

M.Sc. PHYSICS
FOURTH SEMESTER
CONDENSED MATTER PHYSICS-II
MSP - 401A
[USE OMR FOR OBJECTIVE PART]

**SET
A**

Duration: 3 hrs.

Full Marks: 70

(Objective)

Time: 30 min.

Marks: 20

Choose the correct answer from the following:

1X20=20

- The mobility is defined as
 - velocity per unit electric field
 - velocity per unit current
 - electric field per unit velocity
 - current per unit velocity
- Einstein relation reads as
 - $D = \frac{\mu k_B T}{e}$
 - $\mu = \frac{D k_B T}{e}$
 - $D\mu = \frac{k_B T}{e}$
 - $D = e\mu k_B T$
- For H₂O, the transition from liquid phase to gaseous phase is a
 - First order transition
 - Second order transition
 - Third order transition
 - None of these
- n-th order phase transition occurs when the _____th derivative of the Free energy function becomes discontinuous
 - n
 - n - 1
 - n + 1
 - n - 1, n, n + 1
- The product $np = n_i^2$, is a constant, independent of
 - temperature
 - doping
 - both temperature and doping
 - none of these
- Negative differential conductance phenomenon is observed in
 - photoconductivity
 - Gunn effect
 - thermionic emission
 - Hall effect
- The mobility of an electron is higher for
 - smaller effective mass
 - larger effective mass
 - shorter lifetime
 - none of these
- Fundamental absorption takes place for
 - $h\nu \ll E_g$
 - $h\nu < E_g$
 - $h\nu \geq E_g$
 - none of these
- The width of the depletion region
 - decreases with increasing the doping concentration
 - decreases with decreasing the doping concentration
 - is independent of doping concentration
 - None of these

10. For the hot electrons, the magnitude of the applied field is about
 a. 1 V/cm
 b. 10 V/cm
 c. 100 V/cm
 d. 1000 V/cm
11. In a soap bubble film, the soap molecule is arranged such that their ends point towards
 a. hydrophobic outwards, hydrophilic inwards
 b. hydrophobic inwards, hydrophilic outwards
 c. both outwards
 d. both inwards
12. Vacuum in evaporation technique of film deposition is used for
 a. lowering melting point
 b. reduction in impurities
 c. both i and ii
 d. neither i nor ii
13. Angular deposition of a film can be regulated using the technique of
 a. Ion beam assisted Sputtering
 b. DC Sputtering
 c. RF sputtering
 d. GLAD sputtering
14. The relation of momentum transfer in sputtering process is given by
 a. $W = \frac{kVi}{P_T d}$
 b. $W = \frac{Vi}{kP_T d}$
 c. $W = \frac{Vid}{kP_T}$
 d. $W = \frac{1}{kP_T Vd}$
15. In MBE, in order to produce precise beams of atoms/molecules, they are heated up so they're in gas form at the substrate from "guns" also called as
 a. thermal guns
 b. updraft cells
 c. effusion cells
 d. effusion guns
16. In an MBE setup, pyrolytic boron nitride (PBN), is used because it can withstand
 a. high T & low P
 b. high T & high P
 c. low T & high P
 d. low T & low P
17. 3D depositions with the help of MBE is possible due to
 a. stronger adatom interactions
 b. weaker adatom interactions
 c. stronger adatom-substrate interaction
 d. weaker adatom-substrate interaction
18. Pick the top-down approach of nanoparticle synthesis from the techniques below
 a. CVD
 b. Hydrothermal
 c. Ball-milling
 d. None of the above
19. Pick the Bottoms-Up approach of nanoparticle synthesis from the techniques below
 a. CVD
 b. Hydrothermal
 c. Ball-milling
 d. None of the above
20. The morphological characterization of nanoparticle can be done using
 a. XRD
 b. TEM
 c. Raman Scattering
 d. None of the above

(Descriptive)

Time : 2 hrs. 30 min.

Marks : 50

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

1. a. Discuss the diffusion process under different circumstances, namely, (i) behavior of concentration pulse with space at different times, (ii) the same as (i) in the presence of an electric field, and (iii) the same as (i) now with considering recombination. 5+5=10
b. Draw the various absorption processes involving impurities through the band diagrams.
2. a. What are hot electrons? 1+4+5=10
b. Show that the temperature of the hot electrons is higher than the lattice temperature.
c. Discuss Gunn effect with proper diagrams, such as current density as a function of electric field.
3. a. Draw the phase diagram of water (P-T curve) and denote the different phase regions. 3+7=10
b. Consider the condensation of gas into liquid (P, ρ, T) and transformation of paramagnet to ferromagnet (H, M, T). Discuss the features at the critical points by drawing the different phase diagram of the full 3D phase space of (P, ρ, T) and (H, M, T).
4. a. Discuss the photoconductivity phenomenon with proper diagram. 4+6=10
b. Find out the excess carriers using the rate equation in terms of the generation rate and recombination process.
5. Draw a neat diagram of a typical Molecular Beam epitaxy setup and name its components. Describe the utility of effusion cells and cryogenic sink in MBE. 5+5=10
6. Mention the steps involved in PVD technique of thin film deposition. Describe how the deposition rate depends on the position of the wafer in PVD technique. 5+5=10

7. Describe the working principle of Molecular Beam Epitaxy technique of film growth. Also discuss its advantages over other thin film growth technique. 10
8. Discuss the various methods of nanoparticle synthesis and characterization techniques. 5+5=10

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