MATERIAL FOR SPOT TEST II
(ENGLISH VERSION)
(SOURCES: SAMACHEER, OLD STATE BOARD, ARIHANT, APPOLO MATERIAL)
ACID AND BASE

ACIDS, BASES AND SALTS

7TH SAMACHEER

ACIDS, BASES AND SALTS USED IN OUR DAILY LIFE

Curd, lemon juice, orange juice and vinegar taste sour. These substances taste sour because they contain acids. The chemical nature of such substances is acidic. The word acid comes from the Latin word 'acidus' which means sour. We come across many acids in our daily life.

In general, acids are chemical substances which contain replaceable hydrogen atoms. Acids can be classified into two categories namely organic acids and mineral acids or inorganic acids.

Organic acids

Acids which are obtained from animal and plant materials are called organic acids. Many such acids are found in nature. Lemon and orange contain citric acid. Hence they are called citrus fruits. Milk that has turned to curd tastes sour, contains an acid called Lactic acid.

The acids found in food stuffs are weak. Soft drinks contain some carbonic acid which gives a tingling taste. Apple contains malic acid. Even the digestion of food in our body requires the presence of hydrochloric acid.

Mineral acids

Acids that are obtained from minerals are called mineral acids or Inorganic acids. For example, Hydrochloric acid, Nitric acid, Sulphuric acid which are commonly available in the laboratory. They must be used with a lot of care. They are corrosive. It means that they can eat away metal, skin and clothes. But they will not corrode glass and ceramics. Hence they are stored in glass bottles. An acid is a substance which contains replaceable hydrogen ions.

Bases and alkalis in our daily life

Substances such as baking soda, does not taste sour. It is bitter in taste. It shows that it has no acid in it. If you rub its solution with your fingers, it feels soapy.

Substances like these which are bitter in taste and feel soapy on touching are known as bases. The nature of such substances is said to be basic. Bases are oxides or hydroxides of metal. They are chemically opposite to acids. Some bases like caustic soda [Sodium hydroxide] and caustic potash [Potassium hydroxide] are very corrosive.

Bases give hydroxyl ions when treated with water. Bases which are soluble in water are called Alkalis. The hydroxides of Calcium, Sodium and Potassium are examples of alkalis. They are water soluble bases. All alkalis are bases, but not all bases are alkalis. The word alkali is derived from the Arabic word Aquila which means plant ashes. Ashes of plants are composed of mainly sodium and potassium carbonates.

Some common bases used in our daily life.

No	Name	Other Name
1	Calcium oxide	Quick lime
2	Potassium hydroxide	Caustic potash
3	Calcium hydroxide	Slaked lime
4	Sodium hydroxide	Caustic soda
5	Magnesium hydroxide	Antacid

Name of Base	Found in
Calcium hydroxide	Lime Water
Ammonium hydroxide	Window cleaner

Sodium hydroxide/ Potassium hydroxide	Soap
Magnesium hydroxide	Milk of magnesia

Test for identifying acids and bases

We should never touch or taste a substance to find out whether it is an acid or base because, both acids and bases are harmful and burn the skin. A safe way to find out is to use an indicator. Indicators are a group of compounds that change colour when added to solutions containing either acidic or basic substances.

The common indicators used in the laboratory are litmus, methyl orange and phenolphthalein. Apart from these, there are some natural indicators like turmeric, red cabbage juice and beetroot juice.

Indicator	Colour in Acid	Colour in base
Litmus	Red	Blue
Phenolphthalein	Colorless	pink
Turmeric	Yellow	Brick red
Beetroot juice	Pink	Pale yellow
Red cabbage juice	Pink/Red	green

Properties of Acids

1. They have a sour taste.
2. Strong acids are corrosive in nature.

3. Hydrogen is the common element present in all acids. However, all compounds containing hydrogen are not acids. For instance ammonia, Methane and glucose are not acids.

4. They react with metals and produce hydrogen.

Metal + Acids------► Salt + Hydrogen gas

5. Acids turn blue litmus to red.

6. The indicator phenolphthalein is colorless in acids

7. The indicator methyl orange is red in acids.

8. They are good conductors of electricity.

Uses of Acids

Inorganic acids are used in:

1. Chemical laboratories as reagents.
2. Industries for manufacturing dyes, drugs, paints, perfumes, fertilizers and explosives.
3. The extraction of glue from bones and metals from its ore.
4. Preparation of gases like Carbon dioxide, Hydrogen sulphide, Hydrogen, Sulphur dioxide etc.,
5. Refining petroleum.

