LAIKIPIA UNIVERSITY

UNIVERSITY EXAMINATIONS

FIRST SEMESTER 2025/2026 ACADEMIC YEAR

FIRST YEAR EXAMINATION FOR THE DEGREES OF BACHELOR OF EDUCATION (SCIENCE) BACHELOR OF SCIENCE, BIOMED AND BIOCHEMISTRY

CHEM 112: INTRODUCTIION TO PHYSICAL CHEMISTRY

STREAMS: ***BEd(Sc), BSc (Gen), Biomed/Biochem*** ***TIME: 2 HRS***

DAY: WEDNESDAY [8.30 – 10.30 A.M] ***DATE: 04/02/2026***

THIS QUESTION PAPER CONSISTS OF FIVE (5) PAGES

PLEASE DO NOT OPEN UNTIL THE INVIGILATOR SAYS SO.

USEFUL DATA

$R = 0.0821 Latm^{-1}k^{-1} = 8.314 JK^{-1}mol^{-1}$

$P = 1$ atm $= 101325\ Nm^2 = 101325$ pa $= 760$ torr $= 760$ mmHg

$H = 1$, $C = 12$, $N = 14$, $O = 16$, $Br = 80$

Attempt ALL the Questions

QUESTION ONE (30 MARKS)

a.) State the following

i. Avogrado's law

ii. Kinetic theory of gases **(2 Marks)**

b.) State two properties of gases which differentiate them from solids and liquids **(2 Marks)**

c.) A given mass of a gas occupies a volume of 240 cm^3 at a pressure of 1.25 atm. By how much would the volume change if the pressure is changed to 570 torr? **(3 Marks)**

d.) A student at the back of a class releases the weeping gas, $C_6H_{11}OBr$, and moves towards the front of the class. At the same time, the teacher in front of the class releases the laughing gas, N_2O. If there are 13 equidistant rows in the class, determine the row at which the student will be laughing and weeping simultaneously. **(3 Marks)**

e.) A mixture of helium and oxygen gases are used in 'air' tanks for deep sea diving. For a particular dive, ,12 L of O_2 and 46 L of He at 25 °C and 1.0 atm were pimped into a 5.0 L tank. Calculate the:

i) Partial pressure of each gas **(5 Marks)**

ii) Total pressure in the tank at 25 °C

f.) Deviation from ideal gas behaviour depends on two factors. State **(2 Marks)**

g.) 1.0 moles of CO_2 was found to occupy 0.05L at 0 °C. Compute the pressure exerted by the gas assuming that;

i) The gas behaves like an ideal gas **(1.5 Marks)**

ii) The gas behaves like a real gas (a = 3.955 $LatmK\text{-}1mol^{-1}$, b = $0.04267 Lmol^{-1}$

(2.5 Marks)

h.) State whether each of the following statements is true or false about chemical equilibrium

i. The reaction stops at the equilibrium **(2 Marks)**

ii. Equilibrium can be attained in both closed and open systems

iii. Value of equilibrium constant does not depend upon the initial concentration of reactants.

iv. Equilibrium can be initiated from either side of the reaction i.e. from reactants side or products side.

i.) In an experiment, 2.0 moles of NOCl were placed in a one-liter flask. The equilibrium

$$2NOCl_{(g)} \rightleftharpoons 2NO_{(g)} + Cl_{2(g)}$$

was established at 25 °C and the concentration of NO was found to be 0.66 $molL^{-1}$.

i. Use a graph to illustrate how the equilibrium was achieved **(3 Marks)**

ii. Calculate the value of K_c for the reaction at the given temperature **(4 Marks)**

QUESTION TWO (20 MARKS)

a.) Define the following;

i. Electrode potential **(2 Marks)**

ii. Enthalpy

b.) Combustion of ethane from CO_2 and H_2O. Given the information in the table;

Formula and state of compound	C_2H_6 (g)	CO_2 (g)	H_2O (l)
Standard enthalpy of formation (at 298K)/$kJmol^{-1}$	-85	-394	-286

i. Calculate the enthalpy of combustion of ethane **(3 Marks)**

ii. Calculate the energy released when 100 g of ethane is completely burned. **(2 Marks)**

c.) The standard electrode potential for the half-reaction $Fe^{3+}(aq) + e^- \longrightarrow Fe^{2+}(aq)$ is +0.77V

While that for the half-reaction

$Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$ is +0.34V

i. The standard electrode potential for $Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$, was measured directly using a standard hydrogen electrode. Draw a well labelled diagram to demonstrate how this was done.

(6 Marks)

The half-reactions $Fe^{3+}(aq) + e^- \longrightarrow Fe^{2+}(aq)$ and $Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$ can also be used together to make a galvanic cell.

ii. Write the conventional representation for this cell. **(1 Mark)**

iii. Deduce the emf of the cell if both electrodes are set up under standard conditions. **(2 Marks)**

iv. Suggest how the value of the emf of the cell would change if the concentration of Fe^{2+} ion was decreased. Explain your answer **(2 Marks)**

v. If the K_b *f*or 0.1M NH_3 (aq) is 1.8×10^{-5} M. Calculate the pH of this solution. **(2 Marks)**

QUESTION THREE (20 MARKS)

a) Define the following terms as used in chemical kinetics **(4 Marks)**

i. Molecularity of a reaction

ii. Rate law

iii. Activation energy

iv. Order of a reaction

b) Derive the 1st order half-life expression from the following hypothetical rate equation.

$A + A \longrightarrow$ Products

(3 Marks)

c) For the reaction $2NO(g) + H_2(g) + N_2O(g) + H_2O(g)$, the following rate data were collected:

Initial [NO], $MolL^{-1}$	Initial [H_2], $MolL^{-1}$	Initial rate, $MolL^{-1}s^{-1}$
0.60	0.37	3.0×10^{4}
1.20	0.37	1.2×10^{-3}
1.20	0.74	1.2×10^{-3}

i. Deduce the orders of the reaction with respect to NO and H_2 and hence deduce the rate equation for the reaction. **(3 Marks)**

ii. Calculate a value for the rate constant for the reaction and state its units. **(3 Marks)**

d.) Consider the gas phase reaction below;

$$\underset{(g)}{CH_4} + 2\underset{(g)}{H_2S} \rightleftharpoons \underset{(l)}{CS_2} + 4\underset{(g)}{H_2} \quad \Delta +ve$$

(1 Mark)

i. Write the equilibrium constant K_c expression for the above reaction

Predict the effect on the value of K_c for the above reaction when; **(3 Marks)**

ii. The temperature is increased

iii. The pressure is increased

Predict the shift in equilibrium for the above reaction when; **(3 Marks)**

iv. CS_2 is increased

v. Temperature is decreased