MAASAI MARA UNIVERSITY

MAIN EXAMINATIONS 2018/2019

SECOND YEAR FIRST SEMESTER EXAMINATION

FOR

THE DEGREE OF BACHELOR OF SCIENCE IN CHEMISTRY.

CHE2112: CHEMISTRY MATHEMATICS I

DATE: 10TH/DECEMBER/2018 **TIME: 11 AM – 1 PM**

Duration: 2 Hours

INSTRUCTIONS

1. This paper contains **FOUR** (4) questions.
2. Question **ONE** is compulsory
3. Answer question **ONE (1)** and any other **Two** (2) questions.
4. Do not forget to write your Registration Number.

Question ONE (30 Marks)

a. i. Define the term Error ***(1 Mark)***

ii. A scale is off by +5 mg. What are the errors produced with weighing 15 mg and 1.5 g of silver nitrate? And what is the significance of these values in measurements? ***(4 Marks)***

b. i. Formic acid is a weak acid with a dissociation constant Ka of 1.8×10^{-4}. The Ka relates the concentration of the H^+ ions denoted $[H^+]$ and the amount of acid dissolved denoted N by the equation:

$$Ka = \frac{[H^+]^2}{N - [H^+]}$$

Given that there is 0.1 moles of formic acid dissolved, calculate the pH of the solution. ***(6 Marks)***

ii. A solute with a partition coefficient of K_D=1.0 is extracted from 10 mL of phase 1 into phase 2. ($m_1/V_2 = m_1K_d/V_2$)

I. What volume of phase 2 is needed to extract 75% of the solute in a single extraction? ***(5marks)***

II. What percent of the solute is extracted upon three equal-volume extractions using 10 mL each? ***(5marks)***

c. A 48% (w/w) solution of HBr (FW 80.917) in water has a density of 1.50 g/mL.

I. What is the formal concentration of HBr? ***(2 Marks)***

II. What volume of 48% (w/w) solution is needed to prepare 500 mL of a 0.16 F HBr solution? ***(2marks)***

III. What mass of the 48% (w/w) HBr is required to prepare this solution? ***(1mark)***

d. i. Standard deviation is a particularly useful tool. Explain. ***(2 Marks)***

ii. A student analyzing a sample for bromine (Br) makes four trials with the following results: 36.0, 36.3, 35.8, and 36.3. The theoretical value is 36.2. Calculate:

I. the arithmetic mean ***(2 Marks)***

II. the percent error for each trial ***(1 Marks)***

III. the deviation and percent deviation for each trial ***(1 Marks)***

IV. the standard deviation ***(2 Marks)***

e. A general chemical reaction takes place of the form:

$$aA + bB \rightarrow cC + dD$$

where the equilibrium constant K is defined as $K = [A]^{-a} \times [B]^{-b} \times [C]^c \times [D]^d$. Find the logarithm of K as a sum of logarithms. ***(3 Marks)***

Question TWO (20 Marks)

a. 2.0 moles of an ideal gas is compressed isothermally to half of its initial volume. This process happens at 300K. The work done on the gas is given by the equation:

$$\text{Won} = \int_{v1}^{v2} p dv$$

where V_1 and V_2 are the initial and final volumes respectively. By using the ideal gas equation and integration, find the amount of work done on the gas. ***(10 Marks)***

b. The Arrhenius equation below describes the exponential relationship between the rate of a reaction k and the temperature T

$$k = A\exp(-Ea/RT)$$

Where R; Ea and A are all constants. Suppose for a reaction that the activation energy is Ea = 52:0 kJ mol^{-1}, the gas constant R = 8:31 J K^{-1} mol^{-1} and A = 1:00. What is the rate of the reaction k when the temperature T = 241 K? ***(5 Marks)***

c. An ion is moving through a magnetic field. After a time t the ion's velocity has increased from u to v. The acceleration is a, and is described by the equation v = u+at. Rearrange the equation to make a, the subject. ***(5 Marks)***

Question THREE (20 Marks)

a. i. The excited state of molecular oxygen dissociates into two oxygen atoms, one of which is an energy level 190 kJ mol^{-1} above the ground state. To use equation $n_2/n_1 = e^{-\Delta E/kT}$, where k is the Boltzmann constant (1.381 × 10^{-23} J K^{-1}) and T is the absolute temperature. Calculate, the ratio of the number of molecules in the two states at room temperature. ***(5 marks)***

ii. If we consider a solution of hemoglobin of concentration 3.0 × 10^{-4} mol dm^{-3} and a path length of 2.0 cm, for which ε = 532 dm^3 mol^{-1} cm^{-1} at 430 nm, calculate the value of I/I_0: Beer-Lamberts Law is given as log $(I_0/I) = \varepsilon cl$ ***(5 Marks)***

b. Calculate the mean velocity, u^- of an oxygen molecule at 298 K using the formula: $u^- = (3RT/M)^{1/2}$. (R = 8.314 J K^{-1} mol^{-1}, T = 298 K, M = 32.00 g mol^{-1}). ***(10 Marks)***

Question FOUR (20 Marks)

a. i. In thermodynamics, the Gibbs function, ΔG, indicates whether a reaction is feasible at a temperature, T, These quantities are related to each other by: $\Delta G = \Delta H - T\Delta S$. Write an expression in terms of ΔS. ***(6 Marks)***

ii. A 5.0000-g sample of coal was combusted in a pure oxygen atmosphere. The sulfur dioxide generated was catalytically converted to sulfate, trapped in a reagent solution, and precipitated as insoluble calcium sulfate, $CaSO_4$ (136.14 g/mol). The calcium sulfate precipitate was filtered, dried, and weighed to be 0.2909 g. If the atomic mass of sulfur is 32.06 g/mol, calculate the % S by mass in the coal sample. ***(8marks)***

b. Glauber's salt is a form of hydrated sodium sulfate that contains 44.1% by mass of sodium sulfate. Hydrated sodium sulfate can be represented by the formula Na_2SO_4. xH_2O where x is an integer. Calculate the value of x. ***(6 Marks)***

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