



SOUTH EASTERN KENYA UNIVERSITY

UNIVERSITY EXAMINATIONS 2016/2017

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN (PHYSICS) AND BACHELOR OF EDUCATION (SCIENCE)

SPH 403: SOLID STATE II

7TH DECEMBER, 2016

TIME:4.00-6.00 P.M

INSTRUCTIONS:

1. Attempt question **ONE** and any other **TWO** questions.
2. Question one carries **30 marks** while the rest carry **20 marks each**

QUESTION ONE (30 MARKS)

- (a) (i) Distinguish between phonons and photons. (3Marks)
- (ii) State fundamental assumptions of Debye's approximation theory. (4Marks)
- (b) (i) When a certain amount of heat is added to a solid, the increase in energy occurs in two ways. Name them (3 Marks)
- (ii) What is Petit and Dulong law in solids? (3 Marks)
- (c) For a wave motion of one-dimensional atomic lattice, distinguish between
- (i) Phase and group velocity (4 Marks)
- (ii) Under what conditions are the two equal? (3 Marks)
- (d) (i) Distinguish between the following terms as applied to magnetism in solids
- Diamagnetism, paramagnetism, ferromagnetism (6 Marks)

(ii) Classify the following unit cell into proper system

(a) $a = 10.8\text{\AA}, b = 9.47\text{\AA}, c = 5.2\text{\AA}$

$\alpha = 41^\circ \quad \beta = 83^\circ \quad \gamma = 93^\circ$ (2 Marks)

(b) $a = b = 10.73\text{\AA}, c = 5.2\text{\AA}$

$\alpha = \beta = 90^\circ \quad \gamma = 120^\circ$ (2 Marks)

QUESTION TWO (20 MARKS)

Using the dispersion relation for a diatomic lattice

$$\omega_{\pm}^2 = \beta \frac{(m_1+m_2)}{m_1m_2} \pm \beta \left[\left(\frac{m_1+m_2}{m_1m_2} \right)^2 - \frac{4\sin^2 ka}{m_1m_2} \right]$$

Show that

(a) The allowed frequency of propagation splits into branches (10 Marks)

(b) Name them and make a clear distinction between them. (10 Marks)

QUESTION THREE (20 MARKS)

(a) On the basis of free electron theory, State at least five outstanding properties of metals. (4Marks)

(b) Based on 3 (a), deduce the following

(i) Ohm's law (6Marks)

(ii) Electrical conductivity (5Marks)

(iii) Thermal conductivity of solids. (5Marks)

QUESTION FOUR (20 MARKS)

(a) What is superconductivity? (2 Marks)

(b) Show that Meissner's effect contradicts the Maxwell's equations (9 Marks)

(c) Explain Meissner's effect using the second London's equation (9 Marks)

QUESTION FIVE (20 MARKS)

- (a) State the factors which determine the state of magnetization when an external field is applied (7 Marks)
- (b) (i) derive the Curie-weiss law (8 Marks)
- (ii) What conclusions can you make from 5(b) (i) (5 Marks)