

## CLASS XI

### UNIT 5: STATES OF MATTER

#### 5.7 KINETIC ENERGY AND MOLECULAR SPEEDS

Molecules of gases remain in continuous motion. While moving they collide with each other and with the walls of the container. This results in change of their speed and redistribution of energy. So the speed and energy of all the molecules of the gas at any instant is not the same. Thus, we can obtain only average value of speed of molecules. If there are  $n$  number of molecules in a sample and their individual speeds are  $u_1, u_2, u_3, \dots, u_n$ , then average speed of molecules  $u_{av}$  can be calculated as follows :

$$u_{av} = \frac{u_1 + u_2 + \dots + u_n}{n}$$

Maxwell and Boltzmann have shown that actual distribution of molecular speeds depends on temperature and molecular mass of a gas. Maxwell derived a formula for calculating the number of molecules possessing a particular speed. Fig.A(1) shows schematic plot of number of molecules vs. molecular speed at two different temperatures  $T_1$  and  $T_2$  (Temperature  $T_2$  is higher than temperature  $T_1$ ). The distribution of speeds shown in the plot is called Maxwell-Boltzmann distribution of speeds.

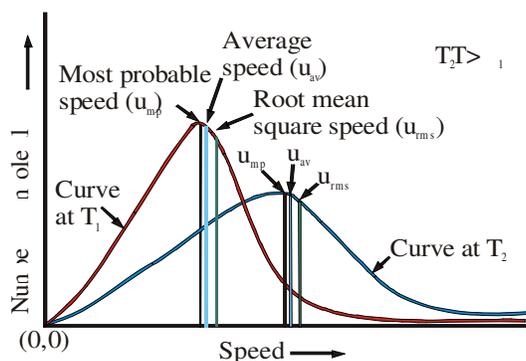


Fig.A(1) : Maxwell-Boltzmann distribution of speeds

The graph shows that number of molecules possessing very high and very low speed is very small. Maximum in the curve represents speed possessed by maximum number of molecules. This speed is called most probable speed,  $u_{mp}$ . This is very close to the average speed of the molecules. On increasing the temperature most probable speed increases. Also, speed distribution curve broadens at higher temperature. Broadening of curve shows that number of molecules moving at higher speed increases. Speed distribution also depends upon mass of molecules. At the same temperature, gas molecules with heavier mass have slower speed than lighter gas molecules. For example, at the same temperature lighter nitrogen molecules move faster than heavier chlorine molecules. Hence, at any given temperature, nitrogen molecules have higher value of most probable speed than the chlorine molecules. See the molecular speed distribution curve of chlorine and nitrogen given in Fig. A(2). Though at a particular temperature the individual speed of molecules keeps changing, the distribution of speeds remains same.

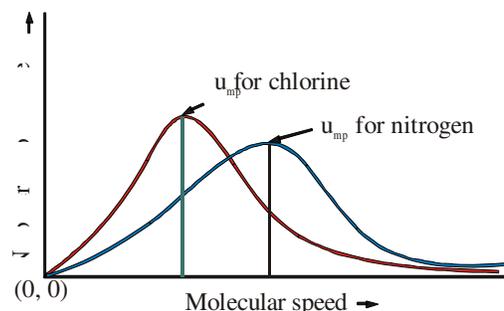


Fig. A(2): Distribution of molecular speeds for chlorine and nitrogen at 300 K

We know that kinetic energy of a particle is given by the expression:

$$\text{Kinetic Energy} = \frac{1}{2} mu^2$$

Therefore if we want to know average translational kinetic energy  $\frac{1}{2} m\overline{u^2}$ , for the movement of a gas particle in a straight line, we require the value of mean of square of speeds  $\overline{u^2}$ , of all molecules. This is represented as follows:

$$\overline{u^2} = \frac{u_1^2 + u_2^2 + \dots + u_n^2}{n}$$

The mean square speed is the direct measure of the average kinetic energy of gas molecules. If we take the square root of the mean of the square of speeds then we get a value of speed which is different from most probable speed and average speed. This speed is called root mean square speed and is given by the expression as follows:

$$u_{\text{rms}} = \sqrt{\overline{u^2}}$$

Root mean square speed, average speed and the most probable speed have following relationship:

$$u_{\text{rms}} > u_{\text{av}} > u_{\text{mp}}$$

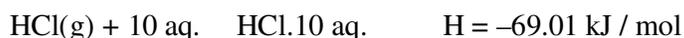
The ratio between the three speeds is given below :

$$u_{\text{mp}} : u_{\text{av}} : u_{\text{rms}} :: 1 : 1.128 : 1.224$$

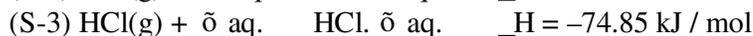
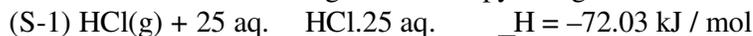
## UNIT 6: THERMODYNAMICS

### 6.5(e) Enthalpy of Dilution

It is known that enthalpy of solution is the enthalpy change associated with the addition of a specified amount of solute to the specified amount of solvent at a constant temperature and pressure. This argument can be applied to any solvent with slight modification. Enthalpy change for dissolving one mole of gaseous hydrogen chloride in 10 mol of water can be represented by the following equation. For convenience we will use the symbol Aq. for water

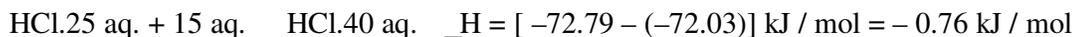


Let us consider the following set of enthalpy changes:



The values of  $\Delta H$  show general dependence of the enthalpy of solution on amount of solvent. As more and more solvent is used, the enthalpy of solution approaches a limiting value, i.e, the value in infinitely dilute solution. For hydrochloric acid this value of  $\Delta H$  in equation (S-3) written above.

