# KISII UNIVERSITY

## UNIVERSITY EXAMINATIONS
### SPECIAL EXAMINATION
### THIRD YEAR EXAMINATION FOR THE AWARD OF THE DEGREE OF BACHELOR OF EDUCATION (SCIENCE)
### FIRST SEMESTER 2021/2022
### (JULY, 2022)

### PHYS 317: PHYSICS OF MATERIALS

**STREAM:  Y3 S1**                                    **TIME:   2 HOURS**

**DAY: THURSDAY, 11:30 AM – 1:30 PM**          **DATE: 28/07/2022**

*INSTRUCTIONS:*

1. *Do not write anything on this question paper.*
2. *Answer Question ONE (Compulsory) and any other TWO questions.*

**QUESTION ONE**

(i)     Differentiate between stress and strain as used in material science and state their SI units if any.                                    (4marks)

(ii)    A steel cable with an initial length of 20 m and a diameter of 0.05 m suspends an elevator car in its shaft. Three people, having a total mass of 238 kg, enter the elevator car. Given the elevator cable is made of steel, what is the amount of stretch that the cable experiences when the three passengers enter the elevator? Given that the Young modulus of steel is $2 \times 10^{11}$ Pa and the earth's gravitational acceleration is $9.8 \text{ m/s}^2$                                    (4marks)

(iii)   Apart from the cubic system, state any other two non primitive unit cells.                                    (2marks)

(iv)    What are the procedure of constructing a wigner-seitz cell in a primitive cell.                                    (3marks)

(v)    Show that in the face centered cubic (BCC) $a=\frac{4R}{\sqrt{3}}$, where R=atomic radius, a=lattice constant.                                    (3marks)

(vi)   calculate the density of the copper given that, R=0.128nm, A=63.5g/mol
       (Hint: copper is an FCC structure).
                                                                        (4marks)

(vii)  Write down the atomic radius in terms of the lattice constant a, for (a) simple cubic structure (c) FCC structure.
                                                                        (4marks)

(viii) In terms of band gap distinguish between metals, insulators and semiconductors. Give an example in each.                 (6marks)

**QUESTION TWO**

(i)    Define the following terms as applied to materials [a] ductility [b] malleability                                                     (4marks)

(ii)   A brass rod is 500m long at 20° C. What is the length of the rod if it is heated to 50°C? [Linear coefficient of brass is $19\times10^{-6}$ °C$^{-1}$] (4marks)

(iii)  A steel beam 12.0m sits next to a concrete wall when the temperature is 20.0°C. A gap must be left between the beam and the concrete wall for expansion purposes. If the temperature rises to 45.0°C, how large must the gap be if the steel beam just touches the concrete wall? [Linear coefficient of steel is $12\times10^{-6}$ °C$^{-1}$]                 (6marks)

(iv)   Differentiate between heat capacity and specific heat capacity and state the SI unit for each.                                  (4marks)

(v)    Why is the study of materials important to a Physics student?
                                                                        (2marks)

**QUESTION THREE**

(i)    Define a crystal defect                                          (2marks)
(ii)   Briefly explain the following categories of crystal defects with suitable diagrams ;
   (a) Point defects    [zero dimensional defects]                      (4marks)
   (b)  Line defects or dislocations [one dimensional defects]          (4marks)
   (c) Planer defects [two dimensional defects]                         (4marks)
   (d) Volume defects [three dimensional defects]                       (4marks)
(iii)   What are the effects of defects on the properties of a material?       (2marks)

**QUESTION FOUR**

(i)     Sketch the planes with the following miller indices
      (a)  (001)                                             (2marks)
      (b)  (100)                                             (2marks)
      (c) (010)                                             (2marks)
      (d) (111)                                             (2marks)
      (e)  (210)                                             (2marks)

(ii)     What is the importance of having a notation system for atomic planes in material science?                      (2marks)

(iii)     If the atomic radius for Pb=0.175nm, find the volume of the unit cell.                (4marks)

(iv)     Draw face centered cubic structure (FCC) and body centered cubic structure (BCC) clearly showing the positions of atoms     (4marks)

## QUESTION FIVE

(i)   Distinguish between the following classification of solids;
      (a) Crystalline solids
      (b) Amorphous solids                                       (4marks)

(ii) Explain the following types of bonding giving one example in each case;
      (a) metallic bond                                      (3marks)
      (b) covalent bond                                      (3marks)
      (c) ionic bond                                         (3marks)
      (d) van der waals                                     (3marks)
      (e) hydrogen bond                                    (3marks)

(iii) Define a crystal structure                              (1marks)