M.Sc. PHYSICS
THIRD SEMESTER
CONDENSED MATTER PHYSICS
MPH-304 A

Duration: 3 Hrs. Marks: 70

PART : A (OBJECTIVE) = 20
PART : B (DESCRIPTIVE) = 50

[PART-B : Descriptive]

Duration: 2 Hrs. 40 Mins. Marks: 50

[Answer question no. One (1) & any four (4) from the rest]

1. (a) Deduce the relation between specific heat Cv and thermal conductivity by following free electron gas theory. (5+5=10)
   (b) What is Wiedmann Franz Law? Deduce the expression for Wiedmann Franz Law.

2. What is density of states? From band theory of electronic states show that the Fermi energy can be given as: $E_F=\frac{\hbar^2}{2m}\left(\frac{3N}{8\pi}\right)^{2/3}$ (2+8=10)

3. What is Hall-effect? Explain with figure with proper direction of axes. From Lorentz force deduce the expression for hall coefficient. In the field of semiconductor industry how hall effect can be a useful physical phenomena? (2+2+4+2=10)

4. (a) From bloch theorem show that number of possible wave function for an electron per band is $na=L$; where L is linear crystal length, a is lattice constant, and n is quantization. (5+5=10)
   (b) Why effective mass of an electron in a crystal is variable and not constant? Explain with mathematical deduction.

5. (a) What is dispersion of light? From Maxwell equations deduce the dispersion relation between k and ω. Where k is wave vector and ω is angular frequency. (1+4+1+4=10)
   (b) What are measurable optical constants, give two examples? Express the dielectric constant ϵ of a material in terms of measureable optical constant.

6. What are first and second order phase transitions briefly describe with examples? What is critical point of a phase transition? From real gas equation deduce the expressions for temperature pressure and volume at critical point. (4+1+5=10)

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7. (a) Discuss briefly the important features of BCS theory. Explain how critical magnetic field varies with temperature in superconductors. (3+7=10)

(b) Critical temperature of a sample with isotopic mass of 204.87 is 19.2 k. Find T_c when isotopic mass changes to 218.87.

8. (a) Prove that zero electrical resistivity and perfect diamagnetism are the two mutually consistent properties of a superconductor. (5+3+2=10)

(b) Describe the Joshephson effect underlying a SQUID. Discuss applications of SQUID.

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[PART-A : Objective]

Choose the correct answer from the following : **1×20=20**

1. According to drude model, in a metal:
   a. Electrons are intact and ions are free to move in the block.
   b. Electrons are free to move and ions are intact in the block.
   c. Both electrons and ions are intact in the block.
   d. Both electrons and ions are free in the block.

2. In drude model thermal conductivity is:
   a. Directly proportional to mean free path.
   b. Inversely proportional to mean free path.
   c. Independent of mean free path.
   d. Proportional to inverse square root of mean free path.

3. With increase in temperature the electrical conductivity of intrinsic semi-conductor:
   a. Decreases.
   b. Increases.
   c. Remain same.
   d. First increase and then decreases.

4. In an extrinsic n-type semiconductor the fermi level_____ in the energy band diagram.
   a. Remain in the same position.
   b. Moves downwards.
   c. Moves upwards.
   d. Moves left.

5. A typical conductor usually have_____ visible optical behavior due to_____ band gap.
   a. Good, Small b. Bad, Small
   c. Good, Large d. Bad, Large

6. A typical insulator usually have_____ visible optical behavior due to _____ band gap.
   a. Good, Small b. Bad, Small
   c. Good, Large d. Bad, Large

7. Frank Condon principle is related to:
   a. Lattice vibrational states.
   b. Phonon vibrational states.
   c. Sound vibrational states.
   d. Molecular vibrational states.

8. The Bloch theorem provides the notion of:
   a. The periodic motion of the electrons in a crystal.
   b. The periodic motion of a soliton in a crystal.
   c. The free random motion of an electron in a crystal.
   d. The free random motion of a soliton in a crystal.

9. Curie temperature is the temperature above which:
   a. A liquid become gas.
   b. A paramagnet becomes diamagnet.
   c. A ferromagnet becomes paramagnet.
   d. A gas becomes liquid.

10. A brillouin zone in a solid state material is:
    a. Allowed electronic energy band in k-space.
    b. Forbidden electronic energy band in k-space.
    c. Allowed electronic energy band in real-space.
    d. Forbidden electronic energy band in real-space.

11. Can an electron have negative mass inside a solid?
    a. No b. Yes
    c. Never d. Always

12. If electric field applied along X-axis and magnetic field is applied along Y-axis, then the Hall Voltage will be generated in:
    a. X-direction.
    b. Y-direction.
    c. Z-direct.
    d. At an angle $\Theta<90^{o}$ between X and Y.

13. An exciton is:
    a. A strongly bound electron and ion pair.
    b. A weakly bound electron ion pair.
    c. A strongly bound electron hole pair.
    d. A weakly bound electron hole pair.

14. Conversion of boiling water at 1 atmospheric pressure and 100^{o}c in vapour is:
    a. Zeroth order phase transition.
    b. First order phase transition.
    c. Second order phase transition.
    d. Third order phase transition.

15. The triple point of a substance:
    a. Multiple.
    b. Depends on Temperature, pressure, and volume.
    c. Have two values.
    d. Has one value.

16. Cooper pairs behaves as:
    a. Fermions
    b. Bosons
    c. π-mesons
    d. None of these

17. Energy gap of gallium in semiconducting state is:
    a. ~1.1 eV
    b. ~0.72 eV
    c. ~10^{-4} eV
    d. ~10^{4} eV

18. Below the critical temperature, the entropy of superconductors_____ compared to normal conductor.
    a. Increases.
    b. Decreases.
    c. Remain same.
    d. Depends on the material.

19. The quantum of flux through the non-supper conducting region of a superconducting ring is equal to
    a. h
    b. h/e
    c. he
    d. h/2e

20 Penitration depth and super electron density are related as:
    a. $\lambda=n_s$
    b. $\lambda\alpha(n_s)^{1/2}$
    c. $\lambda\alpha(n_s)^{-1}$
    d. $\lambda\alpha(n_s)^{-1/2}$

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UNIVERSITY OF SCIENCE & TECHNOLOGY, MEGHALAYA

[PART (A) : OBJECTIVE]

Duration : 20 Minutes

Serial no. of the main Answer sheet

Course : .....

Semester : ..... **Roll No :** .....

Enrollment No : ..... **Course code :** .....

Course Title : .....

Session : 2017-18 **Date :** .....

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Instructions / Guidelines

- The paper contains twenty (20) / ten (10) questions.
- Students shall tick (✓) the correct answer.
- No marks shall be given for overwrite / erasing.
- Students have to submit the Objective Part (Part-A) to the invigilator just after completion of the allotted time from the starting of examination.

Full Marks	Marks Obtained
20	

Scrutinizer's Signature *Examiner's Signature* *Invigilator's Signature*