Acids, Bases and Salts

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:

Q1. 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

Q2. 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 (1)

b. (1) and (II)
c. (II) and (IV)
d. (1) and (IV)

Q3. 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

Q4. 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

Q5. 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) (1) and (IV)
Base (D) + Acid (E) $\rightarrow\rightarrow\rightarrow\rightarrow$ 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.

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:

Q1. For the solutions provided, which group is/ are likely to have pH value (i) less than 7, (ii) greater than 7?

Q2. List two ways of determining pH of a solution.

Q3. 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

(ii) Group C
1. (1) Group A

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 1litre 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:

Q1. Which compound in the table reacts with acids to release carbon dioxide?

a. NaCl
b. Ca50
c. CaCO3
d. Mg504

Q2. 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

Q3. What is the saturated solution of Sodium Chloride called?

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

Q4. 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) $CaCO3$
2. (c) 45 g of salt contains 6 g magnesium sulphate

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

$$\therefore \text{Amount of magnesium sulphate in 135 g salt} = \frac{6}{45} \times 135 = 18\ \text{g}.$$

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:

Q1. Identify the compound of sodium 'X'.

Q2. Is the pH value of 'X' solution lower than or higher than 7?

Q3. Write the chemical equation of preparation of 'X.

Q4. Write the chemical reaction involved when 'X' is heated.

Q5. How would you test the presence of gas which is evolved on heating 'X'?

Answers

1. The compound is sodium hydrogen carbonate (NaHCO3), 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 CO2.

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:

Q1. What is 'white powder' and 'white hard solid mass' called as?

Q2. Write the chemical name of 'white powder' and 'white hard solid mass.

Q3. After treatment, the doctor repacked the white powder back into moisture proof, airtight container. Why?

Q4. Write a chemical equation to show the reaction between white powder and water.

Q5. 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 CaSO4. 2H20 and

white powder, *i.e.*, Plaster of Paris is $CaSO_4 \cdot \frac{1}{2}H_2O$

Difference in number of water molecules

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

Solutions for Questions 6 to 15 are Given Below

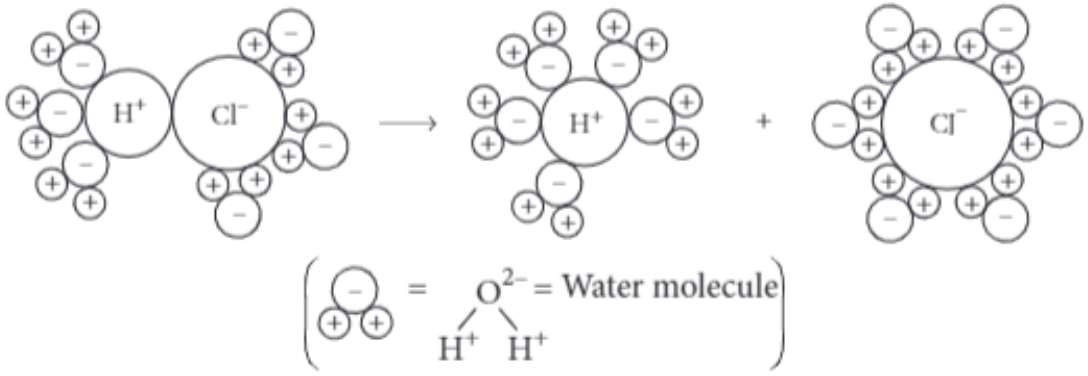
Case Study 6

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

The acidic behaviour of acids is due to the presence of hydrogen(H^+) ions in them. They produce hydrogen ions in the presence of water. Water is a polar solvent and this property of water helps in weakening the bond between the ions and makes them soluble. Hence, acids and bases produce ions in aqueous solutions.

It may be noted that a dry HCl gas or a solution of hydrogen chloride in organic, non-polar solvents like toluene or benzene do not show acidic properties. This is because hydrogen chloride does not undergo ionization in toluene.

The reason why HCl splits into H^+ and Cl^- ions in presence of water lies in the fact that water molecules, being polar, pull the H^+ and Cl^- ions apart and thus, the bond in HCl is broken.



Dissociation of HCl into H^+ and Cl^- ions in presence of water

(i) Identify the wrong statement.

(a) Higher the hydronium ion concentration, lower is the pH value.

(b) Universal indicator is used to judge how strong a given acid or base is.

(c) As the pH value increases from 7 to 14, it represents increase in H^+ ion concentration in the solution.

(d) Value less than 7 on the pH scale represents an acidic solution.

