KFT 131/3 - Physical Chemistry I

Course Objective: To provide students with the basic knowledge of gases, kinetics theory of gases, molecular collisions, transport phenomena of gases, chemical kinetics and chemical thermodynamics.

Topic	Content	Number of lecture hours	Expected outcome - upon completion of these experiments, the student should be able to:
1. Gases	• Properties of gases • Ideal gas law, Boyle's Law, Charles's Law, Avogadro's hypothesis • Gas mixtures, partial pressures, mole fractions • Critical phenomena, compressibility factor, Z • Van der Waals equation and other equations of state	5	• Know basic principles and properties of gases. • Write and derive the ideal gas law. • Relate partial pressures of two or more components of ideal gas mixture with various mole fractions at constant total pressure. • Distinguish the properties of ideal and real gases. • Know the limitations and the deviation from ideal gas law. • Apply the van der Waals and other equations of state. • Know the limitations of these equations of state in their applications.
2. Kinetics Theory of Gases	• Elementary kinetic theory • Maxwell – Boltzmann equation, probability density • Types of average molecular speeds, v_{rms}, v and v_{mp}	3	• Understand the assumptions of the kinetic theory of gases. • Derive ideal gas law from the kinetic theory of gases. • Apply the Maxwell-Boltzmann equation to calculate the probability of the gas molecules (to determine the number/fraction of molecules) between two molecular speeds. • Distinguish the different molecular speeds. • Calculate the three different molecular speeds at a particular temperature. • Understand the effects of temperature and mass on the molecular speed.

Topic	Content	Number of lecture hours	Expected outcome - upon completion of these experiments, the student should be able to:
3. Molecular Collisions	• The concept of hard sphere collision, mean free path, collision frequency factors, collision diameter • Graham's law of effusion • Fick's law, flux, pressure of an ideal gas • Knudsen method	4	• Apply appropriate equations in solving problems related to collision frequency and collision density. • Calculate the number of collisions per unit area per unit time in a collision with a surface. • Calculate the rate of effusion. • Apply Graham's Law to determine the physical parameters of effusion. • Know the relationship between the flux and Knudsen method. • Determine vapour pressure using the relationship.
4. Transport Phenomena of Gases	• Diffusion, thermal conductivity and viscosity of gases	3	• Know the transport phenomena/properties of gases. • Know the effects of temperature, velocity and composition on transport processes. • Calculate diffusion, thermal conductivity and viscosity using appropriate formulae.

Topic	Content	Number of lecture hours	Expected outcome - upon completion of these experiments, the student should be able to:
5. Chemical Kinetics	• Simple reactions • Rate laws and rate constants • Integrated rate laws • Determination of rate laws • Effect of temperature on reaction rate • Complex reactions • Reaction mechanism • Chain reactions • Relaxation methods	8	• Define the rate of a reaction. • Define the order of a reaction with respect to a reactant and the overall order. • Define the rate constant. • Write the rate equation for a simple reaction and integrate the equation. • Explain the half-life of a reactant and its significance. • Apply the various methods to determine the order of a reaction and the rate constant. • Apply the Arrhenius equation to determine the activation energy. • Apply the steady-state approximation to obtain the rate equations for complex and chain reactions. • Apply the methods for fast reactions to calculate the rate constant and relaxation time.

Topic	Content	Number of lecture hours	Expected outcome - upon completion of these experiments, the student should be able to:
6.Chemical Thermodynamics	• Definitions: system, state, state function, process, intensive and extensive variables • Work and heat • First law of thermodynamics • Internal energy(U) and enthalpy(H) • Heat capacities • Application of first law on ideal gases • Reversible and irreversible processes • Calculation on thermodynamic changes: isothermal, isochoric, isobaric and adiabatic changes • Applications of first law on real gases • Thermochemistry	7	• State and understand the first law of thermodynamics. • Distinguish between state and non state functions. • Understand the concepts of heat, energy and work. • Demonstrate the relationship between ΔU and ΔH. • Distinguish between reversible and irreversible processes. • Calculate thermodynamic quantities for various processes. • Apply Hess' law to calculate ΔH for reactions. • Determine ΔH when the temperature of a system changes.
	TOTAL	**30**	