THE PRIME MINISTER'S OFFICE

REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT

KILIMANJARO REGIONAL COMMISSIONER'S OFFICE

FORM SIX MOCK EXAMINATION

CHEMISTRY 1

032/1

TIME: 3:00 Hours **Wednesday 04th November 2026 Pm**

INSTRUCTIONS

1. This paper consists of section **A** and section **B** with total of **ten (10)** questions
2. Answer **all** questions in section A and Any two (02) questions in section B.
3. Each question carries ten (10) marks in section A and **fifteen (15)** marks in section B.
4. Mathematical tables and Non-Programmable calculators may be used.
5. Cellular phones and Unauthorized materials are **not** allowed in examination room.
6. Write your examination number of every page of your answer book[1] or Answer sheets.
7. Calculation you may use the following; -Rydberg constant
   (RH = $1.09678 \times 10^{7} m^{-1}$
   Planck's constant, $h = 6.63 \times 10^{-34}$ Js
   Atomic masses; N=14, H=1, C=12, O=16, Na=23, Cl=35.5, Ca=40, Cu=63.5, K=39, I=127, S=32

SECTION A (70 Marks)

Answer **all** the question in this section

1 (a) (i) What part of Bohr's theory of the atom is considered unrealistic as a result of Heisenberg's uncertainty principle?

(ii) The Heisenberg's uncertainty principle is not a practical way of examining the behaviors of macroscopic objects, but it is the most significant in describing the behaviors of electrons or system on a very small scale Explain. **(03 Marks)**

(b) Which of the following sets of orbitals are degenerate and why?

(i) 1s, 2s and 3s in Mg atom

(ii) $2p_x$, $2p_y$, and $2p_z$ in C atom

(iii) 3s, $3p_x$, and 3d orbitals in H atom **(03 Marks)**

(c) (i) Which energy level in Li^{2+} has same energy as the fourth energy level of hydrogen atom?

(ii) Calculate the ratio of wavelength of first spectral line of Lyman and Balmer series of hydrogen spectrum. **(04 Marks)**

2. (a) Structure of molecules of two compounds are below:

Compound (I): ortho-nitrophenol

Compound (II): para-nitrophenol

(i) Which of the two compounds will have intermolecular hydrogen bonding; and which compound is expected to show intramolecular hydrogen bonding?

(ii) Which of the above compound will show higher melting point?

(iii) Which of the above compound will form hydrogen bond with water easily and be more soluble in it? **(03 Marks)**

(b) (i) Explain why BeH_2 molecule has a zero-dipole moment although, the Be-H bond are polar?

(ii) What factor affect the strength of van de Waals forces? **(04 Marks)**

(c) Give the type of hybridization and geometrical shape of the following molecules:

(i) SiO_2

(ii) SO_2

(iii) H_2SO_4 **(03 Marks)**

3. (a) (i) State Charles's law

(ii) Explain the practical applications of Charles's law in real life. **(03 marks)**

(b) (i) It is not safe to put aerosol canister in a campfire. Explain

(ii) Pressure of 1g of an ideal gas A at 27 °C is found to be 2 bar. When 2g of another ideal gas B is introduced in the same flask at same temperature the pressure become 3 bar. Find a relationship between their molecular masses. **(04 Marks)**

(c) For each of the following, show how the final volume V_f is related to initial volume V_i for fixed mass of a gas:

(i) The pressure is decreased from 3 atm to 1 atm while temperature remain constant

(ii) The temperature is risen from 200K to 300K while pressure is increased from 2 atm to ? atm

(iii) The temperature is lowered from 400K to 100K while the pressure remains constant. **(03 Marks)**

4. (a) Briefly explain the effect of presence of dissolved solute in pure solvent with respect to:
   (i) Freezing point
   (ii) Boiling point (02 Marks)

   (b) (i) State the limitations of the laws of osmotic pressure
   (ii) On dissolving 3.24g of sulphur in 40g of benzene, boiling point of solution was higher than that of benzene by 0.81K. Kb value for benzene is 2.53K kg/ mol. What is the molecular formula of sulphur? **(03 Marks)**

   (c) (i) Calculate the freezing point and boiling point of a solution that is 3.725 M $CaCl_2$ in ethanol from the following data.

Solvent	Normal freezing point(°C)	Normal boiling point(°C)	K_f (°Ckg/mol)	K_b (°Ckg/mol
Ethanol	-117.3	78.5	1.99	1.22

   (ii) Do you expect the magnitude of practical value to be greater than, or smaller than, or the same as one calculated in (c) (i) above? Explain **(05 Marks)**

5. (a) (i) Explain the merits of the modern periodic table over others.
   (ii) What would be impacts on the existing periodic table if new elements are discovered? **(04 marks)**

   (b) Explain the following facts:
   (i) Group IA elements have lower melting and boiling points than group IIA elements.
   (ii) Group IIA elements have higher densities than Group IA elements.
   (iii) The melting and boiling point of group VIIA elements increase down the group, while those of group IA and group IIA decrease down the group **(03 Marks)**

   (c) With the aid of the chemical equations, explain how Cl_2 and Br_2 react with each of the following:
   (i) Dilute sodium hydroxide
   (ii) Hot concentrated sodium hydroxide solution. **(03 Marks)**

