UNIVERSITI TEKNOLOGI MARA

CHM271: PRINCIPLES OF PHYSICAL CHEMISTRY

Course Name (English)	PRINCIPLES OF PHYSICAL CHEMISTRY APPROVED
Course Code	CHM271
MQF Credit	3
Course Description	This course deals with selected important principles, laws, theories, and concepts in physical chemistry. The topics covered are thermodynamics, thermochemistry, ionic equilibrium, electrochemistry, chemical kinetics, phase equilibrium, as well as colloid and surface chemistry. The understanding of the concepts and theories of topics is gained via collaborative learning, interactive engagement, and lecture-discussion and further enhanced by the active participation of students in hands-on blended learning and hands-on guided instruction in practical sessions. The course learning outcomes will be assessed through written tests, observations, group tasks, and written reports.
Transferable Skills	Knowledge, scientific and analytical skills, and leadership skills
Teaching Methodologies	Lectures, Blended Learning, Lab Work, Case Study, Discussion, Collaborative Learning
CLO	CLO1 Apply the theories and laws of the state of equilibrium and behaviour of matters in chemical reactions and processes. CLO2 Perform (plan, conduct, and analyse outcomes of) scientific investigations in the areas of physical chemistry. CLO3 Demonstrate the ability to effectively lead team members in performing scientific investigations in the areas of physical chemistry.
Pre-Requisite Courses	No course recommendations

Topics
1. Thermodynamics 1.1) 1.1 Types of System (open, closed, isolated) 1.2) 1.2 First Law of Thermodynamics 1.3) 1.2.1 Internal energy, work (pressure-volume) and heat 1.4) 1.2.2 Specific heat and Heat capacity 1.5) 1.2.3 Concept of Enthalpy 1.6) 1.2.4 Effect of temperature on enthalpy 1.7) 1.2.5 Reversible and irreversible processes 1.8) 1.2.6 Types of thermal process (isothermal, isobaric, isochoric, adiabatic) 1.9) 1.3 Second Law of Thermodynamics 1.10) 1.3.1 Entropy change and spontaneity of reaction 1.11) 1.3.2 Gibbs free energy 1.12) 1.3.3 Dependence
2. Thermochemistry 2.1) 2.1 Exothermic and endothermic reactions 2.2) 2.2 Enthalpy change 2.3) 2.2.1 Enthalpy of formation 2.4) 2.2.2 Enthalpy of combustion 2.5) 2.2.3 Enthalpy of neutralization 2.6) 2.3 Determination of enthalpy change of reaction 2.7) 2.3.1 Using standard enthalpy of formation 2.8) 2.3.2 Calorimetry (Simple calorimeter and bomb calorimeter) 2.9) 2.3.3 Hess's Law and calculations

3. Ionic equilibrium
3.1) 3.1 Definitions of acid and base by Arrhenius, Bronsted- Lowry and Lewis
3.2) 3.1.1 Types of acids & bases
3.3) 3.1.2 Acid-Base Conjugate pairs
3.4) 3.2 Calculation of pH and pOH (monoprotic, diprotic & triprotic acid and base)
3.5) 3.2.1 Definitions of pH, pOH, Kw, pKw, Ka, Kb, pKa and pKb
3.6) 3.2.2 Strong acids and bases
3.7) 3.2.2 Equilibria in solutions of weak acids and bases
3.8) 3.2.3 Degree of dissociation (percent ionization)
3.9) 3.3 Hydrolysis reaction
3.10) 3.3.1 Methods producing salt
3.11) 3.3.2 Acidic, basic and neutral salt solutions
3.12) 3.3.3 Salt hydrolysis. Calculation of pH/pOH values
3.13) 3.4 Buffer System
3.14) 3.4.1 Acidic Buffer
3.15) 3.4.2 Basic Buffer
3.16) 3.4.3 Simple calculation of pH/pOH of buffer solution

4. Electrochemistry
4.1) 4.1 Types of electrochemical cell (Galvanic & Electrolytic)
4.2) 4.2 Half-reactions and electrodes
4.3) 4.2.1 Redox reaction
4.4) 4.2.2 Calculation of standard cell potential, E°cell by Standard Reduction Potential (SRP)(only principle of measurement is required)
4.5) 4.2.3 Symbolic representation of a cell (Cell Notation)
4.6) 4.2.4 Predicting spontaneity of redox reactions
4.7) 4.2.5 The Nernst equation
4.8) 4.2.6 Concentration cells
4.9) 4.2.7 Factors affecting the redox potential
4.10) 4.3 Electrolysis
4.11) 4.3.1 Factors affecting electrolysis and Electrochemical series
4.12) 4.3.2 Faraday's law and quantitative aspects of electrolysis
4.13) 4.3.3 Applications of electrolysis (electro- refining, electroplating, manufacturing of
4.14) chlorine gas, sodium hydroxide and hydrogen from electrolysis of brine)

