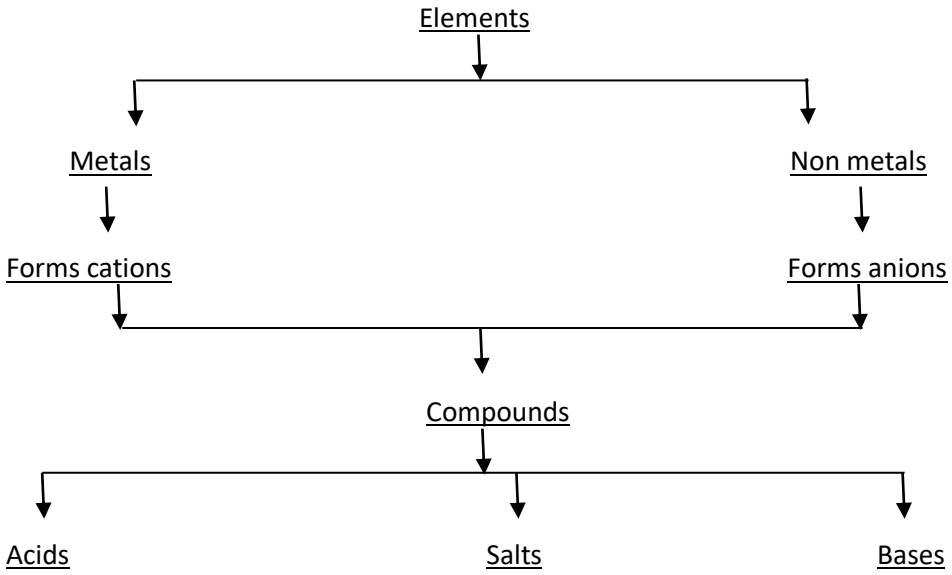
Columbia Foundation Sr. Sec. School

Ch 2- Chemistry - (Class X)

ACIDS, BASES AND SALTS



ACIDS & BASES

ACIDS

The name Acid is derived from the word called 'ACIDUS' which means Sour. The substances which are sour in taste are said to be acids or contains acid. For eg.

1) Tomato contain Oxalic Acid
2) Tamarind contains Tartaric Acid
3) Curd contains Lactic Acid
4) Lemon contains Citric Acid
5) Vinegar contains Acetic Acid

BASES

The substances which are bitter in taste and soapy to touch are known as bases.
For eg. All detergents are bases.

CHEMICAL PROPERTIES OF ACIDS AND BASES

1. Reaction with Metals
   a) With acids
      All acids react with metals to produce respective salts along with liberation of Hydrogen gas.

      Acid + Metal → Salt + H_2

      $HX + M \rightarrow MX + H_2$

      For eg.: $HCl + Na \rightarrow NaCl + H_2$

      $H_2SO_4 + Ca \rightarrow CaSO_4 + H_2$

      $CH_3COOH + K \rightarrow CH_3COOK + H_2$

* Metals do not produce Hydrogen gas with HNO_3 except Magnesium and Manganese.

b) With Bases

Only NaOH (Conc.) reacts with Zinc and Aluminium to produce respective salt along with liberation of Hydrogen gas.

$NaOH + Zn \rightarrow Na_2ZnO_2 + H_2$

Sodium Zincate

**Amphoteric metals*: The metals which react with both acids as well as bases are known as Amphoteric Metals eg. Zn and Al.

2. Reaction with Metal carbonates and Bicarbonates

a) With acids

All acids react with Metal carbonates and Bicarbonates to produce respective salts, water along with the liberation of Carbon dioxide.

$Acid + Metal\ Carbonates/Bicarbonates \rightarrow Salt + H_2O + CO_2$

$HX + MCO_3/MHCO_3 \rightarrow MX + H_2O + CO_2$

For eg.:

$HCl + Na_2CO_3/NaHCO_3 \rightarrow NaCl + H_2O + CO_2$

$H_2SO_4 + MgCO_3 \rightarrow MgSO_4 + H_2O + CO_2$

$CH_3COOH + K_2CO_3 \rightarrow CH_3COOK + H_2O + CO_2$

*This reaction act as a unique characteristic of Acids and can be utilized to detect the presence of an acid in laboratories as the liberated gas can be tested using a lime water test.

b) With Bases

Bases do not react with metal carbonates/ bicarbonates.

