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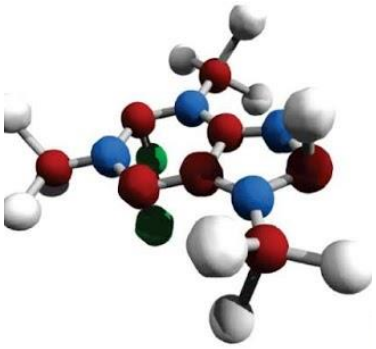

Acids, Bases And Salts

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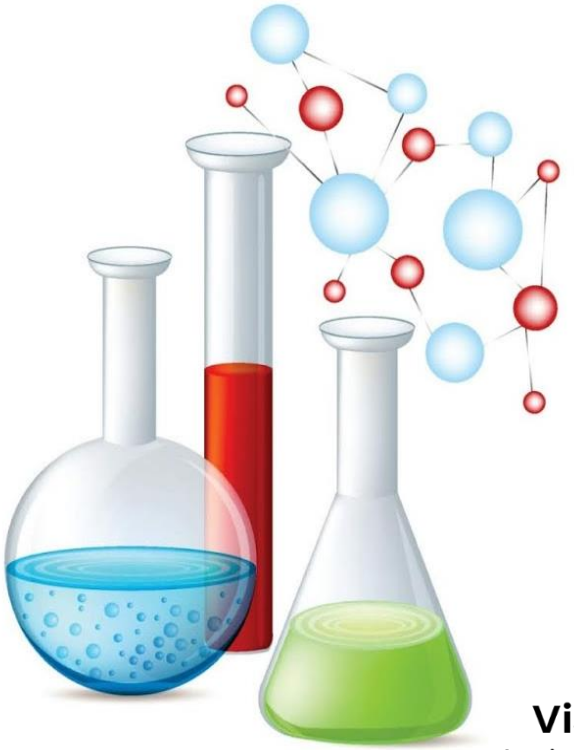

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ACIDS - BASES AND SALTS

Quick Revision

1. Acids

- Acids are those chemical substances which have a sour taste and turn blue litmus solution red.
- According to **Arrhenius concept,** substances that furnish H^+ ions in an aqueous solution are called acids.
  e.g. $H_2SO_4 \longrightarrow 2H^+ + SO_4^{2-}$
- Acids may be **strong** (which completely dissociates) or **weak** (which partially dissociates).

2. Chemical Properties of Acids

- **Reaction with Metals** Dilute acids (e.g. HCl and H_2SO_4, not HNO_3) react with certain active metals like zinc (Zn), iron (Fe), etc., to evolve H_2 gas.
  e.g.

$$\underset{\text{Zinc}}{Zn(s)} + \underset{\text{Sulphuric acid}}{H_2SO_4(aq)} \longrightarrow \underset{\text{Zinc sulphate}}{ZnSO_4(aq)} + \underset{\text{Hydrogen}}{H_2(g)}$$

- **Reaction with Metal Oxides** Acids react with certain metal oxides (basic oxides) to form salt and water.
  e.g.

$$\underset{\text{Calcium oxide}}{CaO(s)} + \underset{\text{Hydrochloric acid}}{2HCl(aq)} \longrightarrow \underset{\text{Calcium chloride}}{CaCl_2(aq)} + \underset{\text{Water}}{H_2O(l)}$$

- **Reaction with Metal Carbonate and Hydrogen Carbonate** Acids react with metal carbonates and hydrogen carbonates to produce carbon dioxide gas. e.g.

$$\underset{\text{Calcium carbonate}}{CaCO_3(s)} + \underset{\text{Hydrochloric acid}}{2HCl(aq)} \longrightarrow \underset{\text{Calcium chloride}}{CaCl_2(aq)} + \underset{\text{Water}}{H_2O(l)} + \underset{\text{Carbon dioxide}}{CO_2(g)}$$

$$NaHCO_3(s) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(s) + CO_2(g)$$

3. Bases

- Substances that furnish hydroxide ions (OH^-) in aqueous solution are called bases. e.g. Caustic soda or sodium hydroxide, NaOH.
- **Strong Bases** The substances/bases which ionise completely to furnish OH^- ions are called strong bases. e.g. KOH (caustic potash).
- **Weak Bases** The bases which ionise only partially are called weak bases. e.g. Calcium hydroxide [$Ca(OH)_2$].
- **Alkali** Water soluble base is called alkali. e.g. NaOH. All alkalies are base, but all base are not alkalies.
- Bases have bitter taste, turn red litmus to blue and soapy to touch.

4. Chemical Properties of Bases

- **Reaction with Metals** Strong bases react with active metals to produce hydrogen gas. e.g.

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

- **Reaction with Non-metallic Oxide** Bases react with non-metallic oxides (acidic oxides) to produce salt and water. This reaction proves that non-metallic oxides are acidic in nature. e.g.

$$\underset{\text{Carbon dioxide}}{CO_2(g)} + \underset{\text{Slaked lime}}{Ca(OH)_2(aq)} \longrightarrow \underset{\text{Calcium carbonate}}{CaCO_3(s)} + \underset{\text{Water}}{H_2O(l)}$$

5. Reaction Between Acids and Bases

- Acids react with bases to produce salt and water. In this reaction, acid neutralises a base, i.e. reduce its effect or *vice-versa*, thus the reaction is known as **neutralisation reaction.**
- In general, neutralisation reaction can be written as

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

e.g.

$$\underset{\text{Sodium hydroxide}}{NaOH(aq)} + \underset{\text{Hydrochloric acid}}{HCl(aq)} \longrightarrow \underset{\text{Sodium chloride}}{NaCl(aq)} + \underset{\text{Water}}{H_2O(l)}$$

6. Effect of Dilution on an Acid or Base

- Mixing of an acid or base with water is called **dilution**. It results in decrease in the concentration of ions (H_3O^+/OH^-) per unit volume and the acid or base is said to be **diluted**.
- The process of diluting an acid or base is a highly exothermic process. The acid must be added slowly to water with constant stirring.
- If water is added to a concentrated acid, the heat generated may cause the mixture to splash out and cause burns.