If we subtract the first equation from the second equation in the above set of equations, we obtain-



The value of  $\Delta H$  is enthalpy of dilution, the heat withdrawn from the surroundings when additional solvent is added to the solution. The enthalpy of dilution of a solution is dependent on the original concentration of the solution and the amount of solvent added.

### 6.6(c) Entropy and Second Law of Thermodynamics

We know that for an isolated system the change in energy remains constant. Therefore, increase in entropy in such systems is the natural direction of a spontaneous change. This, in fact is the second law of thermodynamics. Like first law of thermodynamics, second law can also be stated in several ways. The second law of thermodynamics explains why spontaneous exothermic reactions are so common. In exothermic reactions heat released by the reaction increases the disorder of the surroundings and overall entropy change is positive which makes the reaction spontaneous.

### 6.6(d) Absolute Entropy and Third law of Thermodynamics

Molecules of a substance may move in a straight line in any direction, they may spin like a top and the bonds in the molecules may stretch and compress. These motions of the molecule are called translational, rotational and vibrational motion respectively. When temperature of the system rises these motions become more vigorous and entropy increases. On the other hand when temperature is lowered, the entropy decreases.

The entropy of any pure crystalline substance approaches zero as the temperature approaches absolute zero. This is called third law of thermodynamics. This is so because there is perfect order in a crystal at absolute zero. The statement is confined to pure crystalline solids because theoretical arguments and practical evidences have shown that entropy of solutions and super cooled liquids is not zero at 0 K. The importance of the third law lies in the fact that it permits the calculation of absolute values of entropy

of pure substance from thermal data alone. For a pure substance, this can be done by summing  $\frac{q_{\text{rev}}}{T}$  increments from 0K to 298 K. Standard entropies can be used to calculate standard entropy changes by a Hess's law type of calculation.

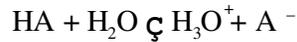
## UNIT 7: EQUILIBRIUM

### 7.12.1 Designing Buffer Solution

Knowledge of  $pK_a$ ,  $pK_b$  and equilibrium constant help us to prepare the buffer solution of known pH. Let us see how we can do this.

#### Preparation of acidic buffer

To prepare a buffer of acidic pH we use weak acid and its salt formed with strong base. We develop the equation relating the pH, the equilibrium constant,  $K_a$  of weak acid and ratio of concentration of weak acid and its conjugate base. For the general case where the weak acid  $HA$  ionises in water,



For which we can write the expression -

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{A}^-]}{[\text{HA}]}$$

Rearranging the expression we have,

$$[\text{H}_3\text{O}^+] = K_a \frac{[\text{HA}]}{[\text{A}^-]}$$

Taking logarithm on both the sides and rearranging the terms we get -

$$\text{pH} = \text{p}K_a + \log \frac{[\text{A}^-]}{[\text{HA}]}$$

$$\text{Or } \text{pH} = \text{p}K_a + \log \frac{[\text{A}^-]}{[\text{HA}]} \quad (\text{A-1})$$

$$\text{pH} = \text{p}K_a + \log \frac{[\text{Conjugate base, A}^-]}{[\text{Acid, HA}]} \quad (\text{A-2})$$

The expression (A-2) is known as Henderson – Hasselbalch equation. The quantity  $\frac{[\text{A}^-]}{[\text{HA}]}$  is the ratio of concentration of conjugate base (anion) of the acid and the acid present in the mixture. Since acid is a weak acid, it ionises to a very little extent and concentration of [HA] is negligibly different from concentration of acid taken to form buffer. Also, most of the conjugate base, [A<sup>-</sup>], comes from the ionisation of salt of the acid. Therefore the concentration of conjugate base will be negligibly different from the concentration of salt. Thus, equation (A-2) takes the form:

$$\text{pH} = \text{p}K_a + \log \frac{[\text{Salt}]}{[\text{Acid}]}$$

In the equation (A-1), if the concentration of [A<sup>-</sup>] is equal to the concentration of [HA] then pH = pK<sub>a</sub> because value of log 1 is zero. Thus if we take molar concentration of acid and salt (conjugate base) same, the pH of the buffer solution will be equal to the pK<sub>a</sub> of the acid. So for preparing the buffer solution of the required pH we select that acid whose pK<sub>a</sub> is close to the required pH. For acetic acid pK<sub>a</sub> value is 4.76, therefore pH of the buffer solution formed by acetic acid and sodium acetate taken in equal molar concentration will be around 4.76.

