Chapter 3 (Wave Nature of Particle)
PYQ [IIT-JAM]

$A_2 \rightarrow$ De Bogile Hypthesis

Q1. A particle of rest mass m_0 is moving uniformly in a straight line with relativistic velocity βc, where c is the velocity of light in vacuum and $0 < \beta < 1$. The phase velocity of the de Broglie wave associated with the particle is,

(a) βc (b) $\frac{c}{\beta}$ (c) c (d) $\frac{c}{\beta^2}$

IIT-JAM 2006

Q2. Consider a free electron (e) and a photon (ph) both having $10\,eV$ of energy. If λ and P represents wavelength and momentum respectively, then

(mass of electron $= 9.1 \times 10^{-31}\ kg$; speed of light $= 3 \times 10^8\ m/s$)

(a) $\lambda_e = \lambda_{ph}$ and $P_e = P_{ph}$ (b) $\lambda_e < \lambda_{ph}$ and $P_e > P_{ph}$

(c) $\lambda_e > \lambda_{ph}$ and $P_e < P_{ph}$ (d) $\lambda_e > \lambda_{ph}$ and $P_e < P_{ph}$

IIT-JAM 2016

Q3. The de Broglie wavelength of a relativistic electron having $1\ MeV$ of energy is_____________$\times 10^{-12}\ m$. (Take the rest mass energy of the electron to be $0.5\ MeV$. Plank constant $= 6.63 \times 10^{-34}\ Js$, speed of light $= 3 \times 10^8\ m/s$, Electronic charge $= 1.6 \times 10^{-19}\ C$)

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$B_2 \rightarrow$ Other

Q4. The relation between angular frequency ω and wave number k for given type of waves is $\omega^2 = \alpha k + \beta k^3$. The wave number k_0 for which the phase velocity equals the group velocity is,

(a) $3\sqrt{\frac{\alpha}{\beta}}$ (b) $\left(\frac{1}{3}\right)\sqrt{\frac{\alpha}{\beta}}$ (c) $\sqrt{\frac{\alpha}{\beta}}$ (d) $\left(\frac{1}{2}\right)\sqrt{\frac{\alpha}{\beta}}$

IIT-JAM 2006

Q5. A wave packet in a certain medium is constructed by superposing waves of frequency ω around $\omega_0 = 100$ and the corresponding wave-number k with $k_0 = 10$ as given in the table here.

Find the ratio v_g / v_p of the group velocity v_g and the phase velocity v_p.

ω	k
81.00	9.0
90.25	9.5
100.00	10.0
110.25	10.5
121.00	11.0

(a) $\frac{1}{2}$ (b) 1

(c) $\frac{3}{2}$ (d) 2

IIT-JAM 2009

Q6. For a wave in a medium the angular frequency ω and the wave vector $\vec{k}$ are related by, $\omega^2 = \left(\omega_0^2 + c^2 k^2\right)$, where ω_0 and c are constants. The product of group and phase velocities, i.e., $v_g . v_p$ is

(a) $0.25c^2$ (b) $0.4c^2$ (c) $0.5c^2$ (d) c^2

IIT-JAM 2010

Q7. A slit has width 'd' along the x-direction. If a beam of electrons, accelerated in y-direction to a particular velocity by applying a potential difference of $100 \pm 0.1\ kV$ passes through the slit, then, which of the following statement (s) is (are) correct?

(a) The uncertainty in the position of the electrons in x-direction before passing the slit is zero

(b) The momentum of electrons in x- direction is $\sim \frac{\hbar}{d}$ immediately after passing the slit

(c) The uncertainty in the position of electrons in y- direction before passing the slit is zero

(d) The presence of the slit does not affect the uncertainty in momentum of electrons in y-direction

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