(ii) If the pH of a solution is 8, then its $[H^+]$ ion is

(a) $\log 10^{-8}$ (b) 10^8 (c) 10^{-8} (d) 8

(iii) 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

(iv) Which of the following compounds does not give H^+ ions in aqueous solution?

(a) H_3PO_4 (b) C_2H_5OH (c) H_2CO_3 (d) CH_3COOH

(v) Four solutions labelled as *P*, *Q*, *R* and *S* have pH values 1, 9, 3 and 13 respectively. Which of the following statements about the given solutions is incorrect?

(a) Solution *P* has higher concentration of hydrogen ions than solution *R*.
(b) Solution *Q* has lower concentration of hydroxide ions than solution *S*.
(c) Solutions *P* and *Q* will turn red litmus solution blue.
(d) Solution *P* is highly acidic while solution *Q* is weakly basic.

Case Study 7

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

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

(i) What is the compound, *X*?

(a) $NaHCO_3$ (b) Na_2CO_3 (c) NaOH (d) NaCl

(ii) The compound, *Y* is

(a) $NaHCO_3$ (b) Na_2CO_3 (c) $Na_2CO_3 \cdot 10H_2O$ (d) NaCl

(iii) What is the nature of the solution formed by dissolving *Y* in water?

(a) Alkaline (b) Acidic (c) Neutral (d) It remains insoluble.

(iv) Identify the compound, *Z*.

(a) CO_2 (b) H_2CO_3 (c) NaOH (d) H_2O

(v) Sodium carbonate is a basic compound because it is a salt of a

(a) strong acid and strong base
(b) weak acid and weak base
(c) strong acid and weak base
(d) weak acid and strong base.

Case Study 8

Read the following and answer any four questions from 3(i) to 3(v).

Sodium chloride obtained from sea water or from lakes contains many impurities such as sulphates of sodium and magnesium along with chlorides of calcium and magnesium. The chlorides of calcium and magnesium are particularly undesirable on account of their deliquescent nature.

For its purification, common salt is dissolved in minimum quantity of water to get a saturated solution from which insoluble impurities are filtered off. Then hydrogen chloride gas is passed through the saturated solution and the crystals of pure NaCl separate out. The soluble impurities remain in the mother liquor. The crystals are filtered, washed and dried.

(i) Select the correct statement regarding salt NaCl.
(a) Pure NaCl is hygroscopic in nature.
(b) It is soluble in alcohol.
(c) Pure NaCl is not hygroscopic, it shows hygroscopic nature due to impurities.
(d) It is a brown crystalline solid.

(ii) Nature of aqueous solution of common salt is
(a) acidic (b) alkaline (c) basic (d) neutral.

(iii) In the given series of reactions, *Y* and *Z* respectively are

$$NaCl + H_2O + CO_2 + NH_3 \longrightarrow X + Y$$

$$\Delta \downarrow -H_2O, -CO_2$$

$$Q \xleftarrow{+10H_2O} Z$$

(*Q* is used in removing permanent hardness of water.)
(a) $NaHCO_3$, $NaOCl_2$ (b) NH_4Cl, Na_2CO_3 (c) Na_2CO_3, NH_4Cl (d) Na_2CO_3, $NaHCO_3$

(iv) Which of the following compounds is alkaline in aqueous medium?
(a) Na_2CO_3 (b) NaCl (c) H_2CO_3 (d) $CuSO_4$

(v) Some statements regarding salt NaCl are given below:
(I) It is prepared by chlor-alkali process.
(II) It is a white crystalline substance.
(III) It also exists in the form of rocks and is called rock salt.
(IV) It is a neutral salt, pH value of NaCl is 7.
Select the correct statements.
(a) II and III only (b) III and IV only (c) I and IV only (d) II, III and IV only

Case Study 9

Read the following and answer any four questions from 4(i) to 4(v).

Chemically, Plaster of Paris (POP) is calcium sulphate hemihydrate, *i.e.*, containing half molecule of water of crystallisation. It is represented by the formula, $CaSO_4 \cdot 1/2H_2O$. Half molecule of water of crystallisation means that one water molecule is shared by two formula units of $CaSO_4$. Hence, we also represent its formula as $(CaSO_4)_2 \cdot H_2O$. The name, plaster of Paris, was given to this compound because for the first time, it was made from gypsum which was mainly found in Paris.

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

(ii) Plaster of Paris hardens by
(a) giving off CO_2 (b) changing into $CaCO_3$
(c) combining with water (d) giving out water.

