Group – E

8. (a) Nickel (Ni) has FCC structure. Its lattice constant is 3.52 Å; atomic weight of Ni is 58.71. Calculate its radius, Atomic packing factor and density.

   (b) Calculate the inter-planar spacing d of a plane (hkl) in a cubic lattice of side a = b = c.

   (c) In a cubic crystal, a plane has intercepts at 2a, 3a, and 4a along three axes. Find the Miller indices.

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

9. (a) Sketch crystal planes (011) and (112) in a cubic crystal.

   (b) Determine the expected Bragg angle for the first order reflection from the (113) set of planes for FCC platinum (at. Wt. = 195.08 gm/mol; density = 21.45 gm/cm^3) when monochromatic radiation of wavelength 0.1542 nm is used.

   (c) Calculate the packing faction of Body Centered Cubic unit cell.

   (d) A cubic crystal has lattice constant 43Å and density 963 kg/m^3. What type of cubic unit cell does it from if its atomic weight is 63.

(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) Two waves having the intensities in the ratio of 25:4 produce interference. Find the ratio of maximum to minimum intensity of interference pattern
   (a) 25:4 (b) 49:9 (c) 5:2 (d) 125:16.

   (ii) An electron being accelerated through a potential difference 150.55 volt, is associated with de Broglie wavelength
   (a) 1Å (b) 1.227Å (c) 12.27Å (d) 2Å.

   (iii) 1 milligram of matter after getting completely converted to energy will yield
   (a) 90 Joule (b) 9×10^{10} Joules
   (c) 9 Joule (d) 900 Joules.

   (iv) The nearest neighbour distance in case of FCC structure
   (a) $\frac{a}{\sqrt{2}}$ (b) $\frac{2a}{\sqrt{3}}$ (c) $\frac{2a}{\sqrt{2}}$ (d) a.

   (v) If the refractive index of water is 1.33, the angle of polarization of light reflected from water is
   (a) 53.1° (b) 60° (c) 30° (d) 36.9°.

   (vi) Two sources of intensities I and 4I are used in an interference experiment. Obtain intensity at points where the waves from two sources superimpose with a phase difference of π
   (a) I (b) 4I (c) 5I (d) 3I.

   (vii) Calculate the energy in electron volt of a photon of wavelength 1Å.
   (a) 12412.5 eV (b) 12.4125 eV
   (c) 124.125 eV (d) 1.24125 eV.

(viii) Find the de-Broglie wavelength of a proton whose kinetic energy is equal to the rest energy of an electron. Mass of proton is 1840 times that of an electron.
(a) 0.0004Å (b) 0.004Å
(c) 0.4Å (d) 0.04Å.

(ix) If λ_L and λ_K are the wavelength of L and K x-rays respectively, then
(a) $\lambda_L > \lambda_K$ (b) $\lambda_L < \lambda_K$
(c) $\lambda_L = \lambda_K$ (d) $\lambda_L = 2\lambda_K$.

(x) In the process of Laser, Spontaneous emission rate depends on
(a) the number of atoms in excited state
(b) intensity of the exciting radiation
(c) both (a) and (b)
(d) the number of atom in the ground state.

Group – B

2. (a) What is polarization? State Brewster's law of polarization?

(b) What is the difference between the natures of ordinary and extraordinary rays of light when they pass through positive and negative crystals?

(c) Explain the difference between interference and diffraction of light.

(d) What is the condition for the missing order spectra for a diffraction grating? What particular order will be absent if width of the slit is equal to width of opaque space of grating?

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

3. (a) State fundamental conditions for production of interference fringes.

(b) Newton's ring are observed in reflected light of $\lambda = 5.9\times10^{-7}m$. The diameter of the 10th dark ring is 0.005 m. Find the radius of curvature of the lens and the thickness of the air film.

(c) In a two slit interference pattern at a point, we observe 10th order maximum for wavelength of 7000Å. What order will be visible here if the source of light is replaced by light of wavelength 5000Å.

(d) What do you mean by laser? Why population inversion is an essential condition for stimulated emission in laser action?

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

Group – C

4. (a) A simple harmonic oscillator is characterized by $y = \cos wt$. Calculate the displacement at which kinetic energy is equal to its potential energy.

(b) Given that a mass of 5 kg is suspended from a spring of stiffness constant 5 Nm^{-1}. If the frequency of natural oscillations be $\frac{2}{\sqrt{3}}$ times the frequency of damped oscillations, find the damping constant.

(c) What are the conditions for overdamped, critically damped and underdamped motions? Write the displacement-time relationship in underdamped case.

(d) A simple pendulum has a period of 1 second and amplitude of 10 mm. After 10 complete oscillations, its amplitude is reduced to 5 mm. What is the relaxation time of the pendulum?

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

5. (a) Discuss the variation of velocity amplitude with driving force frequency in the steady state of a forced harmonic oscillator and show its behaviour graphically.

(b) Write down the differential equation of an LCR circuit. Make a comparison between mechanical parameters and electrical parameters in relation to vibration.

(c) Derive the classical wave equation. Verify $\varphi = ae^{(x-2t)}$ is the solution of classical wave equation or not?

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

Group – D

6. (a) Why Compton effect is not observed with visible light? An x-ray photon found to have its wavelength doubled on being scattered through 90°. Find the wavelength and energy of the incident photon.

(b) State the basic postulates of Planck's quantum theory. Show Wien's law can be derived from Planck's radiation law.

(c) An electron and photon both have momentum 10MeV/C. Find the total energy of each.

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

7. (a) What do you mean by matter wave? Write the difference between electromagnetic and matter wave.

(b) Show that the product of group velocity and phase velocity of the de Broglie wave are constant.

(c) State Heisenberg uncertainty principle. Give one application of this principle in real world.

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