Organic Acids like carboxylic acids are used:

- ❖ As food preservatives.
- ❖ As a source of vitamin C.
- ❖ For preparation of baking soda.
- ❖ To add flavour to food stuffs and drinks.

Properties of Bases

1. Bases are bitter in taste.

2. Strong bases are highly corrosive in nature.
3. Generally they are good conductors of electricity
4. Basic solutions are soapy to touch.
5. Bases turn red litmus paper to blue.
6. Bases are compounds that contain hydroxyl group.

Uses of Bases

1. As a reagent in chemical laboratories.
2. In industries for manufacture of soap, textile, plastic.
3. For the refining of petroleum.
4. For manufacturing paper, pulp and medicine.
5. To remove grease and stains from clothes.

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ACIDS, BASES AND SALTS

Acids, bases and salts are used in everyday life. Let it be a fruit juice or a detergent or a medicine. They play a key role in our day-to-day activities. Our body metabolism is carried out by means of hydrochloric acid secreted in our stomach.

ACIDS

Acid is a substance which furnishes H^+ ions or H_3O^+ ions when dissolved in water. Acids have one or more replicable hydrogen atoms.

The word acid is derived from the Latin name 'acidus' which means sour taste. Substances with 'sour taste' are acids. Lemon juice, vinegar and grape juice have sour taste, so they are acidic. They change blue litmus to red. They are colorless with

phenolphthalein and pink with methyl orange. Many organic acids are naturally present in food items.

CLASSIFICATION OF ACIDS

1. Based on their sources:

Acids are classified into two type's namely organic acids and inorganic acids.

Organic acids:- Acids present in plants and animals (living beings) are organic acids eg. HCOOH, CH_3COOH (Weak acids).

Inorganic acids:- Acids from rocks and minerals are inorganic acids or mineral acids eg. HCl, HNO_3, H_2SO_4 (Strong acids).

2. Based on their basicity

Monobasic acid:- It is an acid which gives one hydrogen ion per molecule of the acid in solution eg. HCl, HNO_3.

Dibasic acid:- It is an acid which gives two hydrogen ions per molecule of the acid in solution e.g., H_2SO_4, H_2CO_3.

Tribasic acid:- It is an acid which gives three hydrogen ions per molecule of the acid in solution. e.g.,H_3PO_4,

3. Based on ionization

Acids are classified into two types based on ionization.

Strong acids:-These are acids which ionise completely in water eg.HCl

Weak acids:-These are acids which ionise partially in water eg. CH_3COOH

4. Based on concentration:-

Depending on the percentage or amount of acid dissolved in water acids are classified into concentrated acid and dilute acid.

Concentrated acid:- It is an acid having a relatively high percentage of acid in its aqueous solution.

Dilute acid:-It is an acid having a relatively low percentage of acid in aqueous solution.

CHEMICAL PROPERTIES OF ACIDS

1.Reaction of Metals with Acid

Note that zinc reacts with dilute hydrochloric acid to form zinc chloride and hydrogen gas.

$$\mathbf{Zn + 2HCl \rightarrow ZnCl + H_2\uparrow}$$

When a burning candle is brought near the bubble containing hydrogen gas, the flame goes off with a **'popping'** sound. This confirms that metal displaces hydrogen from the dilute acid. (Hydrogen gas burns with a **'popping'** sound)

$$\mathbf{Metal + Acid \rightarrow Salt + Hydrogen}$$

Another example

$$\mathbf{Mg + H_2SO_4 \rightarrow MgSO_4 + H_2\uparrow}$$

Few metals do not liberate hydrogen gas on reaction with acids.eg Ag,Cu.

Lime stone, Chalk and Marble are different physical forms of calcium carbonate. They react with acids giving the corresponding salts, carbon dioxide and water.

2. Reaction of Metal Carbonate and Metal Bicarbonate with Acids

Test tube I

$$\mathbf{Na_2CO_3 + 2\ HCl \rightarrow 2\ NaCl + H_2O + CO_2\uparrow}$$

Test tube II

$$\mathbf{NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2\uparrow}$$

When carbon dioxide is passed through lime water, it turns milky.

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

(milky)

From the above activity the reaction can be summarized as

Metal carbonate or Metal bicarbonate + Acid----►Salt+water+Carbon dioxide

Other examples:

$$MgCO_3 + 2\,HCl \rightarrow MgCl + H_2O + CO_2\uparrow$$

$$Mg(HCO_3)_2 + 2\,HCl \rightarrow MgCl_2 + 2H_2O + 2CO_2\uparrow$$

Some metal carbonates and metal bicarbonates are basic, they react with acids to give salt and water with the liberation of carbon dioxide.