(iii) Which of the following statements is incorrect?
(a) Plaster of Paris is used to ornate designs on walls and ceilings.
(b) On heating gypsum above 373 K, $CaSO_4$ is obtained.
(c) Dead burnt plaster is $CaSO_4 \cdot 2H_2O$.
(d) Setting of plaster is due to its hydration into gypsum.

(iv) Select the incorrect statement with respect to gypsum.

(a) It is slightly soluble in water.

(b) It is also known as alabaster.

(c) On heating gypsum at 373 K, it loses water molecules and becomes calcium sulphate hemihydrate.

(d) Chemical formula of gypsum is $CaSO_4 \cdot 1/2H_2O$.

(v) Plaster of Paris is obtained by

(a) adding water to calcium sulphate

(b) adding sulphuric acid to calcium hydroxide

(c) heating gypsum to a very high temperature

(d) heating gypsum to 100° C.

Case Study 10

Read the following and answer any four questions from 5(i) to 5(v).

pH is quite useful to us in a number of ways in daily life. Some of its applications are :

Control of pH of the soil : Plants need a specific pH range for proper growth. The soil may be acidic, basic or neutral depending upon the relative concentration of H^+ and OH^-. The pH of any soil can be determined by using pH paper. If the soil is too acidic, it can be corrected by adding lime to it. If the soil is too basic, it can be corrected by adding organic manure which contains acidic materials.

Regaining shine of a tarnished copper vessel by use of acids : A copper vessel gets tarnished due to formation of an oxide layer on its surface. On rubbing lemon on the vessel, the surface is cleaned and the vessel begins to shine again. This is due to the fact that copper oxide is basic in nature, which reacts with the acid (citric acid) present in lemon to form a salt (copper citrate) which is washed away with water. As a result, the layer of copper oxide is removed from the surface of the vessel and the shining surface is exposed.

Self-defence by animals through chemical warfare : Stings of bees and ants contain methanoic acid. When stung, it causes lot of pain and irritation. This can be cured by rubbing the affected area with mild base like baking soda.

(i) When black copper oxide placed in a beaker is treated with dilute HCl, its colour changes to

(a) white (b) dark red (c) bluish green (d) no change.

(ii) *P* is an aqueous solution of acid and *Q* is an aqueous solution of base. When these two are diluted separately, then

(a) pH of *P* increases while that of *Q* decreases till neutralisation.

(b) pH of *P* decreases while that of *Q* increases till neutralisation.

(c) pH of both *P* and *Q* decrease.

(d) pH of both *P* and *Q* increase.

(iii) Which of the following acids is present in bee sting?

(a) Formic acid (b) Acetic acid

(c) Citric acid (d) Hydrochloric acid

(iv) Sting of ant can be cured by rubbing the affected area with soap because

(a) it contains oxalic acid which neutralises the effect of formic acid

(b) it contains aluminium hydroxide which neutralises the effect of formic acid

(c) it contains sodium hydroxide which neutralises the effect of formic acid

(d) none of these.

(v) The pH of soil *X* is 7.5 while that of soil *Y* is 4.5. Which of the two soils, should be treated with powdered chalk to adjust its pH?

(a) *X* only (b) *Y* only (c) Both *X* and *Y* (d) None of these

Case Study 11

Read the following and answer any four questions from 6(i) to 6(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.

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

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

(a) NaOH (b) $NaHCO_3$

(c) $Na_2CO_3 \cdot 10H_2O$ (d) $Na_2CO_3 \cdot H_2O$

(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 dissolves in a solution of sodium hydroxide. (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

Case Study 12

Read the following and answer any four questions from 7(i) to 7(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 NaOH 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.

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

(a) $CaOCl_2$ (b) $CaCl_2$ (c) $Ca(ClO_3)_2$ (d) $CaCO_3$

Case Study 13

Read the following and answer any four questions from 8(i) to 8(v).

The preparation of washing soda is carried out through following steps :

Step-I : Manufacture of sodium hydrogen carbonate : $NaCl + H_2O + NH_3 + CO_2 \longrightarrow \underset{\text{Sodium hydrogen carbonate}}{NaHCO_3} + NH_4Cl$

Step-II : Thermal decomposition of sodium hydrogen carbonate : When dry crystals of sodium hydrogen carbonate are heated strongly, they decompose to form anhydrous sodium carbonate (soda ash).

$$2NaHCO_{3(s)} \longrightarrow Na_2CO_{3(s)} + CO_{2(g)} + H_2O_{(g)}$$

Step-III : Recrystallisation of sodium carbonate : Sodium carbonate thus obtained is recrystallised to form crystals of washing soda.

