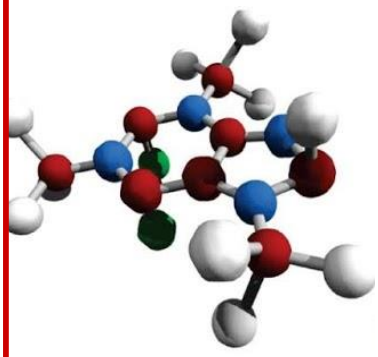
AEP
IIT-JEE | NEET | CBSE
STUDY CIRCLE
ACCENTS EDUCATIONAL PROMOTERS
OFFLINE-ONLINE LEARNING ACADEMY

01
CHEMISTRY
ACIDS BASES SALTS
CBSE - X

ACIDS-BASES-SALTS:CBSE-CHEMISTRY



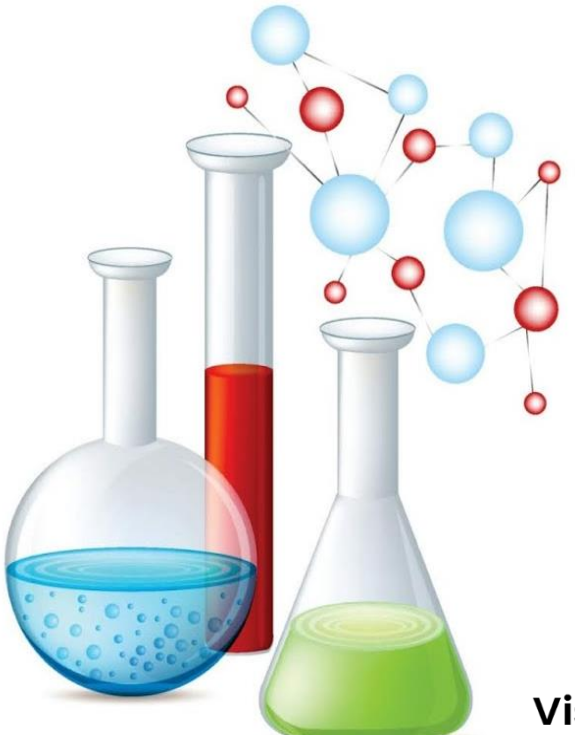
Acids, Bases And Salts

CHEMISTRY

IIT MAINS & ADV

NEET

CBSE

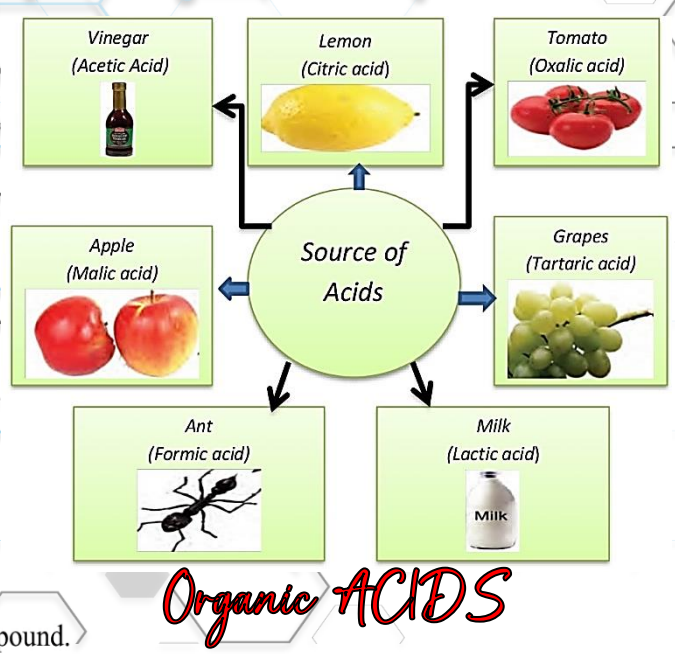


Call Us:
+91 99395 86130, +91 7739650505

Visit Us:
www.aepstudycircle.com

2ND FLOOR, SATKOUDI COMPLEX, THANA CHOWK, RAMGARH, JHARKAHAND - 829122

Chemistry Acids Bases Salts



Acids and bases are among most familiar of all chemical compound.

The acid word is derived from the latin word 'acidus' which means sour to taste whereas bases are bitter in taste. Lemon juice, vinegar, grape fruit juice and spoilt milk etc. taste sour as they are acidic in nature. Many substances are identified as acids based on their taste but some of the acids like sulphuric acid that has very strong action on the skin that means they are corrosive in nature. So, some acids are found in foods whereas some acids are harmful for us. So, acids were identified as the substance that taste sour e.g., citric acids, vinegar.

On the other hand, substances such as washing soda, lime and materials like soap that have soapy touch and bitter taste.

Bases are sometime known as alkali & they are characterised by their bitter taste and soapy touch e.g., hand soaps, washing soda etc.

Acids

An acid is defined as a substance that release one or more Hydronium ion or H^+ ions in an aqueous solution.

Acids that are mostly derived from natural sources. On the basis of their source/occurence acids are of two types -

(1) Mineral acids

(2) Organic acids

(1) Mineral Acids

Acids that are obtained from rocks and minerals are known as mineral acids. e.g., HCl, HNO_3

Table- 1: Some of the commonly used mineral acid along their uses are given below as:-

	Name	Type of acid	Chemical Formula	Uses
1.	Hydrochloric acid	Mineral Acid	HCl	Purification of NaCl, to make aqua regia mixture of Hu_2HNO_3 in ratio of 3 : 1, bleaching agent
2.	Phosphoric acid	Mineral Acid	H_3PO_4	In fertilizers and in antirust paints.
3.	Carbonic acid	Mineral acid	H_2CO_3	Used in tanning industry, in soft drinks etc.

	Name	Type of acid	Chemical Formula	Uses
4.	Sulphuric acid	Mineral Acid	H_2SO_4	Used in car batteries, in paints, plastics, drugs, in petroleum refining.
5.	Nitric acid	Mineral Acid	HNO_3	Used in explosives manufacture like TNT and fertilizers, refining of gold and silver.

(2) Organic Acids

Acids that are present in animals and plants are called as organic acids. e.g., Lactic acid, Formic acid.

Table- 2: Some of commonly used organic acids along their chemical formula with their uses are given as:-

	Name	Type of acid	Chemical Formula	Uses
1.	Lactic acid	Organic Acid	$CH_3CH(OH)COOH$	Flavouring agent and food preservative.
2.	Benzoic acid	Organic Acid	C_6H_5COOH	Used in dyes, perfumes and insect repellents, food preservative.
3.	Acetic acid	Organic Acid	CH_3COOH	Used as a solvent in the manufacture of dyes and perfumes, in vinegar, production of plastics.
4.	Formic acid	Organic Acid	HCOOH	In tanning leather, in medicines for treating disease like gout of joints.
5.	Citric acid	Organic Acid	$C_6H_8O_7$	Flavouring and preserving agent in soft drink and toffees.

Table- 3: Some of the Common Organic Acids and Their Natural Sources are given below:-

Substance that contain acids	Organic acid present in them
1. Orange, lemon	Citric acid, ascorbic acid (vitamin C)
2. Apple	Malic acid
3. Tamarind (imli), grape	Tartaric acid
4. Olive oil	Oleic acid
5. Vinegar	Acetic acid
6. Curd (sour milk)	Lactic acid
7. Urine	Uric acid
8. Tomato	Oxalic acid
9. Tea	Tannic acid
10. Red ants	Formic acid
11. Green leafy vegetables	Folic acid
12. Gastric juice	Hydrochloric acid
13. Amla	Ascorbic acid
14. Spinach	Oxalic acid
15. Bees and nettle sting	Formic acid
16. Rancid butter	Butyric acid

Classification of Acids on the basis of their Basicity

- The acid that contains 1 replaceable hydrogen atom in its molecule is known as monobasic acid and its basicity is 1.
- The acids that contain 2 replaceable hydrogen atoms in their molecules are known as a **dibasic acids**. Its basicity is 2.
- The acids that contains 3 replaceable hydrogen atoms in their molecules are known as **tri basic acids**. Its basicity is 3.

Table- 4: Examples of a few acids with their basicities are given in the table below.

Acid	Basicity
Hydrochloric (HCl)	1
Nitric acid (HNO_3)	1
Sulphuric acid (H_2SO_4)	2
Phosphoric acid (H_3PO_4)	2
Carbonic acid (H_2CO_3)	3
Orthoboric acid (H_3BO_3)	3

NCERT Corner

1. You are given three test tubes. The three test tubes contain distilled water, acidic solution and the basic solution respectively. There is only red litmus paper available in order to identify what is there in each test tube. How will you find out what is in each of the test tubes?

Ans. The content in each of the test tubes can be identified by using red litmus paper. The colour change of the red litmus paper can be noticed.

On litmus paper, the three solutions in the test tubes are poured separately.

The solution that turns red litmus to blue contains a basic solution.

The formed blue litmus paper are divided into two parts.

The solution from the test tube that turns blue litmus paper to red will contain the acidic solution.

Solution of the test tube that do not change to either red or blue litmus paper contain water.

Chemical Properties of the Acids

Reaction of Acids with Metals

- Dilute acids like dilute HCl and dilute H_2SO_4 both react with certain metals to release hydrogen gas.

$Mg(s) + H_2SO_4$ (dilute) $\longrightarrow MgSO_4$ (aq) + $H_2(g)$

$Na(s) + H_2SO_4 \longrightarrow Na_2SO_4 + H_2$ (g)

$2Na(s) + 2HCl$ (dilute) $\longrightarrow 2NaCl(aq) + H_2$ (g)

Mind it

- Metals that can displace hydrogen from dilute acids are known as active metals. e.g. Na, K, Zn, Fe, Mg, Ca etc.

  $Zn(s) + H_2SO_4$ (dilute) $\longrightarrow ZnSO_4(aq) + H_2(g)$

- The active metals that lie above the hydrogen in the activity series has electropositive nature. Their atoms lose electrons to form positive ions and these electrons are accepted by hydronium or H^+ ions of the acid and H_2 is evolved.

Reaction of Acids with Metal Oxides

- Acids react with metal oxides to produce salt and water.
- Metal oxides are also known basic oxides.

For e.g.

$ZnO\ (s) + H_2SO_4\ (aq) \longrightarrow ZnSO_4(aq) + H_2O(l)$

$ZnO(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2O(l)$

$CuO(s) + HCl(aq) \longrightarrow CuCl_2(aq) + H_2O(l)$

$MgO(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2O(l)$

Reaction of Acid with Metal Carbonates and Metal Bicarbonates

Both metal carbonates and bicarbonates salts react with acids to release CO_2 gas and give salts and water.

For e.g.

$$\underset{\text{Calcium carbonate}}{CaCO_3(s)} + 2HCl(aq) \longrightarrow \underset{\text{Calcium chloride}}{CaCl_2(aq)} + H_2O + CO_2(g)$$

$$\underset{\text{Ferrous carbonate}}{FeCO_3} + H_2SO_4 \longrightarrow \underset{\text{Ferrous sulphate}}{FeSO_4(aq)} + H_2O + CO_2(g)$$

$$\underset{\text{Sodium bicarbonate}}{2NaHCO_3(s)} + H_2SO_4(aq) \longrightarrow \underset{\text{Sodium sulphate}}{Na_2SO_4(aq)} + H_2O(aq) + CO_2(g)$$

Reaction of Acids with Bases

Acids react with bases to produce salts and water.

$$\underset{\text{Nitric acid}}{HNO_3} + \underset{\text{Magnesium Oxide}}{MgO} \longrightarrow \underset{\text{Magnesium nitrate}}{Mg(NO_3)_2} + H_2O$$

$$\underset{\text{Hydro chloric}}{HCl} + \underset{\text{Sodium hydroxide}}{NaOH} \longrightarrow \underset{\text{Sodium Chloride}}{NaCl} + H_2O$$

Example

Q. Explain the following chemical properties of acids by the help of balanced chemical equations.

1. **When an acid reacts with a metal carbonate.**
2. **When an acid reacts with a metal bicarbonate.**
3. **When an acid reacts with a metal oxide.**

Ans. 1. $CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$

2. $NaHCO_3 + HCl \longrightarrow NaCl + H_2O + CO_2$

3. $Al_2O_3 + 6HCl \longrightarrow 2AlCl_3 + 3H_2O$

Mind it

Egg-shell also contain calcium carbonate ($CaCO_3$) as the main constituent Thus they react with the acids.

Acids Classification On The Basis of Their Strength

1. **Strong acids:** Acids that are completely ionised in water are called as strong acids.

   For e.g.

   Hydrochloric acid (HCl), sulphuric acid (H_2SO_4), nitric acid (HNO_3) etc. are all considered as strong acids.

   $HCl + Water \longrightarrow H^+(aq) + Cl^-(aq)$

   $H_2SO_4 + Water \longrightarrow 2H^+(aq) + SO_4^{2-}(aq)$

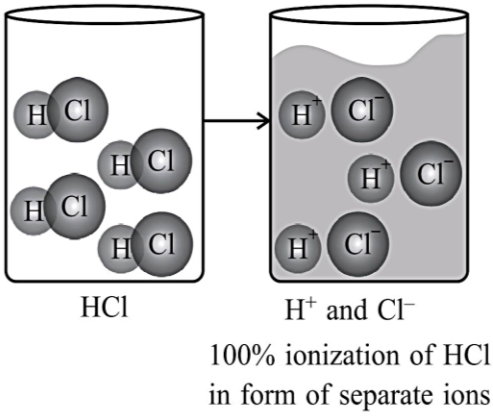


Fig. 1: Completely Dissociate of Strong Acids in Water

2. **Weak acids:** Acids that are weakly ionised in water are called as weak acids.
   For e.g.
   Carbonic acids (H_2CO_3), acetic acid (CH_3COOH), formic acid (HCOOH), are considered as weak acids.

   $CH_3COOH + Water \longrightarrow CH_3COO^-(aq) + H^+(aq)$

Mind it

- In general mineral acids are **strong acids** while organic acids are **weak** acids.
- Aqua regia is a mixture of conc. HCl & conc. HNO_3 in 3 : 1 ratio. It can dissolve noble metals like Ag, Au and Pt.

