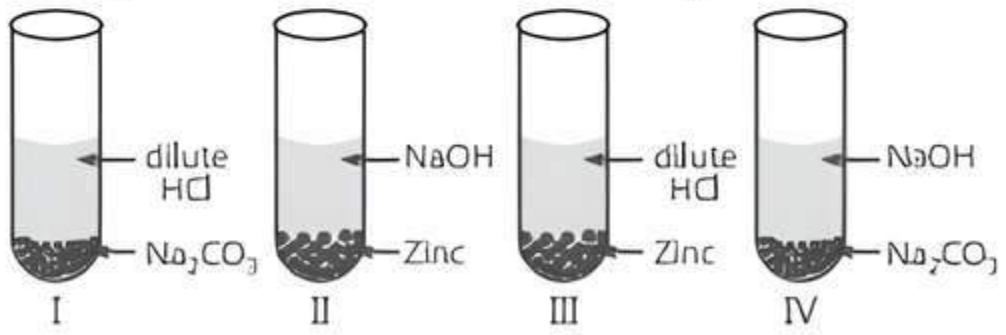
a. absorb the evolved gas

b. moisten the gas

c. absorb moisture from the gas

d. absorb Cl^- ion from the evolved gas

Q 2. Four students were asked by their teacher to arrange the set-ups I-IV as given below and identify the gas evolved in each case, if any.



The students observed the gases evolved and recorded their inferences in the table given below:

Students	I	II	III	IV
A	Hydrogen	No gas	Carbon dioxide	Hydrogen
B	Carbon dioxide	Hydrogen	No gas	Carbon dioxide
C	Carbon dioxide	Hydrogen	Hydrogen	No gas
D	No gas	Carbon dioxide	Carbon dioxide	Hydrogen

The correct inferences have been reported by student:

a. A b. B c. C d. D

Q 3. Due to excess passing of CO_2 through an aqueous solution of slaked lime, its milkiness fades because:

a. calcium carbonate is formed

b. calcium bicarbonate is formed

c. quick lime is formed

d. calcium hydroxide is formed

Q 4. Our body works within the pH range of:

a. 7.0 to 7.8 b. 5.5 to 6.5

c. 10.0 to 11.8 d. 6.0 to 6.8

Assertion and Reason Type Questions

Directions (Q. Nos. 5-6): *Each of the following questions consists of two statements, one is Assertion (A) and the other is Reason (R). Give answer:*

a. Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

b. Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

c. Assertion (A) is true but Reason (R) is false.

d. Assertion (A) is false but Reason (R) is true.

Q 5. **Assertion (A):** Non-metallic oxides are acidic in nature.
Reason (R): Non-metallic oxides react with bases to form salt and water.

Q 6. **Assertion (A):** Higher the H^+ ion concentration, lower is the pH value.
Reason (R): pH of neutral solution = 7, that of a acidic solution > 7 and that of a basic solution < 7.

Case Study Based Question

Q 7. Indicators are the substance that change their colour or odour when added into an acid or an alkaline solution to indicate the presence of acid or base. By knowing this Aditi performed an experiment. The solutions A and B, where taken by Aditi in a test tubes. She added different indicators in each test tubes. The observations were recorded in the form of table as given below.

Indicators	A	B
Litmus	Red	Blue
Phenolphthalein	Colourless	Pink
Methyl orange	Red	Yellow

Read the above passage carefully and give the answer of the following questions:

(i) Identify solutions *A* and *B*.

(ii) Name two substances which can be used as olfactory indicator.

(iii) What will be the action of following substances on litmus paper?
(a) Soap solution
(b) Carbonated soft drink

(iv) What is the colour of red cabbage in solution *A* and *B*?

Very Short Answer Type Questions

Q 8. (i) At what pH rain water is said to be acidic?
(ii) Name the chemicals used in soda-acid fire extinguishers.

Q 9. Name the acids present in (i) nettle sting (ii) sour milk.

Short Answer Type-I Questions

Q 10. A baker found that the cake prepared by him is hard and small in size. Which ingredient has he forgotten to add that would have made the cake fluffy? Give reason.

Q 11. Why does distilled water not conduct electricity, whereas rainwater does?

Q 12. Give suitable reasons to justify the following statement: an aqueous solution of sodium chloride is neutral but an aqueous solution of sodium metal is basic.

Short Answer Type-II Questions

Q 13. Give the chemical names with formulae of the following compounds and state one important use of each of them.
(i) Washing soda (ii) Baking soda
(iii) Bleaching powder

Q 14. (i) *A* compound '*P*' forms the enamel of teeth. It is the hardest substance of the body. It does not dissolve in water but gets corroded when the pH is lowered below 5.5.
(a) Identify the compound '*P*'.
(b) How does it undergo damage due to eating of chocolates and sweets? What should we do to prevent tooth decay?
(ii) The pH of soil '*A*' is 7.5 and that of soil '*B*' is 4.5. Which of the two soils '*A*' or '*B*' should be treated with powdered chalk to adjust the pH and why?

Q 15. (i) What is chlor-alkali process? Write a balanced chemical equation for the reaction involved in this process to justify your answer.
(ii) Define the term water of crystallisation.

Long Answer Type Questions

Q 16. Explain the reaction of:
(i) acid with metal
(ii) base with metal
(iii) metal carbonate or metal hydrogencarbonate with acid
(iv) metallic oxide with acid
(v) non-metallic oxide with base

Q 17. (i) The metal salt '*A*' is blue in colour. When salt '*A*' is heated strongly over a burner, then a substance '*B*' present in it is eliminated and a white powder '*C*' is left behind. When few drops of a liquid '*D*' is added to powder '*C*', it becomes blue again.
(a) Identify *A*, *B*, *C* and *D*.
(b) Write the chemical equations involved.
(c) Give an example of salt which also shows the above property.
(ii) Identify the acid and base from which the following salts have been formed.
(a) Na_2SO_4 (b) KNO_3