5. Chemical Kinetics
5.1) 5.1 Rates of reaction
5.2) 5.1.1 Definition and units
5.3) 5.1.2 Determination of rates of reaction
5.4) 5.2 Factors affecting rates of reaction
5.5) 5.2.1 Collision Theory
5.6) 5.3 Rate Law and order of reaction
5.7) 5.3.1 Rate law for Zero, First and Second order of reactions
5.8) 5.4 Methods to determine order of reactions
5.9) 5.4.1 Initial rate
5.10) 5.4.2 Integrated rate law
5.11) 5.4.3 Half life
5.12) 5.5 Relationship between rate and temperature
5.13) 5.5.1 Arrhenius equation
5.14) 5.5.2 Determination of activation energy using Arrhenius equation by graphical method
5.15) and calculation
5.16) 5.6 Reaction mechanism
5.17) 5.6.1 Definition: Reaction mechanism, Elementary steps, Molecularity, Rate-determining
5.18) step
5.19) 5.6.2 Relationship between rate law and reaction mechanism
5.20) 5.6.2.1 A mechanism with a slow step followed by fast step
5.21) 5.6.2.2 A mechanism with a fast reversible step followed by a slow step
5.22) 5.7 Catalytic kinetics
5.23) 5.7.1 Homogeneous and heterogeneous catalysis
5.24) 5.7.2 Enzyme catalysis

6. Phase Equilibrium
6.1) 6.1 Definitions & concepts
6.2) 6.1.1 Phases
6.3) 6.1.2 Components
6.4) 6.1.3 Gibbs Phase rule: Degree of Freedom
6.5) 6.2 One-component system
6.6) 6.2.1 Phase diagram of water system
6.7) 6.2.2 Phase diagram CO2 system
6.8) 6.3 Two-component system
6.9) 6.3.1 Ideal mixture vs Non-ideal Mixture
6.10) 6.3.2 Raoult's Law
6.11) 6.3.3 Vapour Pressure Lowering: The effect of non-volatile solute on vapour pressure of
6.12) solvent, melting and boiling point
6.13) 6.3.4 Two completely miscible liquids- ideal, positive and negative deviation from
6.14) Raoult's Law

6.15) 6.3.5 Vapour pressure-composition diagram versus boiling point-composition
6.16) diagram for ideal, negative and positive deviation of solutions
6.17) 6.3.6 Fractional distillation and azeotropic system
6.18) 6.3.7 Two completely miscible solids – eutectic system and cooling curves
6.19) 6.4 Colligative properties
6.20) 6.4.1 Boiling point elevation
6.21) 6.4.2 Freezing point depression

7. Colloid and Surface Chemistry
7.1) 7.1 Definitions of colloid, true solution and suspension system
7.2) 7.2 Types of colloid and uses
7.3) 7.3 Lyophilic and lyophobic sols
7.4) 7.3.1 Stability of lyophobic sols
7.5) 7.3.2 Preparation of lyophilic and lyophobic sols (dispersion and condensation methods)
7.6) 7.3.3 Properties of colloids – Brownian, dialysis, Tyndall effect, electric double layer,
7.7) electrophoresis, electro-osmosis & coagulation
7.8) 7.4 Adsorption
7.9) 7.4.1 Adsorption phenomenon
7.10) 7.4.2 Types of adsorption (Differences of chemical adsorption and physical adsorption)
7.11) 7.4.3 Types of adsorption isotherm (introductory and without calculation)
7.12) – Langmuir and Freundlich
7.13) – Brunauer-Emmett-Teller (B.E.T)

Assessment Breakdown	%
Continuous Assessment	70.00%
Final Assessment	30.00%

Details of Continuous Assessment

Assessment Type	Assessment Description	% of Total Mark	CLO
Practical	Written Lab Report	20%	CLO2
Presentation	Video/Online Presentation	25%	CLO3
Test	Ongoing Online Test	25%	CLO1

Reading List

Reference Book Resources

- **Fellow of Lincoln College Peter Atkins,Julio De Paula,Professor and Chair Department of Chemistry Julio de Paula 2016, *Elements of Physical Chemistry*, 7th Ed., Oxford University Press [ISBN: 9780198796701]**
- **Peter Atkins,Julio de Paula 2014, *Atkins' Physical Chemistry*, 10th Ed., Oxford University Press [ISBN: 9780199697403]**
- **Raymond Chang,Kenneth Goldsby 2015, *Chemistry*, 12th Ed., McGraw-Hill Education [ISBN: 9780078021510]**
- **Steven Zumdahl,Susan Zumdahl 2013, *Chemistry*, 9th Ed., Cengage Learning [ISBN: 9781133611097]**
- **Martin Silberberg,Patricia Amateis 2014, *Chemistry: The Molecular Nature of Matter and Change*, 7th Ed., McGraw-Hill Education [ISBN: 9780073511177]**
- **Georgios M. Kontogeorgis,Soren Kiil 2016, *Introduction to Applied Colloid and Surface Chemistry*, John Wiley & Sons [ISBN: 9781118881187]**
- **Duncan J. Shaw 2013, *Introduction to Colloid and Surface Chemistry*, 4th Ed., Butterworth-Heinemann [ISBN: 9780750611824]**

Article/Paper List: This Course does not have any article/paper resources

Other References: This Course does not have any other resources