Acids Classification On The basis of their Concentration

- An acid solution is classified as concentrated or dilute depending upon the amount of the acid that are present in the solution. Concentrated and dilute solutions of acids are usually used in laboratories.
- An acid is usually used as solution in water. When the solution contains a larger concentration of the acid, it is known as concentrated acid whereas a dilute solution contains smaller concentration of the acid.

Mind it

Carbonic acid (H_2CO_3) turns blue litmus to pink that shows it is a weak acid.

Uses of Acid

Acids	Uses
Boric acid (H_3BO_3)	• In the manufacturing of glass and enamels, leather, paper and explosives • Used as preservative for grains • Used in detergents
Nitric acid (HNO_3)	• Nitric acid that is present in rainwater forms nitrates in the soil that are then used by plants to obtain nitrogen. • In the manufacturing of fertilizers.
Sulphuric acid (H_2SO_4)	• In the manufacture of detergents and artificial fibre • In storage batteries • In the manufacturing of hydrochloric acid and alum
Hydrochloric acid (HCl)	• Its is present in the gastric juice which helps digestion of food. • As a bathroom cleaner • Used in polyvinyl chloride (PVC) manufacture.

Find it

Q. What will happen when egg shell is placed in conc. HNO_3?

Base

Substances that are bitter in taste and soapy touch are identified as bases. Some of the bases like sodium hydroxide and potassium hydroxide have corrosive action on the skin and they can even harm the body.

A base is defined as a substance that are capable of releasing one or more OH^- ions in an aqueous solution.

Alkalies

Alkalies is defined as the soluble bases. Some bases like sodium hydroxide and potassium hydroxide are water soluble. These are called as alkalies. Example: KOH, NaOH, $Mg(OH)_2$.

Table- 5: A few typical bases along with their chemical formulae and uses are given below:

Name of base	Chemical Formula	Commercial Name	Uses
Potassium hydroxide	KOH	Caustic potash	Storage batteries, in alkaline manufacturing of soap.
Calcium hydroxide	$Ca(OH)_2$	Slaked lime	In manufacturing of bleaching powder, used in softening of hard water etc.
Aluminum hydroxide	$Al(OH)_3$	-	In fire extinguishers used as foaming agent.
Sodium hydroxide	NaOH	Caustic Soda	In manufacture of soap, paper, pulp, refining process of petroleum etc.
Magnesium hydroxide	$Mg(OH)_2$	Milk of Magnesia	Used as laxative as an antacids to remove acidity from stomach and heartburn
Ammonium hydroxide	NH_4OH	-	In cleaning window panes, In removing greases stains from clothes, used in fertilizer.

Chemical Properties of Bases

1. **Reaction of bases with metals**

   Metals like zinc, tin and aluminum react with strong bases like NaOH, KOH to release hydrogen gas.

   $$2Al(s) + 6\ KOH(aq) \longrightarrow 2K_3AlO_3 + 3H_2(g)$$

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

2. **Reaction of bases with non-metallic oxides**

   Bases react with oxides of non-metals to form salt and water. Non metal oxides are acidic in nature.

   For e.g.

   $$2NaOH(aq) + CO_2(g) \longrightarrow Na_3CO_3(aq) + H_2O(l)$$

3. **Reaction of Bases with Acids**

   Bases react with acids to form salt and water.

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

4. The solutions of bases in water give a soapy touch. When bases are dissolved in water they form hydroxide ions (OH^-) in solution.

   $$NaOH \xrightarrow{H_2O} Na^+ + OH^-$$

5. **Reaction of Bases reacts with other salts**

   When Bases react with certain salts to form another salt and another base. For example, when NH_4OH is added to a solution of $Al_2(SO_4)_3$, $(NH_4)_2SO_4$ and $Al(OH)_3$ are produced.

   $$\underset{\text{ammonium hydroxide}}{6NH_4OH} + \underset{\text{aluminium sulphate}}{Al_2(SO_4)} \longrightarrow \underset{\text{aluminium hydroxide}}{2Al(OH)_3} + \underset{\text{aluminimum sulphate (salt)}}{3(NH_4)_2SO_4}$$

Bases Classification On the Basis of their Strength

1. **Strong base :** Those Bases that are almost completely ionised in water and release more hydroxyl (OH) groups in an aqueous solution upon ionisation.

   For e.g. NaOH

   $$NaOH(s) + Water \longrightarrow Na^+(aq) + OH^-(aq)$$

2. **Weak bases :** Bases that are weakly ionised on dissolving in water and has a low concentration of hydroxyl ions. eg. NH_4OH

   $$NH_4OH(aq) \underset{}{\overset{Water}{\rightleftharpoons}} NH_4^+(aq) + OH^-(aq)$$

Classification of Bases On The Basis of Their Acidity

The acidity of a base is defined as the number of hydroxyl (OH) groups that are present in a molecule of the base.

- The base that contain one hydroxyl group in a molecule is called as **mono acidic base**. e.g. NaOH. Its acidity is 1.
- The base that contain two hydroxyl groups is called as **diacidic base**. e.g., $Ca(OH)_2$. Its acidity is 2.
- The base that contain three hydroxyl groups is called as **triacidic base**. e.g., $Fe(OH)_3$. Its acidity is 3.

Comparison Between Acids & Bases

Acids	Bases
1. Acids are those that has sour taste.	1. Bases are those that has Bitter taste.
2. Acids shows electrolytic conductivity in aqueous solution.	2. Bases shows electrolytic conductivity in aqueous solutions.
3. Acids depends on concentration of H^+ ions.	3. Bases depends on concentration of OH^- ions.
4. In Acids, litmus paper turns from blue to red, phenolphthalein will remains colourless.	4. In bases, litmus turns from red to blue, phenolphthalein will turn from colourless to pink.
5. Acids decompose carbonate salts.	5. No decomposition of carbonate salts, by bases.

NCERT Corner

1. Why should curd and sour substances not be kept in brass and copper vessels?

Ans. Curd and sour food items that contain acids when combine with metal to produce H_2. This reaction turns food to poison that will damage people's health.

2. Which gas is usually liberated when an acid reacts with a metal? Illustrate with an example. How will you test for the presence of this gas?

Ans. When an acid reacts with any metal, salt and hydrogen gas are formed.

Metal + Acid → Salt + Hydrogen gas

$Zn + HCl \rightarrow ZnCl_2 + H_2\uparrow$

If we bring candle/matchstick near H_2 gas it will burn with poping sound.

3. Metal compound A reacts with dilute hydrochloric acid to produce effervescence. The gas evolved extinguishes a burning candle. Write a balanced chemical equation for the reaction if one of the compounds formed is calcium chloride.

Ans. As metal compound released is Calcium Chloride the gas released here is CO_2. Thus metal A will be Calcium Carbonate. Thus the reaction between Calcium Carbonate and HCl is

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

The Ionisation of Acids & Bases

- Substances can only act as acids and bases in the presence of water in an aqueous solution.
- In dry state that is also known as anhydrous state, ionisation of acids & bases cannot be seen.
- As, water helps in the ionisation of acids or base by separating the ions. This is also known as dissociation and it is explained on the basis of Arrhenius theory of acids and bases.
- In the dry state, Hydrochloric acid (HCl) is known as hydrogen chloride gas i.e. HCl(g). It will not to give any H^+ ions in dry state.
- Thus, the acidic character is not seen. When HCl gas is passed through water that is taken in a beaker with the help of glass pipe, H_2O molecules, which are of polar nature that means they will have partial negative charge on oxygen atom and partial positive charge on hydrogen atoms. So, they will try to make a type of envelope around the H atoms as well as Cl atoms present in the acid and therefore help in their separation as an ions. Thus, these ions are known as hydrated ions.

$$HCl(g) + \text{Water} \longrightarrow H^+\ (aq) + Cl^-\ (aq)$$

(Hydrated ions)

- So, the electrical current is carried through these ions. This applies same for acids as well as bases. Therefore,
  1. Acids are those that release H^+ ions only in an aqueous solution.
  2. Base are those that release OH^- ions only in an aqueous solution.
  3. Hydration helps in the release of ions from both acids and bases.

Find it

Q. If solution of glucose will conduct electricity and if not mention the reason for the same.

Test Prep

Arrhenius concept

- **Arrhenius Acid:** Substance that gives H^+ ion on dissolving in water (H^+ donor). E.g., HNO_3, $HClO_4$, HCl, HI, HBr, H_2SO_4, H_3PO_4 etc
- **Arrhenius base:** Substance that releases OH^- (hydroxyl) ion in water (OH^- ion donor). Eg. NaOH, KOH.

Bronsted - Lowry concept

- **A Bronsted-Lowry acid** is any species that is capable of donating a proton H^+
- **A Bronsted-Lowry base** is any species that is capable of accepting a proton, which requires a lone pair of electrons to bond to the H^+.
- **Amphoteric (amphiprotic):** Substances which can act as acid as well as base are known as amphoteric

Conjugate Acid Base Pair

- The **conjugate base** of a Bronsted-Lowry acid is the species formed after an acid donates a proton. The **conjugate acid** of a Bronsted-Lowry base is the species formed after a base accepts a proton.

In a typical acid base reaction

$HX + B \rightleftharpoons X^- + HB^+$

Acid		Base		Conjugate Acid		Conjugate Base
HCl	+	H_2O	$\rightleftharpoons$	H_3O^+	+	Cl^-
HSO_4^-	+	NH_3	$\rightleftharpoons$	NH_4^+	+	SO_4^{-2}
$[Fe(H_2O)_6]^{3+}$	+	H_2O	$\rightleftharpoons$	H_3O^+	+	$[Fe(H_2O_5)(OH)]^{2+}$

Lewis Concept (electronic concept)

An acid is a molecule/ion that can accept an electron pair with the formation of a coordinate bond.

Chemical species acts as Lewis Acid.

E.g. Electron deficient molecules : BF_3, $AlCl_3$, $FeCl_3$

Cations : H^+, Fe^{2+}, Na^+

- Molecules with vacant orbitals : SF_4, PF_3

A base is any molecule/ion that has a lone pair of electrons which can be donated.

Base → (One electron pair donate)

E.g. Molecules with lone pairs : NH_3, PH_3, H_2O, CH_3OH

- All negative charged ions e.g., CN^-, Cl^-.

Dilution of Acids and Bases

- Acids and bases are mostly soluble in water and they can be diluted by adding the required amount of water.
- The amount of acid or base per unit volume decrease with the addition of water and then dilution occurs. This process is generally exothermic in nature.
- A concentrated acid like sulphuric acid or nitric acid is to be diluted with water.

Mind it

Acid should be added dropwise to water taken in the container with constant stirring. As the process of dissolving acid into water is a highly exothermic process so this will produce a lot of heat.

Indicators

An acid-base indicator is defined as those substance which assumes different colours in different medium like acidic, basic and neutral solutions.

A few common acid-base indicator as given below.

Litmus: It is a natural dye made from small plants called lichens (a plant belong to division Thallophyta).Litmus solution is a purple dye that is used as an indicator. Blue and red litmus solutions are prepared from two different varieties of lichens.

Litmus paper: Blue or red litmus paper is made by dipping a strip of filter paper in blue or red litmus solutions. The paper is then removed from the solution and then dried up.

Blue litmus paper will turn red in an acidic solution and red litmus paper will turn blue in a basic solution.

Synthetic Indicators

Methyl orange: Solid methyl orange in very little amount is dissolved in hot water and then filtered. The filtrate is used as methyl orange that will turn red in acidic solutions and yellow in basic solutions.

Phenolphthalein: An alcoholic solution of phenolphthalein is used as an indicator. It become colourless in an acidic solution, but it will become pink (red) in basic solution.

Table- 6: Some acid-base indicators in acid, base and neutral solution are given below:

Indicator	Acid solution	Basic solution	Neutral solution
Red litmus solution	No colour change	Blue	No colour change
Blue litmus solution	Red	No colour change	No colour change
Phenolphthalein	Colourless	Red	Colourless
Methyl orange	Red	Yellow	Orange

Some Common Household Indicators

Some useful household indicators are given below.

1. **Turmeric juice** It has yellow colour. It is yellow in acidic or neutral solutions but changes to deep brown colour in a basic solution.
2. **Red-cabbage juice** It has purple colour, it changes to red colour in an acidic solution, but green in a basic solution.

Table- 7: The household indicators is used to test whether some of the substances of daily use as given below that are acidic or basic.

Acidic substances	Basic substance
Vitamine C tablets	Soap and both solution
Tomato juice	Toothpaste
Vinegar	Antacids
Lemon juice	Washing soda solutions
Orange juice	Bleach

Olfactory Indicators

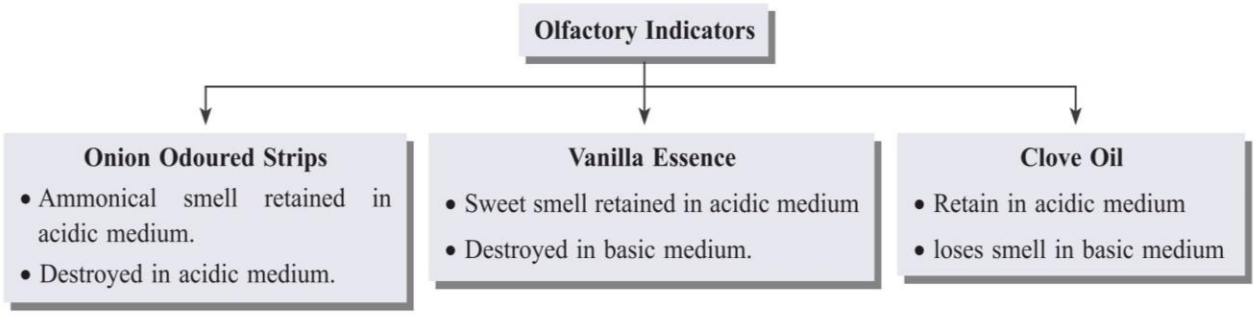
An Olfactory indicator are those substance whose smell varies depending on whether it is mixed with an acidic or basic solution. In olfactory titration, olfactory indicators are used in the laboratory to test whether a solution is a base or an acid.

For eg: Vanilla extract has a characteristic pleasant smell, onion and clove oil, etc.