7. Indicators

Indicators are the substances that change their colour or odour when added into an acid or alkaline solution. Indicators can be classified as natural, synthetic indicators, olfactory indicators and universal indicators.

(i) **Natural Indicators** These indicators are found in nature in the plants. e.g. Litmus solution is a purple colour dye extracted from the lichen plant.

(ii) **Synthetic Indicators** The indicators which are synthesised in the laboratory or industry are known as synthetic indicators. e.g. Methyl orange, phenolphthalein.

Indicator	pH-range	Colour (In Acidic Medium)	Colour (In Basic Medium)
(i) Natural Indicators			
Litmus	–	Red	Blue
Turmeric	–	Yellow	Red
Red cabbage juice (from leaves)	–	Red	Green
(ii) Synthetic indicators			
Phenolphthalein	8.4-10.00	Colourless	Pink (Red)
Methyl orange	3.1-4.4	Red	Yellow

(iii) **Olfactory Indicators** Those substances whose odour changes in acidic or basic medium are called olfactory indicators. e.g. Vanilla extract and onion.

(iv) **Universal Indicators** To judge how strong a given acid or base is, a universal indicator is used which is a mixture of several indicators. It shows different colours at different concentrations of hydrogen ion in a solution.

8. Strength of an Acid or Base

- Strength of an acid or base depends on the number of H^+ ions or OH^- ions produced by them respectively.
- Larger the number of H^+ ions produced by an acid, stronger is the acid. Similarly, larger the number of the OH^- ions produced by a base, stronger is the base.

9. pH Scale

- It is a scale used for measuring hydrogen ion concentration. The *p* in the pH stands for **potenz** which means **power** in German. It has values ranging from 0 (very acidic) to 14 (very alkaline).

  Thus, pH is a number which indicates the acidic or basic nature of a solution.
- According to Danish chemist Sorensen, pH is the negative of logarithm to the base 10 of hydrogen ion concentration present per litre of solution.

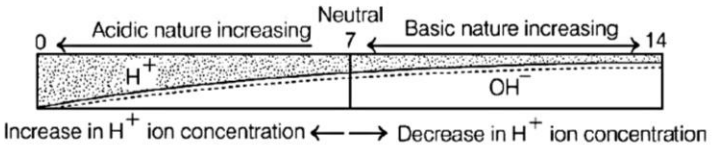
- In other words, value of pH is equal to the logarithm to the base 10, inverse of hydrogen ion concentration.

$$\Rightarrow \quad pH = -\log_{10}[H^+] = \log_{10}\frac{1}{[H^+]} \Rightarrow [H^+] = 10^{-pH}$$

$$\text{Similarly,} \quad pOH = -\log[OH^-] = \log\frac{1}{[OH^-]}$$

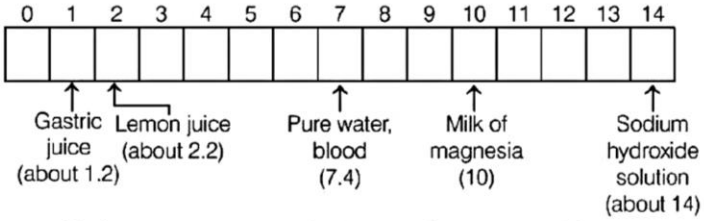
$$\text{and} \quad pH + pOH = pK_w = 14$$

- Higher the hydronium ion concentration present in the solution, lower is its pH value [pH means power of hydrogen ions].
  - If pH > 7, solution is basic.
  - If pH < 7, solution is acidic.
  - If pH = 7, solution is neutral.



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

- Pure water is neutral because of the absence of free ions. A paper impregnated with the universal indicator is used for measuring pH.



pH of some common substances shown on a pH paper

10. Importance of pH in Everyday Life

Following are the examples showing importance of pH in everyday life

(i) **Plants and Animals are pH Sensitive** Our body works normally within a pH range of 7.0 to 7.8. When pH of rain water goes below 5.6, it is called acid rain. It lowers the pH of the river water and makes survival of aquatic life difficult.

(ii) **pH of the Soil** Nature of soil is known by testing its pH and then a particular crop is grown in it by selecting fertilizer.

(iii) **pH in Our Digestive System** During indigestion the stomach produces too much acid, it causes pain and irritation. To correct the disturbed pH range, milk of magnesia (a mild base) is used as a medicine, which is also called **antacid**.

(iv) **pH Change Leads to Tooth Decay** If the pH inside the mouth decreases below 5.5 (acidic), the decay of tooth enamel begins. The bacteria present in the mouth degrades the sugar and left over food particles and produce acids that remains in the mouth after eating.

To prevent tooth decay, toothpastes (basic) are used which neutralise the excess acid.

(v) **Self Defence by Animals and Plants through Chemical Warfare** When insects like honeybee, ant, etc., bite, they inject an acid into the skin, that causes pain and irritation. If a mild base like baking soda is applied on the affected area, it gives relief.

(vi) **pH in Plants** Stinging hair of nettle leaves injects methanoic acid in the skin which causes burning pain. It is cured by rubbing with leaves of dock plant.

11. Salts

- These are produced by the **neutralisation reaction** between acid and base.

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

$$HX + MOH \longrightarrow \underset{\text{Salt}}{MX} + HOH$$

Here, X is non-metal and M is metal.

- Salts of strong acid and strong base are neutral (pH=7). Salts of strong acid and weak base are acidic [pH < 7] and salts of strong base and weak acid are basic in nature (pH > 7).

12. Common Salt : Sodium Chloride

Common salt is formed by the combination of hydrochloric acid and sodium hydroxide solution. It is the salt that we use in food.