3. Reaction of Metallic Oxides with Acids

Take about 2g copper (II)oxide in a watch glass and slowly add dilute hydrochloric acid to it. Note the colour of the salt. The colour changes from black to green. This is due to the formation of copper (II) chloride in the reaction. Since metal oxides are basic, they react with acid to form salt and water.

$$CuO + 2HCl \rightarrow CuCl + H_2O$$

From the above activity we conclude that

Metallic oxide + Acid → Salt + Water

Another example

$$CaO + 2HCl \rightarrow CaCl + H_2O$$

4. Action of Acids with Water.

An acid produces hydrogen ions in water.

$$HCl + H_2O \rightarrow H_3O^+ + Cl^-$$

Hydrogen ions cannot exist alone, but they exist in the form of hydronium (H_3O^+) ions with water. When water is absent, the separation of hydrogen ions from an acid does not occur.

USES OF ACIDS

- Sulphuric acid (King of chemicals) is used in car battery and in the preparation of many other compounds.
- Nitric acid is used in the production of ammonium nitrate which is used as a fertilizer in agriculture.
- Hydrochloric acid is used as cleansing agent in toilet.
- Tartaric acid is a constituent of baking powder.
- Salt of benzoic acid (sodium benzoate) is used in food preservation.
- Carbonic acid is used in aerated drinks.

BASES

Base is a substance which releases hydroxide ions(OH^-) when dissolved in water. It is a substance which is bitter in taste and soapy to touch (e.g. Washing soda, caustic soda and caustic potash). They change red litmus to blue. They are pink with phenolphthalein and yellow with methyl orange.

Classification of bases

1. Based on ionization

Strong bases:-These are bases which ionize completely in aqueous solution eg.NaOH, KOH.

Weak bases:-These are bases which ionize partially in aqueous solution eg. NH_4OH, $Ca(OH)_2$

2. Based on their acidity

Monoacidic base:-It is a base which ionizes in water to give one hydroxide ion per molecule eg.NaOH, KOH.

Diacidic base:- It is a base which ionizes in water to give two hydroxide ions per molecule eg. $Ca(OH)_2$, $Mg(OH)_2$.

Triacidic base:-It is a base which ionizes in water to give three hydroxide ions per molecule eg. $Al(OH)_3$, $Fe(OH)_3$.

3. Based on the concentration:

Depending on the percentage or amount of base dissolved in water, bases are classified as concentrated alkali and dilute alkali.

Concentrated alkali:- It is an alkali having a relatively high percentage of alkali in its aqueous solution.

Dilute alkali:- It is an alkali having a relatively low percentage of alkali in its aqueous solution.

Bases which dissolve in water are called alkalies.All alkalies are bases,but not all bases are alkalies.NaOH and KOH are alkalies, whereas $Al(OH)_3$ and$Zn(OH)_2$ are bases.

Chemical Properties ofBases

1. Reaction of Base with Metals

Zinc reacts with sodium hydroxide to form sodium zincate with the liberation of hydrogen gas.

$$\mathbf{Zn + 2\ NaOH \rightarrow Na_2\ ZnO_2 + H_2\uparrow}$$

Metal + Base → Salt + Hydrogen

Another example is

$$\mathbf{2Al + 2NaOH + 2\ H_2O \rightarrow 2\ NaAlO_2 + 3\ H_2\uparrow}$$

Few metals do not react with sodium hydroxide e.g. Cu, Ag, Cr.

2. Reaction of Non-metallic oxides with bases

Sodium hydroxide reacts with carbon dioxide gives sodium carbonate and water.

$$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$$

The above reaction indicates that

Nonmetallic oxide + Base → Salt + Water

Another example is

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

3. Action of Bases with Water

Bases generate hydroxide (OH^-) ions when dissolved in water.

$$NaOH \rightarrow Na^+ + OH^-$$

4. Reaction of acids with bases

The effect of a base is nullified by an acid.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

The above reaction between an acid and a base is known as neutralization reaction.

Acid + Base → Salt + Water

USES OF BASES

- ❖ Sodium hydroxide is used in the manufacture of soap.
- ❖ Calcium hydroxide is used in white washing the buildings.
- ❖ Magnesium hydroxide is used as a medicine for stomach troubles.
- ❖ Ammonium hydroxide is used to remove grease stains from clothes.