Example

Q. Define olfactory indicators. Name two subtances which can be used as olfactory indicator.

Ans. Those substances whose smell (odour) changes in acidic or basic solution are called olfactory indicators, e.g. onion and vanilla.



NCERT Corner

1. Why do HCl, HNO_3, etc., show acidic characters in aqueous solutions while solutions of compounds like alcohol and glucose do not show acidic character?

Ans. Release of H^+ ion in water will make a compound whether it is acidic or non-acidic. Acids are those substance that upon dissociating in water results in release of H^+ ions. Some compounds that show acidic character because they dissociate in the aqueous solution to give H^+ ions (acids like HCl, HNO_3). While alcohol and glucose do not dissociate to give H^+ ions. So they do not show acidic character.

2. Why does an aqueous solution of an acid conduct electricity?

Ans. Charged particles are mainly responsible for the conductance of electricity in an acid. These charged particles are known as ions which helps in conductance of electricity in an acid.

3. Why does dry HCl gas not change the colour of the dry litmus paper?

Ans. HCl gas will not give H^+ ions in dry state thus HCl does not show any acidic behaviour and colour of the litmus paper will remain the same on reacting with HCl gas.

4. While diluting an acid, why is it recommended that the acid should be added to water and not water to the acid?

Ans. On diluting an acid, it is advised that the acid should be added to water and not water to the acid because if water is added to concentrated acid, it will release enormous amount of heat that can result in explosion and can cause acid burns on clothes, face and body parts. This it is safe to add acid to water but not water to acid.

5. How is the concentration of hydronium ions (H_3O^+) affected when a solution of an acid is diluted?

Ans. When acid is added to water there will be a definite amount of H_3O^+ present in the fixed volume of solution. If we add water, hydronium ion per volume of solution decrease, this in-turn decreases H_3O^+ concentration in the solution.

6. How is the concentration of hydroxide ions (OH^-) affected when excess base is dissolved in a solution of sodium hydroxide?

Ans. When base is dissolved in NaOH solution its OH^- ions increase but it will reach to a saturation at some point. After achieving saturation point hydroxide ion concentration will not be affected even after adding base further.

Find it

Q. A knife, which is used to cut a fruit, was immediately dipped into water containing drops of blue litmus solution. What is the change in colour of solution and what inference can be drawn about the nature of the fruit?

Strength of Acid and Base

pH Scale

A scale that is used measuring the strength of acids and bases in a solution is known pH scale. It has been developed by S.P.L. sorensen. The P in pH stands for 'potenz' in German meaning power and 'H' stands for hydrogen ions.

The acidity or basicity of a solution is usually expressed in terms of a function of the H^+ ion concentration. This function is called the pH of a solution.

- pH should be thought of simply as a number that indicates the acidic or basic strength of solution.
- On the pH scale we can measure pH from 0 (very acidic) to 14 (very alkaline).
- Higher the H^+ ion concentration, Lower will be value of the pH scale.

The pH of an aqueous solution is the negative logarithm of its H^+ ion concentration. That is,

$pH = -\log [H^+]$.

$pOH = -\log [OH^-]$

Characteristic of pH scale are -

1. For acidic solution, pH < 7
2. For alkaline solution, pH > 7
3. For neutral solution, pH = 7

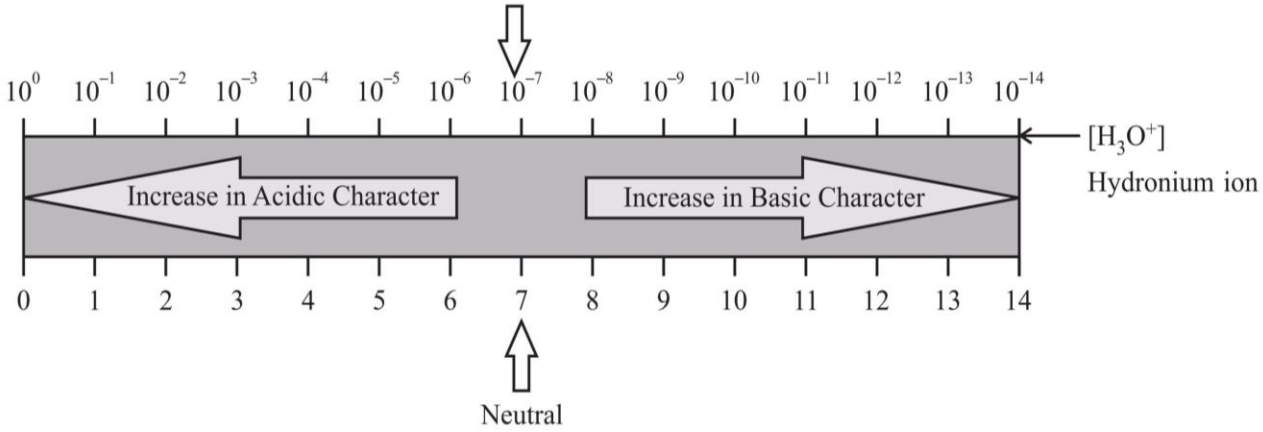


Fig. 2: pH Scale for measuring acidic and basic strength

Example

1. **A student detected the pH of four unknown solution P, Q, R and S as follows 11, 5, 7 and 2. Predict the nature of the solution.**

Ans. P is basic 'Q' is acidic 'R' is neutral and 'S' is strongly acidic.

2. **You are given three solutions A, B and C with pH values 2, 10 and 13 respectively. Write which solution has more hydrogen ion concentration among the three and state the nature 'acidic or basic' of each solution.**

Ans. 'A' has maximum $[H_3O^+]$ equal 10^{-2} mol L^{-1}

'A' is acidic whereas B and C are basic in nature.

Universal Indicator Papers for pH Values

Indicators like litmus paper, phenolphthalein and methyl orange that are generally used in predicting the acidic and basic nature of the solutions. So universal indicator papers have been developed to determine the pH of different solutions. These papers will represent specified colours in terms of pH values for different concentrations.

The exact pH of the solution will be measured with the use of pH meter that will give instant reading and it can be relied upon.

Table- 8: pH values of a few common solutions are given below -

Solution	pH range	Solution	pH Range
Coffee	4.5 – 5.5	Lime water	12.0
Milk	6.5	Sodium hydroxide	14.0
Tears	7.4	Saliva	6.5 – 7.5
Gastric juices	1.0 – 3.0	Pure water	7.0
Vinegar	3.0	Baking soda solution	8.4
Acid rain	5.6	House hold ammonia	11.9
Sea water	9.0	Bear	4.0 – 5.0
Lemon juices	2.2 – 2.4	Blood	7.36 – 7.42
Tomato juice	4.1	Washing soda solution	10.5

Test Prep

pH Value acidic mixture

- If two strong acids are mixed

  When V_1 is volume of acid 1 and V_2 is volume of acid 2 and N_1 and N_2 are their normality respectively.

  $$[H^+] = \frac{N_1V_1 + N_2V_2}{V_1 + V_2}$$

  $$\text{pH value} = \log\frac{1}{N_R}$$

- If two strong bases are mixed

  $$= \left[OH^-\right] = \frac{N_1V_1 + N_2V_2}{V_1 + V_2}$$

Ionic product of water (K_W)

- The product of the concentration of hydrogen ions (or) hydronium ions and hydroxide ions at any temperature in pure water or in any aqueous solution is known as the ionic product of water. It is represented by K_w.

  $K_w = [H^+][OH^-]$

  $K_w = [H_3O^+][OH^-]$

  $\boxed{pK_w = -\log K_w}$

- For any aqueous solution, the sum of pH and pOH depends on the ionic product of water.
- pH + pOH = pK_w at any temperature
- pH of neutral water decreases as its temperature is raised. Ionization of H_2O increases $\therefore$ K_w also increases.
- At 25° C, for any aqueous solution. pH + pOH = 14

Importance of pH in Everyday Life

pH plays a very important role in our everyday life.

1. **pH of our digestive system:** Hydrochloric acid that is produced in our stomach helps in digestion of food without causing any harm to the stomach. But if the amount of the acid is above a certain limit due to indigestion or eating spicy foods so, pain and irritation occur in the stomach.

   Remedy : In order to neutralize the effect of excess acid, a mild base called antacid is usually taken. Eg: Magnesium hydroxide (milk of magnesia) is a mild base that is usually used as an antacid.

2. **pH change leads to tooth decay:** When we eat high sugar content food, it break down by bacteria present in the mouth and an acid is formed. When the pH of the mouth becomes lower than 5.5 then tooth enamel (made of calcium phosphate) gets corroded. Saliva, that is slightly alkaline in nature produced in the mouth neutralizes some acid, but excess acid remains unaffected.

   Remedy : The excess acid is removed only by the use of toothpaste that is alkaline in nature. Neem stick also contains alkaline juice. So, the cleaning of tooth by Neem stick or toothpaste helps in reducing tooth decay.

3. **pH change lead to fatigued muscle:** Physical exercise result in stiffness and pain in the muscle starts due to the formation of lactic acid. So, the amount of oxygen supply in the muscle is decreased. This causes difficulty in the release of energy that leads to increase in the rate of anaerobic metabolism. As a result, lactic acid gets collected in the muscles.

4. **Self defence by animals and plants through chemical warfare:** Honey-bee inserts an acid through its stings that causes pain and irritation. This, a mild base like baking soda is applied to treat the wound. Similarly, nettle leaves, that have stinging hairs, when touched insert formic acid in our body. This causes a burning sensation.

5. **pH change in Soil:** Plants require a specific pH range for their healthy growth.

NCERT Corner

1. You have two solutions, A and B. The pH of solution A is 6 and pH of solution B is 8. Which solution has more hydrogen ion concentration? Which of this is acidic and which one is basic?

Ans. To find the H^+ concentration, pH value is used. As the pH of any solution is inversely proportional to the H^+ concentration thus, it if solution has a lower pH number then it will have a higher H^+ concentration. Thus, solution A will have a higher hydrogen ion concentration. In addition, solution B will be basic and A will be acidic.

2. What effect does the concentration of H^+(aq) ions have on the nature of the solution?

Ans. Hydrogen ion concentration decides the nature of the solution. If H^+ concentration increase then solution will turn acidic and similarly if H^+ concentration decreases then solution will turn basic.

3. Do basic solutions also have H^+(aq) ions? If yes, then why are these basic?

Ans. Basic solutions also has H^+ ions, but hydroxide ions present in basic solution are more in basic solution. Thus OH^- turn solution to basic.

4. Under what soil condition do you think a farmer would treat the soil of his fields with quick lime (calcium oxide) or slaked lime (calcium hydroxide) or chalk (calcium carbonate)?

Ans. If the soil is acidic in nature (pH is below 7) then in such field will be treated with quick lime (calcium oxide) or slaked lime (calcium hydroxide) or chalk (calcium carbonate).

Find it

Q. What is change in pH values of milk when it changes into curd?

Salts

A salt is a compound that is formed by the reaction of an acid with a base in which the hydrogen of the acid is replaced by the metal.

$$H_2SO_4 + NaOH \rightarrow \underset{\text{sodium hydrogensulphate}}{NaHSO_4} + \underset{\text{water}}{H_2O}$$

This type of reaction is known as **neutralisation reaction**.

Different Types of Salts

The different types of salts are: normal salt, acid salt, basic salt and double salt.

1. **Normal salt:** A salt which does not contain any replaceable H atoms or hydroxyl groups

   Examples $CaSO_4$, K_3PO_4, Na_2SO_4

2. **Acidic salt:** When a polybasic acid is not completely neutralized by a base, the salt formed will contain replaceable H atoms.

   A salt that contains replaceable hydrogen atoms is called an acidic salt.

   $H_2SO_4 + NaOH \rightarrow NaHSO_4 + H_2O$

   $NaHSO_4 + NaOH \rightarrow Na_2SO_4 + H_2O$

   Examples**:**

   $NaHSO_4$, $KHCO_3$ and KH_2PO_4 are examples of acidic salts.

3. **Basic salt :** When these salts are the product of incomplete neutralization of strong base and weak acid, the salt produced contain hydroxyl group(s) (OH) also. Such a salt is known a basic salt. Example: $2PbCO_3.Pb(OH)$, $Br(OH)_2NO_3$

   $Bi(OH)_3 + HNO_3 \rightarrow Bi(OH)_2NO_3 + H_2O$

4. **Double salt :** In a double salt, there are two different negative ions and/or positive ions are present. For example, Hence, it is a double salt. Example: Potash alum, $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$, also is a double salt

Classification of Salts Based on pH Values

1. **Neutral salt solutions:** Salt solutions of strong acids and strong bases that are neutral in nature and they have pH value equal to 7. They do not change the colour of litmus solution.

   For e.g. : NaCl, $NaNO_3$, Na_2SO_4 etc.

2. **Acidic salt solutions:** It is salt solutions of strong acids and weak bases that are of acidic nature and they have pH value less than 7. They change the colour of blue litmus solution to red.

   For e.g. $(NH_4)_2SO_4$, NH_4Cl etc.

   In both these salts, the base NH_4OH is weak while the acids H_2SO_4 and HCl are strong.

3. **Basic salt solutions:** Salt solutions of strong bases and weak acids that are of basic nature and they have pH value more than 7. They change the colour of red litmus solution to blue.

   For e.g. K_3PO_4, Na_2CO_3 etc.

Example

Q. Why the salts solutions of strong acid and strong alkali are neutral?

Ans. Salt solution of strong acid and strong bases are neutral because they do not hydrolyse in water as both the acid & base nulify each other and hence solution is neutral in nature.

Example. $\underset{\text{Neutral Ionised}}{K_2SO_4} + 2H_2O \longrightarrow 2\underset{\text{Feebly Ionised}}{KOH} + \underset{\text{Highly Ionised}}{H_2SO_4}$

Mind it

The pH of human blood varies between 7.36 to 7.42. It is maintained by the soluble hydrogen carbonates and carbonic acid present in blood. These are known as 'buffer'. In general, the role of different buffer is to help in controlling the pH of solution.