(i) **Caustic Soda** (Sodium Hydroxide [NaOH])
When electricity is passed through an aqueous solution of sodium chloride (called brine), it decomposes to form sodium hydroxide.

The process is called the **chlor-alkali process.**

$$\underset{\text{Sodium chloride}}{2NaCl(aq)} + \underset{\text{Water}}{2H_2O} \longrightarrow \underset{\text{Sodium hydroxide}}{2NaOH(aq)} + \underset{\text{Chlorine}}{Cl_2(g)} + \underset{\text{Hydrogen}}{H_2(g)}$$

(ii) **Bleaching Powder** (Calcium Oxychloride [$CaOCl_2$]) It is produced by the action of chlorine on dry slaked lime.

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

(iii) **Baking Soda** (Sodium Hydrogen Carbonate or Sodium Bicarbonate [$NaHCO_3$])

The soda commonly used in the kitchen for making tasty crispy pakoras is baking soda.

It is the major constituent of baking powder. It is produced by using sodium chloride as one of the raw materials.

Manufacture of baking soda is shown in reaction below

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

(iv) **Washing Soda** (Sodium Carbonate [$Na_2CO_3 \cdot 10H_2O$]) Sodium carbonate can be obtained by heating baking soda; recrystallisation of anhyd. sodium carbonate gives washing soda. It is also a basic salt.

$$Na_2CO_3(s) + 10H_2O(l) \longrightarrow Na_2CO_3 \cdot 10H_2O(s)$$

(v) **Plaster of Paris** (Calcium Sulphate Hemihydrate [$CaSO_4 \cdot 1/2\ H_2O$]) It is obtained by heating gypsum ($CaSO_4 \cdot 2H_2O$) at 373 K. At this temperature, gypsum loses water molecules and forms plaster of Paris.

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

13. Water of Crystallisation

It is the fixed number of water molecules present in one formula unit of a salt. e.g. Hydrated copper sulphate, $CuSO_4 \cdot 5H_2O$ contains five molecules of crystallisation.

Objective Questions

Multiple Choice Questions

01. Which of the following is the mineral acid?
(a) Hydrochloric acid
(b) Citric acid
(c) Acetic acid
(d) Lactic acid

02. Which of the following statements is incorrect about acids?
(a) Acids conduct electricity
(b) Acids do not corrode metals
(c) Acids gives hydrogen ions after dissociation
(d) All of the above are correct

03. Which of the following acids is present in sour milk? *(NCERT Exemplar)*
(a) Glycolic acid (b) Oxalic acid
(c) Lactic acid (d) Citric acid

04. Which of the following is acidic in nature?
(a) Lime juice (b) Human blood
(c) Lime water (d) Antacid

05. Select the acid which contains four hydrogen atoms in it.
(a) Formic acid (b) Sulphuric acid
(c) Nitric acid (d) Acetic acid

06. Match the acids given in Column I with their correct source given in Column II and select the correct answer using the options given below:

	Column I		Column II
A.	Lactic acid	1.	Tomato
B.	Citric acid	2.	Curd
C.	Acetic acid	3.	Oranges
D.	Oxalic acid	4.	Vinegar

Codes

	A	B	C	D
(a)	1	3	2	4
(b)	3	1	4	2
(c)	4	2	1	3
(d)	2	3	4	1

07. Which of the following statements is not correct? *(NCERT Exemplar)*

(a) All metal carbonates react with acid to give a salt, water and carbon dioxide
(b) All metal oxides react with water to give salt and acid
(c) Some metals react with acids to give salt and hydrogen
(d) Some non-metal oxides react with water to form an acid

08. Which gas is evolved, when hydrochloric acid is added in first test tube containing small pieces of marble and then in second test tube containing zinc granules?

(a) H_2 is first test tube, O_2 in second test tube
(b) CO_2 in first test tube, H_2 in second test tube
(c) O_2 in first test tube, Cl_2 in second test tube
(d) Cl_2 in first test tube, CO_2 in second test tube

09. When dilute sulphuric acid reacts with iron sulphide, the gas evolved is ..... .

(a) hydrogen sulphide
(b) sulphur dioxide
(c) sulphur trioxide
(d) vapour of sulphuric acid

10. Which of the following gives OH^- ions on dissociation in water?

(a) Calcium carbonate (b) Iron sulphide
(c) Calcium oxide (d) All of these

11. Which of the following hydroxides is not an alkali?

(a) Ammonium hydroxide
(b) Calcium hydroxide
(c) Copper hydroxide
(d) Sodium hydroxide

12. Sodium hydroxide and potassium hydroxide are used as electrolytes.

(a) True (b) False
(c) Can't say (d) Partially true/false

13. Which of the following statements is incorrect about bases?

(a) Bases are bitter in taste
(b) They are soapy to touch
(c) They are corrosive in nature
(d) All bases are alkali

14. Which of the following combination justify that lime water is basic in nature?

(a) $Ca(OH)_2 + CO_2(g)$ (b) $Ca(OH)_2 + NaOH$
(c) $Ca(OH)_2 + NaCl$ (d) Both (b) and (c)

15. Identify 'X' and 'Y' in the fol,lowing reaction:

$$Ca(OH)_2(aq) + X(g) \longrightarrow CaCl_2(s) + Y + 2NH_3(g)\uparrow$$

(a) $X = NH_4Cl$, $Y = O_2$
(b) $X = NH_4Cl$, $Y = H_2O$
(c) $X = (NH_4)_2SO_4$, $Y = SO_2$
(d) $X = NH_4OH$, $Y = O_2$

16. An acid when dissolved in water gives ..... ions.

(a) hydroxide (b) negative
(c) hydronium (d) All of these

17. What happens, when sodium hydroxide is mixed in water?

I. Hydronium ions will be produced.
II. Heat is released during dissolution.
III. The process is endothermic.

IV. Hydroxide ions will be produced

Choose the correct option.

