CHAPTER 2

# Acids, Bases and Salts

EXAM DRILL

## ANSWERS

**1.** The compound is washing soda, $Na_2CO_3 \cdot 10H_2O$.

**2.** Baking powder contains sodium hydrogen carbonate and tartaric acid.

**3(i).** Strong acid : HCl

Strong base : NaOH

**3(ii).** $pOH = -\log [OH^-] = -\log 10^{-3} = -(-3) = 3$

**3(iii).** $pH = -\log (0.100) = 1$

**3(iv).** $pH = -\log (1.00) = 0.00$

**4(i).** A salt is a compound formed from an acid by the replacement of the hydrogen in the acid by a metal. Salts are formed when acids react with bases.

**4(ii).** Sodium carbonate decahydrate.

**4(iii). (b) :** Acidic salt

**4(iv). (a) :** caustic soda turns red litmus blue because it is basic in nature.

**5. (b) :** Baking soda ($NaHCO_3$) solution is basic in nature and turns red litmus blue.

**OR**

**(d) :** 20 mL of NaOH = 2 × 8 mL of HCl = 16 mL of HCl

**6. (a) :**

$$NaCl + H_2O \longrightarrow \underset{\text{strong base}}{NaOH} + \underset{\text{strong acid}}{HCl} \Big\} \text{Neutral}$$

$$NaHCO_3 + H_2O \longrightarrow \underset{\text{strong base}}{NaOH} + \underset{\text{weak acid}}{H_2CO_3} \Big\} \text{Basic}$$

$$Na_2CO_3 + 2H_2O \longrightarrow 2\underset{\text{strong base}}{NaOH} + \underset{\text{weak acid}}{H_2CO_3} \Big\} \text{Basic}$$

NaOH is a strong base. NaCl is neutral and neutral solutions have pH 7. Basic solutions have pH greater than 7. Thus, in the given option 0.1 molar NaCl solution will have lowest pH as it is neutral while other solutions are basic.

**7. (b) :** $HCl_{(aq)} + H_2O_{(l)} \longrightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$

**OR**

**(a) :** $CH_3COOH$ has one replaceable $H^+$ ion.

**8. (d) :** Neutralisation reaction takes place when an acid is mixed with a base. Salt and water are formed with evolution of heat.

Acid + Base ⟶ Salt + Water + heat

**9. (a) :** $pH = -\log[H^+]$

$pH = -\log[1 \times 10^{-3}] = -(-3) \log 10 = 3$

**10. (c) :** Calcium chloride absorbs moisture from the gas and keeps it dry.

**11. (d) :** An antacid is a mild base hence, it will turn the pH paper to greenish-blue.

**12. (c) :** The solution formed by mixing equal volumes of same concentration of NaOH and HCl will be neutral with pH 7, hence the colour of the pH paper will be yellowish green.

**OR**

**(b) :** Water becomes electrolyte hence, it ionizes to give hydronium ions and the acid is diluted with addition of water.

$$\underset{\text{(from HCl)}}{H_2O + H^+} \longrightarrow \underset{\text{Hydronium ion}}{H_3O^+}$$

**13. (a)** **14. (a)**

**15.** (a) Solution *X* turns purple, it means *X* has pH around 11 and solution *Y* turns red, it means it has pH around 2. As we know, higher the pH, stronger is the base, therefore, solution *X* is a base.

(b) *X* is sodium chloride. Name of the process is chlor-alkali process.

**16.** Basic solution turns red litmus paper blue. The salt of weak acid and a strong base gives a basic solution. So, the given salt *X* is the salt of weak acid and a strong base.

*e.g.,* $\underset{\text{Basic salt}}{Na_2CO_{3(s)}} + 2H_2O_{(l)} \rightleftharpoons \underset{\text{Strong base}}{2NaOH_{(aq)}} + \underset{\text{Weak acid}}{H_2CO_{3(aq)}}$

Being a strong base, NaOH is fully ionised and gives a large amount of $OH^-$ ions. Carbonic acid is a weak acid which is only slightly ionised and hence, gives a small amount of $H^+$ ions. The $H^+$ ions produced by carbonic acid neutralises only a small amount of $OH^-$ ions produced by sodium hydroxide and the rest amount of $OH^-$ ions are present in the solution. Hence, the $Na_2CO_3$ solution is basic in nature. It turns red litmus blue.

**17.** (a) The pH range within which our body works is (7.0-7.8).

(b) During indigestion, stomach produces too much acid which causes pain. Antacids are alkaline in nature and neutralize the excess acid *e.g.,* milk of magnesia.

