DEPARTMENT: PHYSICAL AND CHEMICAL SCIENCES
FIRST SEMESTER EXAMINATIONS: 2017/2018 ACADEMIC SESSION
COURSE CODE: CHM 305 COURSE TITLE: PHYSICAL CHEMISTRY II
HOD's SIGNATURE

TABLE OF CONSTANTS:
Speed of light c, 2.997 x10^{8}m/s
Faraday constant F, 96500 C/mol
Gas constant R, 8.314JK^{-1}mol^{-1}
Gas constant R, 8.314 x 10^{-2}Lbar K^{-1}mol^{-1}
Mass of proton, 1.672x x10 $^{-27}$kg
Mass of electron 9.109x10 $^{-31}$kg
Elementary charge e, 1.602 x 10^{-19}C
Boltzmann constant k, 1.38 x10^{-23}J/K
Planck's constant h, 6.626 x10^{-34}Js,
Atomic mass unit u, 1.661 x10^{-27}kg
Mass of neutron, 1.6739 x 10^{-27}kg
Avogadro's constant Na, 6.022 x10^{23} mol^{-1}

INSTRUCTIONS:
1. **SECTION A - ATTEMPT ANY TWO QUESTIONS**
2. **SECTION B - ATTEMPT ANY TWO QUESTIONS**

DURATION: 2 HOURS

SECTION A
ATTEMPT ANY TWO QUESTIONS FROM THIS SECTION

QUESTION ONE

A. Distinguish between the following; **[6 Marks]**
- **i.** strong and weak electrolytes
- **ii.** ideal solution and non – ideal solution
- **iii.** polarizable and non – polarizable electrodes
- **iv.** the electrical double layer and the Nernst diffusion layer

B. Define flocculation and coagulation according to the DLVO theory using only schematic diagram(s) **[2 Marks]**

C. The mobility of Li^+ ion in aqueous solution is 4.01 x 10 $^{-8}$ m ^{2} s $^{-1}$ V $^{-1}$ at 29^{o}C. the potential difference between two electrodes placed in solution is 12.0 V, if the electrodes are 1.00cm apart, what is the drift speed of the ion. **[2 Marks]**

D. Explain how colligative properties are used to determine molar mass. **[5 Marks]**

QUESTION TWO

A. What is the limiting current density at an electrode with Mg^{2+} ions of concentration 2.5mmol/dm^3 at 25 ^{0}C given that the thickness of the Nernst diffusion layer is 0.32mm, ionic conductivity of Mg^{2+} at infinite dilution and 25 ^{0}Cis 10.60Sm^2 /mol. **[2marks]**

B. State and discuss two applications of the electrical double layer **[4marks]**

C. Given the mobility of sulphate ion in solution at 298K is 8.29 x 10 $^{-8}$ m ^{2} s $^{-1}$ V $^{-1}$ and the viscosity is 0.891cp, calculate its: (i) diffusion coefficient (ii) the limiting molar conductivity (iii) the hydrodynamic radius of sulphate ion in solution **[4marks]**

D. 0.25g of an unknown nonvolatile solid was dissolved in 40.0g of CCl_4. The boiling point of the solution formed was 0.579°C higher than the pure solvent. Calculate the molar mass of the solute. $K_b = 5.02^0C/m$ **[2 Marks]**

E. The enthalpy of fusion of lead (M.wt 207.8g/mol) is 5.2kJ/mol and its melting point is 327°C. what is its ideal solubility in bismuth (M.wt 208.98g/mol) at 280°C.**[3 Marks]**

QUESTION THREE

Provide a molecular interpretation for the observation that mediated transport across a bio-membrane leads to a maximum flux J_{max} when the concentration of the species becomes very large. **[15 Marks]**

SECTION B

ATTEMPT ANY TWO QUESTIONS

QUESTION ONE

A. Show that $TV^{\gamma-1}$ is a constant for the reversible adiabatic expansion of a mole of an ideal gas of constant heat capacity where $\gamma = C_p/C_v$ **[5 marks]**

B. 8 g of oxygen at 10°C and 5 atm are subjected to reversible adiabatic expansion to a pressure of 760 mmHg. Calculate the work done. **[4 marks]**

C. 64 g of oxygen expands reversibly under isothermal conditions from a volume of $0.0015m^3$ to 45 dm^3 at 250°C. Evaluate: (i) q, (ii) ΔE and (iii) W. **[6 marks]**

QUESTION TWO

A. Distinguish between Gibbs free energy and Helmholts free energy **[2 marks]**

B. 5 moles of an ideal gas at 10°C is compressed adiabatically to $1/8^{th}$ of the original volume. What is the temperature of the gas after compression? **[5 marks]**

C. 3 moles of Argon at 38cm Hg is compressed adiabatically and reversibly from 100 L to 5 x 10^4 cm^3 at 10°C. The molar heat capacity, Cv at constant volume of Argon is 12.5 j/mol/k. Calculate the final pressure of Argon in atm. **[8 marks]**

QUESTION THREE

A. **i.** What is meant by system of independent particles? **[2 marks]**

ii. Show that the partition function for translation in a system of independent particles is given by **[6 marks]**

$$Q_t = \frac{(2\pi mKT)^{3/2}}{h^3} \cdot V$$

B. From the above equation, derive the expression for the calculation of $E_{(t)}$; $H_{(t)}$; $Cv_{(t)}$; $Cp_{(t)}$. **[4 marks]**

C. Calculate the standard translational entropy of $O_{2(g)}$ at 25°C. Assume $C_2 = -9.68$ JK^{-1} **[3 marks]**