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

18. The aqueous solution of sulphur dioxide is ..... .

(a) acidic (b) basic
(c) neutral (d) amphoteric

19. When a small amount of acid is added to water, the phenomena which occur are *(CBSE 2020)*

I. Dilution
II. Neutralisation
III. Formation of H_3O^+ ions
IV. Salt formation

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

20. Sodium hydrogen carbonate when added to acetic acid 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.

(NCERT Exemplar)

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

21. When metal carbonate reacts with acid like HCl in aqueous solution, then which gas will evolved?

(a) H_2 (b) CO_2 (c) O_2 (d) NO_2

22. Mixing of an acid or base with water results in ..... in the concentration of ions per unit volume. *(NCERT Exemplar)*

(a) decrease (b) increase
(c) no change (d) reverse change

23. When a metallic oxide is dissolved in water, the solution formed has a high concentration of which ions

(a) H^+ (b) H_3O^+
(c) OH^- (d) M^+ (M = metal)

24. Which one of the following can be used as an acid-base indicator by a visually impared student? *(NCERT Exemplar)*

(a) Litmus (b) Turmeric
(c) Vanilla essence (d) Petunia leaves

25. The correct statement regarding universal indicator is

(a) it is an indicator having pH = 7
(b) it gives blue colour at pH = 3
(c) it becomes colourless at pH = 7
(d) it gives red colour at pH = 3

26. A blue litmus paper was first dipped in dil. HCl and then in dil. NaOH solution. The colour of the litmus paper will be

(a) changed first to red and then to blue
(b) changed first to blue and then colourless
(c) remains blue in both times
(d) changed to red

27. The turmeric solution will turn red by an aqueous solution of

(a) CH_3COOK (b) $CuSO_4$
(c) Na_2SO_4 (d) $FeCl_3$

28. Which of the following is not a natural indicator? *(NCERT Exemplar)*

(a) Red cabbage juice
(b) Turmeric juice
(c) Flowers of *hydrangea* plant
(d) None of the above

29. An aqueous solution turns red litmus solution blue. Excess addition of which of the following solution would reverse the change? *(NCERT Exemplar)*

(a) Baking powder
(b) Lime
(c) Ammonium hydroxide solution
(d) Hydrochloric acid

30. Methyl orange and phenolphthalein are used for ..... purposes.

(a) titration (b) cooking
(c) dissolution (d) neutralisation

31. Match the indicators given in the Column I with its colour transition on reacting with base in Column II and select the correct answer using the options given below.

Column I (Indicators)	Column II (Change in colour in basic medium)
A. Red litmus	1. Yellow
B. Methyl orange	2. Blue
C. Phenolphthalein	3. No change
D. Blue litmus	4. Pink

Codes

	A	B	C	D
(a)	2	3	1	4
(b)	3	1	4	2
(c)	2	1	4	3
(d)	3	2	4	1

32. What is pH?

(a) The positive logarithm of the hydroxide ion concentration
(b) The positive logarithm of the hydrogen ion concentration
(c) The negative logarithm of the hydroxide ion concentration
(d) The negative logarithm of the hydrogen ion concentration

33. Which of the following statements is correct about an aqueous solution of an acid and a base?

I. Higher the pH, stronger the acid.
II. Higher the pH, weaker the acid.
III. Lower the pH, stronger the base.
IV. Lower the pH, weaker the base.

(NCERT Exemplar)

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

34. When the pH increases, the acidity decreases.

(a) True (b) False
(c) Can't say (d) Partially true/false

35. A solution turns red litmus blue, its pH is likely to be

(a) 1 (b) 4
(c) 5 (d) 10

36. Which of the following statement is correct?

(a) pH of acid rain is 7- 7.8
(b) Acid rain makes survival of aquatic life difficult
(c) Acid rain clear the marble buildings
(d) All of the above

37. A sample of soil is mixed with water and allowed to settle. The clear supernatant solution turns the pH paper yellowish-orange. Which of the following would change the colour of this pH paper to greenish-blue?

(a) Lemon juice (b) Vinegar
(c) Common salt (d) An antacid

38. Calcium phosphate is present in tooth enamel. Its nature is ..... .

(a) basic (b) acidic
(c) neutral (d) amphoteric

39. Antacids contain .....

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

40. Which of the following substances can be used to get relief from bee sting?

(a) Vinegar (b) Baking soda
(c) Formic acid (d) Alcohol

41. Useful substance for disinfecting water is ..... .

(a) washing soda (b) common alum
(c) baking soda (d) bleaching powder

42. The chemical formula of washing soda is .....

(a) $NaHCO_3$ (b) $Na_2CO_3 \cdot 10H_2O$
(c) $CaOCl_2$ (d) NaOH

43. Identify the correct representation of reaction occurring during chloralkali process. *(NCERT Exemplar)*

(a) $2NaCl(l) + 2H_2O(l) \longrightarrow 2NaOH(l) + Cl_2(g) + H_2(g)$

(b) $2NaCl(aq) + 2H_2O(aq) \longrightarrow 2NaOH(aq) + Cl_2(l) + H_2(aq)$

(c) $2NaCl(aq) + 2H_2O(l) \longrightarrow 2NaOH(aq) + Cl_2(aq) + H_2(aq)$

(d) $2NaCl(aq) + 2H_2O(l) \longrightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$

44. The chemical name of bleaching powder is calcium chloride.

(a) True
(b) False
(c) Can't say
(d) Partially true/false

45. Plaster of Paris can be harden by

(a) giving out water
(b) combining with water
(c) changing into $CaCO_3$
(d) giving of CO_2

46. Match the chemical substances given in Column I with their appropriate application given in Column II.

Column I	Column II
A. Bleaching powder	1. Preparation of glass
B. Baking soda	2. Production of H_2 and Cl_2
C. Washing soda	3. Decolourisation
D. Sodium chloride	4. Antacid

Codes *(NCERT Exemplar)*

	A	B	C	D
(a)	2	1	4	3
(b)	3	2	4	1
(c)	3	4	1	2
(d)	2	4	1	3

47. Which of the following salts does not contain water of crystallisation?

(a) Blue vitriol
(b) Baking soda
(c) Washing soda
(d) Gypsum

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

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

(NCERT Exemplar)

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

49. Baking soda is a mixture of *(CBSE 2020)*

(a) sodium carbonate and acetic acid
(b) sodium carbonate and tartaric acid
(c) sodium hydrogen carbonate and tartaric acid
(d) sodium hydrogen carbonate and acetic acid

Assertion-Reasoning MCQs

Direction (Q.Nos. 50-57) For question numbers 50 to 57 two statements are given–one labeled **Assertion** (A) and the other labeled **Reason** (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

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

50. **Assertion** Lemon juice is sour in taste.