A similar analysis of a buffer made with a weak base and its conjugate acid leads to the result,

$$\text{pOH} = \text{p}K_b + \log \frac{[\text{Conjugate acid, BH}^+]}{[\text{Base, B}]} \quad (\text{A-3})$$

pH of the buffer solution can be calculated by using the equation pH + pOH = 14. We know that pH + pOH = pK<sub>w</sub> and pK<sub>a</sub> + pK<sub>b</sub> = pK<sub>w</sub>. On putting these values in equation (A-3) it takes the form as follows :

$$\text{pH} = \text{p}K_a + \log \frac{[\text{Conjugate acid, BH}^+]}{[\text{Base, B}]}$$

$$\text{Or } \text{pH} = \text{p}K_a + \log \frac{[\text{Conjugate acid, BH}^+]}{[\text{Base, B}]} \quad (\text{A-4})$$

If molar concentration of base and its conjugate acid (cation) is same then pH of the buffer solution will be same as  $pK_a$  for the base.  $pK_a$  value for ammonia is 9.25; therefore a buffer of pH close to 9.25 can be obtained by taking ammonia solution and ammonium chloride solution of equal molar concentration. For a buffer solution formed by ammonium chloride and ammonium hydroxide, equation (A-4) becomes:

$$pH = 9.25 + \log \frac{[\text{Conjugate acid, } BH^+]}{[\text{Base, } B]}$$

pH of the buffer solution is not affected by dilution because ratio under the logarithmic term remains unchanged.

## CLASS XII

### UNIT 14 : BIOMOLECULES

#### 14.5 Hormones

Hormones are molecules that act as intercellular messengers. These are produced by endocrine glands in the body and are poured directly in the blood stream which transports them to the site of action.

In terms of chemical nature, some of these are steroids, e.g., estrogens and androgens; some like insulin and endorphins are poly peptides, and amino acid derivatives such as epinephrine and nor epinephrine.

Hormones have several functions in the body. They help to maintain the balance of biological activities in the body. The role of insulin in keeping the blood glucose level within the narrow limit is an example of this function. Insulin is released in response to the rapid rise in blood glucose level. On the other hand hormone glucagon tends to increase the glucose level in the blood. The two hormones together regulate the glucose level in the blood. Epinephrine and norepinephrine mediate responses to external stimuli. Growth hormones and sex hormones play role in growth and development. Thyroxine produced in the thyroid gland is an iodinated derivative of amino acid tyrosine. Abnormally low level of thyroxine leads to hypothyroidism which is characterised by lethargy and obesity. Increased level of thyroxine causes hyperthyroidism. Low level of iodine in the diet may lead to hypothyroidism and enlargement of the thyroid gland. This condition is largely being controlled by adding sodium iodide to commercial table salt ("Iodised" salt).

Steroid hormones are produced by adrenal cortex and gonads ( testes in male and ovaries in females).Hormones released by the adrenal cortex play very important role in the functions of the body. For example glucocorticoids control the carbohydrate metabolism, modulate inflammatory reactions, and are involved in reactions to stress. The mineralocorticoids control the level of excretion of water and salt by the kidney. If adrenal cortex does not function properly then one of the results may be Addison's disease characterised by hypoglycemia, weakness and increased susceptibility to stress. The disease is fatal unless it is treated by glucocorticoids and mineralocorticoids. Hormones released by gonads are responsible for development of secondary sex characters. Testosterone is the major sex hormone produced in males. It is responsible for development of secondary male characteristics (deep voice, facial hair, general physical constitution) and estradiol is the main female sex hormone. It is responsible for development of secondary female characteristics and participates in the control of menstrual cycle. Progesterone is responsible for preparing the uterus for implantation of fertilised egg.

### UNIT 16 : CHEMISTRY IN EVERYDAY LIFE

#### 16.4.3 Antioxidants in Food

These are important and necessary food additives. These help in food preservation by retarding the action of oxygen on food. These are more reactive towards oxygen than the food material they are protecting. The two most familiar antioxidants are butylated hydroxyl toluene (BHT) and butylated hydroxy anisole (BHA). The addition of BHA to butter increases its shelf life from months to years.

Some times BHT and BHA along with citric acid are added to produce more effect. Sulphur dioxide and sulphite are useful antioxidants for wine and beer, sugar syrups and cut peeled or dried fruits and vegetables.

## CHEMISTRY (CLASSES XI –XII)

### RATIONALE

Higher Secondary Stage is the most crucial stage of school education because at this stage specialised discipline based, content oriented courses are introduced. Students reach this stage after 10 years of general education and opt for Chemistry with a purpose of mostly for pursuing their career in basic sciences or professional courses like medicines, engineering, technology and studying courses in applied areas of science and technology at tertiary level. Therefore, at this stage, there is a need to provide learners with sufficient conceptual background of Chemistry, which will make them competent to meet the challenges of academic and professional courses after the higher secondary stage.

