EDO UNIVERSITY IYAMHO, EDO STATE

FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

FIRST SEMESTER EXAMINATION, 2017/18 SESSION

COURSE TITLE: BASIC PHYSICAL CHEMISTRY

COURSE CODE: CHM 211 TIME ALLOWED: 3 HOURS

INSTRUCTION: ATTEMPT FIVE QUESTIONS IN ALL

Question 1

a. Explain the significance of the constants ***a*** and ***b*** in the Vander Waal equation for real gases.

b. You are in charge of the manufacture of cylinders of compressed gas at a small company. Your company president would like to offer a 4.00 L cylinder containing 500 g of chlorine in the new catalog. The cylinders you have on hand have a rupture pressure of 40 atm. Use both the ideal gas law and the Vander Waals equation to calculate the pressure in a cylinder at 25°C. Is this cylinder likely to be safe against sudden rupture (R = 0.08206, a = 6.26 $L^2atmmol,^{-2}$ b = 0.0542$Lmol^{-1}$ for Cl_2).

c. Account for the deviation of real gases from ideal gas behavior.

d. A photochemical process consists of the following primary and secondary reactions:

$HBr + hv \rightarrow H^{\circ} + Br^{\cdot\,\circ}$ primary reaction

$HBr + H^{\circ} \rightarrow H_2 + Br^{\circ}$ secondary reaction

$Br^{\circ} + Br^{\circ} \rightarrow Br_2$ secondary reaction

Write the overall reaction for this process. **14 marks**

Question 2

a. The following gas phase reaction has been studied under different conditions:

$2N_2O_{5(g)}$ $4NO_{2(g)} + O_{2\,(g)}$

The rate constant k, at 30^0C, has been determined to be $7.3 \times 10^{-5}s^{-1}$ and for a temperature of 60◦C; $2.9 \times 10^{-3}s^{-1}$. What is the activation energy (Ea) for the reaction?

b. Write short note on the following:

i. intermediate ii. Photosensitizer iii. component iv. degree of freedom

c. State any two differences between a photochemical and thermochemical reaction.

d. Determine the feasibility of the reaction

$2Al_{(s)} + 2Sn^{4+}_{(aq)} \longrightarrow 2Al^{3+} + 3Sn^{2+}_{(aq)}$

Given

Al/Al^{3+} $E^o = -1.66V$

Sn^{4+}/Sn^{2+} $E^o = +0.15V$ **14 marks**

Question 3

a. One mole of an ideal gas at 25°C is allowed to expand reversibly at constant temperature from a volume of 10 litres to 20 litres. Calculate the work done by the gas.

b. Given the equation for the melting of ice:

$H_2O_{(s)} \rightarrow H_2O_{(l)}$

For which

$\Delta H^0 = 6.03 \times 10^3 J/ mol$ and $\Delta S^0 = 22.1 J/K.mol$

Calculate ΔS_{uni} and $\Delta G°$ at 0°C

c. Identify the number of phases present in the following mixtures:

i. monoclinic and rhombic sulphur

ii. nitrogen, oxygen and carbon (iv) oxide

ii. ethanol and water

iv. chloroform and water

d. State any two uses of electrode potential table **14 marks**

Question 4

a. When a substance A was exposed to light, 0.002 mole of it reacted in 20 minutes and 4 seconds. In the same time A absorbed 2.0×10^6 photons of light per second. Calculate the quantum yield of the reaction. (Avogadro number $N = 6.02 \times 10^{23}$)

b. Differenciate clearly between Intermediate Compound Formation theory and The Adsorption theory of catalysis

c. State and explain Stark-Einstein Law of Photochemical Equivalence.

d. Calculate the energy associated with (a) one photon; (b) one einstein of radiation of wavelength 8000 Å. h = 6.62×10^{-27} erg-sec; c = 3×10^{10} cm sec^{-1}. **14 marks**

Question 5

a. Calculate the EMF of the cell : Zn/Zn^{2+} (0.001M//Ag^{+} (0.1M)/Ag

The standard potential of Ag/Ag^{+} half-cell is + 0.80 V and Zn/Zn^{2+} is – 0.76 V.

b. Differenciate between enantiotropy and dynamic allotropy

c. Write short note on the following:

i. Phase diagram ii. Non-variant system iii. Transition point iii.quantum efficiency

d. Given that $\Delta G = \Delta H - T\Delta S$, show that

$\Delta S_{univ} = -\Delta G/T$ **14 marks**

Question 6

a. The initial rate of a reaction A + B → C was measured for several different starting concentrations of A and B, and the results are as follows:

Expt. No.	[A] (M)	[A] (M)	Initial Rate (M/S)
1	0.100	0.100	4.0×10^{-5}
2	0.100	0.200	4.0×10^{-5}
3	0.200	0.100	16.0×10^{-5}

Using these data, determine (**a**) the rate law for the reaction (**b**) the rate constant, (**c**) the rate of the reaction when [A] = 0.050*M* and [B] = 0.100 *M*.

b. Give any two examples of autocatalytic reactions.

c. Explain the Michaelis and Menten mechanism for enzyme catalysis.

d. For the general equation: $aA + bB \rightarrow cC + dD$

Write an expression for the average rate of the reaction.

Question 7

a. Given the Ka values of the acids: acetic acid (1.74×10^{-5}), carbonic acid (1.70×10^{-4}) and phosphoric acid (7.25×10^{-3}). With one reason, arrange the acids in the order of their strength.

b. Define the term buffer and explain the role of the blood as a biological buffer.

c. What is the pH of a mixture of 0.042M NaH_2PO_4 and 0.058M Na_2HPO_4?

d. If 1.0 mL of 10.0M NaOH is added to a liter of the buffer prepared in (c), how will the pH change ?