Reason Lemon juice is acidic in nature.

51. **Assertion** Sodium hydrogen carbonate is used in fire extinguisher.

Reason Sodium hydrogen carbonate is a mild base.

52. **Assertion** HCl produces hydronium ions (H_3O^+) and chloride ions (Cl^-) in aqueous solution.

Reason In presence of water, base gives H^+ ions.

53. **Assertion** Sodium carbonate is an acidic salt.

Reason Sodium carbonate is salt of weak acid and strong base.

54. **Assertion** Phenolphthalein gives pink colour in basic solution.

Reason Phenolphthalein is a natural indicator.

55. **Assertion** If the pH inside the mouth decreases below 5.5, the decay of tooth enamel begins.

Reason The bacteria present in mouth degrades the sugar and left over food particles and produce acids that remains in the mouth after eating.

56. **Assertion** Aqueous solution of ammonium nitrate turns the blue litmus into red.

Reason Ammonium nitrate is a salt of strong acid and strong base.

57. **Assertion** Magnesium hydroxide is used as an antacid.

Reason Magnesium hydroxide is a strong base.

Cased Based MCQs

58. Read the following and answer questions from (i) to (v).

Acids produce hydrogen ions, $H^+(aq)$, in solution, which are responsible for their acidic properties. Hydrogen ions cannot exist alone, but they exist after combining with water molecules.

Bases generate hydroxide (OH^-) ions in water. Bases which are soluble in water are called **alkalis**, that all acids generate $H^+(aq)$ and all bases generate $OH^-(aq)$,

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

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.

(i) Ammonium hydroxide is a weak base because
(a) it has low vapour pressure
(b) it is only slightly ionised
(c) it is not a hydroxide of any metal
(d) it has low density

(ii) The poisonous effect of acid present in stings of bees and ants can be neutralised by use of a solution that contains
(a) acetic acid
(b) formic acid
(c) sodium hydroxide
(d) sodium chloride

(iii) Which of the following is an alkali?
(a) $Ca(OH)_2$
(b) KOH
(c) $Mg(OH)_2$
(d) $CaCO_3$

(iv) Acids and bases are important because of ..... .
(a) their use in industry
(b) their effects on human health
(c) their effect on farmer's crop
(d) All the above are correct

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

59. Read the following and answer questions from (i) to (v).

Sodium is a very important element. Many of its compound are widely used by us, even in our food as well as for washing clothes.

Sodium carbonate decahydrate ($Na_2CO_3 \cdot 10H_2O$) is called washing soda and is widely used for washing clothes. When it is saturate with dioxide of carbon in moist environment, it gives a product called baking soda.

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

Baking soda is used in small amount in making bread and cake. It helps to make these soft and spongy. An aqueous solution of baking soda turns red litmus blue. It is also used in soda-acid fire extinguisher.

Bleaching powder is also known as chloride of lime. It is 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.

Aqueous solution of bleaching powder is basic in nature.

(i) Baking powder helps in making cakes and bread soft and spongy by
(a) providing hydrogen gas
(b) releasing carbon monoxide gas
(c) releasing carbon dioxide gas
(d) reacting dough of cakes and bread

(ii) Which reaction is used in soda-acid fire extinguishers ?
(a) $NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$
(b) $NaHCO_3 + H^+ \longrightarrow CO_2 + H_2O$ + Sodium salt of acid
(c) Both (a) and (b)
(d) None of the above

(iii) The approximate pH value of bleaching powder solution is
(a) 4 (b) 7
(c) 9 (d) 5.5

(iv) How many water of crystallisation present in washing soda?
(a) 2 (b) 5
(c) 6 (d) 10

(v) Which of the following statement is correct about heating washing soda?
(a) Washing soda will give pungent smell
(b) Washing soda will lose its water of crystallisation
(c) The colour of washing soda will change into black
(d) All are correct

60. Read the following and answer questions from (i) to (v).

The strength of a base depends on the concentration of the hydroxyl ions present in a solution. Greater the number of hydroxyl ion present, greater is the strength of base. However, some bases do not dissociate to any appreciable extent in water, e.g. NH_4OH. Some bases dissolve in water to form alkali. Examples of such bases are sodium hydroxide and potassium hydroxide.

Strong alkalis like sodium hydroxide and potassium hydroxide are highly corrosive or caustic in nature. Sodium hydroxide and potassium hydroxide are commonly called caustic soda and caustic potash respectively.

(i) Which of the following is the characteristics of a base?
(a) Turns blue litmus to red
(b) Turns phenolphthalein pink from colourless
(c) Decomposes carbonates
(d) Gives H^+ ions on dissociation

(ii) Strength of base can be explained on the basis of
(a) its concentration in solution
(b) its degree of ionisation
(c) both (a) and (b) required
(d) it is an inherent property of acid.