National Curriculum Framework - 2005 recommends a disciplinary approach with appropriate rigour and depth with the care that syllabus is not heavy and at the same time it is comparable to the international level. It emphasizes a coherent focus on important ideas within the discipline that are properly sequenced to optimize learning. It recommends that theoretical component of Higher Secondary Science should emphasize on problem solving methods and the awareness of historical development of key concepts of science be judiciously integrated into content. The present exercise of syllabus development in Chemistry at Higher Secondary Stage is based on this framework.

### **Salient features of the present syllabus are thus:**

- Some background of Chemistry from secondary stage is assumed; however, no specific knowledge of topics in Chemistry is pre-supposed.
- The course is self-contained and broadly covers fundamental concepts of Chemistry.
- Attempt has been made to see discipline of Chemistry does not remain only the science of facts but becomes related to modern applications in the world around us.
- The syllabus provides logical sequencing of the 'Units' of the subject matter with proper placement of concepts with their linkages for better understanding.
- Emphasis has been on promoting process - skills, problem solving abilities and applications of concepts of Chemistry useful in real life situation for making learning of Chemistry more relevant, meaningful and interesting.
- An effort has been made on the basis of feedback, to remove repetition besides reducing the content by suitably integrating the different content areas.
- Practical syllabus has two components. There are core experiments to be undertaken by the students in the classroom and will be part of examination while each student will carry out one investigatory project and submit the report for the examination.

With this background, the Chemistry curriculum at the higher secondary stage attempts to

- promote understanding of basic principles in Chemistry while retaining the excitement in Chemistry;
- develop an interest in students to study Chemistry as discipline;

- strengthen the concepts developed at the secondary stage and to provide firm foundation for further learning of Chemistry at tertiary level more effectively;
- develop positive scientific attitude, and appreciate contribution of Chemistry towards the improvement of quality of human life;
- develop problem solving skills and nurture curiosity, aesthetic sense and creativity;
- inculcate values of honesty, integrity, cooperation, concern for life and preservation of the environment;
- make the learner realise the interface of Chemistry with other disciplines of science such as Physics, Biology, Geology, etc;
- equip students to face challenges related to health, nutrition, environment, population, whether industries and agriculture.

## CLASS XI (THEORY)

(Total Periods 180)

### Unit I: Some Basic Concepts of Chemistry

(Periods 14)

*General Introduction:* Importance and scope of chemistry.

Historical approach to particulate nature of matter, laws of chemical combination, *Dalton's atomic theory*: concept of elements, atoms and molecules.

Atomic and molecular masses. Mole concept and molar mass; percentage composition and empirical and molecular formula; chemical reactions, stoichiometry and calculations based on stoichiometry.

### Unit II: Structure of Atom

(Periods 16)

Discovery of electron, proton and neutron; atomic number, isotopes and isobars. Thompson's model and its limitations, Rutherford's model and its limitations, Bohr's model and its limitations, concept of shells and subshells, dual nature of matter and light, de Broglie's relationship, Heisenberg uncertainty principle, concept of orbitals, quantum numbers, shapes of *s*, *p* and *d* orbitals, rules for filling electrons in orbitals - Aufbau principle, Pauli exclusion principle and Hund's rule, electronic configuration of atoms, stability of half filled and completely filled orbitals.

### Unit III: Classification of Elements and Periodicity in Properties

(Periods 8)

Significance of classification, brief history of the development of periodic table, modern periodic law and the present form of periodic table, periodic trends in properties of elements –atomic radii, ionic radii, inert gas radii, ionization enthalpy, electron gain enthalpy, electronegativity, valence. Nomenclature of elements with atomic number greater than 100.

### Unit IV: Chemical Bonding and Molecular Structure

(Periods 16)

Valence electrons, ionic bond, covalent bond, bond parameters, Lewis structure, polar character of covalent bond, covalent character of ionic bond, valence bond theory, resonance, geometry of covalent molecules, VSEPR theory, concept of hybridization involving *s*, *p* and *d* orbitals and shapes of some simple molecules, molecular orbital theory of homonuclear diatomic molecules (qualitative idea only). Hydrogen bond.

### Unit V: States of Matter: Gases and Liquids

(Periods 14)

Three states of matter, intermolecular interactions, types of bonding, melting and boiling points, role of gas laws in elucidating the concept of the molecule, Boyle's law, Charles's law, Gay Lussac's law, Avogadro's law, ideal behaviour, empirical derivation of gas equation, Avogadro number, ideal gas equation. Kinetic energy and molecular speeds (elementary idea), deviation from ideal behaviour, liquefaction of gases, critical temperature.

Liquid State – Vapour pressure, viscosity and surface tension (qualitative idea only, no mathematical derivations).

## Unit VI: Thermodynamics

(Periods 18)

Concepts of system, types of systems, surroundings, work, heat, energy, extensive and intensive properties, state functions.

First law of thermodynamics – internal energy and enthalpy, heat capacity and specific heat, measurement of  $\Delta U$  and  $\Delta H$ , Hess's law of constant heat summation, enthalpy of : bond dissociation, combustion, formation, atomization, sublimation, phase transition, ionization, solution and dilution.

Introduction of entropy as a state function, Second law of thermodynamics, Gibbs energy change for spontaneous and non-spontaneous process, criteria for equilibrium.

Third law of thermodynamics –Brief introduction.