ACIDS, BASES AND SALTS

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1. Equivalent mass of acid:

Acids contain one or more replaceable hydrogen atoms. The number of replaceable hydrogen atoms present in a molecule of the acid is referred to its basicity.

Equivalent mass of an acid is the number of parts by mass of the acid which contains 1.008 parts by mass of replaceable hydrogen atom.

$$\text{Equivalent mass of an acid} = \frac{\text{molar mass of the acid}}{\text{No. of replaceable hydrogen atom}}$$

(Or)

$$= \frac{\text{molar mass of the acid}}{\text{Basicity of the acid}}$$

For example, the basicity of sulphuric acid is 2.

$$\text{Equivalent mass of } H_2SO_4 = \frac{\text{Molar mass of } H_2SO_4}{2}$$

$$= 98 / 2 = 49$$

2. Equivalent mass of the base

Equivalent mass of a base is the number of parts by mass of the base which contains one replaceable hydroxyl ion or which completely neutralizes one gram equivalent of an acid.

The number of hydroxyl ions present in one mole of a base is known as the acidity of the base. Sodium hydroxide, potassium hydroxide, ammonium hydroxide are examples of monoacidic bases.

Calcium hydroxide is a diacidic base.

In general, equivalent mass of a base= $\frac{\text{Molar mass of the base}}{\text{acidity of the base}}$

Equivalent mass of KOH = 56 /1 = 56

ACIDS, BASES AND SALTS

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Acids, bases and salts are the three distinct classes into which almost all organic and inorganic compounds are divided. Each of these classes has a definite characteristic set of properties.

Acids

The word acid is derived from the Latin word "acidus" which means sour. Acids are compounds found naturally in plants or derived from minerals which have sour taste. Acids are directly or indirectly encountered in our daily life and in our diet.

Definition

- An acid is a substance which gives hydrogen ions when dissolved in water (or) acid is a substance which contains **replaceable** hydrogen ions)
- However all compounds containing hydrogen are not acids. For instance ammonia (NH_3), methane (CH_4,), glucose ($C_6H_{12}O_6$) are not acids.
- Acids derived from animals and plants are called organic acids. eg. citric acid, formic acidAcids derived from minerals are called inorganic acids.eg, hydrochloric acid, sulphuric acid

Acids used in our day to day life and their sources

No.	Name of the acid	Sources
1.	Citric acid	Citrus fruits like lemons, and oranges
2.	Lactic acid	Sour milk
3.	Formic acid	Stings of bees and ants

4.	Butyric acid	Rancid butter
5.	Tartaric acid	Tamarind, grapes and apples
6.	Acetic acid	Vinegar
7.	Malic acid	Apples
8.	Uric acid	Urine
9.	Oxalic acid	Tomato
10.	Stearic acid	Fats
11.	Cholic acid	Bile acids

Some common acids (mineral acids or inorganic acids)used in laboratories.

No.	**Chemical Name**	**Common Name**	**Formula**
1.	Hydrochloric acid	Muriatic acid	*HCl*
2.	Sulphuric acid	Oil of vitriol or king of chemicals	H_2SO_4
3.	Nitric acid	Aqua fortis	HNO_3

Preparation of some acids

1. By direct combination of elements

Hydrogen gas reacts with chlorine gas to give hydrogen chloride gas. Hydrogen chloride gas is dissolved in water to get hydrochloric acid.

$$\text{hydrogen} + \text{chlorine} \rightarrow \text{hydrogen chloride}$$

$$H_2 + Cl_2 \longrightarrow 2HCl$$

2. By dissolving an acidic oxide in water

Carbon dioxide gas is dissolved in water to get carbonic acid. Soda water we drink contains carbonic acid. carbon dioxide + water -» carbonic acid

$$CO_2 + H_2O \longrightarrow H_2CO_3$$

Properties

Physical Properties

- ***Colour:***Mineral acids are colorless liquids. Sometimes sulphuric acid becomes light brown and hydrochloric acid becomes yellow due to impurities. Some organic acids are white coloured solids, eg. Benzoicacid.
- ***Solubility****:* Mostly all the acids are soluble in water except some organic acids.
- ***Nature:***Mineral acids are highly corrosive in nature. They burn the skin and eat away metals.
- ***Taste:*** Acids are sour in taste. (Never taste or touch the concentrated acids. Taste a drop of very dilute solution of hydrochloric acid)

5. Indicator test

i) Acids turn Blue litmus paper into Red colour (ABR)

ii) Acids give no colour with phenolphthalein

iii) Acids give pink colour with methyl orange.