Uses of Salts

1. As a table salt,
2. In the manufacture of butter and cheese.
3. Used in leather Industry.

Sodium Chloride (NaCl) - Common Salt

- Sodium chloride (NaCl) also known as common salt or table salt. It is the most important part of our diet.
- It is produced by the reaction between of sodium hydroxide (NaOH) and hydrochloric acid (HCl) solutions.
- It is separated by some suitable methods.
- Deposits of the salts that are found in different part of the world and is called as rock salt. When salt is pure, it is white in colour & crystalline solid. However, it is often brown in colour due to the presence of impurities in it.

Uses of NaCl

1. **Raw material for chemical:** Sodium chloride is also a very useful raw material for different chemicals. Like for hydrochloric acid (HCl), washing soda ($Na_2CO_3.10H_2O$), baking soda ($NaHCO_3$).
2. **Essential for life :** Sodium chloride is quite important for life. Biologically, NaCl has a number of functions to perform such as in muscle contraction, in conduction of nerve impulse in the nervous system and it is also converted in HCl that helps in the digestion of food in the stomach.

Sodium Hydroxide (NaOH)

NaOH is chemically known as **Caustic Soda**.

When electricity is passed through an aqueous solution of sodium chloride (called brine), it decomposes to form sodium hydroxide. The process is known as the **chlor-alkali process** because of the products formed–chlor for chlorine and alkali for sodium hydroxide.

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

- Chlorine gas is released at the anode.
- Hydrogen gas is released at the cathode.
- Sodium hydroxide solution is formed near the cathode.

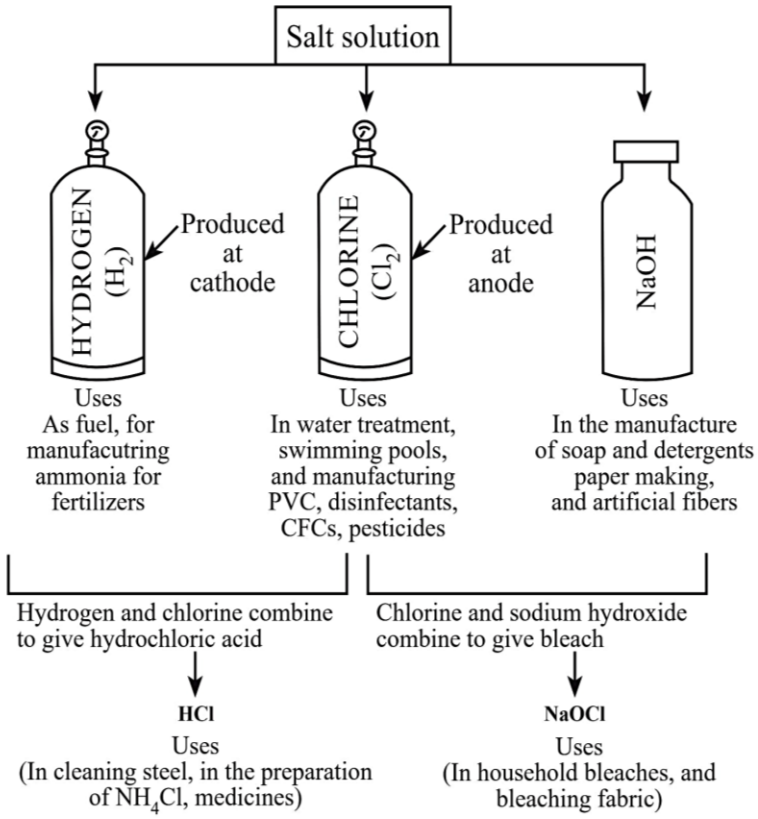


Fig. 3: Chloro-alkali process

Washing Soda ($Na_2CO_3.10H_2O$)

Chemical name: Sodium carbonate decahydrate

Chemical formula: $Na_2CO_3.\ 10H_2O$

- Washing soda is manufactured by **Solvay's Process**.
- This process is also known as ammonia soda process. The raw materials that are needed for this process are sodium chloride, limestone ($CaCO_3$) and ammonia (NH_3). The reactions involved are

First step

$$\underset{\text{Common Salt}}{NaCl(aq)} + H_2O(l) + CO_2(g) + NH_3(g) \longrightarrow \underset{\text{Ammonium Chloride}}{NH_4Cl(aq)} + \underset{\text{Sodium Hydrogen Carbonate}}{NaHCO_3(s)}$$

The CO_2 that is required in this reaction is obtained by heating limestone.

$$\underset{\text{Limestone}}{CaCO_3(s)} \xrightarrow{\text{Heat}} \underset{\text{Quick lime}}{CaO(s)} + CO_2(g)$$

Second step

Dry sodium hydrogen carbonate is heated strongly to give sodium carbonate

$$2NaHCO_3(s) \xrightarrow{\text{Heat}} \underset{\substack{\text{Anhydrous Sodium} \\ \text{Carbonate (Soda Ash)}}}{Na_2CO_3(s)} + H_2O(l) + CO_2(g)$$

Third step

Sodium carbonate is recrystallized by dissolving in water to get washing soda. It is a basic salt.

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

Mind it

Compounds that take up enough water from the air to dissolve in the water they have taken up are called deliquescent. Calcium chloride ($CaCl_2$) and Sodium hydroxide (NaOH) are the examples of deliquescent.

Baking Soda ($NaHCO_3$)

Baking soda is chemically known as **sodium hydrogen carbonate** or **sodium bicarbonate ($NaHCO_3$)**.

Baking soda is obtained as an intermediate product in the preparation of Na_2CO_3 by Solvay process. In this process, a saturated sodium chloride solution in water is saturated with NH_3 and then carbon dioxide gas is passed into the liquid.

Sodium chloride NaCl is converted into sodium bicarbonate $NaHCO_3$ which being less soluble, separates out from the solution.

$$2NH_3\,(g) + H_2O + CO_2\,(g) \rightarrow (NH_4)_2\,CO_3(aq)$$

$$(NH_4)_2CO_3\,(aq) + 2NaCl(aq) \rightarrow Na_2CO_3\,(aq) + 2NH_4Cl(aq)$$

$$Na_2CO_3(aq) + H_2O + CO_2\,(g) \rightarrow 2NaHCO_3$$

Properties of $NaHCO_3$

1. It is a white crystalline substance which forms an alkaline solution with water. The aqueous solution of $NaHCO_3$ is neutral in methyl orange but it gives pink colour with phenolphthalein orange.
2. When $NaHCO_3$ is heated above 543 K, it is converted into Na_2CO_3.

$$\underset{\text{Baking soda}}{2NaHCO_3\,(s)} \xrightarrow[\Delta]{543\,K} \underset{\text{Sodium carbonate}}{Na_2CO_3\,(s)} + CO_2\,(g) + H_2O$$

Uses of Baking Soda

1. It is used in the manufacture of baking powder. Baking powder is a mixture or potassium hydrogen tartar ate and sodium bicarbonate. During the bread preparation, the release of CO_2 causes of bread to rise (swell).

$$\begin{matrix}CH(OH)COOK\\|\\CH(OH)COOH\end{matrix} + NaHCO_3 \longrightarrow \begin{matrix}CH(OH)COOK\\|\\CH(OH)COONa\end{matrix} + CO_2 + H_2O$$

2. It used in medicine as soda bicarb, which acts as an antacid.
3. Used in a particular type of fire extinguishers.
4. It used in the tanning, textile, paper etc.

Bleaching Powder ($CaOCl_2$)

Bleaching powder is commercially called 'chloride of lime or' chlorinated lime'.

Preparation

Bleaching powder is prepared by passing chlorine over slaked lime at 313 K.

$$\underset{\text{Slaked lime}}{Ca(OH)_2(aq)} + Cl_2(g) \xrightarrow{313K} \underset{\text{Bleaching powder}}{Ca(OCl)Cl(s)} + H_2O(g)$$

Mind it

Actually beaching powder is not a compound but a mixture of compounds : $CaOCl_2$. $4H_2O$, $CaCl_2$. $Ca(OH)_2$. H_2O

Uses

1. It is used as a bleaching agent in paper and textile industries.
2. Used to prepare chloroform ($CHCl_3$).
3. It is used for disinfecting water.

Plaster of Paris ($CaSO_4.1/2\ H_2O$)

Chemical Name: Calcium Sulphate Hemihydrate

Preparation

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

During the preparation of plaster of Paris (POP), temperature is to be controlled carefully. Else, anhydrous calcium sulphate ($CaSO_4$) formation take place. Anhydrous calcium sulphate does not set into hard mass when it is mixed with water. So, if temperature is not set into hard mass then Plaster of Paris formed will have poor setting property.

$$CaSO_4.2H_2O(s) \xrightarrow[373K]{\text{More than}} \underset{\text{Dead burnt plaster}}{CaSO_4(s)} + 2H_2O(g)$$

Properties of POP

1. At ordinary room temperature, Plaster of Paris absorbs water and a large amount of heat is released.
2. When mixed with a limited amount of water (50% by mass), then it will forms a plastic mass, which evolves heat and quickly sets to a hard porous mass within minutes. This is known as **setting process**.

   During setting, there is a slight expansion in volume occurs. It is due to this that it will fills the mould completely and gives sharp impression. The reaction during process is

$$\underset{\text{Plaster of Paris}}{CaSO_4.\frac{1}{2}H_2O(s)} + \underset{\text{Water}}{\frac{3}{2}H_2O(l)} \longrightarrow \underset{\text{Gypsum (hard mass)}}{CaSO_4.2H_2O(s)}$$

Uses of POP

1. It is also used for making toys, cosmetic and casting statues.
2. It is used in the laboratories for sealing gaps where airtight arrangement is needed.
3. It use in making moulds in pottery.

Mind it

Gypsum slows down the rate of quick setting of cement water paste.

Water of Crystallisation

Certain salts that contain fixed amount of some H_2O molecules loosely attached to their own molecules. They are known as hydrated salts and they are of crystalline nature. The molecules of H_2O present are called as '**water of crystallisation**'.

Hydrated salts: There are certain salts in which water of crystallisation are present. These salts are known as hydrated salts. Eg sodium carbonate decahydrate is $Na_2CO_3.10H_2O$,Calcium sulphate dihydrate $CaSO_4.2H_2O$.

Anhydroys salts: There are certain salts in which water of crystallisation are absent.These salts are known as Anhydrous salts. E.g Anhydrous copper sulphate,anhydrous ferrous sulphate.

The molecules of water of crystallisation also account for their specific colours in coloured crystalline and hydrated salts Hence, upon heating of hydrated salt, its colour changes as molecules of water of crystallisation are removed and the salt becomes anhydrous, For example, if we take a few crystals of blue vitriol i.e. hydrated copper sulphate in a dry or boiling tube. Test tube is heated from below. The salt will change color to a white anhydrous powder and water droplet will appear on the walls of the tube. Then the tube is cooled and few drops of water is added again. The white anhydrous powder will again gain blue colour.

$$\underset{\text{Copper sulphate (Hydrated)}}{CuSO_4.5H_2O} \xrightarrow{\Delta} \underset{\text{Copper sulphate (Anhydrous)}}{CuSO_4} + 5H_2O$$

NCERT Corner

1. What is the common name of the compound $CaOCl_2$?

Ans. Common name of $CaOCl_2$ is bleaching powder.

2. Name the substance which on treatment with chlorine yields bleaching powder

Ans. The substance that on treatment with chlorine yields bleaching powder is Calcium hydroxide.

3. Name the sodium compound which is used for softening hard water.

Ans. Sodium carbonate Na_2CO_3 is the compound that is used for softening hard water.

4. What will happen if a solution of sodium hydrocarbonate is heated? Give the equation of the reaction involved.

Ans. Sodium hydrocarbonate on heating yields sodium carbonate and carbon dioxide gas is released in the process.

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

5. Write an equation to show the reaction between Plaster of Paris and water.

Ans. The chemical equation for the reaction of Plaster of Paris and water is

$$CaSO_4.1/2H_2O + 3/2H_2O \rightarrow CaSO_4.2H_2O$$

Summary

Acids

Acids are those substance which release one or more H^+ ions in aqueous solution.

Example: Sulphuric acid (H_2SO_4), Acetic Acid (CH_3COOH)

- ❒ Acidic solution conducts electricity,
- ❒ Acids are sour in taste and turn blue litmus red,

Classification of acids on the basis of their occurrence/source

1. Organic acids
   They are derived from plants and animals. Eg: formic acid (HCOOH), acetic acid (CH_3COOH)
2. Mineral acids.
   They are derived from rock and minerals. Eg.: HCl, HNO_3

Classification of acids on the basis of their strength

1. An acid which is completely ionised in water and produces (H^+) is called **Strong Acid**. Example: Hydrochloric acid (HCl)
2. An acid which is partially ionised in water and thus produces a small amount of hydrogen ions (H^+) is called a **Weak Acid**. Example: Acetic acid (CH_3COOH)

Bases

Bases are those substances which releases hydroxide ions (OH^-) in aqueous solution.

Examples: Sodium hydroxide (caustic soda) – NaOH, $Ca(OH)_2$

- ❒ Bases are bitter in taste, have soapy touch, turn red litmus blue

Classification of bases on the basis of their strength

1. A base which is completely ionised in water and produces (OH^-) is called **Strong Base**.
2. A base which is partially ionised in water and thus produces a small amount of hydrogen ions (OH^-) is called a **Weak base**.

Chemical Reaction of Acids and Bases

1. Acid + metal → metal salt + hydrogen gas
   Base + metal → salt + hydrogen gas
2. Acid + metal carbonate → metal salt + water + carbon dioxide gas
   Base + metal carbonate → No reaction
3. Acid + metal bicarbonate → metal salt + water + carbon dioxide
   Base + metal bicarbonate → No reaction
4. Acid + Base → salt + water
5. Metal oxide are basic in nature
   Acid + metal oxide → Salt + Water
   Non-metal oxides are acidic in nature
   Base + Non-metal oxide → Salt + Water

Indicators

Indicators are those substances which tell us whether a substance is acidic or basic by change in colour. For e.g., litmus solution.

- ❒ **Natural indicators:** Turmeric, litmus (obtained from lichen)
- ❒ **Synthetic indicators:** Methyl orange, phenolphthalein.
- ❒ **Olfactory indicators:** Those substances whose odour changes in acidic or basic media are known as Olfactory indicators. For e.g., clove, vanilla essence, onion.

