Group – D

6. (a) For a Compton effect experiment write down the expressions of various conservation principles used by drawing relevant diagram.

(b) Find the relation between group velocity and phase velocity of a de-Broglie wave. State Heisenberg uncertainty principle involving position and momentum of a particle in one dimension.

(c) Total energy of a relativistic particle of rest mass m_0 is μ times its rest energy. If the momentum of the particle is 'p' and kinetic energy is 'T', show that $T = \frac{p^2}{(\mu+1)m_0}$.

4 + (2 + 2) + 4 = 12

7. (a) Write the mathematical expression for Planck's radiation law in terms of wave length. Hence obtain Wien's law of radiation at lower wave-length range.

(b) The wave lengths corresponding to maximum intensity of radiation emitted by two black-bodies are $15000A^0$ and 12000 A^0 respectively. Find out the ratio of their absolute temperatures.

(c) Show that electrons can not reside inside the nucleus.

(d) What is the de Broglie wavelength of an electron which has been acelerated from rest through a potential difference of 100 V.

(2+2) + 3 + 3 +2 = 12

Group – E

8. (a) What do you mean by Miller indices. What is the Miller indices of a plane which have intercepts at 2a, 3b, 4c along X, Y, Z axes, respectively (with lattice constants a, b, c).

(b) Draw the planes and directions denoted by (100), $(1\bar{1}0)$,(102).

(c) Show that in cubic crystal of side a, the interplaner spacing between consecutive parallel planes of Miller indices (hkl) is $d_{hkl} = \frac{a}{\sqrt{h^2+k^2+l^2}}$

(d) Write Bragg's law of diffraction explaining all the terms.

(1+2) +3 +4 + 2 = 12

9.(a) Define coordination number of a crystal. Find out the values of coordination numbers for BCC and FCC crystal.

(b) Define primitive and non-primitive unit cells and atomic radius. Calculate the atomic radius of a BCC crystal.

(c) A beam of X-rays of wavelengths 0.842 $\AA$ is incident on a crystal at a glancing angle of $8^0 30'$, when first order Bragg's reflection occurs. Calculate the glancing angle for the third order reflection.

(2+2) + (3+2) +3 = 12

PHYSICS -I
(PHYS 1001)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) In a Young double slit experiment interference is achieved by
(a) division of amplitude (b) division of wave front
(c) division of refracted ray (d) division of reflected ray.

(ii) In Brewster's experiment when the reflected ray is completely polarized the angle between reflected ray and the ray refracted becomes
(a)π/2 (b)π/3 (c) π/4 (d)π/6.

(iii) If B_{21} is the Einstein's coefficient of stimulated emission and A_{21} is the Einstein's coefficient of spontaneous emission , then the ratio between B_{21} and A_{21} is
(a) $\frac{8\pi h\nu^3}{c^3}$ (b) $\frac{8\pi h\nu^2}{c^3}$ (c) $\frac{8\pi h\nu^3}{c}$ (d) $\frac{c^3}{8\pi h\nu^3}$

(iv) For a weakly damped oscillation the average energy per unit cycle decreases _____over time
(a) linearly (b)logarithmically
(c) sinusoidaly (d)exponentially.

(v) For a forced oscillating system at velocity resonance the resonance frequency is
(a) independent of natural frequency
(b) independent of damping factor
(c) time dependent
(d) amplitude dependent.

(vi) The relation among group velocity v_g, phase velocity v_{ph} and wave number k is

(a) $v_g = v_{ph} - k\frac{dv_{ph}}{dk}$ (b) $v_g = v_{ph} + k\frac{dv_{ph}}{dk}$

(c) $v_g = v_{ph} - \frac{dv_{ph}}{dk}$ (d) $v_g = k - \frac{dv_{ph}}{dk}$

(vii) A proton, electron and a helium nucleus move with equal velocity. Rank their de Broglie wavelengths from longest to shortest.
(a) helium nucleus , proton, electron
(b) proton, electron , helium nucleus
(c) helium nucleus , electron, proton
(d) electron, proton, helium nucleus.

(viii) Ultraviolet catastrophe is a consequence of
(a) Wein's law (b) Heisenberg uncertainty principle
(c) De-Broglie hypothesis (d) Rayleigh-Jeans law.

(ix) For relativistic particle the relation between energy and momentum is given by
(a) $E - p^2c^2 = m_0^2c^4$ (b) $E^2 - p^2c^2 = m_0^2c^4$
(c) $E = \sqrt{p^2c^2 - m_0^2c^4}$ (d) $E^2 - p^2c^2 = m_0c^2$.

(x) The coordination number of an FCC crystal is
(a)12 (b)8 (c) 6 (d)0.

Group – B

2. (a) Show that in case of Newton's ring experiment the diameter of the nth dark fringe is $\sqrt{\frac{4Rn\lambda}{\mu}}$ where λ, μ , R have usual meaning.

(b) A newton's ring experiment is done with two different media of refractive indices n and 1.44n. If the radius of the 10th dark ring in the first case is m times that of the second, find the value of m.

(c) What happens to the width of the interference fringe formed in young's double slit experiment if the system is immersed in water.

(d) Obtain the expression of the shift of fringes in Young's double slit experiment if a thin glass of refractive index n and thickness d is placed on the path of any one of the two coherent rays under consideration. Hence, show that the shift undergone by any fringe is independent of its order.

4 + 3 +2+ (2 + 1) = 12

3.(a) A polarized light wave is given by the expression **E**(z,t) = cos(kz-ωt)**i**+sin(kz-ωt)**j**. Find the type of polarisation. Explain briefly how a circularly polarized light can be converted to a linearly polarized light.

(b) When the angle of incidence of a light ray polarized parallel to plane of incidence is π/3, the angle of refraction is π/6. Find the angle of incidence for which the reflected ray will disappear.

(c) A diffraction grating 2 cm wide is just able to resolve sodium D-lines in second order. Find the number of rulings per mm (assume λ=589 nm and 589.6 nm)

(d) An optical fibre is immersed in a liquid of refractive index n_0. If the refractive indices of its core and cladding are n_1 and n_2 respectively find out its numerical aperture.

(2 + 2) + 3 +2 + 3= 12

Group – C

4. (a) What is Lissajous figure? Show that in case an oscillator is subjected to two mutually perpendicular S.H.M having a phase difference $\frac{\pi}{2}$ and same amplitude describes a resultant circular oscillation.

(b) The equation of motion of a damped harmonic oscillator is given by $\frac{d^2x}{dt^2} + 0.2\frac{dx}{dt} + x = 0$. Show that this is a weakly damped oscillation. Plot its x (displacement) v/s t (time) with any initial condition of your choice. Find out the logarithmic decrement and relaxation time.

(c) Check whether y (x,t)= 2 Cos(2x-10t) (all units are in SI system) represents a wave or not. If yes, find the velocity of propagation.

(1 + 2) + (2 +2 +2 +1) +2 = 12

5. (a) Comment on the relation between the time period of a weakly damped oscillator and the time period of its free (undamped) oscillation.

(b) Write down the expression of amplitude of oscillation (A) for a forced-damped oscillator, explaining all terms. Plot amplitude v/s driving frequency graph for different values of damping constants.

(c) A vibrator of mass 1 gm is acted upon by restoring force of 10^4 N/m of displacement, a retarding force of 4N-s/m a driving force of $\cos\omega t$ N . Find the value of maximum possible amplitude in steady state.

(d) Briefly mention the differences between a elastic wave and electromagnetic wave.

2 +(2+ 3) +3 + 2 = 12