Physics (Hons.) Paper-VI

Group-A is compulsory. Answer any two questions each from Group-B and Group-C.

Group-A

1. Write the correct answer of the following :

(a) What is the correct value of the magnetic moment of proton ?

(i) $\mu_p = +2.79276\ \mu_N$ (ii) $\mu_p = -2.76215\ \mu_N$

(iii) $\mu_p = 2.19135\ \mu_N$ (iv) None of these

(b) Which is the correct form of Geiger-Nuttal law for a-decay ?

(i) $\lambda = A \log R + B$ (ii) $\log \lambda = A \log R + B$

(iii) $\lambda = A \log R^2 + B$ (iv) None of these

Where λ is disintegration constant, R is the range and A and B are constants

(c) Which of the given statement is incorrect for β-decay ?

(i) It is called a weak interaction process

(ii) It is called a strong interaction process (iii) The process violates parity

(iv) The process follows conservation of angular momentum

(d) For a nucleus of mass M containing Z protons and N neutrons, which is the correct expression for the binding energy of nucleus ?

(i) $B = (Z M_p + N M_n - M) C^2$ (ii) $B = [(Z + A) M_p + N M_n - M] C^2$

(iii) $B = [Z M_p + M + N M_n] C^2$ (iv) None of these

Where Mp and Mn stands for masses of proton and neutron respectively.

(e) Which is the false statement for nuclear force ?

(i) It is spin dependert (ii) It is charge independent

(iii) It is a tensor force (iv) It is a long range force

(f) Which is the correct form of the probability current density ?

(i) $\vec{j}(\vec{r}, t) \frac{ih}{2m}\left(\psi \nabla \psi^* - \psi^* \nabla \psi\right)$ (ii) $\vec{j}(\vec{r}, t) \frac{ih}{2m}(\psi^* \nabla \psi - \psi \nabla \psi^*)$

(iii) $\vec{j}(\vec{r}, t) = \frac{h}{2m}(\psi \nabla \psi^* - \psi^* \nabla \psi)$ (iv) None of these

(g) Which is the false statement ?

(i) For stationary state, probability density $\rho(r, t)$ is constant in time.

(ii) Commutating operators have common sets of eigen functions.

(iii) The eigenvalues of Hermitian operators are not real.

(iv) Linear operators are Hermitian operators.

(h) Which is the correct form of the wavelength of matter wave ?

(i) $\lambda = h/mv$ (ii) $\lambda = h/m$ (iii) $\lambda = h^2/m^2v^2$ (iv) $\lambda = h/v$

(i) Which is the correct form of width of the spectral line ?

(i) $\tau \Delta E \sim h$ (ii) $E\Delta \tau \sim h$

(iii) $\tau \Delta E \sim h^2$ (iv) None of these

(j) Which is the correct form of the Hamiltonian operator ?

(i) $\hat{H} = -\frac{h^2}{2m} \nabla^2 + v(\vec{r})$ (ii) $\hat{H} = -\frac{h}{2m} \nabla^2 + v(\vec{r})$

(iii) $\hat{H} = -\frac{h^2 \nabla^2}{2m^2} + v(\vec{r})$ (iv) None of these

Group-B

2. State Weizsacker semi-empirical mass formula. Discuss the physical meaning of each term involved in the formula.
3. Discuss the law of radioactive disintegration. How decay constant λ is calculated?
4. What are cosmic ray showers ? Describe the theory of electron showers.
5. Write short notes on any two of the following :
   (i) Liquid drop model (ii) Fission chain reaction
   (iii) Synchrocyclotron (d) Photographic emulsion technique

Group-C

6. Derive time independe.it and time dependent Schrodinger equation. Discuss the physical meaning of wave function y.
7. What are linear operators ? Discuss its physical properties. When do you say two functions are orthogonal ?
8. A particle of mass m is moving in a one-dimensional potential given by :

$$V(r) = \begin{cases} 0 & -a < x < a \\ \alpha & |x| > a \end{cases}$$

   Obtain the eigenvalues and eigen functions of the potential.
9. Write short notes on any two of the following : (a) de Broglie hypothesis and its experimental verification. (b) Hermitian operator and its properties (c) Heisenberg uncertainty relation (d) Eigenvalues of rigid rotator