## Unit VII: Equilibrium

(Periods 20)

Equilibrium in physical and chemical processes, dynamic nature of equilibrium, law of mass action, equilibrium constant, factors affecting equilibrium – Le Chatelier's principle; ionic equilibrium – ionization of acids and bases, strong and weak electrolytes, degree of ionization, ionization of polybasic acids, acid strength, concept of pH., Hydrolysis of salts (elementary idea), , buffer solutions, Henderson equation, solubility product, common ion effect (with illustrative examples).

## Unit VIII : Redox Reactions

(Periods 6)

Concept of oxidation and reduction, redox reactions, oxidation number, balancing redox reactions in terms of loss and gain of electron and change in oxidation numbers , applications of redox reactions.

## Unit IX Hydrogen

(Periods 8)

Position of hydrogen in periodic table, occurrence, isotopes, preparation, properties and uses of hydrogen; hydrides – ionic, covalent and interstitial; physical and chemical properties of water, heavy water; hydrogen peroxide-preparation, reactions, use and structure; hydrogen as a fuel.

## Unit X: *s*-Block Elements (Alkali and Alkaline earth metals)

(Periods 14)

*Group 1 and Group 2 elements:*

General introduction, electronic configuration, occurrence, anomalous properties of the first element of each group, diagonal relationship, trends in the variation of properties (such as ionization enthalpy, atomic and ionic radii), trends in chemical reactivity with oxygen, water, hydrogen and halogens; uses.

Preparation and Properties of Some Important Compounds:

Sodium carbonate, sodium chloride, sodium hydroxide and sodium hydrogencarbonate, biological importance of sodium and potassium.

CaO, CaCO<sub>3</sub>, and industrial use of lime and limestone, biological importance of Mg and Ca.

## Unit XI: Some *p*-Block Elements

(Periods 16)

General Introduction to *p*-Block Elements

*Group 13 elements:* General introduction, electronic configuration, occurrence, variation of properties, oxidation states, trends in chemical reactivity, anomalous properties of first element of the group; Boron-physical and chemical properties, some important compounds: borax, boric acids, boron hydrides. Aluminium: uses, reactions with acids and alkalis.

*Group 14 elements*: General introduction, electronic configuration, occurrence, variation of properties, oxidation states, trends in chemical reactivity, anomalous behaviour of first element. Carbon - catenation, allotropic forms, physical and chemical properties; uses of some important compounds: oxides.

Important compounds of silicon and a few uses : silicon tetrachloride, silicones, silicates and zeolites, their uses.

## **Unit XII: Organic Chemistry – Some Basic Principles and Techniques**

**(Periods 14)**

General introduction, methods of purification, qualitative and quantitative analysis, classification and IUPAC nomenclature of organic compounds.

Electronic displacements in a covalent bond: inductive effect, electromeric effect, resonance and hyper conjugation.

Homolytic and heterolytic fission of a covalent bond: free radicals, carbocations, carbanions; electrophiles and nucleophiles, types of organic reactions.

## **Unit XIII: Hydrocarbons**

**(Periods 16)**

Classification of Hydrocarbons.

Aliphatic Hydrocarbons:

*Alkanes* – Nomenclature, isomerism, conformations (ethane only), physical properties, chemical reactions including free radical mechanism of halogenation, combustion and pyrolysis.

*Alkenes* – Nomenclature, structure of double bond (ethene), geometrical isomerism, physical properties, methods of preparation; chemical reactions: addition of hydrogen, halogen, water, hydrogen halides (Markovnikov's addition and peroxide effect), ozonolysis, oxidation, mechanism of electrophilic addition.

*Alkynes* – Nomenclature, structure of triple bond (ethyne), physical properties, methods of preparation, chemical reactions: acidic character of alkynes, addition reaction of - hydrogen, halogens, hydrogen halides and water.

*Aromatic hydrocarbons* – Introduction, IUPAC nomenclature; Benzene: resonance, aromaticity ; chemical properties: mechanism of electrophilic substitution – nitration sulphonation, halogenation, Friedel Craft's alkylation and acylation; directive influence of functional group in mono-substituted benzene; carcinogenicity and toxicity.

## **Unit XIV: Environmental Chemistry**

**(Periods 6)**

*Environmental pollution* – Air, water and soil pollution, chemical reactions in atmosphere, smogs, major atmospheric pollutants; acid rain, ozone and its reactions, effects of depletion of ozone layer, greenhouse effect and global warming – pollution due to industrial wastes; green chemistry as an alternative tool for reducing pollution, strategy for control of environmental pollution.

## PRACTICALS

**Total Periods 60**

Micro-chemical methods are available for several of the practical experiments. Wherever possible such techniques should be used.

### **A. Basic Laboratory Techniques (Periods 2)**

1. Cutting glass tube and glass rod
2. Bending a glass tube
3. Drawing out a glass jet
4. Boring a cork

### **B. Characterization and Purification of Chemical Substance (Periods 6)**

1. Determination of melting point of an organic compound.
2. Determination of boiling point of an organic compound.
3. Crystallization involving impure sample of any one of the following:  
Alum, copper sulphate, Benzoic acid.