3. Reaction with Oxides

a) Acids react with metallic Oxides

Acids react with metallic oxides to form Salt and water stating that metallic oxides are basic in nature.

$Acid + Metallic\ Oxides \rightarrow Salt + H_2O$

$HX + MO \rightarrow MX + H_2O$

For eg.:

$NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

$H_2SO_4 + MgO \rightarrow MgSO_4 + H_2O$

b) Bases react with Non metallic Oxides

Bases react with Non metallic oxides to form Salt and Water stating that Non metallic oxides are acidic in nature.

$Base + Non\ Metal\ Oxides \rightarrow Salt + H_2O$

For eg.:

$NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

$Mg(OH)_2 + SO_2 \rightarrow MgSO_4 + H_2O$

$Ca(OH)_2 + NO_2 \rightarrow Ca(NO_3)_2 + H_2O$

4. Reaction of acids with bases

Acids and bases are opposites of each other; hence they tend to nullify each other's effect when they react with each other. This reaction is called as <u>Neutralisation reaction</u>. In this reaction an acid reacts with a base to form the respective salt along with water.

$Acid + Base \rightarrow Salt + H_2O$

$HX + MOH \rightarrow MX + H_2O$

For eg.

$HCl + NaOH \rightarrow NaCl + H_2O$

$H_2SO_4 + Mg(OH)_2 \rightarrow MgSO_4 + H_2O$

$HNO_3 + Ca(OH)_2 \rightarrow Ca(NO_3)_2 + H_2O$

$CH_3COOH + KOH \rightarrow CH_3COOK + H_2O$

<u>ACIDS AND BASES IN WATER</u>

Acid shows its acidic property due to presence of H^+ ions (Hydrogen/Hydronium ions) and bases show its basic properties due to presence of OH^-(Hydroxide ions).

Hence, liberation of these respective ions is necessary for an acid to act as an acid and for a base to act as a base. This is only possible when acids and bases are ionised in presence of water. Therefore, without the presence of water neither acids nor bases can show their respective properties.

$H_2O \rightarrow H^+ + OH^-$

$HX \rightarrow H^+ + X^-$ $\quad (H_3O^+ = H^+ + H_2O)$

$ROH \rightarrow R^+ + OH^-$

Q. While dissolving acids in water, it is preferred to add acid to water than water to acid. Why?

INDICATORS

Indicators are the chemical substances which help to distinguish between Acids and bases. These indicators change their colour In the presence of acids and bases.

There are two types of indicators:

1. *Natural indicators:* Indicators which are directly obtained from nature are known as natural indicators. For eg. : Litmus, Turmeric, red cabbage leaves etc.
   Litmus is a natural indicator extracted from a plant called lichens. The colour of this indicator in neutral conditions is MAUVE. In acidic conditions, it changes to RED and in basic conditions, it changes to BLUE.
2. *Synthetic indicators:* Indicators which are manmade or synthetically prepared are known as synthetic indicators. For eg.:

Indicator	Neutral Condition	Acidic Condition	Basic Condition
PHENOLPHTHALIEN	Colourless	Colourless	Pink
METHYL ORANGE	Orange	Pink	Yellow

Olfactory Indicators: These are certain types of indicators which indicates the presence of an acid or a base by bringing out change in their odour (smell). For eg. : Vanilla essence, Clove oil and onion.

Strength of an Acid or a Base

Strong and weak Acid: If we have two acids of same concentration of equal volume, then on equal dilution, the acid producing more number of hydrogen ions is a strong acid whereas the acid producing less number of hydrogen ions is a weak acid.
Egs.of strong acids: H_2SO_4, HCl, HNO_3 etc. Egs.of weak acids: H_2CO_3, CH_3COOH etc.

Strong and weak Base: If we have two bases of same concentration of equal volume, then on equal dilution, the base producing more number of hydroxyl ions is a strong base whereas the base producing less number of hydroxyl ions is a weak base.
Egs.of strong bases: KOH, NaOH etc. Egs.of weak bases: $Ca(OH)_2$, NH_4OH etc.

Universal Indicators: It is a mixture of indicators which show different colours for different substances indicating the strength of acids and bases.