Indicators	Acids	Bases
1. Blue litmus	turns red	remains blue
2. Phenolphthalein	colourless	pink
3. Methyl orange	red	yellow
4. Red litmus	remains red	turns blue

Salts

A **salt** is a compound formed by the reaction of an acid with a base.

There are three types of salts

Acidic salt: It is formed when strong acid react with weak base. Eg Ammonium chloride.

Basic salt: It is formed when Strong Base Reacts With weak acid. Eg Calcium Carbonate.

Neutral salt: It is formed when Weak Or Strong Acid And Base React With Each other. They neutralize each other. eg NaCl.

pH Scale

Strength of acid and base is expressed in terms of pH scale that ranges from 0 to 14 using pH paper.

It is the Logarithm of Reciprocal of Hydrogen ion Concentration.

i.e.: $pH = -\log[H^+]$

In pH scale, Acids : 0 to 7 ; bases : 7 to 14 ; neutral : 7

Chemicals from Common Salt

Sodium chloride is called as common salt and is used in our food. It is extracted from seawater.

Following is a list of common salts that are used in our daily

1. **Sodium hydroxide (NaOH):**

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

   Uses: It is used to make soap and as a main ingredient in household products such as liquid drain cleaners.

2. **Bleaching Powder ($Ca(OCl)_2$):**

   Preparation: $Ca(OH)_2(aq) + Cl_2(g) \xrightarrow{313\,K} Ca(OCl)Cl(s) + H_2O(g)$

   Uses: Used in textile factories, laundries and as a disinfectant

3. **Baking soda ($NaHCO_3$):**

   Preparation: $NaCl + H_2O + CO_2 + NH_3 \rightarrow NH_4Cl + NaHCO_3$

   Uses: Used in glass manufacturing, soap and paper industry, as cleaning agent for domestic purpose, to make baking powder, antacids etc.

4. **Washing soda ($Na_2CO_3.10H_2O$):**

   Preapration: $NaCl + H_2O + CO_2 + NH_3 \rightarrow NH_4Cl + NaHCO_3$

   Dry Sodium hydrogen carbonate is heated strongly to produce sodium carbonate.

   $$2NaHCO_3(s) \xrightarrow{\text{Heat}} \underset{\text{Anhydrous Sodium Carbonate (Soda Ash)}}{Na_2CO_3(s)} + H_2O(l) + CO_2(g)$$

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

   Uses: For softening of hard water, used in detergents as it has cleansing properties.

5. **Plaster of Paris ($CaSO_4.\frac{1}{2}H_2O$):** On heating gypsum to 373K it becomes $CaSO_4.\frac{1}{2}H_2O$ that is plaster of Paris

   $$CaSO_4\,2H_2O \longrightarrow CaSO_4\,\frac{1}{2}H_2O + \frac{3}{2}H_2O$$

   If temperature is more than 373 K.

   $$CaSO_4\,2H_2O \xrightarrow[373\,K]{\text{More than}} \underset{\text{Dead burnt plaster}}{CaSO_4(s)} + 2H_2O(g)$$

   Uses: Making toys, decorative materials and smooth surfaces.

Quick Recall

Fill in the blanks

1. Acids turn _____ litmus to _____ .
2. Basic solution of pH is always _____ than 7.
3. Mild base like _____ gives relief on the bee-stung area.
4. _____ is the fixed number of water molecules that is attached chemically to each formula unit of a salt in its crystalline form.
5. The stomach produces too much _____ during indigestion and this causes pain and irritation.
6. _____, are the products formed when bleaching powder reacts with dilute sulphuric acid.
7. The presence of _____ in acids is responsible for their acidic properties.
8. KNO_3 has pH value equal to _____ .
9. Among the given acid HCl, H_2SO_4 and CH_3COOH, _____ is a weak acid.
10. _____ is one of the raw materials for the production of baking soda.

True and False Statements

1. Methyl orange indicator gives yellow colour in basic solution.
2. All the organic acids are strong acids.
3. Litmus (indicator) is obtained from nettle plant.
4. The strength of an acid or base is measured on the basis of scale of numbers known as pH paper.
5. Oxalic acid is present in ant sting.
6. The dilution of a concentrated acid is always done by adding concentrated acid to water slowly slowly with stirring.
7. The sodium chloride aqueous solution is acidic in nature.
8. Glucose solution will conduct electricity.
9. Plaster of Paris can be stored in any type of containers.
10. The more alkaline a solution, the more is the pH.

Match The Followings

In this section, each question has two matching lists. Choices for the correct combination from column-I and Column-II are given as options (a), (b), (c) and (d) out of which one is correct.

1.

Column-I	Column-II
(P) Strong acid	1. H_2SO_4
(Q) Weak acid	2. CH_3COOH
(R) Weak base	3. NaOH
(S) Strong base	4. NH_4OH

a. P-1, Q-2, R-4, S-3 b. P-1, Q-2, R-3, S-4
c. P-4, Q-3, R-2, S-1 d. P-1, Q-3, R-4, S-2

2.

Column-I pH value	Column-II Solution
(P) 6.5 to 6.7	1. Vinegar
(Q) 7.4	2. Milk
(R) 2.4 - 3.4	3. Human blood
(S) 12.4	4. Lime water

a. P-1, Q-1, R-2, S-3 b. P-1, Q-2, R-3, S-4
c. P-2, Q-3, R-1, S-4 d. P-3, Q-4, R-1, S-2

3.

Column-I	Column-II
(P) Water is produced	1. Metal + acid
(Q) H_3O^+	2. Acid + Base
(R) H_2	3. Metal carbonate + acid
(S) Carbon dioxide gas	4. Acid + water

a. P-1, Q-4, R-3, S-2 b. P-2, Q-4, R-1, S-3
c. P-2, Q-1, R-3, S-4 d. P-1, Q-3, R-4, S-2

4.

Column-I	Column-II
(P) $Mg(OH)_2$	1. Plaster of Paris (POP)
(Q) $CaSO_4.1/2H_2O$	2. Gypsum
(R) $CaSO_4.2H_2O$	3. Bleaching Powder
(S) $CaOCl_2$	4. Milk of magnesia

a. P–4, Q–1, R–2, S–3
b. P–4, Q–2, R–3, S–1
c. P–1, Q–4, R–3, S–2
d. P–2, Q–3, R–1, S–4

AEP STUDY CIRCLE
ACCENTS EDUCATIONAL PROMOTERS
Since 2001...
IIT-JEE | NEET | CBSE

5.

Column-I	Column-II
(P) Manufacture of antacid	1. NaOH
(Q) Preservation of food	2. H_2SO_4
(R) Manufacturing of soap	3. $NaHCO_3$
(S) Used in Automobile batteries	4. CH_3COOH

a. P–3, Q–4, R–1, S–2

b. P–2, Q–4, R–1, S–3

c. P–1, Q–4, R–3, S–2

d. P–2, Q–3, R–1, S–4

Answers

Fill in the Blanks

1. blue, red
2. more/greater
3. baking soda
4. Water of crystallisation
5. acid (HCl)
6. $CaSO_4$, Cl_2, H_2O
7. H^+
8. 7
9. CH_3COOH
10. Sodium chloride

True & False

1. True
2. False
3. False
4. True
5. False
6. True
7. False
8. False
9. False
10. True

Match the Following

1. (a) **2.** (c) **3.** (b) **4.** (a) **5.** (a)

NCERT Exercise

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

a. 1 **b 4**

c. 5 **d. 10**

Exp. (d) Litmus paper turns blue because it reacts with basic solution that has (pH more than 7). Thus 10 is the correct answer.

2. A solution reacts with crushed egg-shells to give a gas that turns lime-water milky. The solution contains

a. NaCl **b. HCl**

c. LiCl **d. KCl**

Exp. (b) Answer is HCl.

Egg shells contains calcium carbonate, that react with HCl to release CO_2 gas that turn lime water to milky.

$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2 \uparrow$

3. 10 mL of a solution of NaOH is found to be completely neutralised by 8 mL of a given solution of HCl. If we take 20 mL of the same solution of NaOH, the amount HCl solution (the same solution as before) required to neutralise it will be

a. 4 mL **b. 8 mL**

c. 12 mL **d. 16 mL**

Exp. (d) As 10 ml of NaOH requires 8 mL of HCl, solution to neutralise

20 ml of NaOH require 8 x 2 = 16mL of HCl is required.

Thus, the answer is option (d).

4. Which one of the following types of medicines is used for treating indigestion?

a. Antibiotic **b. Analgesic**

c. Antacid **d. Antiseptic**

Exp. (c) Excess production of acid in the stomach leads to indigestion. Medicines that is used to treat indigestion is known as Antacid.

5. Write word equations and then balanced equations for the reaction taking place when

a. Dilute sulphuric acid reacts with zinc granules.

b. Dilute hydrochloric acid reacts with magnesium

c. Dilute sulphuric acid reacts with aluminium powder.

d. Dilute hydrochloric acid reacts with iron filings.

Exp. (a) dilute sulphuric acid + zinc → Zinc Sulphate + Hydrogen Gas

$H_2SO_4(dil.) + Zn(s) \rightarrow ZnSO_4(aq) + H_2(g)$

b. dilute Hydrochloric acid + Magnesium → Magnesium Chloride + Hydrogen Gas

$2HCl(dil.) + Mg(s) \rightarrow MgCl_2(aq) + H_2(g)$

c. dilute Sulphuric Acid + Aluminium → Aluminium Sulphate + Hydrogen Gas

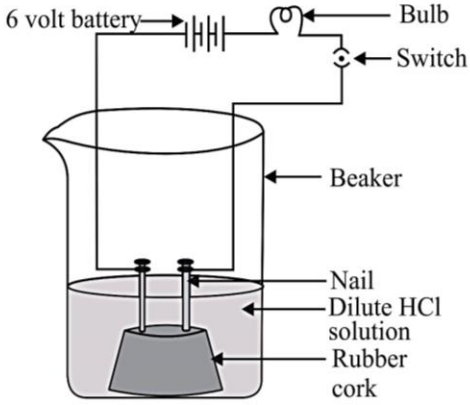
$3H_2SO_4(dil.) + 2Al(s) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$

d. dilute Hydrochloric Acid + Iron → Ferrous Chloride + Hydrogen Gas

$\Rightarrow 6HCl(dil.) + 3Fe(s) \rightarrow 3FeCl_2(aq) + 3H_2(g)$

6. Compounds such as alcohols and glucose also contain hydrogen but are not categorised as acids. Describe an Activity to prove it

Exp. Two nails are inserted on the wooden or rubber cork and placed them on a beaker as shown in figure below. Iron nail is connected to a bulb, then 6 volt battery and a wire is connected to a switch. Some alcohol or glucose is poured to dip the nails in the glucose or alcohol solution. The switch is turned on and we will the see the bulb is not glowing despite being connected to switch. The beaker is emptied then and HCl solution is added. This time bulb glows. This proves that acid can conduct electricity but alcohol and glucose will not conduct electricity.



7. Why does distilled water not conduct electricity, whereas rain water does?

Exp. Distilled water will not contain any ionic compounds in it.

While rainwater contain a lot of more compounds that has ions.

Rainwater will dissolved acidic gas such as CO_2 from the air and CO_2 gas will forms carbonic acid. This means that it has H^+ ions and carbonate ions. Thus, with the presence of acids, rainwater will conduct electricity.

8. Why do acids not show acidic behaviour in the absence of water?

Exp. The acidic nature from acids is due to the presence of H^+ ions. Hydrogen ions is produced in the presence of water and thus water is needed, if acids wanted to show their acidic behaviour.

9. Five solutions A, B, C, D and E when tested with universal indicator showed pH as 4, 1, 11, 7 and 9, respectively. Which solution is

a. Neutral?

b. Strongly alkaline?

c. Strongly acidic?

d. Weakly acidic?

e. Weakly alkaline?

Exp. In increasing order of hydrogen ion concentration:

pH 11(C) < pH 9(E) < pH 7(D) < pH 4 (A) < pH 1 (B)

a. pH-7 – Neutral (D)

b. pH-11 – Strongly alkaline (C)

c. pH-1 – Strongly acidic (B)

d. pH-4 – Weakly acidic (A)

e. pH-9 – weakly alkaline (E)

10. Equal lengths of magnesium ribbons are taken in test tubes A and B. Hydrochloric acid (HCl) is added to test tube A, while acetic acid (CH_3COOH) is added to test tube B. Amount and concentration taken for both the acids are same. In which test tube will the fizzing occur more vigorously and why?

Exp. HCl is a strong acid while acetic is a weaker acid. The reaction of the acid on the magnesium ribbon will result in formation of H_2. Since HCl is a very strong acid there is a lot of evolution of H_2 gas from test tube A which result in fizzing thus, more fizzing take place in test tube A.

11. Fresh milk has a pH of 6. How do you think the pH will change as it turns into curd? Explain your answer.

Exp. Fresh milk will change into curd due to formation of lactic acid. Lactic acid will reduces the pH of the milk.

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

a. Why does he shift the pH of the fresh milk from 6 to slightly alkaline?

b. Why does this milk take a long time to set as curd?

Exp. (a) Milk man will shift the pH of the fresh milk from 6 to slightly alkaline to avoid milk from getting sour due to formation of lactic acid.

(b) This milk will take long time to set into curd because the lactic acid produced here will first neutralises the pH then the pH is reduced to turn milk into curd.

13. Plaster of Paris should be stored in a moisture-proof container. Explain why?

Exp. Plaster of Paris should be stored in moisture-proof container because moisture will affect plaster of Paris by slowing down the setting rate of the plaster due to hydration which will turn plaster useless.

14. What is a neutralisation reaction? Give two examples.

Exp. The reaction of the acid + base gives salt + water, which is known as neutralization reaction.

Examples:

$NaOH + HCl \rightarrow NaCl + H_2O$

$Mg(OH)_2 + H_2CO_3 \rightarrow MgCO_3 + 2H_2O$

15. Give two important uses of washing soda and baking soda.

Exp. Washing soda

1. It is used as an electrolyte
2. It be is used domestically as water softener for laundry purpose.

Baking soda

1. It is used to test the garden soil for acidity. If bubbles are produced then the soil is too acidic
2. It is used on washing car as it will remove dead bug bodies without damaging the colour or the paint on the car.

