THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

A. M. E. C. E. A

MAIN EXAMINATION

SEPTEMBER –DECEMBER 2021

FACULTY OF SCIENCE

DEPARTMENT OF CHEMISTRY

REGULAR PROGRAMME

CHEM 405: MATERIAL CHEMISTRY

Date: DECEMBER 2021	Duration: 2 Hours
INSTRUCTIONS: Answer Question ONE and any TWO Questions	

Required Formulae:

Intrinsic carrier concentration:

$$n_i = \frac{\sigma}{|e|(\mu_e + \mu_h)}$$

FCC: a = 2r$\sqrt{2}$, FCC: 4r = $\sqrt{2}$a, BCC: 4r = $\sqrt{3}$a, SCC: a = 2r

Q1.

(a) Define the following terms:
(5marks)
  (i) Non-metal
  (ii) Monomer
  (iii) Unit Cell
  (iv) Doping
  (v) Material Chemistry

ISO 9001:2015 Certified by the Kenya Bureau of Standards

(b) Silver crystallizes with face centred cubic unit cell and each side of unit cell has length of 409 pm. What is the radius of an atom of silver?

(3marks)

(c) Write short notes on the following:

(4marks)

    (i) Neel Temperature
    (ii) Demagnetizatizing field

(d) With respect to bonding and structure, distinguish between ceramics and metals.

(2marks)

(e) Why does one need a sychrotron source in order to perform XAFS studies?

(2marks)

(f) What is tempered glass and how are they produced?

(4marks)

(g) What is meant by the term "density of states"? How does Density of states influence the electrical conductivity of semiconductors?

(4marks)

(h) How do "self-cleaning coatings work?

(2marks)

(i) State two basic functions of refractories.

(2marks)

(j) Mercedes-Benz and other manufacturers feature scratch-resistant cleat coats as standard on new vehicles. What are these coatings comprised of?

Q2.

    (a) Distinguish between hard and soft magnetic materials with examples. **(5marks)**
    (b) Explain briefly diamagnetism, Para-magnetism and ferromagnetism. **(6marks)**
    (c) Compare the temperature dependence of conductivity for metals and intrinsic semiconductors. Briefly explain the difference in behavior. **(5marks)**
    (d) For intrinsic gallium arsenide, the room-temperature electric conductivity is 10^{-6} $(\Omega^{-}m)^{-1}$; the electron and hole mobilities are respectively 0.85 m^3/V^{-s} and 0.04m^2/v^{-s}. Compute the intrinsic carrier concentration. **(4marks)**

Q3.

    (a) Distinguish between additional and condensation polymerization.

(5marks)

    (b) Why are some polymers recyclable? State the properties of elastomers.

(6marks)

(c) Briefly classify the composite materials. Cite importance of composite materials over the engineering alloys. Clearly state the difference between particle reinforced and fiber reinforced composites.

(9marks)

Q4.

(a) Define the term "glass material".

(2marks)

(b) Discuss the four properties of glasses.

(4marks)

(c) Explain the three processes by which glass is made to absorb visible spectrum (thus becoming colored).

(6marks)

(d) What are refractory materials? Give two examples of an acid and basic refractory materials. **(6marks)**

(e) How do acid refractories differ from basic refractories?

(2marks)

Q5.

(a) Define the term "crystallography".

(2marks)

(b) Write short notes on the basic methods available for growing crystals:

(8marks)

(i) Growth from vapour.
(ii) Growth from solution.
(iii) Growth from solid.
(iv) Growth from melt

(c) Briefly explain how Schooty and Frenkel crystal defects are formed.

(4marks)

(d) Calculate the packing efficiency of Simple cubic cell (SCC), Body centered cubic cell (BCC), and Face centered cubic cell (FCC).

(6marks)

END