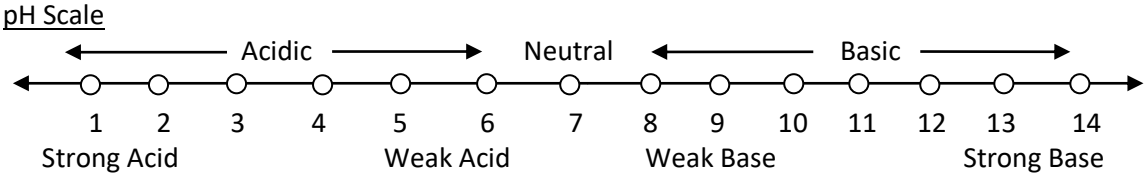
pH

pH means potential for Hydrogen. It measures the amount of Hydrogen ions present in a solution. It is defined as the negative logarithm to the base 10 of hydrogen ion concentration. Its mathematical expression is

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

Therefore, the value of pH of a solution depends on the amount of Hydrogen ions in the solution. The negative sign indicates the inverse relation between the pH value and H^+ concentration which implies more the H^+ concentration, less will be the pH and vice versa.

pH Scale



Application of pH in daily life

1. The aquatic plants and animals can survive in water within a narrow range of pH change. Due to acid rain or effluents flowing in the water bodies alters the pH of the water which disturbs the life of aquatic flora and fauna.
2. Soil types are classified on the basis of their pH values. Types of crops and fertilizers for a particular type of soil are planned accordingly.
3. Tooth decay takes place when the pH of the mouth is highly acidic i.e. below 5.5. This happens when the sweet substances remain stuck in the teeth and decomposes due to bacteria present in the mouth. Hence, it is advised to wash your mouth thoroughly and brush regularly using toothpaste which contains basic substances.

4. Bee stung injects an acid called Methanoic acid in the body which causes itching. Appling baking soda or any basic substance helps in reducing the effect.
5. Human digestion requires the role of gastric juice for digestion in the stomach. Irregular eating habits causes excess of secretion of gastric juice in the stomach which results into uneasiness called Acidity. Basic substances like milk of magnesia work well to treat it.

SALTS

Preparation of salts

Salts are formed when an Acid combines with Base

Acid + Base → Salt + Water

Types of salts

1. On the basis of acid and base from which they are formed.
   a) Acidic Salts: The salts formed from Strong Acid and a Weak Base. Eg. $CaSO_4$, NH_4Cl. These salts turn blue litmus red and the pH value is less than 7.
   b) Basic Salts: The salts formed from Weak Acid and a Strong Base. Eg., CH_3COOK,Na_2CO_3. These salts turn red litmus blue and has pH value higher than 7.
   c) Neutral Salts: The salts formed from Strong Acid and a Strong Base or from Weak Acid and a Weak Base. Eg. Na_2SO_4,$(NH_4)_2CO_3$. These salts does not show any change with litmus and the pH value is 7.
2. On the basic of Cation present in the salt:
   a) Sodium Salts: The salts which has sodium as the metal ion. Eg. Na_2SO_4, Na_2CO_3
   b) Calcium Salts: The salts which has Calcium as the metal ion. Eg. $CaSO_4$, $CaCO_3$
   c) Ammonium Salts: The salts which has Ammonium as the cation. Eg. $(NH_4)_2SO_4$, NH_4Cl
   Etc.
3. On the basic of Anion present in the salt:
   a) Carbonate salts: The salts which have carbonate ion as the anion. Eg. Na_2CO_3, $CaCO_3$
   b) Sulphate Salts: The salts which has Sulphate ion as the anion. Eg. Na_2SO_4, $CaSO_4$
   Etc.

Common Salt: Sodium Chloride (NaCl)

Sodium chloride is commonly known as Common Salt and is widely used in food items. Sea and oceans are a wide source of common salt. It is the raw material for making many chemicals.

Chlor Alkali Process: Electrolysis of Brine(aqueous solution of NaCl) is known as Chlor Alkali process.

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

This process produces three very important substances which are Hydrogen gas(cathode), Chlorine gas (anode) and Sodium Hydroxide(near cathode).