Subjective Questions

Very Short Answer Type Questions

1. If the pH of a vegetable soup is 6.5. How is the taste of the soup likely to be?
2. What is the colour of phenolphthalein in milk of magnesia?
3. Which acid is present in honey bee sting and hair of nettle leaves?
4. Name two flowers whose colour or petals can be used as indicator.
5. What effect does an increase in concentration of H^+(aq.) in a solution have on the pH of solution?
6. When bitter gourd extract is added to red litmus solution. What will happen? Is it acidic or basic?
7. Name the planet that contains yellowish clouds of sulphuric acid?
8. Why few drops of H_2SO_4 is added to water before electrolysis?
9. A bud of petunia became reddish purple after first shower of rain. What does it indicate?
10. When hydrochloric acid reacts with an active metal? a gas is liberated. How will you test for the gas?
11. Name the gas that is evolved when sodium hydrogencarbonate reacts with dilute hydrochloric acid?
12. Name an acid-base indicator prepared at home.
13. What effect will the concentration of H^+(aq) will have on the acidic nature of the solution?
14. Dry ammonia gas has no action on litmus paper, but a solution of ammonia in water turns red litmus paper blue. Why is it so?
15. Name a salt that does not contain water of crystallisation.

Short Answer Type Questions

1. Name the acid present in the following:
   (a) Tomato (b) Tamarind
2. A white coloured powder which is used by doctors for supporting fractured bones.
   (a) Write chemical name and formula of the powder.
   (b) When this white powder is mixed with water a hard solid mass is formed. Write balanced chemical equation for the following change.
3. Explain how antacid works.
4. 20 mL of water and 15 mL of sulphuric acid are to be mixed in a beaker
   (a) State the method that should be followed with reason.
   (b) What is this process known as?
5. A student dropped few pieces of marble in A dilute hydrochloric acid contained in a test tube. The evolved gas was passed through lime water.
   (a) What change would be observed in lime water?
   (b) Write balanced chemical equation for the change.
6. Explain the preparation of washing soda from baking soda. Write balanced chemical equation of the reaction involved.
7. "Sodium hydrogencarbonate is a basic salt". Justify the statement. The common name of above compound.
8. Name the natural occurence of each of the given acid
   (a) Citric acid (b) Oxalic acid.
   (c) Lactic acid (d) Tartaric acid.
9. What is the colour of $FeSO_4.7H_2O$ crystals? Will there is any colour change upon heating the $FeSO_4.7H_2O$ crystal? Give balanced chemical equation for the changes.
10. Give reaction involved in baking soda preparation. Write one of baking soda uses.

Long Answer Type Questions

1. (a) A metal compound 'A' reacts with dil. sulphuric acid to produce effervescence, The gas evolved extinguishes a burning candle. If one of the compound formed in the above reaction is calcium sulphate, then name the compound 'A' and the gas evolved? Also, write a balanced chemical equation for the reaction that occurred.
   (b) (i) How does antacid help to relieve indigestion in stomach? Name one antacid.
   (ii) A farmer treats the soil with $CaCO_3$. What is the nature of soil? Why does the farmer treat the soil with $CaCO_3$?

2. State reason for the following statements:
   (a) Tap water conducts electricity whereas distilled water does not.
   (b) Dry hydrogen chloride gas does not turn blue litmus red whereas dilute hydrochloric acid does.
   (c) During summer season, a milk man usually adds a very small amount of baking soda to fresh milk.
   (d) For a dilution of acid, acid is added into water and not water into acid.
   (e) Ammonia is a base but does not contain hydroxyl group.
3. (a) Define indicator. Name two indicators obtained from plants.
   (b) Write a balanced chemical equation for the reaction taking place when sodium oxide reacts with water. How will this solution behave towards phenolphthalein and red litmus paper?
   (c) State what happens when sodium hydroxide solution reacts with hydrochloric acid.
4. (i) Crystals of a substance changed their colour when heating take place in a closed test tube but regained it after sometime when they were allowed to cool down. Name the substance and write its formula and explain the phenomenon that is involved.
   (ii) Name the compound whose one formula unit is asvsociated with 10 water molecules. How is it prepared? Give equations of related reactions. Give two uses of the compound.
5. Explain the reaction of dilute HCl on the following substance with the help of chemical equation:
   (a) Magnesium ribbon
   (b) Sodium hydroxide
   (c) Crushed egg shells

Integer Type Questions

1. The basicity of phosphorous acid is
2. Molecules of water that is present in gypsum is
3. Among the given acids, strong acids are H_2SO_4, H_2CrO_4, HCN, HCl, Phenol, HNO_3.
4. pH of H_2O is
5. What is the pOH of a solution whose pH is 12?

Multiple Choice Questions

Level-I

1. Which of the following compound is not a base?
a. $Al(OH)_3$ b. NaOH
c. KOH d. NaCl

2. Plaster of Paris is formed
a. When water is added to calcium sulphate
b. When sulphuric acid is added to calcium hydroxide
c. When gypsum is heated to a very 100 temperature
d. When gypsum is heated to 100° C.

3. Which gas is released when acids react with metal carbonates?
a. CO_2 b. H_2
c. NO_2 d. O_2

4. The acid that is used in flavoured drinks is:
a. Boric acid b. Carbonic acid
c. Oxalic acid d. Acetic acid

5. Arrhenius acid gives
a. H^+ in water b. OH^- in water
c. Both of the above d. None of these

6. Aqueous solution of copper sulphate reacts with aqueous ammonium hydroxide solution to produce
a. Black ppt. b. Pale blue ppt.
c. Green ppt. d. White ppt.

7. Bleaching powder is soluble in cold water giving a milky solution because of
a. Available Cl_2
b. Lime present in it
c. Formation of calcium carbonate
d. The absorption of CO_2 from atmosphere

8. The bleaching powder is prepared by passing chlorine gas into
a. Slaked lime
b. Quick lime
c. Lime
d. Plaster of paris at 120° C

9. Which one is not used as raw material in the preparation of baking soda?
a. NH_3 b. NaCl
c. CO_2 d. NaOH

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

11. _____ is called impure sodium chloride.
a. Gypsum salt b. Rock salt
c. Blue vitrol salt d. Carbonate salt

12. Which of following compound is alkaline in aqueous medium?
a. Na_2CO_3 b. KCl
c. H_2CO_3 d. $CuSO_4$

13. Which of the following compounds is neutral to litmus?
a. $NaNO_3$ b. $CuSO_4.5H_2O$
c. $Mg(OH)_2$ d. $NaHCO_3$

14. In $CuSO_4.5H_2O$, no. of H_2O molecules that are bounded by "H" bond
a. 4 b. 1
c. 2 d. 3

15. Which of the following is considered as a strong acid?
a. Acetic acid b. Maleic acid
c. Nitric acid d. Tartaric acid

16. Which of the following is considered as a strong base?
a. Ammonium hydroxide (NH_4OH)
b. Sodium hydroxide (NaOH)
c. Water (H_2O)
d. Nitric acid (HNO_3)

17. The metal oxides that will show both acidic and basic characters?
a. K_2O b. Na_2O
c. CuO d. Al_2O_3

18. The pH of a solution that will turn red litmus to blue-
a. 1 b. 9
c. 3 d. 7

19. The acidic soil that is not good for health of growing plants, is neutralized by
a. Magnesium hydroxide ($Mg(OH)_2$)
b. Calcium oxide (CaO)
c. Sodium chloride (NaCl)
d. Ammonium hydroxide (NH_4OH)

20. Select the element that react with acid as well as base

a. Sulphur b. Copper

c. Magnesium d. Aluminium

21. The reaction of vinegar with baking soda will release which gas

a. Hydrogen b. Nitrogen

c. Carbon dioxide d. Nitrogen dioxide

22. What is product formed when zinc metals granules reacts with sodium hydroxide?

a. Sodium zincate and carbon dioxide

b. Sodium zincate and hydrogen gas

c. Zinc hydroxide and sodium

d. Sodium zinc-oxide and hydrogen gas

23. The correct statements about an aqueous solution of an acid and of a base from the following are:

(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

a. (i) and (iii) b. (i) and (iv)

c. (ii) and (iii) d. (ii) and (iv)

24. When lime water reacts with chlorine to give:

a. Bleaching powder

b. Baking soda

c. Baking powder

d. Washing powder

25. $NaHCO_3$ is formed by which of the following reaction:

a. $NaOH + H_2CO_3$ b. $NaCl + Na_2CO_3$

c. $Na_2CO_3 + H_2O$ d. $NaCl + H_2CO_3$

26. Ag_2S reacts with H_2SO_4 to form which products?

a. $AgSO_4 + H_2O$ b. $Ag_2SO_4 + H_2S$

c. $Ag_2O + SO_2$ d. $AgOH + H_2S$

27. Which one of the following can be used as an acid-base indicator by a blind student?

a. Turmeric b. Litmus

c. Vanilla essence d. Methyl orange

28. NaOH is obtained by the electrolysis of

a. Aq. solution of NaCl

b. Aq. $Na_2CO_3 + CaCl_2$(aq)

c. Aq. $NaHCO_3$

d. Molten NaCl

29. When copper oxide and dilute hydrochloric acid react, the colour changes to which of the following colour?

a. Black b. Bluish-green

c. White d. Yellow

30. When HCl gas is prepared on a humid day, the gas is generally passed through the guard tube containing $CaCl_2$. The role of $CaCl_2$ taken in the guard tube is to

a. Absorb Cl^- ions from the evolved gas

b. Absorb the gas

c. Absorb moisture from the gas

d. Absorb the evolved gas

Level-II

1. 'Z' is a substance that is water soluble and its aqueous solution turns red litmus to blue and release H_2 gas on reaction with zinc metal. It is prepared by electrolysis of NaCl(aq). What is Z?

a. $NaNO_3$ b. $NaClO_3$

c. NaOH d. NH_4OH

2. If the $[OH^-] = 3 \times 10^{-14}$ M, then the resulting solution is

a. Acidic

b. Basic

c. Neutral

d. Both (a) and (b)

3. An unknown solution in a test tube was given to a student, when universal indicator solution is added to test tube, it turned out violet. The unknown solution is:

a. Vinegar solution

b. Iodine solution

c. Caustic Soda solution

d. Baking soda solution

4. Name the gas that is evolved on reaction of dilute hydrochloric acid with sodium sulphite?

a. Sulphur trioxide b. Hydrogen Sulphide

c. Sulphur dioxide d. Carbon dioxide

5. $A + H_2O \rightarrow B$, B is used to remove grease stains from woolen clothes, Identify A and B respectively are

a. NH_3, NH_4Cl b. NH_3, NH_4OH

c. NH_4OH, NH_3 d. Cl_2, HCl

6. In cold countries, which of the following compound is usually spread on icy roads for melting ice?
   a. Sodium bicarbonate
   b. Rock salt
   c. Sodium carbonate
   d. Magnesium hydroxide

7. The pH of three solutions X, Y, Z is 6, 4, 8 respectively which of the correct option from the following?
   a. X > Y > Z decreasing acidic strength
   b. Z > Y > X increasing acidic strength
   c. Y > X > Z is decreasing acidic strength
   d. Z > Y > X decreasing acidic strength

8. $CuSO_4.K_2SO_4$ is an example
   a. An acid salt
   b. A mixed salt
   c. Basic salt
   d. Double salt

9. Choose the correct oxide from following oxides which when dissolved in water gives a solution that will turns blue litmus to red?
   a. MgO
   b. CaO
   c. CO_2
   d. Na_2O

10. The acid that is used by goldsmiths for cleaning gold and silver ornaments is:
   a. CH_3COOH
   b. H_3PO_4
   c. HNO_3
   d. H_2SO_4

11. Which is not correct pair of conjugate acid and base from the following?
   a. HNO_3 and NO_3^-
   b. NH_4^+ and NH_3
   c. H_3PO_2 and $H_2PO_2^-$
   d. H_2SO_4 and SO_4^{2-}

12. A man is using excess quantities of chemical fertilizers in fields for a number of years. The crop productivity gradually began to decrease inspite of using chemical fertilizers.

   Which of the following are correct statements?
   1. The soil has become more acidic in nature
   2. The soil has become more alkaline in nature
   3. The productivity of crop is enhanced by adding slaked lime to the soil.
   4. The productivity of crop is enhanced by adding some organic matter.
   5. The productivity of crop can be enhanced by adding NaCl.

   a. 1 and 5
   b. 1 and 3
   c. 2 and 5
   d. 2 and 4

13. pH of a 0.001 M NaOH solution is
   a. 2
   b. 10
   c. 3
   d. 11

14. The turmeric solution will turn red by an aqueous solution of-
   a. Potassium acetate
   b. Copper nitrate
   c. Ferric chloride
   d. Sodium sulphate

15. When HCl (g) is passed through water
   a. It gives both H^+ ions and OH^- in the solution
   b. It ionises in solution
   c. It does not ionise in solution
   d. None of the above

Assertion & Reason Type Questions

Direction: In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice.

a. Both A and R are individually true and R is the correct explanation of A:

b. Both A and R are individually true but R is not the correct explanation of A.

c. A is true but R is false

d. A is false but R is true

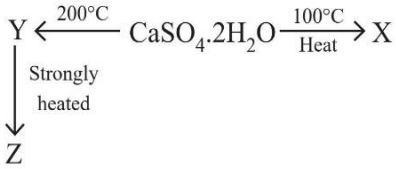
1. **Assertion:** Acetic acid will not acts as an acid in benzene solution.
   Reason: Benzene will not accept proton.
2. **Assertion:** Ammonia is a base.
   Reason: It does not contain OH^- ions.
3. **Assertion:** Most of factories wastes are considered acidic in nature.
   Reason: Usually bases are added to all factory wastes before discharging into the water bodies
4. **Assertion:** Methanoic acid is present in Ant's sting.
   Reason: The body part where ant bite is treated with dry baking soda.
5. **Assertion:** Concentrated H_2SO_4 can be diluted by adding water dropwise to acid.
   Reason: Concentrated H_2SO_4 has a more affinity for water.

Case-Based Type Questions

Case-Based-I: A solid compound A on heating gives carbon dioxide gas and a solid residue. The residue when mixed with water forms B. On passing excess of CO_2 through B in water a clear solution C is obtained.

