TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR DEGREE OF:

BACHELOR OF TECHNOLOGY IN RENEWABLE ENERGY
BACHELOR OF TECHNOLOGY IN APPLIED PHYSICS

APS 4206: STRUCTURE & PROPERTIES OF MATTER

END OF SEMESTER EXAMINATION
SERIES: APRIL 2015
TIME ALLOWED: 2 HOURS

Instructions to Candidates:
You should have the following for this examination
- *Mathematical tables*
- *Scientific Calculator*

This paper consist of **FOUR** questions
Answer question **ONE (COMPULSORY)** and any other **TWO** questions
Maximum marks for each part of a question are as shown
This paper consists of **THREE** printed pages

You may use:
1eV = 1.602 x 10^{-19}J
Planks constant, h = 6.626 x 10^{-34}Js
Acceleration due to gravity g = 9.8ms^{-2}
Avogadro's number N = 6.02 x 10^{23} g/mole
Electron's charge e = 1.6 x 10^{-16}C

$$\varepsilon_o = 8.85\times10^{-12}\,Fm^{-1}$$

Permittivity of free space,
Bolt 2mann constant K = 1.38 x 10^{-23}Jk^{-1}

$\mathring{A} = 10^{-10}\,m$

$$\mu_o = 4\pi\times10^{-7}\,Hm^{-1}$$

Permeability of free space

$$E_g = 8\times10^{10}\ Nm^{-2}$$

Young's modulus of glass

$$_g = 0.314 J/m^2$$

Surface energy of glass

$$V_g = 0.25$$

Poisson's ratio of glass,

Question One (Compulsory)

a) (i) What is the capacity of any sub sheet having an orbital quantum number, L? **(1 mark)**

(ii) Determine the maximum number of electrons for the orbital quantum number L = 3 **(3 marks)**

b) List various types of bonds in materials giving an example of a material for ach bond **(6 marks)**

c) (i) Draw the f_{cc} unit cell and; **(1 mark)**
(ii) Calculate the packing factor **(4 marks)**

d) (i) Distinguish between long range order and short range order in solids **(2 marks)**

(ii) Give TWO examples of short range order materials **(2 marks)**

e) (i) What is a dislocation? **(1 mark)**
(ii) Briefly describe TWO basic types of dislocations **(4 marks)**

f) Describe TWO methods of hardening materials **(4 marks)**

g) How significant are phase diagrams for alloys **(2 marks)**

Question Two

a) (i) What is coordination number of an atom? **(1 mark)**

(ii) Calculate the basis of a unit all for: Simple cubic (sc) **(2 marks)**
face centred cubic (f_{cc}) and **(2 marks)**
body centred cubic (b_{cc}) **(2 marks)**

b) Determine the critical ratio of ionic radii for $\frac{r^+}{r^-}$ which the bcc structure is just stable, showing clearly your working **(5 marks)**

c) List all the <101> members **(5 marks)**

Question Three

a) Explain the difference between soft loading and hard loading **(2 marks)**

b) Distinguish between plastic and elastic behavior of materials **(2 marks)**

c) Describe how the charpy test is used to determine toughness of a metal **(4 marks)**

d) Explain what you understand by the following terms:
   (i) Ductility
   (ii) Hardness
   (iii) Annealing of materials
   (iv) Flexure **(8 marks)**

e) Describe TWO ways of strengthening glasses **(4 marks)**

Question Four

a) In connection with alloys define the following:
   (i) Interstitial solid solution **(1 mark)**
   (ii) Substitutional solid solution **(1 mark)**

b) State the conditions necessary for the formation of each of the solid solutions in (a) **(4 marks)**

c) With regard to eutectic mixtures:
   (i) Explain eutectic composition and; **(2 marks)**
   (ii) Describe the eutectic structure **(2 marks)**

d) Refer to the tin-lead T-X diagram below:

I. Define the α phase and β phase **(1 mark)**

II. What is the composition of:
   (i) Liquid phase and; **(1 mark)**
   (ii) Solid phase at the temperature and composition **(1 mark)**

III. Describe all the phase transformations which take place when the solution of the composition Y is cooled from above 327^{o}C down to room temperature (about 20^{o}C) **(4 marks)**

IV. State the lever's rule and use it to calculate the ratio of the amount of solid to liquid at Y **(2 marks)**

V. Determine the maximum amount (in percentage) of tin which may be dissolved in lead at 180^{o}C and say what happens to the rest of tin **(1 mark)**