### **C. Experiments Related to pH Change (Periods 8)**

- (a) Any one of the following experiments:
- Determination of pH of some solutions obtained from fruit juices, solutions of known and varied concentrations of acids, bases and salts using pH paper or universal indicator.
  - Comparing the pH of solutions of strong and weak acid of same concentration.
  - Study the pH change in the titration of a strong acid with a strong base using universal indicator.
- (b) Study of pH change by common-ion effect in case of weak acids and weak bases.

### **D. Chemical Equilibrium (Periods 4)**

One of the following experiments:

- (a) Study the shift in equilibrium between ferric ions and thiocyanate ions by increasing /decreasing the concentration of either of the ions.
- (b) Study the shift in equilibrium between  $[\text{Co}(\text{H}_2\text{O})_6^{3+}]$  and chloride ions by changing the concentration of either of the ions .

### **E. Quantitative Estimation (Periods 16)**

- Using a chemical balance.
- Preparation of standard solution of oxalic acid.
- Determination of strength of a given solution of sodium hydroxide by titrating it against standard solution of oxalic acid.
- Preparation of standard solution of sodium carbonate.

- Determination of strength of a given solution of hydrochloric acid by titrating it against standard sodium carbonate solution.

## F. Qualitative Analysis

(Periods 16)

(a) Determination of one anion and one cation in a given salt

Cations -  $\text{Pb}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{As}^{3+}$ ,  $\text{Al}^{3+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Ni}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Co}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{NH}_4^+$

Anions -  $\text{CO}_3^{2-}$ ,  $\text{S}^{2-}$ ,  $\text{SO}_3^{2-}$ ,  $\text{S}_2\text{O}_3^{2-}$ ,  $\text{NO}_2^-$ ,  $\text{NO}_3^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ ,  $\text{PO}_4^{3-}$ ,  $\text{C}_2\text{O}_4^{2-}$ ,  $\text{C}_4\text{H}_4\text{O}_6^{2-}$

(Note : Insoluble salts excluded)

(b) Detection of nitrogen, sulphur, chlorine, in organic compounds.

## Project

(Periods 10)

Scientific investigations involving laboratory testing and collecting information from other sources.

### A few suggested projects

- Checking the bacterial contamination in drinking water by testing sulphide ions.
- Study of the methods of purification of water.
- Testing the hardness, presence of iron, fluoride, chloride etc. depending upon the regional variation in drinking water and the study of causes of presences of these ions above permissible limit (if any)
- Investigation of the foaming capacity of different washing soaps and the effect of addition of sodium carbonate on them.
- Study of the acidity of different samples of the tea leaves.
- Determination of the rate of evaporation of different liquids.
- Study of the effect of acids and bases on the tensile strength of fibers.
- Analysis of fruit and vegetable juices for their acidity.

Note: Any other investigatory project, which involves about 10 periods of work, can be chosen with the approval of the teacher.

## CLASS XII (THEORY)

Total Periods 180

### Unit I: Solid State

(Periods 12)

Classification of solids based on different binding forces :molecular, ionic covalent and metallic solids, amorphous and crystalline solids(elementary idea),unit cell in two dimensional and three dimensional lattices, calculation of density of unit cell, packing in solids, packing efficiency, voids ,number of atoms per unit cell in a cubic unit cell, point defects, electrical and magnetic properties, Band theory of metals ,conductors, semiconductors and insulators and  $n$  and  $p$  type semiconductors .

### Unit II : Solutions

(Periods 12)

Types of solutions, expression of concentration of solutions of solids in liquids, solubility of gases in liquids, solid solutions, colligative properties – relative lowering of vapour pressure, Raoult's law ,elevation

of B.P., depression of free zing point, osmotic pressure, determination of molecular masses using colligative properties, abnormal molecular mass, Vant Hoff factor.

### Unit III: Electrochemistry

(Periods 14)

Redox reactions; conductance in electrolytic solutions, specific and molar conductivity variations of conductivity with concentration, Kohlrausch's Law, electrolysis and laws of electrolysis (elementary idea), dry cell – electrolytic cells and Galvanic cells; lead accumulator, EMF of a cell, standard electrode potential, Nernst equation and its application to chemical cells. Relation between Gibbs energy change and EMF of a cell, fuel cells; corrosion.

### Unit IV: Chemical Kinetics

(Periods 12)

Rate of a reaction (average and instantaneous), factors affecting rates of reaction: concentration, temperature, catalyst; order and molecularity of a reaction; rate law and specific rate constant, integrated rate equations and half life (only for zero and first order reactions); concept of collision theory (elementary idea, no mathematical treatment). Activation energy, Arrhenius equation.

### Unit V: Surface Chemistry

(Periods 8)

*Adsorption* – physisorption and chemisorption; factors affecting adsorption of gases on solids; catalysis :homogenous and heterogeneous, activity and selectivity: enzyme catalysis; colloidal state: distinction between true solutions, colloids and suspensions; lyophilic, lyophobic multimolecular and macromolecular colloids; properties of colloids; Tyndall effect, Brownian movement, electrophoresis, coagulation; emulsions – types of emulsions.