**18.** Chlorine gas is formed at anode and hydrogen gas at the cathode. Sodium hydroxide solution is left in the vessel.

At anode : $2Cl^- \longrightarrow Cl_2 + 2e^-$

At cathode : $2H^+ + 2e^- \longrightarrow H_2$

The complete reaction, when electricity is passed through a concentrated solution of brine, may be represented as :

$$\underset{\text{Brine}}{2NaCl_{(aq)}} + 2H_2O_{(l)} \xrightarrow{\text{Electrolysis}} \underset{\text{Caustic soda}}{2NaOH_{(aq)}} + \underset{\text{Chlorine (At anode)}}{Cl_{2(g)}}\uparrow + \underset{\text{(At cathode)}}{H_{2(g)}}\uparrow$$

**19.**

| | Salt (Name) | Parent acid | Parent base |
|---|---|---|---|
| 1. | $Na_2CO_3$ (Sodium carbonate) | $H_2CO_3$ | NaOH |
| 2. | $Na_2SO_4$ (Sodium sulphate) | $H_2SO_4$ | NaOH |
| 3. | $CaCO_3$ (Calcium carbonate) | $H_2CO_3$ | $Ca(OH)_2$ |
| 4. | $CuSO_4$ (Copper sulphate) | $H_2SO_4$ | $Cu(OH)_2$ |
| 5. | $Al_2(SO_4)_3$ (Aluminium sulphate) | $H_2SO_4$ | $Al(OH)_3$ |
| 6. | $CH_3COONa$ Sodium acetate | $CH_3COOH$ | NaOH |

**OR**

(a) In aqueous solution, hydrochloric acid ionizes completely to give more $H^+$ ions and therefore, it is a strong acid. In aqueous solution, acetic acid ionizes partially to give less $H^+$ ions and therefore, it is a weak acid.

Take two beaker, one containing HCl and another containing acetic acid. Now, fix two iron nails on rubber cork and insert in each beaker and connect the nail to the two terminal of it 6 V battery through a switch and a bulb. Now switch on the current. A large amount of flow of current takes place from beaker containing HCl solution, which shows that HCl is a strong acid whereas a small amount of current flows in another beaker which contains acetic acid which shows that acetic acid is weak acid.

(b) Because in aqueous solution, acids gets dissociated into ions and these ions are responsible for conduction of electricity.

**20.** (a) Sodium carbonate, $Na_2CO_3$

(b) $CaOCl_2$, Bleaching powder

(c) NaOH, Sodium hydroxide

**21.** (a) Fresh milk has pH value equal to 6 but when it changes into curd (yoghurt) then there is a slightly decrease in its pH value as curd contains lactic acid which is more acidic than milk. More acidic is a substance, lesser will be its pH.

(b) Lime (CaO) and slaked lime $Ca(OH)_2$ can be added to soil to reduce its acidity because plants also needs a specific pH range for proper growth.

**22.** An acidic, basic or neutral solution contains both $H^+$ ions and $OH^-$ ions. If the solution is neutral, $[H^+] = [OH^-] = 10^{-7}$ M. In a solution, $[H^+]$ can vary from $10^0$ to $10^{-14}$ M. Hence, solutions can have pH from 0 to 14. This is called pH scale. Neutral solutions have pH = 7. Acidic solutions have pH < 7 and basic solutions have pH > 7. Lesser is the pH than 7, more acidic is the solution. Greater is the pH than 7, more basic is the solution.

**OR**

(a) The pH of cold drink is 5, it contains acid. It will change blue litmus solution into red. No action on red litmus solution.

(b) As we know, lower the value of pH, stronger is the acid. Therefore, order of increasing acidic strength is $A < C < B$.

**23.** (a) When copper sulphate crystals are heated strongly, the colour of copper sulphate crystals becomes white.

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

(b) When few drops of water are added to anhydrous copper sulphate, the blue colour of copper sulphate is restored.

$$\underset{\text{(White)}}{CuSO_4} + 5H_2O \longrightarrow \underset{\text{(Blue)}}{CuSO_4 \cdot 5H_2O}$$

**24.** (a) Plants and animals are pH sensitive. Our body works within the pH range of 7.0 to 7.8. Living organisms can survive only in a narrow range of pH change.

(b) Plants require soil of a specific pH range which should neither be alkaline nor highly acidic for their healthy growth.