Indicator

Indicators are chemical compounds which show the acidic or basic nature of a solution by a characteristic colour change, eg, phenolphthalein, and methyl orange.

Chemical Properties

1) Reaction with metals

Acids give hydogen gas when treated with active metals like zinc, magnesium etc.,

Metal + acid —> salt+hydrogen gas.

eg-

1. Zinc + sulphuric acid-->zinc sulphate + hydrogen

$$Zn + H_2SO_4 \text{-----} > ZnSO_4 + H_2\uparrow$$

2. Zinc + hydrochloric acid----->zinc chloride +hydrogen

$$Zn + 2HCl \text{-----} > ZnCl_2 + H_2\uparrow$$

3. Magnesium + hydrochloric acid ----->magnesium chloride + hydrogen

$$Mg + 2HCl \text{-----} > MgCl_2 + H_2\uparrow$$

4. Sodium + nitric acid----->sodium nitrate+hydrogen

$$2Na + 2HNO_3 \text{-----} > 2NaNO_3 + H_2\uparrow$$

2) Action with alkalies (bases)

Acids react with bases (alkalies) to form salt and water. This reaction is called neutralization.

eg-

1. Hydrochloric acid + sodium hydroxide--->sodium chloride + water

$$HCl + NaOH \text{ -----> } NaCl + H_2O$$

2. sulphuric acid + potassium hydroxide-----> potassium sulphate + water

$$H_2SO_4 + 2KOH \text{-----> } K_2SO_2 + 2H_2O$$

3. Action with carbonates

Acids react with carbonates to liberate carbon dioxide gas.

eg-

Sodium carbonate + hydrochloric acid ---> sodium chloride +Carbon dioxide+ water

$$Na_2CO_3 + 2HCl \text{-----> } 2NaCl + H_2O + CO_2\uparrow$$

Similarly acids react with bicarbonates.

Bases

Definition

- Bases are oxides or hydroxides of metals which gives hydroxyl ions (OH) when treated with water.

  eg. Sodium hydroxide(NaOH), Potassium hydroxide(KOH), Calcium hydroxide [$Ca(OH)_2$], Calcium oxide (CaO) and Sodium oxide(Na_2O).

- **Note:** Ammonium hydroxide (NH_4OH) is a base but it is not a hydroxide of a metal.

- Bases which are soluble in water are called **"alkalies."** eg. NaOH and KOH

- The word Alkali was derived from the Arabic word "alquili" which means plant ashes. Ashes of plants are composed of mainly sodium and potassium carbonates.All alkalies are bases, but all bases are not alkalies.

Some common bases used in daily life.

No.	Name	Other name	Formula	Solubility in water
1.	Sodium hydroxide	Caustic soda	NaOH	soluble
2.	Potassium hydroxide	Caustic potash	KOH	soluble
3.	Calcium hydroxide	Slaked lime	$Ca(OH)_2$	slightly soluble
4.	Calcium oxide	Quick lime	CaO	insoluble
5.	Iron(III) hydroxide	Ferric hydroxide	$Fe(OH)_3$	insoluble
6.	Magnesium hydroxide	Milk of magnesia	$Mg(OH)_2$	insoluble

Physical properties

- **Colour:**Bases are colorless (except hydroxide of iron and copper) and odorless.
- **Taste:**Bases are '*bitter*' in taste.
- **Nature***:* Bases are soapy or greasy to touch. They are highly corrosive in nature. They burn the skin.

4. Indicator test:

i) **B**ases turn **R**ed litmus paper into **B**lue colour**(BRB).**

ii) Bases give yellow colour with methyl orange

iii) Bases give pink colour with phenolphthalein .

5. They are good conductors of electricity.

6. Most of the bases are insoluble in water except the hydroxides of sodium, potassium, calcium and barium.

Chemical Properties

1. Action with acids

Bases react with acids to form salt and water. This reaction in known as Neutralization reaction.

Base + acid----->salt + water

eg'potassium hydroxide + hydrochloric acid -» potassium chloride + water

$$KOH + HCl \text{-----} > KCl + H_2O$$

2. Action with metals

Metals like aluminium zinc and tin reacts with alkalis and liberate hydrogen.

eg-

1. Aluminium + sodium hydroxide + water-----> sodium, meta aluminate +hydrogen

$$2Al + 2NaOH + 2H_2O \text{-----} > 2NaAlO_2 + 3H_2\uparrow$$

2. zinc+ sodium hydroxide----->sodium zincate + hydrogen

$$Zn + 2NaOH \text{-----} > Na_2ZnO_2 + H_2\uparrow$$

Caustic Nature of alkalis

The solutions of alkalies like sodium hydroxide, potassium hydroxide are soapy to touch and are very corrosive. Skin irritation and burns are the typical results when the body contacts on alkalies.

