MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

WEBUYE CAMPUS (SCHOOL BASED)

UNIVERSITY EXAMINATIONS 2021/2022

FOR THE DEGREE

OF

BACHELOR OF EDUCATION SCIENCE

COURSE CODE: SCH 140

COURSE TITLE: PHYSICAL CHEMISTRY

DATE: 20th APRIL, 2022 **TIME:** 8.00 am

INSTRUCTION TO CANDIDATES: Answer all questions in this paper

TIME: 2 HOURS

MMUST observes zero tolerance to Examination cheating

QUESTION ONE (17MKS)

a)

i) State the Charles law. (1mk)

ii) Using the Kinetic theory of gases explain why the Charles law holds. (3mks)

iii) The volume of a given mass is 360 ml at 15°C, at what temperature will the volume have changed by 120 ml, assuming constant pressure. (3mks)

b) Basing on the kinetic theory of matter show that the relationship $P = \frac{nmc^{-2}}{3v}$ holds between pressure (P), vessel volume (V), number of moles (n) mass (m) and velocities of molecules ($\bar{c}$) (6mks)

c)

i) State the equation of state (1mk)

ii) A cylinder contains oxygen at 20°C and a pressure of 15 atmospheres at a volume of 12 L. The temperature is raised to 35°C and the volume is reduced to 8.5. What is the final pressure? (3mks)

QUESTION TWO (18MKS)

a)

i) State the assumptions of the ideal gas equation. (3mks)

ii) The equation $\frac{PV}{RT} = 1$ represents behavior of gases accurately at low pressures ≤ 10 atmospheres pressure and high temperatures. Deviations however do occur at low temperature and higher pressures. Using a modification to the equation or otherwise explain the deviations. (3mks)

b) One mole of CO_2 was found to occupy a volume of 1.32 L at 45°C and pressure of 15 atm. Calculate the pressure that would be expected from

i) Ideal gas equation (3mks)

ii) Van der waals equation with constants a = 3.6 L atm mol^{-2}, b = 4.28×10^{-2} $litre^{-1}$ R = 0.08206 L atm $mol^{-1}K^{-1}$. (3mks)

c) Given the Van der waals equation in the form $V^3 - (b + \frac{RT}{P})V^2 + \frac{a}{p}V - \frac{ab}{p} = 0$ for given values of a and b, show that $V_e = 3b$, $Pc = \frac{a}{27b^2}$ and $Tc = \frac{8a}{27Rb}$ (6mks)

QUESTION THREE (17MKS)

a) State the

i) law of mass action (2mks)

ii) Le Chatelier's principle (2mks)

b) The table below shows initial and equilibrium concentration of the reactants and products in the water – gas shift reaction $[H_2O_{(g)} + CO_{(g)} \rightleftharpoons H_{2(g)} + CO_{2(g)}]$ at 500K

Experiment	Initial conc. (m)				Equilibrium conc. (m)			
	$[H_2O]$	$[CO]$	$[H_2]$	$[CO_2]$	$[H_2O]$	$[CO]$	$[H_2]$	$[CO]$
1	0.02	0.02	0	0	0.0034	0.0034	0.0166	0.0166
2	0	0	0.02	0.02	0.0034	0.0034	0.0166	0.0166
3	0.01	0.02	0.03	0.04	0.0046	0.0146	0.0354	0.0454

i) Calculate the equilibrium constant, K for this study (2mks)

ii) Explain the significance of the K value found in this study compared with that of

$2H_{2(g)} + O_{2(g)} \rightleftharpoons 2H_2O_{(g)}$ $K = 3x10^{81}$ and

$2CO_{2(g)} \rightleftharpoons 2CO_{(g)} + O_{2(g)}$ $K = 3x10^{-92}$ (2mks)

c) For the following pairs of reactions establish the relationship between the equilibrium constants. (6mks)

i) $2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$ and $N_2O_4 \rightleftharpoons 2NO_{2(g)}$

ii) $2NO_{(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)}$ and $NO_{(g)} + ½\ O_{2(g)} \rightleftharpoons NO_{2(g)}$

iii) $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$ and $2NO_{(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)}$

d) The boiling point elevation and freezing point depression are usually given as $\Delta T_b = iK_bM$ and $\Delta T_f = iK_fM$. Deviations are usually observed from theoretical values when compared with actual experimental values. Give a reason. (3mks)

QUESTION FOUR (18 MRKS)

a)

i) Explain, with an application, how reverse osmosis can be achieved. (3mks)

ii) A molecular compound that is a non-electrolyte was isolated from a Mt Elgon tree. A 47 mg sample was dissolved in water to make 2.5 ml of solution at 25°C and osmotic pressure of the solution was 0.489 atm. Calculate the molar mass of the compound given R = 0.08206 L atm $mol^{-1}K^{-1}$. (3mks)

b)

i) What are colligative properties? (2mks)

ii) Using Bronsted-Lowry theory define acids and bases. (2mks)

iii) Acetone is a non-conducting liquid but does so when HF is dissolved in it. Explain. (2mks)

iv) For any acid HA in water

$HA + H_2O \rightleftharpoons H_3O + A^-$ show that $K_a^1 = \frac{a^2C}{1-a}$ where K_a is ionization concentration quotient. (2mks)

c) Consider the reduction potentials

$Fe_{(aq)}^{3+}/Fe_{(aq)}$ $E\theta = {}^{+}0.77V$

Sn^{4+}/S_n^{2+} $E = {}^{+}0.45V$

If the two half cells are connected in a circuit with a relevant salt bridge.

i) Write the cell reaction (1mk)

ii) What would be the cell representation (1mk)

iii) Calculate the cell e.m.f (2mks)