(c) Our stomach produces hydrochloric acid. It helps in the digestion of food without harming the stomach. During indigestion the stomach produces too much acid and this causes pain and irritation.

**OR**

(a) (i) Solution of glucose will not conduct electricity because it does not give ions.

(ii) Dil. hydrochloric acid will conduct electricity because it produces $H^+$ ions in water.

(b) Hydrochloric acid is stronger because it releases more $H^+$ ions than acetic acid.

(c) The strength of the acid decreases.

**25.** Caustic soda is prepared by electrolysis of an aqueous solution of sodium chloride (brine). The complete reaction can be represented as :

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

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

**At anode :** $Cl_2$ gas is liberated.

$2Cl^- \longrightarrow Cl_2 + 2e^-$

**At cathode :** $H_2$ gas is liberated.

$$2H^+ + 2e^- \longrightarrow H_2$$

The reaction between hydrogen and chlorine, forms hydrochloric acid.

$$H_2 + Cl_2 \longrightarrow 2HCl$$

**26.** (i) (a) Solution *C* is strongly alkaline (pH = 12).

(b) Solution *B* is strongly acidic (pH = 1).

(c) Solution *D* is neutral (pH = 7).

(d) Solution *A* is weakly acidic (pH = 5).

(e) Solution *E* is weakly basic (pH = 9).

(ii) (i) They react with metals to give out hydrogen gas, *e.g.*,

$$\underset{\text{Zinc}}{Zn} + \underset{\text{Hydrochloric acid}}{2HCl} \longrightarrow \underset{\text{Zinc chloride}}{ZnCl_2} + \underset{\text{Hydrogen}}{H_2\uparrow}$$

(ii) They react with bases to form salt and water, *e.g.*,

$$\underset{\text{Sodium hydroxide}}{2NaOH} + \underset{\text{Sulphuric acid}}{H_2SO_4} \longrightarrow \underset{\text{Sodium sulphate}}{Na_2SO_4} + \underset{\text{Water}}{2H_2O}$$

(iii) They react with metal carbonates to liberate carbon dioxide gas, *e.g.,*

$$\underset{\text{Sodium carbonate}}{Na_2CO_3} + \underset{\text{Hydrochloric acid}}{2HCl} \longrightarrow \underset{\text{Sodium chloride}}{2NaCl} + \underset{\text{Water}}{H_2O} + \underset{\text{Carbon dioxide}}{CO_2}$$

**OR**

(a) Anhydrous salts are those which do not contain any water molecule *i.e.*, all water molecules are removed *e.g.*, $CuSO_4$ (white colour). Hydrated salts are those which contain a fixed number of water of crystallisation, *e.g.*, $CuSO_4 \cdot 5H_2O$ (blue colour) etc.

(b) It is prepared from gypsum which is calcium sulphate dihydrate ($CaSO_4 \cdot 2H_2O$). Gypsum is heated in a kiln to a temperature of 100°C (373 K). At this temperature, it loses three-fourth of its water of crystallisation forming plaster of Paris.

$$\underset{\text{Gypsum}}{CaSO_4 \cdot 2H_2O} \xrightarrow{100\,^\circ C\ (373K)} \underset{\text{Plaster of Paris}}{CaSO_4 \cdot \frac{1}{2}H_2O} + 1\frac{1}{2}H_2O$$

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

**27.** (i) Calcium chloride, water and $CO_2$ gas is formed.

$$\underset{\text{Limestone}}{CaCO_{3(s)}} + 2HCl_{(dil.)} \longrightarrow \underset{\text{Calcium chloride}}{CaCl_{2(aq)}} + H_2O_{(l)} + CO_{2(g)}$$

(ii) Sodium aluminate is formed.

$$2Al + 2NaOH + 2H_2O \longrightarrow 2NaAlO_2 + 3H_2\uparrow$$

(iii) When excess of $CO_2$ is passed through lime water, the white ppt. formed dissolves due to the formation of soluble calcium hydrogen carbonate and the solution becomes clear.

$$CaCO_{3(s)} + CO_{2(g)} + H_2O_{(l)} \longrightarrow Ca(HCO_3)_{2(aq)}$$

(iv) Bleaching powder is formed.

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

(v) Formation of sodium carbonate and evolution of $CO_2$ gas takes place.

