

# **ADVANCED PLACEMENT TEST**

## **MODULE DESCRIPTION**

### **CM1121 - Organic Chemistry 1**

This module is intended for students majoring in Chemistry and Applied Chemistry. It deals primarily with the basic principles to understand the structure and reactivity of organic molecules. Emphasis is on substitution and elimination reactions and chemistry of various functional groups.

Its scope includes basic concepts on how simple molecules can be constructed. Reactions mechanism, organic transformations and stereochemistry will also be discussed.

#### **STUDENTS SHOULD BE ABLE TO:**

- i. Understand and able to apply simple organic reaction transformations, functional group interconversion and C-C bond formation reactions.
- ii. Understand the scope and limitations as well as the mechanisms of organic reactions.
- iii. Understand the importance of stereochemistry and be able to view three-dimensional structures with ease.
- iv. Describe and explain currently held views of chemical bonding, and account for the chemical reactivity of reactions.

#### **Syllabus**

1. Organic Structures - hydrocarbon framework and functional groups, systematic nomenclature
2. Structure of Molecules - atomic structure, atomic orbitals, hybridization
3. Organic Reactions - chemical reactions, using curly arrows to represent reaction mechanisms
4. Nucleophilic Addition to Carbonyl Group - nucleophilic attack by hydrides, organometallic reagents, water and alcohol
5. Delocalization and Conjugation - structure of alkene, benzene; conjugation, the allyl system, aromaticity

6. Acidity, Basicity and pKa - definition of pKa, nitrogen and oxygen bases
7. Using Organometallic Reagents to Make C-C Bonds
8. Conjugate Addition - effects of conjugation, polarization, conjugate addition of alcohols, conjugate addition or direct addition to the carbonyl group, copper (I) salt and organometallic reagents
9. Nucleophilic Substitution at the Carbonyl Group - carboxylic acid derivatives and their substitution reactions.
10. Equilibria, Rates and Mechanisms - effects of reactants, temperature and products on the equilibrium constant, kinetic versus thermodynamic products
11. Nucleophilic Substitution at C=O with Loss of Carbonyl Oxygen - hemiacetal and acetal formation, reductive amination, Wittig reaction
12. Stereochemistry - enantiomers, optical activity, diastereoisomers, resolution
13. Nucleophilic Substitution at Saturated Carbon - leaving group, nucleophiles, SN1 and SN2 reactions, elimination and rearrangement reactions
14. Conformational Analysis - bond rotation, barriers to rotation, conformation of alkanes and cycloalkanes, ring strain
15. Elimination Reactions - E1 and E2 reactions and mechanisms
16. Electrophilic Addition to Alkenes - bromination, oxidation, regioselectivity, Iodolactonization and bromolactonization
17. Electrophilic Aromatic Substitution - enols and phenols, reaction of benzene, phenols and substituted benzenes with electrophiles

### **Recommended Text**

Organic Chemistry

**Authors:** *Jonathan Clayden et al*, Oxford University Press.

## CM1131 – Physical Chemistry 1

### **Aim**

To introduce students to basic concepts in physical chemistry.

### **Syllabus**

#### Chapter 1: The properties of gases

Ideal or perfect gases – Boyle's Law; Charles Law; Amonton's Law; Avogadro's Law; Ideal gas law; Dalton's law of partial pressures; postulates of the kinetic molecular theory; molecular view of gas laws; effusion; diffusion

Real gases – deviation from ideal behavior; various types of intermolecular interactions and their importance; compression factors, virial coefficients; critical constants; equation of state; principle of corresponding states

#### Chapter 2: The first law of thermodynamics

Scope of thermodynamics; basic terms in thermodynamics; the first law of thermodynamics and its applications; internal energy; work; reversible versus irreversible processes; heat capacity; enthalpy; calorimetry; adiabatic changes; thermochemistry; Hess' law; standard enthalpies; temperature dependence of reaction enthalpies; state functions; exact and inexact differentials; changes in internal energy; internal pressure; the Joule experiment; Joule-Thomson effect; inversion temperature; liquefaction of gases.

#### Chapter 3: The second and third law of thermodynamics

Thermodynamics and spontaneity; energy and the number of microstates; the Second Law; entropy; Clausius inequality; heat engines; Carnot cycle and efficiency; Third Law of thermodynamics; Helmholtz energy; Gibbs energy; Gibbs-Helmholtz equation; Gibbs energy change of a reaction; fundamental equation, absolute entropy, criteria for spontaneous change.

#### Chapter 4: Chemical equilibrium

Extent of reaction; reaction quotient  $Q$ ; equilibrium constant ( $K$ ) and chemical potential, activity, Gibbs energy; multicomponent system; relation between  $K_c$  and  $K_p$ ; comparing  $Q$  and  $K$  to determine reaction direction; Le Chatelier's principle; van't Hoff equation.

#### Chapter 5: Phase changes

Stability of phases; phase transitions; phase diagrams of pure substances; chemical potential; effect of temperature and pressure on phase stability; Clapeyron equation; Clausius-Clapeyron equation. Partial molar quantities; thermodynamics of mixing; chemical potentials of liquids; ideal solutions, non-ideal solutions; Raoult's law, Henry's law; colligative properties.

## Chapter 6: Chemical kinetics

Measurements of reaction rates; determination of rate laws; differential and integration methods; various types of rate laws; accounting for the rate laws; steady-state approximation; proposal of reaction mechanisms; the collision theory of reaction rates; the activated complex theory of reaction rates; kinetics of complex reactions; explosion; polymerization kinetics; catalysts and reaction rates; enzyme kinetics; Michaelis-Menten mechanism

### **Recommended Text**

Atkin's Physical Chemistry

**Authors:** *P. Atkins, J. de Paula*, Oxford University Press.