(iii) The acidity of barium hydroxide is
(a) 1 (b) 2
(c) 3 (d) 4

(iv) Which of the following in not an alkali?
(a) NaOH
(b) KOH
(c) $Cu(OH)_2$
(d) LiOH

(v) Which is the strongest base among the following?
(a) NH_4OH (b) NH_3
(c) H_2O (d) NaOH

61. Read the following and answer questions from (i) to (v).

The pH scale can be used to determine the strength of acid solutions as well as basic solutions by making use of hydrogen ion concentrations in them. The 'p' in pH stands for potenz which means power in German. It ranges from 0 to 14. Now-a-days, pH meter is used to measure the value of pH, however in previous years, pH papers were used to measure range of pH.

The negative logarithm is used because most of the pH values are positive numbers. A change of one pH unit represents a ten-fold change in the concentration of hydronium ions and hydroxide ions. Thus, pH equal to 2 is ten times as acidic as pH equal to 3.

Consider two solutions *A* and *B* having pH values 3 and 9.5 respectively.

(i) Which solution will turn phenolphthalein from colourless to pink?
(a) Solution *A* (b) Solution *B*
(c) Both (a) and (b) (d) None of these

(ii) Which of the following substances would have pH less than 7?
(a) Antacid (b) Soap
(c) Vinegar (d) Water

(iii) What effect does the concentration of H^+ ions have on the nature of the solution?
(a) Higher the concentration of H^+ ions, greater is the acidic nature of the solution
(b) Higher the concentration of H^+ ions, greater is the basic nature of the solution
(c) Concentration of H^+ ions does not effect the nature of the solution
(d) None of the above

(iv) pH of solution is defined by expression
(a) $\log[H^+]$ (b) $\log\left[\frac{1}{H^+}\right]$
(c) $\frac{1}{\log[H^+]}$ (d) $\frac{1}{-\log[H^+]}$

(v) If water is added to solution *B*, then pH will
(a) increase (b) decrease
(c) = 7 (d) unchanged

ANSWERS

Multiple Choice Questions

1. (a)	2. (b)	3. (c)	4. (a)	5. (d)	6. (d)	7. (b)	8. (b)	9. (a)	10. (c)
11. (c)	12. (a)	13. (d)	14. (a)	15. (b)	16. (c)	17. (b)	18. (a)	19. (a)	20. (b)
21. (b)	22. (a)	23. (c)	24. (c)	25. (d)	26. (a)	27. (a)	28. (d)	29. (d)	30. (a)
31. (c)	32. (d)	33. (d)	34. (a)	35. (d)	36. (b)	37. (d)	38. (a)	39. (a)	40. (b)
41. (d)	42. (b)	43. (d)	44. (b)	45. (b)	46. (c)	47. (b)	48. (d)	49. (c)	

Assertion-Reasoning MCQs

50. (a) 51. (b) 52. (c) 53. (d) 54. (c) 55. (a) 56. (c) 57. (c)

Cased Based MCQs

58. (i)-(b), (ii)-(c), (iii)-(b), (iv)-(d), (v)-(a)
59. (i)-(c), (ii)-(b), (iii)-(c), (iv)-(d), (v)-(b)
60. (i)-(b), (ii)-(c), (iii)-(b), (iv)-(c), (v)-(d)
61. (i)-(b), (ii)-(c), (iii)-(a), (iv)-(b), (v)-(b)

EXPLANATIONS

1. The mineral acids are those which are obtained from minerals and do not contain carbon.

e.g. HCl, H_2SO_4, HNO_3, etc.

2. Strong acids are generally corrosive in nature. Acids corrode metals and release hydrogen gas on reacting.

3. Lactic acid is present in sour milk.

Glycolic acid is present in fruits and vegetables.

Oxalic acid is present in vegetable, fruits, seeds, etc.

Citric acid is present in citrus fruits like lemons, oranges, etc.

4. Lime juice is acidic in nature because it contains citric acid. Human blood is slightly basic (i.e. having pH 7.8). Lime water and antacid are basic in nature as they contain hydroxide (OH^-) ion.

5. Acetic acid has chemical formula, CH_3COOH in which four hydrogen atoms are present.

6. All organic acids have source from nature as they occur in animals, plant, vegetables, etc.

Lactic acid is present in curd. Citric acid is present in oranges. Acetic acid is present in vinegar and oxalic acid is present in tomato.

7. Most metal oxides are insoluble in water but some of these (e.g. Na_2O, CaO) dissolve in water to form alkalies, not salt and acid e.g.

$$Na_2O(s) + H_2O(l) \longrightarrow 2NaOH(aq)$$

8. In first test tube, the following reaction involves:

$$CaCO_3 + 2HCl \longrightarrow CO_2 + H_2O + CaCl_2$$

CO_2 gas is evolved here.

In second test tube, the following reaction takes place:

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

Here, H_2 gas is evolved.

9. When dilute sulphuric acid treated with iron sulphide, then hydrogen sulphide gas is evolved and iron sulphate is formed.

$$\underset{\text{Iron sulphide}}{FeS(s)} + \underset{\text{Sulphuric acid}}{H_2SO_4(aq)} \longrightarrow \underset{\text{Iron (II) sulphate}}{FeSO_4(aq)} + \underset{\text{Hydrogen sulphide}}{H_2S(g)}$$

10. Calcium oxide dissolves in water to form calcium hydroxide which further ionises to give hydroxyl ion (OH^-).

$$CaO + 2H_2O \rightleftharpoons Ca(OH)_2 \rightleftharpoons Ca^{2+} + 2OH^-$$

11. Copper hydroxide is not an alkali because it is insoluble in water. Hence, it is a base but not an alkali.

12. Sodium hydroxide and potassium hydroxide both are bases and bases are good conductor of electricity. Therefore, these bases are used as electrolytes.

13. Alkali is basic in nature and all alkalies are bases.

But all bases are not alkali because all bases are not soluble in water whereas an alkali is soluble in water.