Uses of Hydrogen gas:
a) Used as a fuel
b) Used for the manufacture of Ammonia, this is a very important constituent of fertilizers.
c) Used for the hydrogenation of oils
d) Used for the production of Hydrochloric Acid.

Uses of Chlorine gas:
a) Used to sterilize drinking water as chlorine is a disinfectant.
b) Used as a bleaching agent.
c) Used for manufacturing PVC, CFC, pesticides, paints , dyes etc.
d) Used for the production of Hydrochloric Acid.

Uses of Sodium Hydroxide:
a) Used in the manufacture of soaps and detergents.
b) used for making artificial textile fibres.
c) used in the manufacture of paper.
d) used for degreasing metals and refining oil

Uses of Hydrochloric acid (Formed from Hydrogen and Chlorine gas):
a) Used for cleaning Iron sheets.
b) Used in medicines and cosmetics

c) Used in preparation of chlorides.

Bleaching Powder: Calcium Oxy Chloride ($CaOCl_2$)

1. Preparation: It is prepared by action of Chlorine gas on Slaked lime.

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

2. Properties: It is a white coloured powder giving strong smell of Chlorine. It is soluble in cold water.
3. Uses:

a) Used for bleaching cotton and linen in textile industries, wood pulp in paper factories
b) Used as an oxidising agent in many chemical industries
c) Used for disinfecting drinking water.

Baking Soda: Sodium Bi Carbonate/ Sodium Hydrogen Carbonate ($NaHCO_3$)

1. Preparation: It is prepared during the preparation of sodium carbonate by Solvay's process.

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

2. Properties: It is a basic salt. It is white coloured powder, releases CO_2 on heating.

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

3. Uses:

a) Used in Soda acid fire extinguishers.
b) Used as an antacid.
c) Used in the preparation of Baking Powder. Baking powder is a mixture of baking soda and a mild acid like tartaric acid. CO2 produced makes the bread or cake soft and fluffy.

$$NaHCO_3 + H^+ \rightarrow \text{Na Salt of acid} + CO_2\uparrow + H_2O$$

Washing Soda: Sodium Carbonate deca hydrated ($Na_2CO_3.10H_2O$)

1. Preparation: It is prepared by heating baking soda.

$$2NaHCO_3 \rightarrow Na_2CO_3 + CO_2\uparrow + H_2O$$

Recrystallisation of Sodium carbonate gives washing soda.

$$Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3.10H_2O$$

2. Properties: It is a basic salt.
3. Uses:

A) Used in glass, soap and paper industries.
b) Manufacture of sodium compounds like Borax.
c) Used as a cleaning agent.
d) Used for removing permanent hardness of water.

Plaster of Paris: Calcium Sulphate hemi hydrated ($CaSO_4.1/2H_2O$)

1. Preparation: Prepared by heating gypsum ($CaSO_4.2H_2O$) to a temperature of 100°C in a Kiln.

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

2. Properties: POP is a white powder which on mixing with water forms solid hard mass called gypsum.
3. Uses:

a) Used in hospitals to set fractures.
b) Used in making toys, decorative materials.
c) Used as a fire proofing material.
d) Used in chemistry labs to seal gaps in the apparatus.
e) To make smooth surfaces and casts for statues.

Water of Crystallisation

The fixed numbers of water molecules which form part of the structure of a crystal of a salt are called water of crystallisation. The salts which contain water of crystallisation are known as hydrated salts.

Egs:

a) $CuSO_4.5H_2O$ (Copper sulphate pentahydrated)
b) $Na_2CO_3.10H_2O$ (Washing Soda)
c) $FeSO_4.7H_2O$ (Iron sulphate heptahydrated)
d) $CaSO_4.2H_2O$ (gypsum)
e) $CaSO_4.1/2H_2O$ (Plaster of Paris)

Water of crystallisation gives colour to different salts for eg. Blue colour of copper sulphate. When the hydrated salts are heated, they lose their colour as well as crystalline nature and become white and amorphous.