### Unit VI: General Principles and Processes of Isolation of Elements

(Periods 8)

*Principles and methods of extraction* – concentration, oxidation, reduction electrolytic method and refining; occurrence and principles of extraction of aluminium, copper, zinc and iron.

### Unit VII: *p*-Block Elements

(Periods 14)

*Group 15 elements:* General introduction, electronic configuration, occurrence, oxidation states, trends in physical and chemical properties; nitrogen – preparation, properties and uses; compounds of nitrogen: preparation and properties of ammonia and nitric acid, oxides of nitrogen ( structure only); Phosphorous-allotropic forms; compounds of phosphorous: preparation and properties of phosphine, halides ( $PCl_3$ ,  $PCl_5$ ) and oxoacids (elementary idea only).

*Group 16 elements :* General introduction, electronic configuration, oxidation states, occurrence, trends in physical and chemical properties; dioxygen: preparation, properties and uses; classification of oxides; ozone. Sulphur – allotropic forms; compounds of sulphur: preparation, properties and uses of sulphur dioxide; sulphuric acid: industrial process of manufacture, properties and uses, oxoacids of sulphur (structures only).

*Group 17 elements :* General introduction, electronic configuration, oxidation states, occurrence, trends in physical and chemical properties; compounds of halogens: preparation, properties and uses of chlorine and hydrochloric acid, interhalogen compounds, oxoacids of halogens (structures only).

*Group 18 elements:* General introduction, electronic configuration, occurrence, trends in physical and chemical properties, uses.

### **Unit VIII: *d* and *f* Block Elements**

**(Period 14)**

General introduction, electronic configuration, occurrence and characteristics of transition metals, general trends in properties of the first row transition metals – metallic character, ionization enthalpy, oxidation states, ionic radii, colour, catalytic property, magnetic properties, interstitial compounds, alloy formation. Preparation and properties of  $K_2Cr_2O_7$  and  $KMnO_4$ .

*Lanthanoids* – electronic configuration, oxidation states, chemical reactivity and lanthanoid contraction and its consequences.

*Actinoids* – Electronic configuration, oxidation states and comparison with lanthanoids.

### **Unit IX Coordination Compounds**

**(Period 12)**

*Coordination compounds* : Introduction, ligands, coordination number, colour, magnetic properties and shapes, IUPAC nomenclature of mononuclear coordination compounds, bonding, Werner's theory VBT, CFT; isomerism (structural and stereo) importance of coordination compounds (in qualitative analysis, extraction of metals and biological systems).

### **Unit X: Haloalkanes and Haloarenes**

**(Periods 12)**

*Haloalkanes*: Nomenclature, nature of C-X bond, physical and chemical properties, mechanism of substitution reactions. Optical rotation.

*Haloarenes*: Nature of C-X bond, substitution reactions (directive influence of halogen for monosubstituted compounds only).

Uses and environmental effects of – dichloromethane, trichloromethane, tetrachloromethane, iodoform, freons, DDT.

### **Unit XI: Alcohols, Phenols and Ethers**

**(Periods 12)**

*Alcohols*: Nomenclature, methods of preparation, physical and chemical properties (of primary alcohols only); identification of primary, secondary and tertiary alcohols; mechanism of dehydration, uses, with special reference to methanol and ethanol.

*Phenols* : Nomenclature, methods of preparation, physical and chemical properties, acidic nature of phenol, electrophilic substitution reactions, uses of phenols.

*Ethers* : Nomenclature, methods of preparation, physical and chemical properties, uses.

### **Unit XII: Aldehydes, Ketones and Carboxylic Acids**

**(Period 12)**

*Aldehydes and Ketones*: Nomenclature, nature of carbonyl group, methods of preparation, physical and chemical properties, and mechanism of nucleophilic addition, reactivity of alpha hydrogen in aldehydes; uses.

*Carboxylic Acids*: Nomenclature, acidic nature, methods of preparation, physical and chemical properties; uses.

### **Unit XIII: Organic Compounds Containing Nitrogen**

**(Periods 10)**

*Amines*: Nomenclature, classification, structure, methods of preparation, physical and chemical properties, uses, identification of primary secondary and tertiary amines.

*Cyanides and Isocyanides* – will be mentioned at relevant places in context.

*Diazonium salts*: Preparation, chemical reactions and importance in synthetic organic chemistry.

## Unit XIV: Biomolecules

(Periods 12)

*Carbohydrates* – Classification (aldoses and ketoses), monosaccharide (glucose and fructose), D-L configuration, oligosaccharides (sucrose, lactose, maltose), polysaccharides (starch, cellulose, glycogen): importance.

*Proteins* - Elementary idea of  $\alpha$ -amino acids, peptide bond, polypeptides, proteins, primary structure, secondary structure, tertiary structure and quaternary structure (qualitative idea only), denaturation of proteins; enzymes.

***Hormones* –Elementary idea (excluding structure).**

*Vitamins* – Classification and functions.

*Nucleic Acids*: DNA and RNA

## Unit XV: Polymers

(Periods 8)

*Classification* – Natural and synthetic, methods of polymerization (addition and condensation), copolymerization. Some important polymers: natural and synthetic like polythene, nylon, polyesters, bakelite, rubber. Biodegradable and non-biodegradable polymers.