14. $\because$ CO_2 is an acidic oxide, thus when it reacts with a base [$Ca(OH)_2$] (aq), i.e. lime water, it gives salt and water.

$$Ca(OH)_2 + CO_2(g) \longrightarrow \underset{\text{(Salt)}}{CaCO_3(s)} + H_2O(l)$$

The above reaction proves that $Ca(OH)_2$ (aq) is basic in nature.

15. When base $Ca(OH)_2$ combines with ammonium salt, NH_4Cl, then it liberates ammonia gas and forms calcium chloride, $CaCl_2$ and water.

$$Ca(OH)_2(aq) + 2NH_4Cl(g) \longrightarrow CaCl_2(s) + 2H_2O(l) + 2NH_3(g)\uparrow$$

So, $X = NH_4Cl$ and $Y = H_2O$

16. When an acid is dissolved in water, then it dissociates and produce hydrogen (H^+) or hydronium ions (H_3O^+).

17. When sodium hydroxide in mixed with water, then ionisation takes place.

$$NaOH + H_2O \longrightarrow Na^+ + OH^- + H_2O$$

Hydroxide ions are formed and a lot of heat is generated or released during dissolution.

18. The sulphur dioxide in aqueous solution is acidic because it shows blue litmus paper test.

19. When a small amount of acid is added to water, the process is called dilution and it results in the formation of H_3O^+ ions.

20. When sodium hydrogen carbonate is added to acetic acid then odourless carbon dioxide (CO_2) gas is evolved.

$$\underset{\text{Sodium hydrogen carbonate}}{NaHCO_3} + \underset{\text{Acetic acid}}{CH_3COOH} \longrightarrow \underset{\text{Sodium acetate}}{CH_3CO\overset{-}{O}\overset{+}{Na}} + CO_2 + H_2O$$

CO_2 turns lime water milky. It is a non-supporter of combustion and is absorbed by strong alkalies like NaOH.

21. The reaction between metal carbonate and an acid is an example of acid and base reaction because metal carbonate is basic in nature. Thus, the reaction will produce salt, water and carbon dioxide. Let metal carbonate be sodium carbonate.

$$Na_2CO_3(aq) + 2HCl(aq) \longrightarrow 2NaCl(s) + H_2O(l) + CO_2(g)$$

22. During the dilution of an acid or base, the concentration of ions per unit volume decreases. Dilution causes lowering of concentration of hydronium ions and hydroxide ions of acids and bases respectively.

23. Metallic oxides are basic in nature. So, on dissolution of water, the concentration of hydroxide ions is highest.

24. Vanilla essence is an olfactory indicator. So, its smell is different in acid and basic media which can be detected easily by a visually air student. Vanilla extract has a characteristic pleasant smell.

If a basic solution like sodium hydroxide solution is added to vanilla extract then we cannot detect the characteristic smell of vanilla extract. An acidic solution like hydrochloric acid, however, does not destroy the smell of vanilla extract.

25. Universal indicator is a mixture of many indicators. Its colour is red at pH = 3 .

26. In acid, blue litmus changes to red and in basic solution, red litmus changes to blue. Hence, blue litmus first changes its colour to red and then to blue.

27. When $CH_3CO\overset{-}{O}\overset{+}{K}$ is treated with water, then KOH, strong base in formed.

$$CH_3CO\overset{-}{O}\overset{+}{K} + H_2O \longrightarrow \underset{\text{Strong base}}{KOH} + CH_3COOH$$

The solution will be basic in nature. So, it turns turmeric to red.

28. The given three indicators are natural indicators which show characteristics colours in acidic as well as in basic medium.

29. Since, the aqueous solution turns red litmus solution blue. So, it is a basic compound. An acid solution (HCl) would reverse the change. That is HCl would turn blue litmus solution to red.

Other options baking powder, lime and ammonium hydroxide solution are basic compounds.

So, the blue litmus solution would not change the colour by adding these compounds.

30. Methyl orange and phenolphthalein are the indicators which are used in laboratory for titrations of strong acids with strong bases.

31. In basic medium,

A. Red litmus turns blue.

B. Methyl orange turns into yellow in colour.

C. Phenolphthalein turns pink in colour.

D. Blue litmus remains blue in colour.

32. pH is calculated by using the expression:

$$pH = -\log[H_3O^+] \text{ or } -\log[H^+]$$

So, pH is the negative logarithm of the hydrogen ion concentration.

33. As the pH of solution decreases from 7 to 0, the hydrogen ion concentration in the solution goes on increasing and hence the strength of acid goes on increasing.

As the pH of solution increases from 7 to 14, the hydroxide ion concentration in the solution goes on increasing, due to which the strength of base also goes on increasing.

It depends on the solution, i.e. higher the pH, weaker the acid and lower the pH, weaker the base.

34. The value of pH for acids ranges from 0 to 7. If pH increases, the value of basicity increases because more the value of pH, more will be the basicity.

35. If a solution turns red litmus blue, then a solution is basic in nature and its pH value is likely to be greater than 7.

36. pH of acid rain is below 5.6 and it have a corrosive effect on marble buildings or sculptures.

37. As pH paper turns greenish blue for weakly basic compound and antacids contain weak base like $Mg(OH)_2$. So, an antacid would change the colour of this pH paper to greenish-blue. Other options (a) and (b) contain acids and option (c) is a neutral salt.

38. $\underset{\text{Calcium hydroxide}}{3Ca(OH)_2} + \underset{\text{Phosphoric acid}}{2H_3PO_4} \longrightarrow \underset{\text{Calcium phosphate}}{Ca_3(PO_4)_2} + 6H_2O$

Calcium phosphate $Ca_3(PO_4)_2$ is basic salt, as it is a salt of weak acid (phosphoric acid) and slightly stronger base (calcium hydroxide) (though both are weak).

Also when pH of our mouth falls below 5.5 due to eating of sweets etc., i.e. mouth is acidic, the dissolution of enamel (calcium phosphate) starts which shows that calcium phosphate is basic in nature.