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

(i) Some of the uses of washing soda are given below:

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

(II) It is used in glass industry.

(III) It is used in paper industry.

(IV) It is used in the manufacture of sodium compounds such as borax.

Select the correct option regarding uses of washing soda.

(a) (I) and (II) only (b) (II) and (III) only

(c) (II) and (IV) only (d) (I), (II), (III) and (IV)

(ii) What products will be formed alongwith water when sodium carbonate reacts with dilute hydrochloric acid?

(a) CO and NaCl (b) Na and CO_2

(c) NaCl and CO_2 (d) Na and CO

(iii) Chief raw materials for the manufacture of washing soda are

(a) sodium chloride, ammonia and limestone

(b) ammonia, sodium hydrogen carbonate and copper sulphate

(c) sodium hydroxide, calcium chloride and ammonia

(d) calcium chloride, sodium chloride and copper sulphate.

(iv) What is the action of sodium carbonate on litmus paper?

(a) Turns red litmus blue (b) Turns blue litmus red (c) No change on litmus (d) Both (a) and (b)

(v) What products will be obtained when solution of sodium carbonate and slaked lime is heated?

(a) NaOH and $CaCl_2$ (b) $CaCO_3$ and NaOH

(c) $NaHCO_3$ and NaOH (d) NaCl and $CaCO_3$

Case Study 14

Read the following and answer any four questions from 9(i) to 9(v).

"Indicator is a chemical compound which is added to the solution in very small amount to detect its acidic or basic nature." As they show colour change in acidic and basic medium, they are also called acid-base indicators. In other words, "an acid-base indicator is that substance which possesses one colour in acidic medium and a different colour in alkaline medium."

Indicators, basically, are coloured organic substances either extracted from plants (natural indicators) or synthesised in the laboratory (synthetic indicators). A few common acid base indicators are : Litmus, phenolphthalein, methyl orange etc. In addition to these there are some naturally occurring substances which have different smell in acidic and basic medium. These substances are called olfactory indicators.

(i) Which one of the following will turn red litmus blue?

(a) Vinegar (b) Baking soda solution (c) Lemon juice (d) Soft drinks

(ii) A solution turns blue litmus red. The pH of the solution is probably

(a) 8 (b) 10 (c) 12 (d) 6

(iii) A solution in test tube '*A*' turns red litmus blue, evolves hydrogen gas on reaction with zinc and does not react with sodium carbonate. Whereas, solution in test tube '*B*' turns blue litmus red, liberates hydrogen gas on reaction with zinc and evolves carbon dioxide gas with sodium carbonate. Identify '*A*' and '*B*'.

(a) '*A*' is an acid, '*B*' is a base. (b) '*A*' is a base, '*B*' is an acid.

(c) Both '*A*' and '*B*' are bases. (d) Both '*A*' and '*B*' are acids.

(iv) Select the incorrect option.

	Indicator	Colour in acidic medium	Colour in basic medium
(a)	Litmus (Purple)	Red	Blue
(b)	Flower of hydrangea plant (Blue)	Red	Green
(c)	Red cabbage juice (Purple)	Red or Pink	Green
(d)	Turmeric Juice (Yellow)	Yellow	Reddish brown

(v) Which one of the following can be used as an acid-base indicator by visually impaired student?

(a) Litmus (b) Turmeric (c) Vanilla essence (d) Methyl orange

Case Study 15

Read the following and answer any four questions from 10(i) to 10(v).

Acids turn blue litmus red but have no effect on red litmus. Bases turn red litmus blue but have no effect on blue litmus. The sample in which phenolphthalein remains colourless while methyl orange changes to pink/ red are acids while the samples in which phenolphthalein colour changes to pink and methyl orange changes to yellow are bases. Some observations of different sample solutions in litmus, phenolphthalein and methyl orange indicator are given in the table.

Sample solution	Red litmus solution	Blue litmus solution	Phenolphthalein indicator	Methyl orange indicator
HCl	No colour change	Red	Colourless	Red/ Pink
H_2SO_4	No colour change	Red	Colourless	Red/Pink
HNO_3	No colour change	Red	Colourless	Red/Pink
CH_3COOH	No colour change	Red	Colourless	Red/Pink
NaOH	Blue	No colour change	Pink	Yellow
$Ca(OH)_2$	Blue	No colour change	Pink	Yellow
KOH	Blue	No colour change	Pink	Yellow
$Mg(OH)_2$	Blue	No colour change	Pink	Yellow
NH_4OH	Blue	No colour change	Pink (Becomes colourless after sometime)	Yellow (Becomes colourless after sometime)

(i) Which of the following substances does not turn red litmus solution to blue?

