KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2017/2018ACADEMIC YEAR

THIRD YEAR FIRST SEMESTER
SPECIAL/SUPPLEMENTARY EXAMINATIONS

FOR THE DEGREE OF BSC (PHYSICS)

COURSE CODE: SPH 320

COURSE TITLE: INTRODUCTION TO MATERIAL SCIENCE

DURATION: 2 HOURS

DATE: 05/10/2018 **TIME: 11:30-1:30PM**

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.

Start every question on a new page and make sure question's number is written on each page

This paper consists of **3** printed pages. Please Turn Over

Some constants which you may find useful

Charge of an electron	$1.6\times10^{-19}C$
Permittivity of free space	$8.85\times10^{-12}F/m$
Madelung constant of NaI	1.748
Young Modulus of steel	$2\times10^{11}Pa$.

QUESTION ONE (30mks)

a) Differentiate between ductile and brittle substances (1mk)
b) Write down the atomic radii r in terms of the lattice constant a, for (i) Simple cubic structure (ii) FCC structure (iii) BCC structure (iv) Diamond structure. (4mks)
c) Write the electronic configuration for potassium whose atomic number is 19. How many unpaired electrons are there in a potassium atom. (2mks)
d) Explain what you understand by the following terms; (i) Notch sensitivity (ii) Creep (iii) Fatique. (3mks)
e) Explain the differences between soft and hard loading. (2mks)
f) Explain the terms ductility and hardness as used in mechanical tests of materials. (4mks)
g) State three differences between ionic compounds and covalent compounds. (3mks)
h) Explain why metallic bonds are non directional. (2mks)
i) State two disadvantages of centre point loading. (4mks)
j) State Griffith's criterion for a crack formation and explain why it is not directly useful to the theory of ductile failure. (3mks)
k) The potential energy of the sodium chloride system is written as;

$$U_P = -\frac{A}{r^n} + \frac{B}{r^m}$$

i) Explain the meaning of each term on the right hand side of this equation. (2mks)

ii) Describe the behavior of each term in this equation as r approaches zero. (2mks)

QUESTION TWO (20mks)

a) Draw a well labeled load-extension curve for mild steel and describe all the main sections of this curve, stating clearly what happens at each part of the curve. (6marks)
b) Show that $\sqrt{3}\pi/8$ and $\pi/6$ of the available volume is occupied by hard spheres in con-tact in a body-centered cubic and simple cubic arrangement (10marks)
c) A cubic lattice has a cube edge a=2.665Å. Find the spacing of adjacent planes with the miller indices. i) (101) ii) (111). (4marks)

QUESTION THREE (20mks)

a) The crystal structure of NaCl is a cubic lattice, the successive lattice sites being occupied by Na and Cl ions respectively. Calculate the spacing between the nearest neighboring ions. Take the density of the NaCl as 2180 Kg/m^3 and number of ions per unit cell as 4. (6marks)

b) The energy of interaction of two atoms a distance apart can be written as:

$$E(r) = -\frac{a}{r} + \frac{b}{r^7}$$

Where a and b are constants.
i) Show that for the particles to be in equilibrium, $r = r_o = (7b/a)^{1/6}$ (3marks)

ii) In stable equilibrium, show that the energy of attraction is seven times that of the repulsion in contrast to the forces of attraction and repulsion being equal. (4marks)

c) In Problem (b) above, if the two atoms are pulled apart, show that they will separate most easily when $r=(28b/a)^{1/6}$ (3marks)

d) Let the interaction energy between two atoms be given by:

$$E(r) = -\frac{A}{r^2} + \frac{B}{r^8}$$

If the atoms form a stable molecule with an inter-nuclear distance of 0.4 nm and a dissociation energy of 3 eV, calculate A and B. (4marks)

QUESTION FOUR (20mks)

a) Suppose a 2 kg mass is attached to the end of a vertical wire of length 2 m and diameter 0.64 mm, and the extension is 0.6 mm, calculate tensile stress, tensile strain and Young Modulus (6 marks)

b) Briefly define stress and strain as applied to elastic properties of solids (2 marks)

c) By using a clearly well labeled diagram, discuss THREE types of stress (6 marks)

d) A bar has dimensions 1 cm by 1 cm by 2 cm. It is subjected to a 10 000 N tension force and stretches 0.01 cm. Find:

i)The stress

ii)The strain

iii) If the stress-strain graph is a straight line, how much does the bar stretch when the applied force increased to 50 000 N (6 marks)

QUESTION FIVE (20mks)

a) Briefly discuss the following types of magnetism giving clear differences between them. (12marks)

(i) Ferromagnetism
(ii) Paramagnetism
(iii) Diamagnetism
(iv) antifferromagnetism

b) Sketch a typical hysteresis loop, and explain the primary magnetic properties of a material that can be determined from it. (8marks)