ASSIGNMENT

Q1. Which gas is evolved when dil. HCl reacts with Zinc?
Q2. Why should curd & sour substances not be kept in brass or copper vessels?
Q3. Which acid is present in Ant sting & Nettle sting?
Q4. What name is given to an indicator which gives different odour in different medium?
Q5. What is the effect of an acid and a basic solution on a blue litmus paper?
Q6. Give one example of strong acid and a weak acid.
Q7. Name the acid present in our stomach that helps in digestion
Q8. What is the effect of dilution on H+ ion concentration of an acid?
Q9. Describe an activity to show that acids produce ions only in aqueous solutions.
Q10. Mention three chemical properties of acids?
Q11. Draw a labeled diagram of a set up of apparatus used to show that acids conduct electricity.
Q12. We should not store pickles in metal containers, why?
Q13. Black color of copper oxide changes to bluish green if reacted with dil. HCl, why?
Q14. Explain the term neutralization reaction with examples.
Q15. What is the color of methyl orange in basic medium?
Q16. What is the color of phenolphthalien in basic medium?
Q17. What is an alkali?
Q18. What is an acid base indicator?
Q19. Give an example each of natural and synthetic indicators?
Q20. Why does dry HCl gas not change the color of the dry litmus paper?
Q21. Give a physical property of Acid.
Q22. What is the nature of metal oxide? Explain using Chemical equations.
Q23. What is the nature of Non metal oxide? Explain using Chemical equations.
Q24. How will you differentiate between acids and Bases chemically?
Q25. What is the difference between strength of Dil. HCl and acetic acid? Explain.
Q26. Explain the term amphoteric metals.
Q27. With the help of an activity show that HCl solution conducts electric current.
Q28. Compounds such as alcohols and glucose also contain hydrogen but are not categorized as acids. Describe an activity to prove it. Also give reason to justify the above statement.
Q29. What is the chemical formula and the chemical name of the common salt?
Q30. What is the range of the pH scale?
Q31. What are the chemical substances used to prepare bleaching powder?
Q32. What is the chemical name of baking soda? What happens when it is heated?
Q33. Name the sodium compound used for softening hard water.
Q34. A chemical substance is used to set the fractured bones in the right position. Give the chemical name and the formula of this substance.
Q35. What are the salts of sulphuric acid called? Give examples.
Q36. What is the ideal pH of the soil for the healthy growth of plants?
Q37. What do you understand by the term pH? What is the pH of neutral, acidic and basic solution?
Q38. How does baking soda help to make cakes soft and spongy?
Q39. How baking soda does helps in extinguishing fire?
Q40. How is Plaster of Paris manufactured? Give two important uses of this compound.
Q41. Fresh milk has a pH of 6. How do you think the pH will change as it turns into curd? Explain your answer.
Q42. A white substance X having a strong smell of chlorine is used to clean a water tank.

a) Identify the substance X and give its chemical formula.
b) How is the above substance X manufactured? Write the chemical equation for its preparation.
c) List two important uses of this compound.

Q43. a) A compound X is used in the glass and soap industry. Identify the compound and give its chemical formula.
b) How many molecules of water of crystallization are present in the compound X?
c) How will you prepare this compound starting from Sodium Chloride? Give all the relevant equations involved in the process.
Q44. Name the mild bases used to reduce acidity in the stomach.
Q45. What is the pH of rain water that leads to acid rain?
Q46. Name the compound of Calcium used for the sterilization of drinking water. Also give its chemical formula.
Q47. What do you understand by the term water of crystallization?
Q48. Name the gases evolved at anode and cathode by the electrolysis of brine?
Q49. Give one example of acidic salt as well as of basic salt?
Q50. Write the chemical name and formula of washing soda.

Q51 A milkman adds a very small amount of baking soda to fresh milk. Why?
Q52. Why does color of Copper sulphate changes from blue to white on heating?
Q53. How does use of toothpaste help in preventing tooth decay caused due to eating chocolates and sweets?
Q54. What is the Chlor- Alkali Process? Why is it so called?
Q55. What happens when POP is made to react with water? Write an equation for the same
Q56. Two students Gita and Shyam were asked to prepare cake. Gita used Baking soda while Shyam used Baking powder for its preparation. Whose cake will taste better and why?
Q57. Five solutions A, B, C, D & E when tested with universal indicator to show pH as 4, 1, 11, 7 & 9 respectively. Which solution is? a) Neutral b) Strongly Alkaline c) Strongly Acidic d) Weakly Acidic e) Weakly Alkaline