UNIVERSITY OF KABIANGA
SCHOOL OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF PHYSICAL SCIENCES

CHE 103: GENERAL AND PHYSICAL CHEMISTRY

1ST YEAR   1ST SEM   2017/2018   (MAIN EXAM)

Time: 3 Hours   Maximum Marks: 70

INSTRUCTIONS:

1. Answer Question **ONE** (Compulsory) and ANY TWO questions
2. Candidates are advised **not to write** on the question paper.
3. Candidates **must** hand in their **answer booklets** to the invigilator while in the examination room.
4. Candidates to be provided with graph papers

QUESTION ONE   (30 Marks)

(a) Derive an expression for the ideal gas equation.   (2marks)

(b) The heat of combustion of ethylene at 17°C and at constant volume is -332.19 kcals. Calculate the heat of combustion at constant pressure considering water to be in liquid state. ($R = 2$ cal degree^{-1} mol^{-1})   (3marks)

(c) Write the rate law equation and reaction order of the following: (4marks)

    (i) $2N_2O_5 \longrightarrow 4NO_2 + O_2$

    (ii) $H_2 + I_2 \longrightarrow 2HI$

    (iii) $2NO_2 \longrightarrow 2NO + O_2$

    (iv) $2NO + 2H_2 \longrightarrow N_2 + 2H_2O$

(d) Given some values of pressure and volume for 2g of hydrogen at 0^0C. Show that the data verify Boyle's law.   (2marks)

Pressure (atm)	2.00	1.00	0.90	0.75	0.50
Volume (dm³)	11.3	22.4	24.7	29.9	44.4

(e) State the following   (2marks)
    (i) Ideal gas laws
    (ii) Avogadro's law

(f) A weather balloon has a volume of 175L when filled with hydrogen at a pressure of 1.00 atm. Calculate the volume of the ballon when it rises to a height of 2000 m, where the atmospheric pressure is 0.80 atm. Assume that the temperature is constant. (2marks)

(g) The following table shows the effect of changing the pressure on the volume of a sample of a gas. The temperature of the gas is held constant. (8mks)

Pressure (atm)	1.00	0.90	0.85	0.75	0.65	0.55	0.45	0.30	0.20
Volume (L)	22.4	24.9	26.3	29.9	40.2	40.7	49.8	74.7	112

(i) Plot the following graphs P vs V, P vs 1/V, and PV vs P, interpret each graph in terms of Boyle's law.

(ii) One of the measurements in the table is wrong. Identify it giving reasons

(iii) Assuming that the pressure values are correct, calculate the volume corresponding to the incorrect point.

(h) Explain giving reasons the following statements: (2marks)

(i) The kinetic energy of the gas increases with increase in temperature.

(ii) Viscosity of gas molecules increases with increase in temperature but is independent of the pressure of the gas.

(i) Calculate the pressure of a gas if 8.04 mol occupies 31.8 L at 35°C. (2marks)

(j) Write the equilibrium constant expression for the reaction. (3marks)

$$N_2O_5(g) \rightleftharpoons NO_2(g) + O_2(g)$$
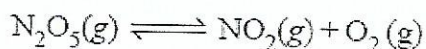
QUESTION TWO (20marks)

(a) If a solution has a pH of 7.41, determine its H^+ concentration. (3marks)

(b) State any five characteristics of a chemical equilibrium. (5marks)

(c) Calculate ΔH^o for the reaction

$$CO_2(g) + H_2(g) \longrightarrow CO(g) + H_2O(g)$$

given that ΔH^o_f for CO_2 (g), CO(g) and H_2O (g) are -393.5, -111.31 and -241.80 kJ mol^{-1} respectively. (4marks)

(d) Explain giving reasons, why gases are more compressible than liquids. (2marks)

(e) How many coulombs are required for the following reactions: (4marks)

(i) 1 mol of Al^{3+} to Al

(ii) 1 mol of Cu^{2+} to Cu

(f) If a gas diffuses at a rate of one-half as fast as O_2, find the molecular mass of the gas. (2marks)

QUESTION THREE (20marks)

(a) 50 ml of gas A effuse through a pin-hole in 146 seconds. The same volume of CO_2 under identical conditions effuses in 115 seconds. Calculate the molecular mass of A. (4marks)

(b) 0.1978 g of copper is deposited by a current of 0.2 ampere in 50 minutes. What is the electrochemical equivalent of copper? (3marks)

(c) Distinguish between order and molecularity of the reaction. (4marks)

(d) Describe the electrolysis of hydrochloric acid solution. (5marks)

(e) Explain the following observations: (4marks)

  (i) Aerated water bottles are kept under water during summer.

  (ii) Liquid ammonia bottle is cooled before opening seal.

  (iii) The tyre of an automobile is inflated to lesser pressure in summer than in winter.

  (iv) The size of a weather balloon becomes larger and larger as it ascends into higher altitudes

QUESTION FOUR   (20marks)

(a) Explain any four types of energy changes that take place during phase transformations.

(8marks)

(b) Discuss Hess's law of constant heat summation (4marks)

(c) Discuss any four factors that affects the rate of reaction. (4marks)

(d) Calculate the heat of formation of potassium hydroxide from the following. (4marks)

$$(i) \quad K(s) + H_2O\,(aq) \longrightarrow KOH + \tfrac{1}{2}H_2 \qquad \Delta H = -48.0\,\text{kcal}$$

$$(ii) \quad H_2(g) + \tfrac{1}{2}O_2(g) \longrightarrow H_2O(l) \qquad \Delta H = -68.5\,\text{kcal}$$

$$(iii) \quad KOH(s) \longrightarrow KOH(aq) \qquad \Delta H = -14.0\,\text{kcal}$$