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

**28.** (a) Sodium chloride on reaction with ammonium bicarbonate produced sodium bicarbonate, which on thermal decomposition gives soda ash, which on further crystallisation gives washing soda.

$$\underset{\substack{\text{Sodium} \\ \text{chloride}}}{NaCl} + \underset{\substack{\text{Ammonium hydrogen} \\ \text{carbonate}}}{NH_4HCO_3} \longrightarrow \underset{\substack{\text{Sodium} \\ \text{bicarbonate}}}{NaHCO_3\downarrow} + NH_4Cl$$

$$2NaHCO_{3(s)} \xrightarrow{\text{Heat}} \underset{\text{(Soda ash)}}{Na_2CO_{3(s)}} + \underset{\substack{\text{water} \\ \text{vapour}}}{H_2O_{(g)}}\uparrow + CO_{2(g)}\uparrow$$

$$Na_2CO_{3(s)} + 10H_2O_{(l)} \xrightarrow{\text{Crystallisation}} \underset{\text{Washing soda}}{Na_2CO_3 \cdot 10H_2O}$$

(b) Aqueous solution of washing soda is alkaline in nature. $Na_2CO_3$ reacts with water to give NaOH and $CO_2$.

(c) Washing soda has detergent properties because it can remove dirt or grease from dirty clothes. It cleans the clothes by attacking dirt and grease to form water soluble products, which are then washed away on rinsing with water.

(d) (i) In textile and petroleum refining.

(ii) In laundry and in softening of water.

**OR**

(a) Gypsum is a soft sulphate mineral composed of calcium sulphate dihydrate. On heating gypsum at 373 K, it loses water molecules and becomes calcium sulphate hemihydrate.

$$\underset{\text{Gypsum}}{CaSO_4 \cdot 2H_2O} \xrightarrow[100^\circ C]{\text{Heat}} \underset{\text{Plaster of Paris}}{CaSO_4 \cdot \frac{1}{2}H_2O} + \underset{\text{Water}}{1\frac{1}{2}H_2O}$$

(b) Sodium carbonate

(c) Calcium sulphate hemihydrate

(d) The substance *X* is tartaric acid. Its function is to neutralise sodium carbonate formed during heating as otherwise the cake or bread being baked will taste bitter.

**29.** (a) Acids are sour in taste and change the colour of blue litmus to red, whereas bases are bitter in taste and change the colour of the red litmus to blue.

Hydrochloric acid (HCl), acetic acid ($CH_3COOH$) are examples of acids. Sodium hydroxide (NaOH) and ammonium hydroxide ($NH_4OH$) are examples of bases.

(b) Strong base : Sodium hydroxide, potassium hydroxide

Weak base : Ammonium hydroxide, calcium hydroxide

(c) (i) Hydronium ions, $H_3O^+$

(ii) Hydroxide ions, $OH^-$

(d) $H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}$

From acid — From base — Water

**30.** Sodium hydrogen carbonate is obtained as the intermediate product in the Solvay or ammonia soda process. Normal carbonate can be changed to bicarbonate by passing carbon dioxide through its saturated solution.

$$Na_2CO_3 + CO_2 + H_2O \longrightarrow \underset{\text{Sparingly soluble}}{2NaHCO_3}$$

**Properties**

$NaHCO_3$ is a white crystalline solid, sparingly soluble in water. The solution is alkaline in nature due to hydrolysis.

$$NaHCO_3 + H_2O \rightleftharpoons NaOH + H_2CO_3$$

On heating, it releases carbon dioxide and water forming sodium carbonate.

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

It is used in baking powder as a leavening agent to make food rise.

**OR**

(a) When zinc reacts with dil. sulphuric acid then hydrogen gas ($H_2$) is produced.

(b) When a burning splinter is brought near the mouth of the gas jar, hydrogen gas burns with a pop sound.

(c) Zinc granules are preferred because they make the reaction comparatively faster.

(d) When zinc metal reacts with sodium hydroxide solution then sodium zincate is formed.

(e) No, only a strong base like sodium hydroxide is capable of releasing hydrogen gas with active metals.