Sodium hydroxide is a powerful alkali and breaks down the proteins of the skin and flesh to a pasty mass. They corrode and destroy the cloths. It is due to caustic nature of alkalies sodium hydroxide is called caustic soda and potassium hydroxide is called as caustic potash.

Preparation of staked lime from quicklime

When calcium oxide (quick lime) is added to water, it readily absorbs water and forms slaked lime (calcium hydroxide) with the liberation of heat energy.

Quicklime + water ----->slaked lime + heat energy

$CaO + H_2O$----->$Ca(OH)_2$ + heat energy

The slaked lime is not soluble in water. It settles down and water comes up. The water over the slaked lime is a solution of quick lime. It is called lime water.

Uses of slaked lime

- ❖ The slaked lime is used to prepare bleaching powder.
- ❖ Slaked lime is used as a good disinfectant.
- ❖ It is also used in white washing.
- ❖ It is used in the preparation of many calcium salts.
- ❖ It is used to prepare Bordeaux mixture.

Differences between acids and bases

No.	Properties	Acids	Bases
1.	Definition	give hydrogen ions (H^+) when dissolved in water.	give hydroxyl ions (OH^-) when dissolved in water.
2.	Taste	Sour taste	bitter taste

3.	Action towards litmus	turn blue litmus into red	turn red litmus into blue
4.	Action with metals	evolve hydrogen gas	Generally bases do not react with metals but they react with metals like zinc and aluminium to liberate H_2
5.	Action with ammonium salts	do not react	evolve ammonia gas
6.	Action towards indicators	do not produce any colour with phenolphthalein but gives red colour with methyl orange,	give pink colour with phenolphthalein and yellow colour with methyl orange
7.	Absorption of CO_2	do not absorb CO_2 gas	bases like NaOH and KOH absorbs CO_2 gas

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1. Acids

The term acid is derived from the Latin word acidus meaning sour. Acids can be defined in many ways but generally their aqueous solutions have the following properties.

- ❖ They are sour in taste.
- ❖ They turn blue litmus red.

- ❖ They react with certain metals and liberate hydrogen gas.
- ❖ They react with oxides and hydroxides of metals forming salt and water.
- ❖ Their aqueous solutions conduct electricity.

2. Bases

Bases are defined in various ways but generally substances having the following characteristics are called bases.

- ❖ They have a bitter taste.
- ❖ Their aqueous solutions have a soapy touch.
- ❖ They turn red litmus blue.
- ❖ They react with acids to form salt and water.
- ❖ Their aqueous solutions conduct electricity.

Some naturally occurring acids and their sources are given in table

Acids and their sources

Acid **Citric acid**	**Source** **Lemon juice**
Ethanoic acid (acetic acid)	Vinegar
Tannic acid	Tea
Lactic acid	Sour milk
Tartaric acid	Grapes
Hydrochloric acid	Stomach juices

3. Arrhenius concept

According to Arrhenius, an acid is a substance which gives hydrogen ions in its aqueous solution. A base is substances which give hydroxyl ions in its aqueous solution.

For example, substances such as Nitric acid, Hydrochloric acid, acetic acid are acids whereas substances such as sodium hydroxide, potassium hydroxide and ammonium hydroxide are bases according to this concept.

$HNO_{3(aq)} \longrightarrow H^+_{(aq)} + NO^-_{3(aq)}$
nitric acid

$HCl_{(aq)} \longrightarrow H^+_{(aq)} + Cl^-_{(aq)}$
hydrochloric acid

$CH_3COOH_{(aq)} \longrightarrow H^+_{(aq)} + CH_3COO^-_{(aq)}$
acetic acid

$NaOH_{(aq)} \longrightarrow Na^+_{(aq)} + OH^-_{(aq)}$
sodium hydroxide

$KOH_{(aq)} \longrightarrow K^+_{(aq)} + OH^-_{(aq)}$
potassium hydroxide

$NH_4OH_{(aq)} \longrightarrow NH^+_{4(aq)} + OH^-_{(aq)}$
ammonium hydroxide

Acids such as HCl, H_2SO_4 and HNO_3 which are almost completely ionised in aqueous solution are termed as strong acids. CH_3COOH is partially ionised and is called a weak acid.