(a) $Al(OH)_3$ (b) $Mg(OH)_2$ (c) H_3PO_4 (d) NH_4OH

(ii) Phenolphthalein's colour in basic medium is _____ but in acid it is _____.

(a) pink, colourless (b) yellow, pink (c) pink, orange (d) blue, red

(iii) Which of the following acids are edible?

(I) Citric acid (II) Tartaric acid (III) Hydrochloric acid (IV) Carbonic acid

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

(iv) The colour of methyl orange in neutral solution is

(a) red (b) orange (c) yellow (d) purple.

(v) Which of the following cannot act as an indicator?

(a) Methyl orange (b) Methyl chloride (c) Turmeric juice (d) Phenolphthalein

HINTS & EXPLANATIONS

6. **(i) (c) :** As the pH value increases from 7 to 14, it represents decrease in H^+ ion concentration in the solution.

(ii) (c) : $pH = -\log_{10}[H^+] = 8$

$\log_{10}[H^+] = -8$

$[H^+] = 10^{-8}$ mol/L

(iii) (a)

(iv) (b): C_2H_5OH is not an ionic compound, it is a covalent compound and hence does not give H^+ ions in aqueous solution.

(v) (c) : (a) Lower the pH of the solution, more acidic is the solution and higher is the $[H^+]$ ions.
Thus, solution *P* (pH = 1) has higher $[H^+]$ ions than solution *R* (pH = 3).
(b) Higher the pH of the solution, more basic is the solution and higher is the $[OH^-]$ ions.
Thus, solution *Q* (pH = 9) has lower $[OH^-]$ ions than solution *S* (pH = 13).
(c) Solution *P* (pH = 1) is acidic which turns blue litmus solution red whereas solution *Q* (pH = 9) is basic which turns red litmus solution blue.
(d) Solution *P* (pH = 1) is highly acidic while solution *S* (pH = 13) is highly basic and solution *Q* (pH = 9) is weakly basic.

7. **(i) (a) :** The compound of sodium that is a constituent of baking powder and is used in antacids, is sodium hydrogen carbonate ($NaHCO_3$).

(ii) (b): $\underset{(X)}{2NaHCO_3} \xrightarrow{\text{Heat}} \underset{(Y)}{Na_2CO_3} + CO_2 + H_2O$

Sodium hydrogen carbonate — Anhydrous sodium carbonate

(iii) (a): $Na_2CO_3 + 2H_2O \longrightarrow \underset{\text{Strong base}}{2NaOH} + \underset{(Z)}{H_2CO_3}$

Weak acid

NaOH ionises completely to give a large amount of OH^- ions whereas H_2CO_3 ionises partially to give a small amount of H^+ ions. Hence, the solution is overall alkaline.

(iv) (b): *Z* is carbonic acid, a weak acid formed when Na_2CO_3 is dissolved in water.

(v) (d)

8. **(i) (c) :** NaCl is insoluble in alcohol and it is a white crystalline solid. Pure NaCl is not hygroscopic in nature.

(ii) (d): Aqueous solution of common salt is neutral in nature.

$NaCl + H_2O \longrightarrow \underset{\text{Strong base}}{NaOH} + \underset{\text{Strong acid}}{HCl}$

(iii) (b): $NaCl + H_2O + CO_2 + NH_3 \longrightarrow \underset{(X)}{NaHCO_3} + \underset{(Y)}{NH_4Cl}$

$\underset{(X)}{NaHCO_3} \xrightarrow{\Delta,\ -H_2O,\ -CO_2} \underset{(Z)}{Na_2CO_3}$

$\underset{(Z)}{Na_2CO_3} \xrightarrow{+10H_2O} \underset{\text{Washing soda}\ (Q)}{Na_2CO_3 \cdot 10H_2O}$

(iv) (a): When Na_2CO_3 (sodium carbonate) is dissolved in water then it forms alkaline aqueous

solution due to the formation of NaOH which is a strong alkali.

(v) **(d):** Sodium hydroxide (NaOH) is prepared by chlor-alkali process.

9. **(i) (d):** Gypsum is $CaSO_4 \cdot 2H_2O$ and plaster of Paris is $CaSO_4 \cdot \frac{1}{2} H_2O$. Difference in number of water molecules $= \frac{3}{2}$

(ii) (c): Plaster of Paris is hardened by combining with water.