## Unit XVI: Chemistry in Everyday Life

(Periods 8)

1. Chemicals in medicines – analgesics, tranquilizers, antiseptics, disinfectants, antimicrobials, antifertility drugs, antibiotics, antacids, antihistamines.
2. Chemicals in food – preservatives, artificial sweetening agents, **elementary idea of antioxidants**.
3. Cleansing agents – soaps and detergents, cleansing action.

## PRACTICALS

**Total Periods 60**

Micro-chemical methods are available for several of the practical experiments. Wherever possible such techniques should be used.

### A. Surface Chemistry

(Periods 5)

- (a) Preparation of one lyophilic and one lyophobic sol.

*Lyophilic sol* : starch , egg albumin and gum.

*Lyophobic sol* : aluminium hydroxide, ferric hydroxide, arsenious sulphide.

- (b) Dialysis of sol prepared in (a) above.  
(c) Study of the role of emulsifying agent in stabilizing the emulsions of different oils.

### B. Chemical Kinetics

(Periods 4)

- (a) Effect of concentration and temperature on the rate of reaction between sodium thiosulphate and hydrochloric acid .  
(b) Study of reaction rates of any one of the following:  
(i) Reaction of iodide ion with hydrogen peroxide at room temperature using different concentrations of iodide ions.  
(ii) Reaction between potassium iodate ( $KIO_3$ ) and sodium sulphite ( $Na_2SO_3$ ) using starch solution as indicator (clock reaction).

**C. Thermochemistry** (Periods 4)

Any one of the following experiments :

- Enthalpy of dissolution of copper sulphate or potassium nitrate.
- Enthalpy of neutralization of strong acid (HCl) and strong base (NaOH)
- Determination of enthalpy change during interaction (Hydrogen bond formation) between acetone and chloroform.

**D. Electrochemistry** (Periods 2)

Variation of cell potential in  $Zn/Zn // Cu /Cu$  with change in concentration of electrolytes ( $CuSO_4$  or  $ZnSO_4$ ) at room temperature.

**E. Chromatography** (Periods 2)

- Separation of pigments from extracts of leaves and flowers by paper chromatography and determination of  $R_f$  values.
- Separation of constituents present in an inorganic mixture containing two cations only (constituents having wide difference in  $R_f$  values to be provided).

**F. Preparation of Inorganic Compounds** (Periods 4)

- Preparation of double salt of ferrous ammonium sulphate or potash alum.
- Preparation of potassium ferric oxalate.

**G. Preparation of Organic Compounds** (Periods 2)

Preparation of any one of the following compounds:

- Acetanilide
- Di-benzal acetone
- p*-Nitroacetanilide
- Aniline yellow or 2 - Naphthol aniline dye

**H. Test for the Functional Groups Present in Organic Compounds** (Periods 5)

Unsaturation, alcoholic, phenolic, aldehydic, ketonic, carboxylic and amino (primary) groups.

**I. Characteristic Tests of Carbohydrates, Fats and Proteins in Pure Samples and Their Detection in Given Food Stuffs.** (Period 4)

**J. Determination of Concentration/Molarity of  $KMnO_4$  Solution by Titrating it against a Standard Solution of –** (Periods 10)

- Oxalic acid
  - Ferrous ammonium sulphate
- (Students will be required to prepare standard solutions by weighing themselves).

## K. Qualitative Analysis

(Periods 16)

- Determination of one cation and one anion in a given salt.

Cations -  $\text{Pb}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{As}^{3+}$ ,  $\text{Al}^{3+}$ ,  $\text{Fe}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Ni}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Co}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{NH}_4^+$

Anions -  $\text{CO}_3^{2-}$ ,  $\text{S}^{2-}$ ,  $\text{SO}_3^{2-}$ ,  $\text{NO}_2^-$ ,  $\text{NO}_3^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ ,  $\text{PO}_4^{3-}$ ,  $\text{C}_2\text{O}_4^{2-}$ ,  $\text{CH}_3\text{COO}^-$

(Note : Insoluble salts excluded)

## Projects

(Periods 10)

Scientific investigations involving laboratory testing and collecting information from other sources.

### A few suggested projects

- Study of presence of oxalate ions in guava fruit at different stages of ripening.
- Study of quantity of casein present in different samples of milk.
- Preparation of soybean milk and its comparison with the natural milk with respect to curd formation, effect of temperature, etc.
- Study of the effect of potassium bisulphate as food preservative under various conditions (temperature, concentration, time etc.)
- Study of digestion of starch by salivary amylase and effect of pH and temperature on it.
- Comparative study of the rate of fermentation of following materials: wheat flour, gram flour, potato juice, carrot juice etc.
- Extraction of essential oils present in *Saunf* (aniseed), *Ajwain* (carum), *Illaiichi* (cardamom).
- Study of common food adulterants in fat, oil, butter, sugar, turmeric powder, chilli powder and pepper.

Note: Any other investigatory project, which involves about 10 periods of work, can be chosen with the approval of the teacher. In addition models and exhibits for exhibition, depicting basic principles and application in daily life may also be included.

# CHEMISTRY