

JANUARY 2024
PHY 403SW
SOLID STATE PHYSICS
2 HOURS

Candidate's Index Number	
1E/P	
Si	

UNIVERSITY OF CAPE COAST
COLLEGE OF EDUCATION STUDIES
SCHOOL OF EDUCATIONAL DEVELOPMENT AND OUTREACH
INSTITUTE OF EDUCATION

FIVE-SEMESTER BACHELOR OF EDUCATION (SANDWICH) PROGRAMME
LEVEL 400, END-OF-FIRST SEMESTER EXAMINATIONS, JANUARY 2024

10TH JANUARY 2024

SOLID STATE PHYSICS

9:00 AM - 11:00 AM

100 MARKS

Answer **THREE** questions in all; Question 1 and any other **TWO** questions.

For items '1a' to '1d', each stem is followed by four options lettered A to D. Read each item carefully and write the letter of the correct or best option. (40 marks)

1.

- a. What is the primary function of a semiconductor amplifier?
 - A. Signal modulation
 - B. Voltage rectification
 - C. Current amplification
 - D. Light emission

- b. Which semiconductor element is commonly used in the fabrication of solar cells?
 - A. Silicon (Si)
 - B. Aluminium (Al)
 - C. Gold (Au)
 - D. Sodium (Na)

- c. What is the primary characteristic that distinguishes conductors from insulators?
 - A. High resistivity
 - B. Low resistivity
 - C. Large band gap
 - D. Perfect crystalline structure

- d. What does the term "Fermi level" represent in solid-state physics?
 - A. Energy of valence electrons
 - B. Energy of conduction electrons
 - C. Energy at absolute zero
 - D. Energy of photon absorption

$$\frac{4/3 \pi r^3 \times 1}{a^3} = 0.52$$

$$a^3 =$$

c. What is the fundamental difference between crystalline and amorphous solids?

2.

a. Explain the concept of band gap in semiconductors. Explain the concept of band gap in semiconductors. (10 marks)

b.

i. explore the phenomenon of phonons in solid-state physics. How do phonons contribute to thermal conductivity and what is their role in the lattice vibrations of crystals? (10 marks)

ii. Calculate the lattice constant for a simple cubic crystal structure if the atomic radius of the constituent atoms is $r=0.2\text{nm}$. (10 marks)

3.

a. Describe the phenomenon of superconductivity and its practical applications. (10 marks)

b.

i. Define the Bravais lattice and discuss its significance in the study of crystal structures. Provide examples of different types of Bravais lattices. (10 marks)

ii. Determine the Debye temperature (T_D) for a metal with a sound velocity (v_s of 5000m/s and a density (ρ) of 8g/m^3 . (10 marks)

4.

a. Explain the concept of the "Hall Effect" in solid-state physics. (10 marks)

b.

i. Discuss the role of defects in crystalline materials. How do point defects, line defects and planar defects influence the mechanical and electrical properties of solids? (10 marks)

ii. A crystal has a bandgap (E_g) of 1.5eV . Calculate the wavelength (λ) of light that can just create an electron-hole pair in this material. (10 marks)

