2021

Time : 3 Hours

Full Marks : 100

Candidates are required to give their answers in

their own words as far as practicable.

Figures in the margin indicate full marks.

The questions are of equal value.

Answer five questions, selecting two questions each from

Group- A and Group- B and Q. No. 1 is compulsory.

1. Answer the following questions by choosing

    the appropriate alternatives given for each of

    them: 10×2=20

    (A) The main constituent of Cosmic rays is:

        (a) Proton

        (b) Meson

        (c) α- particle

        (d) Neutrino

    (B) The emission of α- particles from the nucleus

         shows its:

        (a) Particle character

        (b) Wave character

        (c) Both particle and wave character

        (d) None of these

    (C) The working of a cyclotron is based on the

         principle of:

        (a) Magnetic resonance

        (b) Magnetic effect of current

        (c) Electric resonance

        (d) None of these

    (D) After two hours, 1/16 of the initial amount of a

         certain radioactive isotope remains undecayed,

         the half-life of the isotope is:

        (a) 15 minutes

(b)   30 minutes

(c)   1 Hour

(d)   45 minutes

(E)   The relation between hypercharge Y, actual charge Q and the isospin component of a particle Tz is:

(a) $Y = Q - Tz$

(b) $Y = Q + Tz$

(c) $Y = 2(Q - Tz)$.

(d) $Q = 2(Y + Tz)$

(F)   The number of molecules present in the unit cell of $NaCl$ is:

(a)   5

(b)   2 ·

(c)   4

(d)   None of these

(G)   A p-n junction works like a:

(a)   Conductor

(b)   Amplifier

(c)   Oscillator

(d)   Rectifier

(H)   If $\vec{a}_1, \vec{a}_2, \vec{a}_3$, be the primitive vectors of the direct crystal lattice and $\vec{b}_1, \vec{b}_2, \vec{b}_3$ be the primitive vectors of the reciprocal lattice then:

(a) $\vec{b}_1 = 2\pi \frac{\vec{a}_1 \times \vec{a}_3}{\vec{a}_1.(\vec{a}_2 \times \vec{a}_3)}$

(b) $\vec{b}_1 = 2\pi \frac{\vec{a}_3 \times \vec{a}_1}{\vec{a}_1.(\vec{a}_2 \times \vec{a}_3)}$

(c) $\vec{b}_1 = 2\pi \frac{\vec{a}_1 \times \vec{a}_2}{\vec{a}_1.(\vec{a}_2 \times \vec{a}_3)}$

(d)   All of these

(I)   If R_H is the Hall coefficient and H is the strength of the magnetic field, then :

(a) $R_H \propto H$

(b) $R_H \propto \alpha H^2$

(c) R_H does not depend on H

(d)   None of these

(J) The dependence of mobility of charge carriers in a semiconductor is given by :

(a) $M \propto \frac{1}{T}$

(b) $M \propto \frac{1}{T^{3/2}}$

(c) $M \propto T^{3/2}$

(d) $M \propto T^2$

Group-A

2. Discuss Gamow's theory of α – decay and explain how Geiger Nuttal law is derived from it. 20

3. Discuss the liquid drop model of the nucleus and the limits of stability derived from it. 20

4. Describe the construction and working of a Geiger Muller Counter. How is quenching achieved in this counter? https://www.lnmuonline.com 20

5. Write short notes on any two of the following: 2×10=20

   (a) Binding energy

(b) Moderators

(c) Nuclear chain reaction

(d) Radioactivity and half life time

Group – B

6. Derive Bragg's law of X - ray diffraction in crystals. Give an account of power method for crystal structure analysis. 20

7. What are Miller indices? Show that in a cubic crystal having its side 'a' the spacing between consecutive parallel planes of Miller indices (h,k,l) is given as :

$$d_{nkl} = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$$ 20

8. Give the theory of intrinsic and extrinsic semiconductors. Obtain expression for the carrier concentration of an intrinsic semiconductor. 20

9. Write short notes on any two of the following: 2×10=20

   (a) Properties of reciprocal lattice

(b)   Hall effect

(c)   Band theory of Solids

(d)   Free electron theory of metals

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