Similarly, bases like NaOH and KOH are almost completely ionised in aqueous solution and are therefore called strong bases. Ammonium Hydroxide is partially ionised and is called a weak base. The Arrhenius theory of acids and bases has proved to be very useful in the study of chemical reactions. But the theory has certain limitations. To overcome these limitations, in 1923, a Danish chemist, J.N. Bronsted and a British chemist T.M. Lowry proposed a more logical concept of acids and bases.

4. Bronsted and Lowry theory

According to this theory, an acid is a substance that has the tendency to lose a proton and a base is a substance that has the tendency to accept a proton. This theory will be discussed in detail in higher classes.

ACIDS, BASES AND SALTS

ARIHANT – GENERAL KNOWLEDGE

Arrhenius Concept

According to these concepts, "Acids are those substances which give H^+ ions in their aqueous solution and bases are those which give OH ions in their aqueous solution."

$$HCl(aq)\text{----->}H^+ + Cl^-$$

$$NaOH(sq)\text{----->}\ Na^+ + OH^-$$

Bronsted Lowry Concept

According to this concept, "Acids are proton donors and bases are proton acceptors."

$$CH_3COOH + H_2O \rightleftharpoons (CH3COO)^- + H_3O^+$$

Acid Base Conjugate Conjugate

Base acid

$$H_2O + H_2O \Leftrightarrow OH^- + H_3O^+$$

$$NH_3 + NH_3 \Rightarrow NH_2^- + NH_4^+$$

Lewis Concept

According to this concept, "Acids are electron pair acceptors and bases are electron pair donors."

$$NH_3 + BF_3 \rightarrow H_3N{:}\rightarrow BF_3$$

Base Acid

Properties of Acid sand Bases

- Acids have sour taste and turn blue litmus red.
- Acids give hydrogen with more reactive metals, *e.g.*,

$$Zn + 2HC1 \text{----»} ZnCl_2 + H_2$$

Metal acid salt hydrogen

Acids give carbon dioxide gas (CO_2) with carbonates *e.g.,*

$$CaCO_3 + H_2SO_4 \text{----->} CaSO_4 + H_2O + CO_2 \uparrow$$

Marble sulphuric

or acid

calcium carbonate

Acids are conductor of electricity in aqueous solutions.

A mixture of concentrated hydrochloric acid (HC1) and concentrated nitric acid (HNO_3) in the ratio of 3:1 is called aqua regia.

- It is used to dissolve noble metals like gold and platinum. Generally most of the acids contain hydrogen.
- Pickles are always kept in glass jar because acid present in them reacts with the metal of metallic pot.
- Bases have bitter taste and turn red litmus blue.
- **Water soluble** bases are called alkali *e.g.,* NaOH, KOH.
- **Acidity** is the number of replaceable OH^- ions *e.g.,* it is 1 for NaOH, 2 for $Ca(OH)_2$.
- **Basicity** represents the number of replaceable H-atoms. *e.g.,* it is 1 for HC1, 2 for H_2SO_4.

Sources of Some Important Acids

Acid	Source
Citric acid	Lemon, orange,
	grapes

Maleic acid	Unripe apple
Tartaric acid	Tamarind
Acetic acid	Vinegar
Lactic acid	Milk
Hydrochloric acid	Stomach
Oxalic acid	Tomato

Uses of Some Acids Hydrochloric Acid (HCl)

It is present in gastric juices and is responsible for the digestion. It is used as bathroom cleaner, as pickling agent, tanning of leather, in dying and in the manufacture of gelatin from bones.

Nitric Acid (HNO_3)

It is used for the manufacture of fertilizers like NH_4NO_3; explosive like TNT, picric acid, dynamite etc rayon, dyes and drugs.

Sulphuric Acid (H_2SO_4)

It is also known as oil of vitriol and is used in manufacture of fertilizers, drugs, detergents and explosives.

Acetic Acid (CH_3 COOH)

It is used in vinegar, medicines and as a solvent.

ACIDS, BASES AND SALTS

APPOLO COURSE MATERIAL

- Acids, bases and salts are the three distinct classes into which almost all organic and inorganic compounds are divided.

❖ **Definition of acid and bases**

i. **Arrhenius definition**
ii. **Bronsted-Lowry definition**
iii. **Lewis definition**

Arrhenius definition

➢ An **acid** is a substance which forms H^+ ions as the only positive ion in aqueous solution.