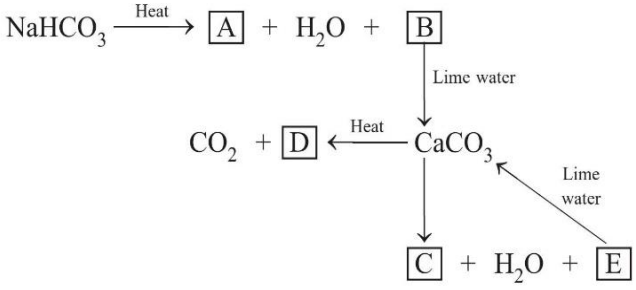
1. Identify the compound A.
   a. $CaCO_3$ b. Na_2CO_3
   c. CaO d. $Ca(OH)_2$
2. Identify the compound B.
   a. CO_2 b. $CaCO_3$
   c. $Ca(OH)_2$ d. $CaCl_2$
3. Write the formula of the compound C.
   a. $Ca(HCO_3)_2$ b. $Ca(OH)_2$
   c. CaO d. $CaCO_3$

Case-Based-II:



1. Name the compound X:
   a. Plaster of paris b. Calcium hydroxide
   c. Slaked lime d. Dead burnt plaster
2. Name the compound Y:
   a. Dead burnt plaster b. Limestone
   c. Lime water d. Plaster of Paris
3. Name the compound Z:
   a. Calcium hydroxide
   b. Lime
   c. Dead burnt plaster.
   d. Plaster of Paris

Case-Based-III: The given questions are based on the following flow chart.



Answer the following questions:

1. The product B is
   a. Quick lime b. Carbon dioxide
   c. Sodium carbonate d. Slaked lime
2. When dihydrated salt of 'C' is heated, the product formed is
   a. Washing soda b. Plaster of Paris
   c. Bleaching powder d. Calcium carbonate
3. Which among the following exists as decahydrate?
   a. D b. B
   c. A d. C
4. Which among the following compounds can be used to prepare bleaching powder?
   a. C b. D
   c. B d. E
5. Which among the following is used for preparing baking powder?
   a. $NaHCO_3$ b. $CaCO_3$
   c. A d. None of these

Case-Based-IV: A compound P of sodium forms a white power and it is constituent of baking powder and is used in some medicine that is used to treat acidity known as antacids. When heated it gives a compound Q that is anhydrous in nature and become hydrated salt, when water is absorbed. This salt when kept open in air, loses water molecule in a process known efflorescence. When dissolved in water it forms a gives base and a weak acid R.

1. What is formula of Q?
   a. $NaHCO_3$ b. Na_2CO_3
   c. NaOH d. $Na_2CO_3.10H_2O$
2. What happens when sodium carbonate decahydrate is exposed to air?
   a. It loses two molecule of water.
   b. It will dissociates to give carbon dioxide.
   c. It loses nine molecule of water.
   d. It loses ten molecule of water.
3. What is the nature of the solution formed by dissolving Q in water?
   a. Alkaline b. It remains insoluble
   c. Neutral d. Acidic
4. Identify R.
   a. CO_2 b. H_2CO_3
   c. NaOH d. NaCl

Multi Correct MCQ's

1. Sodium hydroxide is:
   a. Basic b. Deliquescent
   c. Alkali d. Neutral
2. Which of the following are the INCORRECT increasing order of acid strength?
   a. Water < CH_3COOH < Hydrochloric acid
   b. Water < Hydrochloric acid < CH_3COOH
   c. Hydrochloric acid < Water < CH_3COOH
   d. CH_3COOH > Water < Hydrochloric acid

3. Which of the acid from the following does NOT produces H^+ ions in absence of water?
   a. Hydrochloric acid b. Muriatic acid
   c. Nitric acid d. None of these
4. Which of the following phenomena occur, when a small amount of acid is added to water?
   a. Dilution b. Neutralisation
   c. Ionisation d. Precipitation
5. Neutralization reaction among the following is
   a. $Na_2O + CO_2 \longrightarrow Na_2CO_3$
   b. $NH_3 + H^+ \longrightarrow NH_4^+$
   c. $HCl + NH_3 \longrightarrow NH_4^+ + Cl^-$
   d. None of the above

Olympiad & NTSE Type Questions

1. Which of the following represents the correct order of the acidic strength for equimolar aqueous solutions of HCl, H_2SO_4, NH_4OH and NaOH **[NTSE 2014]**
   a. $HCl < NH_4OH < NaOH < H_2SO_4$
   b. $NH_4OH < NaOH < H_2SO_4 < HCl$
   c. $HCl < H_2SO_4 < NH_4OH < NaOH$
   d. $NaOH < NH_4OH < HCl < H_2SO_4$
2. The lowest pH that is associated with which of the following?
   a. 0.001 M HCl b. 0.001 M HNO_3
   c. 0.05 M H_2SO_4 d. 0.01 M NaOH
3. Which of the following aqueous solution of salts will turns the red litmus to blue?
   a. $Na_2CO_3.10H_2O$ b. $NaHCO_3$
   c. Na_2CO_3 d. All
4. Soda-acid fire extinguishers extinguishes prevent from fire
   a. By cutting the supply of air.
   b. By removing the combustible substance
   c. By increasing the ignition temperature
   d. All the above
5. When pH paper is put in distilled water its colour changes to green. Then some common salt is added to water and pH paper is tested in this solution. Now the change colour of pH paper in this case is:
   a. Green b. Pink
   c. Red d. Blue
6. $KMnO_4$ is a strong oxidizing agent in acidic medium. To provide acidic medium H_2SO_4 is used in place of HCl because:
   a. H_2SO_4 is more stronger acid than HCl
   b. Only H_2SO_4 is not completely ionized
   c. HCl is oxidized by $KMnO_4$ to Cl_2
   d. H_2SO_4 is a dibasic acid
7. Arrange the following substances in decreasing order of their pH values. The correct order from option.
   1. Lemon 2. Tooth paste
   3. Saliva (after dinner) 4. Coffee
   5. Blood
   a. 2 3 5 1 4 b. 2 5 3 4 1
   c. 2 1 3 5 4 d. 2 4 5 3 1
8. Choose the correct statement(s)
   (P) Most of the acids are water soluble
   (Q) Acids react with metallic oxides and hydroxides form metallic salt and water only.
   (R) Acids react with metallic carbonates to form metallic salt and hydrogen gas and water
   (S) Sodium benzoate is used as a food preservative
   a. (P) & (Q) only b. (R) & (S)
   c. (P), (Q) & (S) d. all of the above
9. Following statements are given:
   X. Water acts as an acid or as a base that depends on the other species that is/are present.
   Y. Every liquid is either an acid or a base.
   Which of these statement(s) is/are correct?
   a. (X) only b. (Y) only
   c. Both (X) and (Y) d. Neither (X) nor (Y)
10. Calamine is used to reduce the pain of ant bite as it reacts with (A) released due to the bite of ants with (B) present in calamine. Then (A) and (B) respectively are:
    a. Sodium hydrogen carbonate and methanoic acid
    b. Formic acid and zinc carbonate
    c. Hydrochloric acid and zinc oxide
    d. Acetic acid and common salt
11. When a little sulphur in a spoon is heated, it burns with a blue flame that slowly begin to disappears after some time and we can smell a pungent odour. This pungent odour is due to
    a. carbon dioxide b. sulphur dioxide
    c. sulphur gas d. sulphuric trioxide

Explanations

Subjective Questions

Very Short Answer Type Questions

1. The taste of the vegetable soup likely to be slightly sour because it is weakly acidic.
2. The colour of phenolphthalein in milk of magnesia is pink.
3. Formic acid is present in honey bee sting and hair of nettle leaves.
4. Hydrangea, Petunia are the flowers whose colour or petal can be used as indicator.
5. If a solution has higher the concentration of H^+, then lower will be pH value of the solution.
6. Bitter gourd extract change red litmus blue. It is basic in nature.
7. Venus.
8. Water is poor conductor of electricity so few drops of H_2SO_4 will make water conducting in nature.
9. The rain was acid-rain which changes colour of petunia bud.
10. H_2 gas is produced in this reaction. On bringing a burning matchstick near the gas, it burns with poping sound which shows that it is hydrogen gas.
11. Carbon dioxide gas is released when $NaHCO_3$ react with dil HCl.
12. Beetroot extract is acid base indicator used at home.
13. Acidic nature will increases with increase in conc. of H_3O^+ or H^+ ion.
14. Ammonia dissolves in water to forms ammonium hydroxide (NH_4OH) which is base and it turns red litmus into blue.

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

    Dry NH_3 gas will not change into OH^- ions and can not turns red litmus to blue.
15. Salts like barium sulphate $BaSO_4$ will not contain water of crystallisation.

Short Answer Type Questions

1. (a) Oxalic acid is present in tomato

   (b) Tartaric acid is present int tamorind
2. (a) Calcium sulphate hemihydrate

   $CaSO_4 \cdot \frac{1}{2}H_2O$ is used by doctor supporting bone factured.

   (b) $CaSO_4 \cdot \frac{1}{2}H_2O + \frac{3}{2}H_2O \longrightarrow \underset{\text{hard mass}}{CaSO_4 \cdot 2H_2O}$
3. Hyperacidity is caused by excess of HCl in stomach. Antacid which is basic in nature. It neutralizes the effect of excess of acid in stomach and gives relief from pain caused by hyperacidity.
4. (a) The acid is to be added slowly in water to avoid the mixture to be splashed out. The reaction is highly exothermic in nature therefore, constant cooling should be done.

   (b) The process is known as dilution.
5. (a) Lime water will turn milky due to formation of calcium carbonate ($CaCO_3$).

   (b) $\underset{\text{Lime water}}{Ca(OH)_2}\ (aq) + CO_2\ (g) \rightarrow CaCO_3\ (s) + H_2O(l)$
6. Sodium hydrogencarbonate (baking soda) on heating gives sodium carbonate Na_2CO_3 that on recrystallisation gives washing soda

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

   $Na_2CO_3 + 10H_2O \longrightarrow Na_2CO_3 \cdot 10H_2O$
7. Sodium hydrogencarbonate is a salt of sodium hydroxide (strong base) NaOH and carbonic acid H_2CO_3 (weak acid).

   Thus it is basic salt. Common name is baking soda.
8. (a) Lemon and orange (b) Tomatoes and Guava.

   (c) Sour milk (curd) (d) Tamarind.
9. Pale green is the colour of $FeSO_4.7H_2O$ crystals. Yes, colour will change. It becomes dirty white on heating.

   $\underset{\text{Pale green}}{FeSO_4 \cdot 7H_2O} \xrightarrow{\text{heat}} \underset{\text{Dirty white}}{FeSO_4} + 7H_2O$
10. Preparation

    $NH_3 + CO_2 + H_2O + NaCl \rightarrow \underset{\text{Baking soda}}{NaHCO_3} + NH_4Cl$

    Uses:

    It is used as an antacid in medicine to remove acidity.

Long Answer Type Questions

1. (a) 'A' is $CaCO_3$ (calcium carbonate). The gas liberated is CO_2 as it extinguise a burning candle.

$$\underset{A}{CaCO_3} + H_2SO_4(dil.) \longrightarrow \underset{\text{Calcium sulphate}}{CaSO_4} + H_2O + CO_2 \uparrow$$

(b) (i) Antacid neutralizes, excess of acid produced in the stomach. $NaHCO_3$ is antacid.

(ii) The soil has acidic nature. The farmer wants to make the soil neutral by adding $CaCO_3$ that has basic nature which is good for crops.

2. (a) Tap water contains ions due to which electricity is conducted, distilled water does not contain any ions to conduct electricity.

(b) Dry HCl gas will not form ions but dil HCl gives H^+ and Cl^-.

(c) Baking soda solution will not allow milk to change into lactic acid that makes milk taste sour.

(d) Adding water to acid is highly exothermic in nature that will causes burn if splashed out. Thus water is added very slowly to acid with cooling.

(e) Ammonia dissolves in water to give NH_4OH and forms OH^-. Thus, it is basic in nature.

3. (a) Indicator is a substance which give different colour or odour in acid and base medium e.g., litmus and turmeric are indicators obtained from plants.

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

Solution will turn phenolphthalein pink and red litmus paper blue.

(c) Sodium chloride and water are formed:

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

4. (i) $CuSO_4.5H_2O$ is a blue crystalline solid which becomes dirty white on heating because of loss of water molecules and it will become amorphous.

$$\underset{\substack{\text{Copper sulphate}\\ \text{pentahydrate}\\ \text{(Blue)}}}{CuSO_4 \cdot 5H_2O} \xrightarrow{\text{heat}} \underset{\substack{\text{Anhydrous}\\ \text{copper sulphate}\\ \text{(Dirty white)}}}{CuSO_4} + 5H_2O$$

$CuSO_4$ acquires its colour by absorbing water from atmosphere and becomes blue again in colour.

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

(ii) $Na_2CO_3.10H_2O$ is compound having $10H_2O$ molecule. It is called sodium carbonate decahydrate or washing soda. It is prepared by passing CO_2 gas through saturated solution of ammonical brine.

$$\underset{\text{Ammonia}}{NH_3} + H_2O + CO_2 + NaCl \longrightarrow \underset{\substack{\text{Sodium}\\ \text{bicarbonate}}}{NaHCO_3} + \underset{\substack{\text{Ammonium}\\ \text{chloride}}}{NH_4Cl}$$

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

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

Uses:

(1) It is used in glass manufacturing.

(2) It is used in washing powder production.

5. (a) $Mg(s) + 2HCl(dil) \longrightarrow MgCl_2(aq) + H_2(g)$

Hydrogen gas will be released in this reaction

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

Sodium chloride and water will be formed

(c) $CaCO_3(s) + 2HCl(dil) \longrightarrow CaCl_2(s) + H_2O(aq) + CO_2(g)$

Crushed egg shell contain $CaCO_3$ which reacts with dil HCl to produce brisk effervescence due to CO_2 and eggshells become soft.

Integer Type Questions

1. The basicity of H_3PO_3 is 2

$H_3PO_3 \rightarrow 2H^+ + HPO_3^{2-}$

2. There are 2 water molecule present in gypsum.

Gypsum is $CaSO_4.2H_2O$

3. H_2SO_4, H_2CrO_4, HCl and HNO_3 are strong acids.

4. pH of H_2O is 7 because it is neutral.

