GWANDA STATE UNIVERSITY

FACULTY OF ENGINEERING AND ENVIRONMENT

DEPARTMENT OF METALLURGICAL ENGINEERING

CHEMISTRY FOR METALLURGICAL ENGINEERS

EMG 2103

Part II First Semester Examination Paper

September 2023

This examination paper consists of 4 printed pages

Time Allowed: **3 hours**

Total Marks: **100**

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INSTRUCTIONS

1. Answer **ALL Questions**
2. Each question carries twenty marks
3. Use of calculators is permissible

Additional Requirements
Data Booklet
Graph Paper

MARK ALLOCATION

Part Questions	As shown in each part question
Total Attainable	100

Question 1

a) Bauxite, the principal ore used in the production of aluminum, has a molecular formula of $Al_2O_3.2H_2O$

  i. What is the molar mass of bauxite? [2]
  ii. What is the mass of aluminum in 0.58 moles of bauxite? [5]

b) A binary ionic compound is known to contain a cation with 51 protons and 48 electrons. The anion contains one-third the number of protons as the cation. The number of electrons in the anion is equal to the number of protons plus 1.

    i.   What is the formula of this compound? [3]
    ii. What is the name of this compound? [2]

c) Draw the most appropriate Lewis structures for the following compounds. Note that the central atoms of these compounds do not follow the octet rule.

  i. SF_6 [4]
  ii. XeF_4 [4]

Question 2

a) Use bond energy values from the data booklet to estimate enthalpy changes for the following reactions in the gas phase.

    i. $H_2 + Cl_2 \rightarrow 2HCl$ [3]
    ii. $N_2 + 3H_2 \rightarrow 2NH_3$ [4]

b) Hydrogen bonding is a special case of very strong dipole- dipole interactions possible among only certain atoms.

    i.   Identify any other three atoms, in addition to hydrogen, that are necessary for hydrogen bonding? [3]
    ii. Explain how the small size of the hydrogen atom contributes to the unusual strength of the dipole-dipole forces involved in hydrogen bonding? [4]

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c) Consider the following compounds and formulas.

Ethanol: CH_3CH_2OH

Dimethyl ether: CH_3OCH_3

Propane: $CH_3CH_2CH_3$

The boiling points of these compounds are -42.1°C, -23°C, and 78.5°C. Match the boiling points to the correct compound from the list above and give reasons for your matchings. [6]

Question 3

a) What do you understand about the following terms?

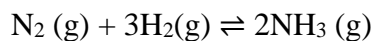   i) Rate of reaction [2]
    ii) Reversible reaction [2]

b) Explain in detail how the rate of an exothermic chemical reaction is affected by:

    i. A decrease in temperature [3]
    ii. An increase in reactant concentrations [3]

c) Ammonia is produced as follows:

$$N_2 (g) + 3H_2(g) \rightleftharpoons 2NH_3 (g)$$

The conditions used in the manufacturing of ammonia (Haber process) are:
    temperature of 500 °C, pressure of 200 atm and Iron as a catalyst.

    i. Outline Le Chateliers' Principle [2]
    ii. Use Le Chateliers' Principle to justify the conditions used in the process [8]

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Question 4

a) Define the following terms:

    i.   Order of reaction   [2]
    ii.   Equilibrium constant   [2]
    iii. Heterogeneous equilibrium   [2]

   b) Explain the difference between equilibrium constant Kc and Kp [4]

   c) The equilibrium mixture present in a $3,0 dm^3$ flask at 250 ºC contain 1,0 mole $PCl_5(g)$, 2,0 moles of $PCl_3(g)$ and 0,3 mole of $Cl_2(g)$.

     i. Calculate the equilibrium constant, Kc for the equilibrium: $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ [8]
     ii. Give the units for K   [2]

Question 5

a) Electrolysis is an important branch of electrochemistry. Give a detailed description of any three industrial applications of electrolysis.   [15]

b) Calculate the mass of copper deposited during constant current electrolysis of copper sulphate at 20A for 10 hours.   [5]

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