Examples:

☞ Hydrochloric acid dissolved in water forms H^+ and Cl^- ions

$$HCl \text{ ---> } H^+ + Cl^-$$

☞ Sulphuric acid dissolved in water forms H^+ and SO_4^{2-} ions

$$H_2SO_4 \text{ --->} 2H^+ + SO_4^{2-}$$

☞ Nitric acid forms H^+ and NO_3^- ions when dissolved in water

$$HNO_3 \text{ ---> } H^+ + NO_3^-$$

☞ Ethanoic acid,also known as acetic acid, forms H^+ and CH_3COO^- ions in water.

$$CH_3COOH \text{ ---> } H^+ + CH_3COO^-$$

- **An alkali** is a substance which forms OH^- ions as the only negative ion in aqueous solution. A base is an insoluble hydroxide.

Example:

- ☞ Sodium hydroxide, when dissolved in water, forms Na^+ and OH^- ions

  $NaOH \text{ ---> } Na^+ + OH^-$

- ☞ Calcium hydroxide dissolves in water to give Ca^+ and OH^- ions

  $Ca(OH)_2 \text{ ---> } Ca^{2+} + 2\ OH^-$

- ☞ Ethanol CH_3CH_2OH does not form OH^- ions when dissolved in water, so it isn't a base.

❖ **Bronsted-Lowry definition**

➡ **An Bronsted acid is a proton (H^+ ions) donor**

- Hydrogen chloride gas and ammonia gas react to give the white solid ammonium chloride.

Example:

$HCl(g) + NH_3(g) \text{ ---> } NH_4Cl(s)$

➡ **A Bronsted base is any substance that can accept an H^+ ion or proton from an acid.**

Example:

$$HCl(aq)+NH_3(aq)\rightarrow NH_4^+(aq)+Cl^-(aq)$$

- Here, hydrochloric acid (HCl) "donates" a proton (H^+) to ammonia (NH_3) which "accepts" it, forming a positively charged ammonium ion (NH_4^+) and a negatively charged chloride ion (Cl^-). Therefore, HCl is a Brønsted-Lowry acid (donates a proton) while the ammonia is a Brønsted-Lowry base (accepts a proton). Also, Cl^- is called the **conjugate**

base of the acid HCl and NH_4^+ is called the **conjugate acid** of the base NH_3.

☙ Lewis definition

- Lewis acids act as electron pair acceptors. Lewis bases act as electron pair donors.

Example:

$$NH_{3(g)} + BF_{3(g)} \rightleftharpoons H_3NBF_{3(g)}$$

- This is a reaction between ammonia (NH_3) and boron trifluoride (BF_3). This is considered an acid-base reaction where NH_3 (base) is donating the pair of electrons to BF_3. BF_3 (acid) is accepting those electrons to form a new compound, H_3NBF_3.

Acids used in Daily life:

S.No	Name	Sources
1	Citric acid	Citrus fruits
2	Lactic acid	Sour milk
3	Formic acid	Ants and bees
4	Butyric acid	Rancid butter
5	Tartaric acid	Tamarind, grapes and apples
6	Acetic acid	Vinegar
7	Malic acid	Apples
8	Uric acid	Urine
9	Oxalic acid	Tomato
10	Stearic acid	Fats
11	Cholic acid	Bile acid

Common acids (Mineral acids or inorganic acids)

S.No	Chemical Name	Common Name	Formula
1	Hydrochloric acid	Muriatic acid	HCl
2	Sulphuric acid	Oil of vitriol or King of chemicals	H_2SO_4
3	Nitric acid	Aqua fortis	HNO_3
4	Carbonic acid	Club soda	
5	1:3 mixture of nitric and hydrochloric acids	Aqua regia	1 HNO_3 : 3 HCl
6	2,4,6-trinitrophenol (TNP)	Picric acid	$C_6H_3N_3O_7$

Differences between acids and bases:

No	Properties	Acids	Bases
1.	Definition	Give hydrogen ions (H^+) when dissolved in water	Give hydroxyl ions (OH^-) when dissolved in water.
2.	Taste	Sour taste	Bitter taste
3.	Action towards litmus	Turn blue litmus into red	Turn red litmus into blue
4.	Action with metals	Evolve hydrogen gas	Generally bases do not react with metals but they react with metals like zinc and aluminium to liberate H_2

5.	Action with ammonium salts	Do not react	Evolve ammonia gas
6.	Action to wards indicators	Do not produce any colour with phenolphthalein but gives red colour with methyl orange.	Give pink colour with phenolphthalein and yellow colour with methyl orange
7.	Absorption of CO_2	Do not absorb CO_2 gas	Bases like NaOH and KOH absorbs CO_2 gas