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3 TDC (Special) PHY M 4

2016

(July)

PHYSICS

(Major)

Paper : 30400

**(Condensed Matter Physics and
Nuclear Physics)**

Full Marks : 67

Time : Three hours

***The figures in the margin indicate
full marks for the questions.***

Choose the correct option from the
following :

$$1 \times 7 = 7$$

- (a) The effective number of atoms in the unit cell of HCP structure is
- (i) 6
 - (ii) 8
 - (iii) 12
 - (iv) 9

Contd.

(b) If K and σ are thermal and electrical conductivity of a metal, according to Wiedemann-Franz law

(i) $\frac{KT}{\sigma} = \text{constant}$

(ii) $\frac{K\sigma}{T} = \text{constant}$

(iii) $\frac{K}{\sigma T} = \text{constant}$

(iv) $\frac{\sigma}{KT} = \text{constant}$

(c) The density of charge carriers in an intrinsic semiconductor is proportional to

(i) $\exp\left(-\frac{E_g}{KT}\right)$

(ii) $\exp\left(-\frac{2E_g}{KT}\right)$

(iii) $\exp\left(-\frac{E_g}{KT^2}\right)$

(iv) $\exp\left(-\frac{E_g}{2KT}\right)$

(d) Bohr magneton (μ_B) is

(i) $\frac{e\hbar}{4\pi m_e}$

(ii) $\frac{eh}{4\pi m_e}$

(iii) $\frac{e\hbar}{2\pi m_e}$

(iv) $\frac{eh}{2\pi m_e}$

(e) Control rods used in nuclear reactors are made up of

(i) iron

(ii) zinc

(iii) cadmium

(iv) bismuth

(f) The experimental electrical method of investigating the size of the nucleus is

(i) neutron scattering

(ii) α -decay

- (iii) α -particle scattering
- (iv) electron scattering
- (g) The energy term involved in the splitting of compound nucleus in nuclear fission is
- (i) surface energy
- (ii) volume energy
- (iii) coulomb energy
- (iv) pairing energy
2. (a) Obtain the Miller indices of a plane which intercepts at a , $\frac{b}{3}$ and $2c$ in a simple cubic unit cell. Draw the diagram showing the plane.
- (b) What is Hall effect? What important conclusion can be drawn from the Hall experiment?
- (c) Obtain an expression for conductivity of intrinsic semiconductor in terms of mobility.

3. (a) What is reciprocal lattice? Derive Bragg's diffraction condition in terms of reciprocal lattice vector. $2+3=5$
- (b) Draw a schematic diagram showing the structure of sodium chloride. Obtain an expression for total cohesive energy of an ionic crystal. What is Madelung constant? $1+3+1=5$
4. (a) What do you mean by density of energy states? Show from $E-K$ curve that materials can be classified into conductors, insulators and semiconductors. $3+3=6$

Or

- (b) Discuss briefly the Kronig-Penney model for motion of an electron in a periodic potential. What important conclusions can be drawn from the model? $3+3=6$
5. What are superconductors? Explain how Meissner effect proves the superconductors to be a perfect diamagnetic material. How does the magnetization M vary with applied magnetic field H in type II superconductors? $1+3+2=6$

6. (a) Using semiempirical mass formula, find an expression for energy released in symmetric fission.
- (b) What are cosmic rays ? Discuss briefly about the origin of cosmic rays.

2+2=4

7. (a) What are the various methods of determining the size of the nucleus? Describe *any one* of them.

2+4=6

- (b) Write the quantum numbers for individual nucleons. Find an expression for electric quadrupole moment.

2+4=6

Or

The mass of hydrogen atom and the neutron are 1.008142 a.m.u. and 1.008982 a.m.u. respectively. Calculate the packing fraction of the ^{16}O -nucleus.

8. (a) Define nuclear reaction cross-section. Describe a method by which the cross-section can be determined. What are the physical quantities that are conserved in nuclear reaction ?

1+3+2=6

- (b) Explain the principle and working of a linear accelerator. Show that the length of each drift tube depends on the frequency of r.f. oscillator and gap voltage.

3+3=6

Or

Discuss the method of classification of elementary particles and state their main characteristics.

3+3=6