(iii) (c): Dead burnt plaster is $CaSO_4$ (anhydrous calcium sulphate).

(iv) (d): Gypsum : $CaSO_4 \cdot 2H_2O$
Plaster of paris: $CaSO_4 \cdot 1/2H_2O$

(v) (d): Gypsum on heating upto 100°C gives plaster of Paris.

$$\underset{\text{Gypsum}}{CaSO_4 \cdot 2H_2O} \xrightarrow{100°C} \underset{\text{Plaster of Paris}}{CaSO_4 \cdot \frac{1}{2}H_2O} + 1\frac{1}{2}H_2O$$

10. **(i) (c):** $CuO + 2HCl \longrightarrow \underset{\text{(Bluish green)}}{CuCl_2} + 2H_2O$

(ii) (a): On diluting, H^+ ion concentration reduces per unit volume thus, pH increases.
On the other hand, on diluting, OH^- concentration also reduces, pOH increases and pH decreases.

As, pOH + pH = 14.
Thus, pH of *Q* (basic solution) decreases while that of *P* (acidic solution) increases on dilution.

(iii) (c): Formic acid is the common name of methanoic acid, and it is present in bee sting.

(iv) (c)

(v) (b): Soil *Y* is acidic. Hence, it should be treated with powdered chalk to reduce its acidity.

11. **(i) (b):** $Na_2CO_3 + H_2O + CO_2 \longrightarrow 2NaHCO_3$

(ii) (b): $NaHCO_3 + CH_3COOH \longrightarrow CH_3COONa + CO_2\uparrow + H_2O$

Carbon dioxide gas is evolved which turns limewater 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): $2NaHCO_3 \xrightarrow{Heat} Na_2CO_3 + H_2O + CO_2$
$NaHCO_3$ is soluble in water.

(iv) (b): $NaHCO_3 + CH_3COOH \longrightarrow CH_3COONa + CO_2 + H_2O$

(v) (c): It is not used in manufacture of soap.

12. **(i) (d)** **(ii) (d)**

(iii) (b): Bleaching powder gives chlorine on exposure to air by reacting with CO_2.

$$CaOCl_2 + CO_2 \longrightarrow CaCO_3 + Cl_2$$

(iv) (d)

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

13. **(i) (d)**

(ii) (c): Na_2CO_3 reacts with dilute acids to give CO_2 gas with brisk effervescence.

$$\underset{\substack{\text{Sodium}\\\text{carbonate}}}{Na_2CO_{3(s)}} + \underset{\substack{\text{Dil. Hydrochloric}\\\text{acid}}}{2HCl_{(aq)}} \longrightarrow \underset{\substack{\text{Sodium}\\\text{chloride}}}{2NaCl_{(aq)}} + \underset{\text{Water}}{H_2O_{(l)}} + \underset{\text{Carbon dioxide}}{CO_{2(g)}\uparrow}$$

(iii) (a): Chief raw materials for the manufacture of washing soda are sodium chloride (NaCl), ammonia (NH_3) and limestone ($CaCO_3$).

(iv) (a): Sodium carbonate turns red litmus blue.

(v) (b): Sodium hydroxide and calcium carbonate are formed when the solution of sodium carbonate and slaked lime, $Ca(OH)_2$ is heated.

$$Na_2CO_3 + Ca(OH)_2 \longrightarrow 2NaOH + CaCO_3$$

14. **(i) (b):** Baking soda ($NaHCO_{3)}$ is basic in nature.

(ii) (d): The solution turns blue litmus red, hence it is acidic.

(iii) (b): Acids turn blue litmus red, liberate hydrogen gas with zinc and evolve carbon dioxide gas with metal carbonates. Bases turn red litmus blue, evolve hydrogen gas with zinc and do not react with metal carbonates.

(iv) (b):

Indicator	**Colour in acidic**	**Colour in basic medium**
Flowers of hydrangea plant (blue)	Blue	Pink

(v) (c): Vanilla essence is an olfactory indicator. So, its smell is different in acidic and basic medium which can be detected easily by a visually impaired student.

15. **(i) (c)** **(ii) (a)**

(iii) (b): Citric and tartaric acid are from organic substances such as lemon and tamarind respectively and they are edible. Hydrochloric acid though formed inside stomach is not edible. Carbonic acid is a mild acid and is edible in the form of soda water.

(iv) (b) **(v) (b)**