SPECIAL SUPPLE B.TECH/AEIE/BT/CE/CHE/CSE/ECE/EE/IT/ME/1ST & 2ND SEM/PHYS 1001/2018

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 simple cubic lattice the share of each corner atom to a unit cell is
(a) $[\frac{1}{2}]$ of an atom (b) $[\frac{1}{4}]$ of an atom
(c) $[\frac{1}{6}]$ of an atom (d) $[\frac{1}{8}]$ of an atom.

(ii) If I_0 be the intensity of the incident unpolarized light on a polarizer, then the intensity of the transmitted light through an analyzer making an angle θ with the polarizer is
(a) $I_0\cos^2\theta$ (b) I_0 (c) $\frac{I_0}{cos^2\theta}$ (d) $\frac{1}{2}I_0cos^2\theta$

(iii) The phase velocity (v_p) of a monochromatic de Broglie wave is
(a) $v_p = c^2v$ (b) $v_p = c^2 / v$
(c) $v_p = cv$ (d) $v_p = v$,
v is the particle velocity and c is the velocity of light in free space

(iv) Newton's rings are produced on the principle of division of
(a) amplitude (b) phase
(c) frequency (d) wavefront.

(v) When light wave is refracted from glass-air interface, the change of phase of the reflected wave is
(a) 90° (b) 180° (c) 0° (d) 270°.

(vi) In a single slit diffraction pattern the ratio of intensity of the first secondary maxima to the second secondary maximum is approximately
(a) $I_1/I_2 = 1/22$ (b) $I_1/I_2 = 1/202$
(c) $I_1/I_2 = 1/5$ (d) $I_1/I_2 = 1$

(vii) Planck's radiation law will satisfy Rayleigh-Jeans law for
(a) high λ (b) low λ
(c) any wavelength (d) for a particular value of λ.
where λ is the wavelength of radiation.

(viii) An electron accelerated through a potential difference 100 volt, is associated with de Broglie wavelength
(a) 12.27 Å (b) 1.227 Å
(c) 0.1227 Å (d) 122.7 Å.

(ix) If λ_L and λ_K are the wavelength of L and K series X-ray lines respectively then
(a) $\lambda_L > \lambda_K$ (b) $\lambda_L < \lambda_K$
(c) $\lambda_L = \lambda_K$ (d) $\lambda_L \geq \lambda_K$

(x) If a and r be respectively the lattice constant and radius of an atom in a simple cubic structure, then
(a) $a = 2r$ (b) $a = r/2$
(c) $a = 4r/\sqrt{3}$ (d) $a = 2r/\sqrt{3}$

Group – B

2. (a) What is interference of light? Show how energy is conserved in interference phenomena?

(b) When two straight narrow slits 0.3 mm apart are illuminated by a monochromatic source of wavelength 5.96×10^{-5} cm. fringes are obtained at a distance of 30 cm from the slit. Find the width of the fringes.

(c) Show that the expression of the radius of curvature of the convex lens used in Newton's ring apparatus is $R = \frac{D_{m+n}^2 - D_n^2}{4m\lambda}$; where symbols have their own meaning.

(d) What is the full form of laser? What is population inversion in laser action?

(2 + 2) + 2 + 4 + 2 = 12

3. (a) What is meant by diffraction of light? What happens in the diffraction pattern due to single slit when the slit width is gradually increased?

(b) A diffraction pattern due to a single slit is obtained on a screen with the help of a lens of focal length 50 cm. If the slit width is 0.1 mm, the wave length is 5×10^{-5} cm, what is the linear width if the central band?

(c) State Brewster's law of polarization indicating clearly the nature of polarization of the reflected and refracted rays. Show that the reflected and refracted rays of light are mutually perpendicular when light is incident on a medium at Brewster's angle.

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

Group – C

4. (a) A point describes simple harmonic motion in a line 4 cm long. Its velocity when passes through the centre of the line is 12 cm/sec. Find the time period of oscillation.

(b) What do you understand by 'logarithmic decrement' and 'relaxation time' of a weakly damped oscillator? How does relaxation time vary with damping coefficient?

(c) A mechanical oscillator has initial energy $E_0 = 50\,J$ having damping coefficient $\gamma = 2$/sec. calculate the time required to decrease to $E = E_0/e$.

(d) Show that $Y = Ae^{i(\omega t - kx)}$ satisfies the wave equation.

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

5. (a) Establish the differential equation of motion of a damped oscillator subjected to a periodic force of constant amplitude and frequency.

(b) Draw the plots of the displacement-amplitude against the frequency of the sinusoidal force driving a mechanical oscillator for different values of damping.

(c) A vibrator of mass 1 gm is acted upon by a restoring force of 10^7 dyne/cm, a retarding force of 4×10^3 dyne-sec/cm and a driving force of $10^7 \cos wt$ dyne. Find the maximum possible amplitude.

(d) What are the effects of dissipative forces on a simple harmonic oscillator?

3 + 3 + 4 + 2 = 12

Group – D

6. (a) Prove that the relativistic relation between mass, energy and momentum $E^2 = P^2C^2 + m_0^2C^2$. [you may assume relativistic mass $m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$]

(b) An electron and photon both have momentum 2.0 MeV/C. Find the total energy of each.

(c) Write down the expression of Planck's black body radiation law and show graphically how the energy density Vs wavelength plot of black

body radiation is changed if the temperature is increased? Derive the Stefan's law from Planck's law of black body radiation.

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

7. (a) What is Compton effect? What are the conservation laws satisfied in Compton scattering experiment?

   (b) State de Broglie's hypothesis of matter wave. Show that the group velocity of the wave packet associated with a moving particle is same as the particle velocity.

   (c) State Heisenberg's uncertainty principle.

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

Group – E

8. (a) Find the glancing angle of the (100) plane of simple cubic crystal (lattice constant = 2.5 Å) corresponding to the 2nd order diffraction maximum for X-ray of wavelength 0.62 Å.

   (b) Find the Miller Indices of a plane in a crystal which cuts intercepts of 2a, 3b, 4c along the X, Y, Z axis respectively.

   (c) Sketch the plane and direction of the plane (110) and (111) in a simple cubic crystals.

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

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

9. (a) Derive the relation between lattice constant and density of the material of a cubic crystal.

   (b) The molecular weight of KBr (FCC) is 119 gm/mole and its density is 2.75 gm/m^3. Calculate the lattice constant of this crystal.

   (c) Calculate the atomic packing fraction of the face centred cubic structure.

   (d) Define coordination number of a crystal and find out the values of coordination numbers for SC and FCC crystal.

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