39. Antacids are weak bases which are given to the patients who are suffering from acidity. They are given to patient so that they get relief.

40. The bee sting is slightly acidic with pH of 4.5-5.5. So, to neutralise the effect of sting, a basic substance can be used such as baking soda.

41. Bleaching powder has ability to kill off the germs because of chlorine. When bleaching powder exposed to moisture, chlorine releases and disinfects the area.

42. $Na_2CO_3 \cdot 10H_2O$ is the formula of washing soda. It contains 10 molecules of water.

43. $2NaCl(aq) + 2H_2O(l) \longrightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$

(because state of Cl_2 and H_2 is gaseous, H_2O is liquid and that of NaCl and NaOH is aqueous).

44. Chemical name of bleaching powder is calcium hypochlorite (calcium oxychloride).

45. The hardening of the plaster of Paris can be done by mixing it with water and it converts into hard material called gypsum.

46. Bleaching powder bleaches the clothes and other coloured substances, baking soda is a constituent of antacid, washing soda is used in the preparation of glass and sodium chloride when subjected to electrolysis gives H_2 and Cl_2 gases.

47. Chemical formula of baking soda is $NaHCO_3$ (sodium hydrogen carbonate). Chemical formulae of blue vitriol is $CuSO_4 \cdot 5H_2O$, washing soda is $Na_2CO_3 \cdot 10H_2O$ and gypsum is $CaSO_4 \cdot 2H_2O$.

So, baking powder does not contain water of crystallisation.

48. When an acid reacts with a base, neutralisation reaction takes place to form salt and water and it is an exothermic reaction. So, the temperature of the solution increases.

49. Sodium hydrogen carbonate and tartaric acid are mixed together and forms baking soda.

50. Both A and R are true and R is the correct explanation of A. Lemon juice is sour in taste as it is an acid and sour taste is one of the characteristics of acid. Therefore, lemon juice is acidic in nature.

51. Both A and R are correct but R is not the correct explanation of R. Sodium hydrogen carbonate react with acid present in fire extinguisher to produce carbon dioxide.

52. A is true but R is false.

HCl produces H^+ ions in aqueous solution because in presence of water, acids give H^+ ions. As H^+ ions cannot exist alone so it combines with water molecules and form H_3O^+.

53. A is false but R is true. Sodium carbonate (Na_2CO_3) is the salt of weak acid carbonic acid (H_2CO_3) and a strong base, sodium hydroxide (NaOH).

$\underset{\text{Sodium hydroxide}}{2NaOH} + \underset{\text{Carbonic acid}}{H_2CO_3} \longrightarrow \underset{\text{Sodium carbonate (salt)}}{Na_2CO_3} + \underset{\text{Water}}{2H_2O}$

54. A is true but R is false. Phenolphthalein is a synthetic indicator. It is used in titrations of acid and base. It will appear pink in basic solution and clear in acidic solution.

55. Both A and R are true and R is the correct explanation of A. Tooth enamel is calcium phosphate, which gets affected when pH of our mouth falls below 5.5.

It happens because the bacteria present in our mouth breakdown sugar and food particles into acids which damage our teeth by corroding them.

56. A is true but R is false because ammonium nitrate is a salt of strong acid and weak base.

57. A is true but R is false because magnesium hydroxide is a mild base and neutralises the excess acid present in a stomach.

58. (i) Ammonium hydroxide (NH_4OH) is a weak base because it does not ionise completely in given aqueous solution.

(ii) NaOH, sodium hydroxide, being a base can neutralise the effect of acid.

(iii) An alkali is a base which is water soluble and KOH is soluble in water whereas $Ca(OH)_2$ and $Mg(OH)_2$ are slightly soluble in water and $CaCO_3$ is insoluble in water.

(iv) Acids and bases are important because of their various uses and impacts. They are used in industry. They have impact on human health and farmer's crop.

(v) Na_2CO_3, sodium carbonate is alkaline in aqueous medium because it is formed from NaOH and H_2CO_3, i.e. strong base and weak acid.

59. (i) $NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$

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

Both the above reactions take place on adding baking powder while making cakes or bread.

The released CO_2 gas makes the cakes or bread soft and spongy.

(ii) In soda-acid fire extinguishers, CO_2 is released by the reaction of sodium bicarbonate with acid.

(iii) Bleaching powder is basic nature, so its pH value must be greater than 7.

(iv) Washing soda has chemical formula, $Na_2CO_3 \cdot 10H_2O$. So, it has 10 water of crystallisation.

(v) When we heat washing soda, the water of crystallisation will be lost (efflorescent occurs) and become anhydrous.

60. (i) A base can turn phenolphthalein pink from colourless. Phenolphthalein is used as indicator in acid-base titration and it shows pink in basic solution.

(ii) Since, for strong base which is completely ionised, only concentration is the measure of strength, but for weak base which is incompletely ionised, both degree of ionisation and concentration will be required.

(iii) Barium hydroxide is $Ba(OH)_2$. It can give two hydroxyl group. So, its acidity is two.

(iv) NaOH, KOH and LiOH are called as alkali because these bases are soluble in water whereas $Cu(OH)_2$ is not alkali because it is insoluble in water.

(v) NaOH is the strongest base among the other compounds because it dissociates completely into ions.

61. (i) Solution *B* will turn phenolphthalein from colourless to pink as it is basic in nature according to its pH.

(ii) Acidic substances have pH value less, than 7. Among the given substances, vinegar would have pH less than 7 as it is an aqueous solution of acetic acid.

(iii) Higher the concentration of H^+ ions greater is the acidic nature of the solution because H^+ ions comes from acid.

(iv) pH is defined as negative logarithm of concentration of H^+ ions.

So, expression of $pH = \log\left[\frac{1}{H^+}\right]$

or $= -\log[H^+]$

(v) When base is diluted with water, the concentration of base decrease and this causes the pH of alkali to fall towards 7. So, the pH will decrease.