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PH 205
Quiz 1 (2023)

Full marks: 10 *Time: 45 minutes*

Tick the correct answer choice on the question paper itself. Correct answer will carry 1 mark, whereas incorrect answer will carry (-1/2) mark. Use back page/ extra sheet for rough work.

1. The lattice constant of Ge is 5.64 Å at room temperature. The number density of Ge atoms (per cubic centimeter) in a Ge crystal is :
(a) 1.1×10^{22}, (b) 2.2×10^{22} (c) 4.4×10^{22}, (d) 8.8×10^{22}

2. If the effective mass of electron in GaAs is $0.07m_0$ and dielectric constant of GaAs is 13.2, using *Hydrogen atom model*, the donor energy level (in meV unit) in GaAs is :
(a) 4.46 meV, (b) 5.46 meV (c) 8.92meV, (d) 10.92 meV 1

3. At room temperature (300 K), the displacement of the Fermi level E_{Fi} from the middle of the band gap ($E_g/2$) in intrinsic Si is given by (take kT=26 meV, $m_e^*=1.1m_0$ and $m_h^*=0.56m_0$)
(a) -6.6 meV, (b) -13.1 meV (c) -26.2 meV, (d) -19.5 meV 1

4. The intrinsic carrier concentration (n_i) of InAs (band gap E_g=0.35eV) at 300 K is given as 1×10^{15}/cc. In this material, the n_i at 600 K will be approximately (note: $n_i=AT^{3/2}\exp(-E_g/2kT)$):
(a) 4.1×10^{17}/cc (b) 8.2×10^{17}/cc (b) 4.1×10^{16}/cc (d) 8.2×10^{16}/cc 1

5. Hall effect cannot be used for which of the following?
(a) Determining whether the semiconductor is p or n type.
(b) Determining the carrier concentration.
(c) Determining both the mobility and the conductivity
(d) Determining the bandgap of the material

$\frac{1}{e}$ $p - b^2 n$ −0.5

6. The diffusion coefficient of electron in a material at room temperature (300 K) is given as 110 cm^2/s. The electron mobility in the material is approximately,
(a) 8500 cm^2/V-s (b) 4230 cm^2/V-s (b) 1350 cm^2/V-s (d) 450 cm^2/V-s 1

7. The energy (E) dependence of electronic density of states, *N(E)*, in a 2-dimensional semiconductor is proportional to
(a) $E^{-1/2}$ (b) $E^{1/2}$ (c) E^0 (d) E^2 1

8. In the Kronig-Penny model for the bandstructure calculation, which of the following is/are incorrect:
(a) This model uses a periodic potential
(b) This model uses Bloch's theorem
(c) This model predicts allowed and forbidden energy bands in a solid −0.5
(d) This model is applicable only for semiconductors

9. The bandgap of a semiconductor is found to be 3.40 eV. The associated wavelength falls in the
(a) UV region, (b) Visible region, (c) Infrared region, (d) X-ray region

10. For modulation doping, which of the following is incorrect:
(a) It enables to achieve very high carrier mobility
(b) It enables to overcome carrier freeze out phenomena
(c) It requires semiconductor heterostructures
(d) It requires wide bandgap semiconductors