6. (a) Differentiate between the following terms:
   (i) Standard enthalpy of neutralization and enthalpy of fusion
   (ii) Standard enthalpy of combustion and standard enthalpy of formation **(02 Marks)**

   (b) Calculate the lattice energy of potassium chloride from the following data:
   The standard enthalpy of formation of potassium chloride = -436 kJ/ mol
   The standard enthalpy of atomization of potassium = +90 kJ/ mol
   The standard enthalpy of atomization of chlorine = +121 kJ/ mol
   The standard electron affinity of chlorine = -364 kJ/ mol
   The standard ionization energy of potassium = +420 kJ/ mol (03 Marks)

   (c) The heat of combustion of methane, carbon and hydrogen are 890, 393 and 285.8 KJ/mol respectively. The heat of sublimation of carbon and heat of dissociation of hydrogen molecule are 720 and 431 KJ/mol. Calculate C-H bond energy in methane. **(05 marks)**

7 (a) (i) What is non-ideal solution

(ii) What is technique can be used to investigate the existence of colored components of black ink and explain? **(02 marks)**

(b) Calculate the mass of a non-volatile solute (molecular mass = 40 g/mol, which should dissolve in 114g octane to reduce its vapour pressure to 80%. (03 Marks)

(c) Given that at 20 °C, only 0.24g of an organic acid A dissolved in 100 mL solution, but 2.70g of the same acid dissolves in 100 mL of ether.

(i) Determine the partition coefficient

(ii) Calculate the extraction percentage if 0.12g of acid is extracted in 100 mL of aqueous solution

(iii) Find the volume of ether required to extract 85% of 3g of acid A in 100 mL solution. **(05 Marks)**

SECTION B (30 Marks)

Answer only two (02) questions in this section

8. (a) Briefly explain the following concepts

(i) Concentrated sulphuric acid is necessary for nitration of benzene **(01 mark)**

(ii) Bromination of benzene take place in the presence of Lewis acid and while that of hydroxylbenzene does not require the presence of Lewis acid **(01 mark)**

(iii) Despite chlorine atom being an electron withdrawing group they direct incoming electrophile towards benzene at ortho or para position in the electrophilic aromatic substitution reaction **(01 mark)**

(iv) $(CH_3)_2CHBr$ undergo SN_1 Mechanism $CH_3CH_2CH_2Br$ undergoes SN_2 mechanism when they react with aqueous alkali. **(02 marks)**

(v) Haloalkane undergo nucleophilic substitution react ion while halobenzene undergo electrophilic substitution reaction **(02 marks)**

(b) Phenols undergo electrophilic aromatic substitution reaction to form ortho and para substituted products. Explain four (04) common electrophilic aromatic substitution reactions of phenols. **(04 Marks)**

(c) (i) What factors contribute to the acidic nature of phenol? Basing on these factors, compare the acidity nature of phenol and cyclohexane. **(02 marks)**

(ii) Benzene is less reactive than phenol towards electrophilic aromatic substitution reactions. Explain. **(02 Marks)**

9. (a) Briefly explain the following observations:

(i) The deactivating and meta-directing nature of the nitro group toward aromatic electrophilic substitution reactions.

(ii) The alkoxyl (-OR) is ortho-para directing even through oxygen is more electronegative than carbon. **(02 Marks)**

b) Complete the following reaction equations.

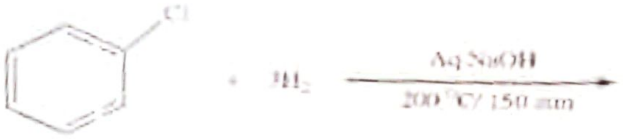
(i)



(ii)



(iii)



(04 Marks)

(c) When 2-bromo-2-methylpropane react with aqueous NaOH at 25 °C, the two products formed are an alcohol and an alkene. Using balanced equations, answer the following questions:

(i) Explain the type of the reaction that leads to formation of the alcohol and give the mechanism for the reaction.
(ii) Give the name and structural formula for the alcohol that is produced
(iii) Explain the type of reaction that leads to the formation of the alkene.
(iv) Give the name and structural formula of the alkene formed.
(v) What conditions will favour the formation of alcohol and alkene?
(06 Marks)

(d) What are possible limitations of halogen derivatives toward their uses in making various household products? **(03 Marks)**

). (a) Give four differences between the types of deviation of solution from Raoult's law. **(04 Marks)**

(b) Steam is passed through a flask containing about 20g of chlorobenzene C_6H_5Cl. The mixture is found to boil at 91 °C and 760mmHg. Given that the vapour pressure of water at 91 °C is 540 mmHg, calculate:

(i) Mole composition of the distillate.
(ii) Mass composition of the distillate.
(iii) Total volume of the distillate obtained when 90% of chlorobenzene has been steam distilled. (Density of chlorobenzene = 1.1 g/cm^3 **(06 Marks)**

(c) At a pressure of 760 mmHg, a mixture of nitrobenzene and water boils at 99 °C. The vapour pressure of water at this temperature is 733 mmHg. Calculate the percentage by mass of nitrobenzene in the distillate obtained by steam distillation of impure nitrobenzene. **(04 Marks)**

(d) A particular liquid compound starts decomposing before it is heated to its boiling point under normal pressure. How can this compound be purified? **(01 Marks)**