5. pH = 12

Thus, pOH = 14 – 12 = 2

Multiple Choice Questions

Level-I

1. **(d)** NaCl is a neutral salt.

2. **(d)** Gypsum on heating upto 100°C gives plaster of paris.

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

3. **(a)** Metal carbonates on reaction with acids give CO_2.

$CaCO_3(s) + 2HCl(dil) \rightarrow CaCl_2(s) + H_2O(l) + CO_2(g)$

4. **(b)** Carbonic acid (H_2CO_3) is present in aerated and flavoured drinks.
5. **(a)** Arrhenius acid gives H^+ in the water .
   $HCl + H_2O \rightarrow H_3O^+ + Cl^-$.
6. **(b)** Blue ppt. is obtained in the below reaction
   $CuSO_4 + 2NH_4OH \longrightarrow \underset{\text{blue ppt}}{Cu(OH)_2} + (NH_4)_2SO_4$
7. **(b)** Bleaching powder contains lime, that will give a milky solution upon dissolution in water.
   $CaOCl_2 + H_2O \rightarrow Ca(OH)_2 + Cl_2$
8. **(a)** Bleaching powder is prepared by treating slaked lime with chlorine gas.
   $Ca(OH)_2 + Cl_2 \rightarrow Ca(OCl_2) + H_2O$
9. **(d)** NaOH is not a raw material for the preparation of baking soda the other three are raw material for baking soda preparation.
10. **(d)** All the above are correct
11. **(b)** Rock salt or halite is a mineral form of sodium chloride usually it is colourless or white in colour.
12. **(a)** Na_2CO_3 is formed from NaOH and H_2CO_3 i.e., strong base and weak acid.
13. **(a)** $NaNO_3$ as it is a salt of strong acid and strong base. So it considered as neutral salt and has no effect on litmus. $Ca(OH)_2$ is a base $CuSO_4.5H_2O$ is a salt of weak base and strong acid while $NaHCO_3$ is a salt of strong base and weak acid so the other three will effects litmus.
14. **(b)** In $CuSO_4.5H_2O$, one H_2O molecules is attached by 4 "H" bond.
15. **(c)** Nitric acid (HNO_3) is a mineral acid. It is corrosive in nature and strong acid.
16. **(b)** Sodium hydroxide (NaOH) is a strong base while ammonium hydroxide (NH_4OH) is a weak base. Water is neutral in nature, HNO_3 is acidic.
17. **(d)** Al_2O_3 is an amphoteric oxide other are basic. Thus (d) is correct option.
18. **(b)** A basic solution will turns Red litmus to blue. Thus the correct option is (b).
19. **(b)** Acidic soil is harmful for the plants as the healthy plants cannot grow in it. Thus the acidic soil is neutralized by adding a base like, calcium oxide (CaO).
20. **(d)** Aluminium is the element that react with acid as well as base it is amphoteric in nature.
21. **(c)** Vinegar is acetic acid and baking soda is sodium hydrogen carbonate $NaHCO_3$. When an acid reacts with a metal carbonate, they produces CO_2 gas.
    $CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + H_2O + CO_2$
22. **(b)** Sodium zincate and H_2 are formed in reaction
    $Zn + 2NaOH \rightarrow Na_2ZnO_2$ (Sodium Zincate) $+ H_2$
23. **(d)** Stronger the acid, lesser is the pH. Stronger the base, higher is the pH.
24. **(a)** $\underset{\text{Slaked lime}}{Ca(OH)_2} + \underset{\text{Chlorine}}{Cl_2} \longrightarrow \underset{\text{Bleaching power}}{CaOCl_2} + H_2O$
25. **(a)** $NaOH + H_2CO_3 \rightarrow \underset{\substack{\text{Baking}\\\text{powder}}}{NaHCO_3} + H_2O$
26. **(b)** $Ag_2S + H_2SO_4 \rightarrow Ag_2SO_4 + H_2S\uparrow$
27. **(c)** Vanilla essence is used as indicator due to its smells that will help blind students to realize in pH change.
28. **(a)** Sodium hydroxide is produced by electrolysis.
    $2NaCl + 2H_2O \rightarrow 2NaOH + H_2 + Cl_2$
29. **(b)** Blue-green colour of solution is due to the formation of copper (II) chloride.
    $2HCl + CuO \rightarrow \underset{\text{blue green}}{CuCl_2} + H_2O$
30. **(c)** $CaCl_2$ from guard tube will absorb water for HCl gas on humid day.

Level-II

1. **(c)** On electrolysis of NaCl (aq) NaOH is produced.
   $\underset{Z}{2NaOH} + Zn \longrightarrow \underset{\substack{\text{Sodium}\\\text{zincate}}}{Na_2ZnO_2} + H_2$
2. **(a)** $pOH = -\log(3 \times 10^{-14}) = 13.523$
   $\therefore$ $pH = 14 - 13.526 = 0.477$
   As pH is low so it is acidic solution.
3. **(c)** The violet color change shows unknown solution is highly alkaline in nature.
4. **(c)** Acids react with sulphites and bisulphites produces to give sulphur dioxide gas.
   $\underset{\text{Sodium sulphite}}{Na_2SO_3(aq)} + \underset{\text{hydrochloric acid}}{2HCl(aq)} \longrightarrow \underset{\text{Sodium chloride}}{2NaCl(aq)} + \underset{\text{water}}{H_2O(l)} + \underset{\text{sulphur dioxide}}{SO_2(g)\uparrow}$
5. **(b)** NH_3 and NH_4OH
   $NH_3 + H_2O \longrightarrow NH_4OH$
   NH_4OH remove stains from woolen clothes.
6. **(b)** Rock salt (NaCl) is usually spread on the roads to prevent the water from freezing at 0°C.
7. **(c)** pH is inversely proportional to the acidic strength. As acidic strength increases pH decreases thus the correct order as Y > X > Z. Hence option (c) is correct.
8. **(d)** Double salt is a combination of two normal salts. $CuSO_4$ & K_2SO_4 are two normal salt.

9. **(c)** MgO, CaO and Na_2O all are examples of metal oxide. Metal oxides are basic in nature. CO_2 is a non-metal oxide and it is acidic in nature. So, CO_2 aqueous solution turns blue litmus to red.
10. **(c)** Nitric acid (HNO_3) is used for cleaning silver and gold ornaments as acid will not react with them as these metals are chemically inert.
11. **(d)** The conjugate base of H_2SO_4 is HSO_4^-.
12. **(b)** Use of excessive chemical fertilizers will leads to soil acidification which means soil pH is lower. Thus the pH of the acidic soil is increased by adding slaked lime as it is basic in nature.
13. **(d)** $[OH^-] = 0.001\ M = 10^{-3}\ M$

    $pOH = -\log[OH^-] = 3$

    $pH + pOH = 14$

    $pH = 14 - 3 = 11$
14. **(a)** Turmeric solution (liquid) + CH_3COOK (Potassium acetate) gives red solution
15. **(b)** It will give H^+ ions that combine with water to produce H_3O^+ ions and Cl^- ions

Assertion & Reason Type Questions

1. **(a)** A substance will acts as an acid only when another substance that is present will act as a base means it will accepts a proton. Acetic acid cannot act as an acid in benzene as benzene is not accepting a proton.
2. **(b)** Ammonia (NH_3) is a considered as base but it does not contain hydroxide OH^- ions. It is a base because it can donate a lone pair of electron (according to Lewis concept). But in aqueous solution, it will acts as base, accept H^+ from water to form NH_4^+ and OH^-
3. **(a)** As factory wastes are considered acidic in nature as direct discharge into water bodies will leads into damage of aquatic life. Thus before discharging of acidic waste it is neutralised with addition of bases.
4. **(c)** The body part where ant bite is treated with moist baking soda.
5. **(d)** Concentrated H_2SO_4 can be diluted by adding acid dropwise to water. This will minimise effect of the heat released during the reaction.

   H_2SO_4 has strong affinity for water because acid from hydrates with water.

Case-Based Type Questions

Case-Based-I

1. **(a)**
2. **(c)**
3. **(a)**

The reactions is shown as:

$$\underset{(A)}{CaCO_3} \longrightarrow \underset{\text{Solid residue}}{CaO} + CO_2 \uparrow$$

$$CaO + H_2O \longrightarrow \underset{(B)}{Ca(OH)_2}$$

$$Ca(OH)_2 + 2CO_2 \longrightarrow \underset{(C)}{Ca(HCO_3)_2}$$

Case-Based-II

1. **(a)**
2. **(a)**
3. **(b)**

Reactions are given below:

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

$$\xrightarrow{200^\circ C} \underset{\substack{(Y)\\ \text{dead burn plaster}}}{CaSO_4} \xrightarrow{\text{Strongly heated}} \underset{\substack{(Z)\\ \text{Lime}}}{CaO} + SO_2 + O_2$$

Case-Based-III

1. **(b)** $NaHCO_3$ when heated it will give Na_2CO_3 (A), water and CO_2 (B).
2. **(b)** Plaster of Paris is obtained on heating dihydrated salt of 'C'.
3. **(c)** Na_2CO_3 exists as decahydrate i.e., $Na_2CO_3.10H_2O$ (washing soda)
4. **(b)** Slaked lime, $Ca(OH)_2$ is formed when water is added to compound D. And, bleaching powder is synthesized by the action of chlorine gas (produced from chlor-alkali process) on dry slaked lime.

   $Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$
5. **(a)** Baking powder is a mixture of baking soda ($NaHCO_3$) and a mild edible acid such as tartaric acid.

Case-Based-IV

1. **(b)**

$$\underset{\substack{(P)\\ \text{Sodium hydrogen carbonate}}}{2NaHCO_3} \xrightarrow{\text{Heat}} \underset{\substack{(Q)\\ \text{Anhydrous sodium carbonate}}}{Na_2CO_3} + CO_2 + H_2O$$

2. **(c)** During the efflorescence process $Na_2CO_3.10H_2O$ loses nine molecules of water to give sodium carbonate monohydrate.

$$Na_2CO_3.10H_2O \xrightarrow{\text{in Air}} Na_2CO_3 \cdot H_2O + 9H_2O$$

3. **(a)** $Na_2CO_3 + 2H_2O \longrightarrow \underset{\text{Strong base}}{2NaOH} + \underset{\substack{(R)\\ \text{Weak acid}}}{H_2CO_3}$

NaOH completely ionises to give a large amount of hydroxide ions whereas H_2CO_3 ionises partially to give a less amount of H^+ ions. Thus, the solution is overall alkaline in nature.

4. **(b)** R is carbonic acid, a weak acid that formed when Na_2CO_3 is dissolved in water.

Multi Correct MCQs

1. **(a,b,c)** NaOH is an alkali, its basic in nature and also has deliquescent in nature.
2. **(b,c,d)** The correct order of acidic strength will be water < CH_3COOH < hydrochloric acid
3. **(a,b,c)** All the acids given does not produces hydrogen ion in absence of water.
4. **(a,c)** When a small amount of acid is added to water, dilution and ionisation both takes place.
5. **(a,b,c)** All of reactions are examples of neutralization.

Olympiad & NTSE Type Questions

1. **(d)** The correct order of acidic strength is given as:

$NaOH < NH_4OH < HCl < H_2SO_4$

$H_2SO_4 \longrightarrow 2H^+ + SO_4^{2-}$

$HCl \longrightarrow H^+ + Cl^-$ H_2SO_4 produces more no. of H^+ ions on dissociation and thus stronger acid than HCl.

$NaOH \longrightarrow NaOH + OH^-$

$NH_4OH \rightleftharpoons NH_4^+ + OH^-$

Both NH_4OH and NaOH will not give H^+ ions on dissociation. But, NH_4OH partially dissociates and NaOH completely dissociate to give OH^- ions. Thus, NaOH is more stronger base and weaker acid than NH_4OH.

2. **(c)** NaOH is the strong base, so its pH is more than 7. Among the given acids, H_2SO_4 will produce highest conc. of H^+ ions. Thus its pH will be lowest.

$\because pH = -\log\left[H^+\right]$

Therefore, 0.05 M H_2SO_4 will have lowest pH. Option c is correct.

3. **(d)** $NaHCO_3 + H_2O \rightarrow NaOH + H_2O + CO_2$

Na_2CO_3, $NaHCO_3$, $Na_2CO_3.10H_2O$ produces NaOH that is basic which will turns red litmus to blue.

Thus, (d) is correct option.

4. **(a)** By cutting the supply of air, fire extinguisher prevent from fire as air helps in burning.
5. **(a)** NaCl solution in water is neutral in nature i.e., pH = 7, the same as that of distilled water as NaCl is a salt combination of strong acid and strong base. Thus, colour will not change and remain same.
6. **(c)** $MnO_4^- + Cl^- \xrightarrow{H^+} Mn^{2+} + Cl_2 \uparrow$
7. **(b)** Decreasing order of the following substance in their pH value

Tooth paste → blood → saliva (after dinner) → Coffee → Lemon Juice

8. **(c)** The third statement is incorrect as acid reacts with metal carbonates to give metallic salt, carbon dioxide gas and water.
9. **(a)** Y statement is wrong example. KNO_3 solution is neutral.
10. **(b)** Calamine solution consist of $ZnCO_3$ (base) and ant's sting consists formic acid. The reaction between acid and base will neutralises the pain of ant's sting.

Thus A is Formic acid and B is zinc carbonate

11. **(b)** This is due to the formation of sulphur dioxide, SO_2.
12. **(a)** Element X will react with both acid and base. It shows that element X has amphoteric nature and it is an electropositive element.
13. **(a)** Addition of water will decrease H^+ ions concentration and increases the pH of solution A while adding water in B decreases OH^- ion concentration and thus decreases pH of solution B.
14. **(d)** HCl is acid so it will not change colour of red litmus. Lactic acid is considered organic acid and milk of magnesia is an antacid not milk.
15. **(b)** Blue vitriol is $CuSO_4.5H_2O$

Espom salt is $MgSO_4(H_2O)_x$

Washing soda $Na_2CO_3.H_2O$

Baking Soda $NaHCO_3$ does not contain any water of crystallisation