# KUT 102/2 – General Chemistry Practical II

**Course Objective:**    To expose students to conduct the basic experiments that covers physical and organic chemistry.

| Experiment Title | Content | Number of laboratory hours | Expected outcome - upon completion of these experiments, the student should be able to: |
|---|---|---|---|
| 1. Behaviour of Gases: Molar Mass of A Vapour | • Boyle's law and Charles's law <br> • Ideal gas law | 3 | • Observe changes in temperature and pressure that affect the volume of gas. <br> • Determine molar mass. |
| 2. Determination of R; The Gas Law Constant | • Determination of R, the gas law constant using ideal gas law and van der Waals equation <br> • Error analysis on the experimentally determined constant | 2.5 | • Determine the ideal gas law constant, R. <br> • Understand factors causing the deviation from ideal behavior. |
| 3. Colorimetric Determination of An Equilibrium Constant in Aqueous Solution | • Measurement of absorbance using spectrophotometer <br> • Determination of $K_{eq}$ for the following equilibrium: <br> $Fe^{3+}(aq) + SCN^{-}(aq) \rightarrow FeSCN^{2+}$ | 2.5 | • Operate a spectrophotometer . <br> • Draw a calibration curve. <br> • Write an equilibrium constant expression and calculate the equilibrium constant. |
| 4. Heat of Neutralization | • Heat capacity of calorimeter <br> • Heat of neutralization of HCl-NaOH (strong acid and strong base) <br> • Heat of neutralization of $CH_3COOH$-NaOH (weak acid and strong base) | 2.5 | • Measure energy change accompanying a neutralization reaction. <br> • Construct a simple calorimeter to determine the heat capacity of a calorimeter. <br> • Use the same calorimeter to determine the heat of neutralization of HCl – NaOH and $CH_3COOH$ –NaOH. |

| Experiment Title | Content | Number of laboratory hours | Expected outcome - upon completion of these experiments, the student should be able to: |
|---|---|---|---|
| 5. Rates of Chemical Reactions I: A Clock Reaction | • Determination of rate law for the reaction: $S_2O_8^{2-} + 2I^- \rightarrow I_2 + 2SO_4^{2-}$<br>• Graphical determination of the rate constant | 2.5 | • Determine the order of reaction with respect to the reactant concentrations.<br>• Plot a graph and calculate the rate constant, k.<br>• Measure the effect of concentration on the rate of reaction. |
| 6. Rates of Chemical Reactions II: Rate and Order of $H_2O_2$ Decomposition | • Determination of rate law for the reaction $2H_2O_2 (aq) \rightarrow O_2 (g) + 2H_2O (l)$ at different temperatures<br>• Recovering the catalyst used | 3 | • Determine the rate and order of reaction for the decomposition of $H_2O_2$.<br>• Relate the activation energy and reaction rate constant (Arrhenius equation).<br>• Identify factors influencing the rate of reaction. |
| 7. Identification of Substances by Physical Properties | • Determination of the solubility of naphthalene in different solvents<br>• Determination of the density for solid and liquid<br>• Determination of the melting point for benzophenone<br>• Determination of the boiling point for isopropyl alcohol. | 2.5 | • Distinguish the degree of solubility of substance in different solvents.<br>• Know how to use and read balances, graduated cylinders and thermometer correctly.<br>• Write the relationship of density to mass and volume.<br>• Determine the density of solid using water displacement method.<br>• Determine the density of liquid using mass and volume.<br>• Operate the melting point apparatus and use it to determine the melting point of a given solid.<br>• Determine the boiling point of liquid.<br>• Identify a given substance by its solubility, density, melting and boiling points. |

| Experiment Title | Content | Number of laboratory hours | Expected outcome - upon completion of these experiments, the student should be able to: |
|---|---|---|---|
| 8. Extraction and Crystallization Using Acid Base Properties | • Separation of binary mixture of benzoic acid and a neutral organic compound by utilizing the acid-base properties in extraction | 3 | • Understand the basic principles of liquid-liquid extraction.<br>• Use the correct technique when handling a separatory funnel.<br>• Purify a crude sample using the recrystallization process. |
| 9. Determination of The Dissociation Constant of A Weak Acid | • Titration of NaOH and an unknown acid<br>• Plotting a pH graph for the above titration<br>• Determination of $pK_a$ | 3 | • Operate a pH meter.<br>• Prepare and standardize NaOH solution.<br>• Develop skills of using pipette and burette correctly.<br>• Use the concept of acid–base titration to determine the equivalence point and calculate the ionization constant of a weak acid.<br>• Calculate the concentration of an unknown acid. |
| 10. Paper Chromatography - Separation of Cations and Dyes | • Using two techniques of separation – horizontal circular technique and ascending strip technique to separate a mixture of food dye | 2.5 | • Understand the basic principles of paper chromatography.<br>• Perform separation/purification of compounds using horizontal circular and ascending strip techniques.<br>• Calculate the $R_f$ values.<br>• Identify unknown substances using their $R_f$ values. |
| 11. Preparation of Aspirin and Oil of Wintergreen | • Reaction of salicylic acid and acetic anhydride with concentrated sulphuric acid<br>• Reaction of salicylic acid and methyl alcohol with concentrated sulphuric acid | 2.5 | • Write the equations for esterification reactions.<br>• Conduct the synthesis of esthers.<br>• Conduct the purification of crude oil sample to get a pure product.<br>• Calculate the percentage yield of product obtained. |
| 12. Analysis of Aspirin | • Hydrolyzing a commercial aspirin with an excess of NaOH and back titrating with acid | 3 | • Understand the concept of back-titration.<br>• Determine the purity of aspirin through an acid-base titration.<br>• Calculate the percentage purity of aspirin. |
| | **TOTAL** | **32.5** | |