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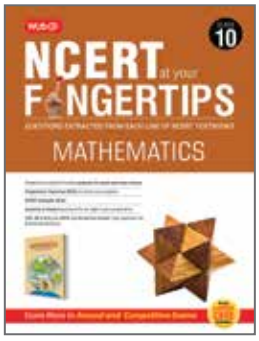



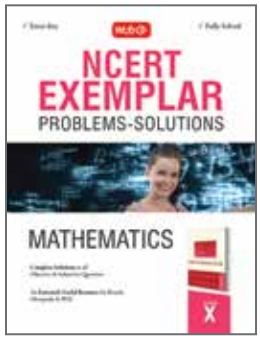



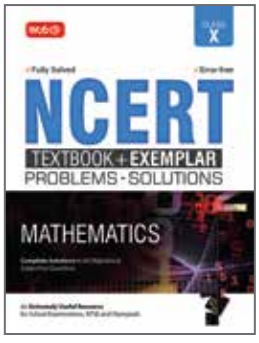


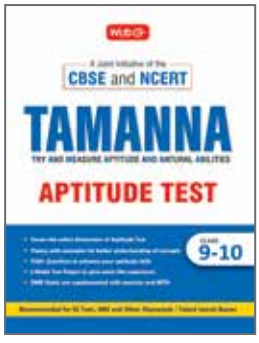


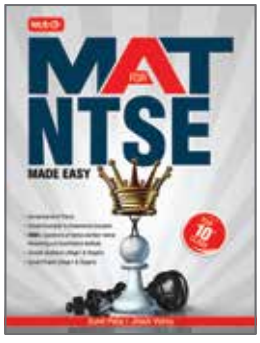


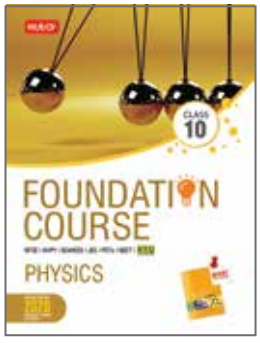


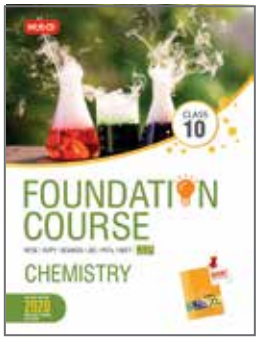


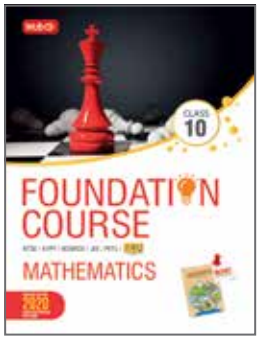


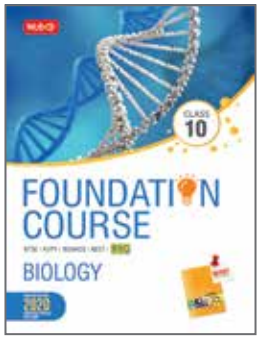




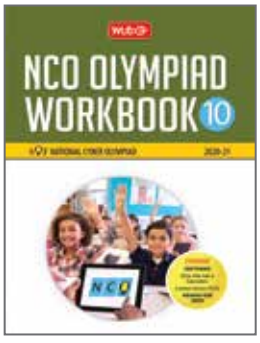


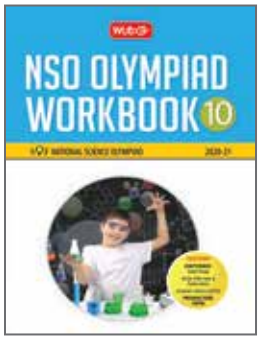


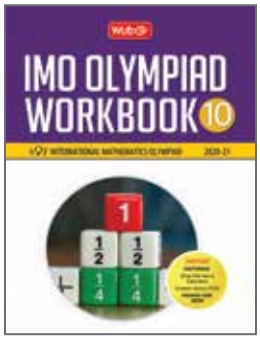


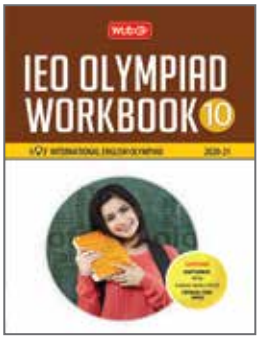


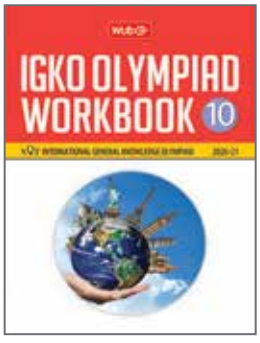


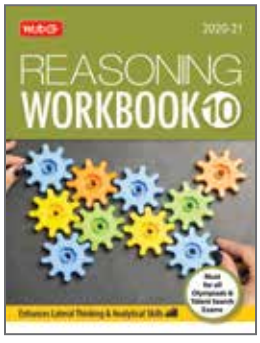


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