

Name :

Roll No. :

Invigilator's Signature :

CS/B.Tech (NEW)/SEM-2/PH-201/2013

2013

PHYSICS - I

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable*

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

i) The time period of a simple pendulum of infinite length is given by

- | | |
|-------------|-------------------|
| a) finite | b) zero |
| c) infinite | d) none of these. |

ii) The velocity with which a wave advances in a medium is called

- | | |
|-------------------|-------------------|
| a) phase velocity | b) group velocity |
| c) wave velocity | d) none of these. |

CS/B.Tech (NEW)/SEM-2/PH-201/2013

- ix) The angle between the planes of vibration and polarization of a beam of plane polarized light is
- a) 90° b) 45°
 c) 0° d) 180° .
- x) How fast a particle must travel so that its mass becomes thrice its rest mass ?
- a) $0.5\ c$ b) $2\ c$
 c) $\frac{\sqrt{3}}{2}c$ d) $\frac{2\sqrt{2}}{3}c$.
- xi) The rest mass of photon is
- a) p/c b) h/c^2
 c) E/c^2 d) 0
- xii) The colour of the laser output in case of ruby laser is
- a) violet b) blue
 c) red d) green.
- xiii) X-rays are
- a) elastic waves b) electromagnetic waves
 c) stationary waves d) radio waves.
- xiv) Origin of continuous X-ray is due to the process of
- a) ionization b) inner orbital transition
 c) bremsstrahlung d) none of these.
- xv) If visible light is used to study Compton scattering then Compton shift will be
- a) negative
 b) more positive than what is observed with X-rays
 c) zero
 d) positive but not detectable in the visible window.

CS/B.Tech (NEW)/SEM-2/PH-201/2013

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. a) What are the characteristics of S.H.M. ? Define time period and frequency.
b) Establish the differential equation of harmonic motion and solve it. $2 + 3$
3. a) Find the atomic packing factor for an FCC and BCC lattice.
b) Describe the origin of characteristic X-ray $2 + 3$
4. Explain the nature of change in the fringe in Newton's ring experiment when
 - i) some oil is placed between the glass plate and the plano-convex lens, and
 - ii) the plano-convex lens is gradually moved away from the glass plate. $2 + 3$
5. a) Why is X-ray diffraction used for crystal structure analysis and not common visible light ?
b) Why in case of moving electrons quantum mechanics is used while for moving cars we use Newtonian mechanics ?
c) What features of photoelectric effect cannot be explained from wave theory of light ? $1 + 2 + 2$
6. a) What is Compton effect ?
b) Calculate the Compton wavelength for an electron.
c) Why does the unmodified line appear in Compton scattering ? $1 + 2 + 2$

CS/B.Tech (NEW)/SEM-2/PH-201/2013

GROUP – C**(Long Answer Type Questions)**Answer any *three* of the following. $3 \times 15 = 45$

7. a) Write down the differential equation of damped oscillation. Solve it for underdamped motion. $1 + 3$
- b) The equation for displacement of a point of a damped oscillator is given by $X = 5e^{-0.25t} \sin(\pi/2)t$ metre. Find the velocity of the oscillating point at $t = T/4$ and T , where T is the time period of oscillation. $2 + 2$
- c) Define logarithmic decrement λ and relaxation time τ . Find expression for these terms $2 + 2$
- d) Give a graphical comparison among underdamped, overdamped and critically damped harmonic motion. 3
8. a) Calculate the distance between the adjacent parallel planes of the type $[100]$, $[110]$ and $[111]$ in an FCC lattice of lattice constant a . Check the validity of the statement "The most closely packed planes are the most widely spaced". $3 + 3$
- b) Establish the relation between lattice constant and density of a material of a simple cubic crystal. 5
- c) If an X-ray tube is subjected to a potential difference of 50 kV and the corresponding current is 8 mA, then find out
- the number of electrons striking per second the target material,
 - minimum wavelength of the X-ray produced. $2 + 2$

CS/B.Tech (NEW)/SEM-2/PH-201/2013

9. a) What is missing order in case of double slit diffraction pattern ? 2
- b) A diffraction grating, 2 cm wide is just able to resolve sodium *D*-lines (having wavelengths 589 nm and 589.6 nm) in second order. Find the number of rulings per mm. 3
- c) Obtain an expression for resultant intensity and hence find the conditions for maxima and minima in a single-slit Fraunhofer diffraction process. 5
- d) What is retardation plate ? A plane polarized light of wavelength 600 nm changes to a circularly polarized light on passing through a quartz crystal cut parallel to optic axis. Calculate the minimum thickness to produce such effect. Given $(\mu_e - \mu_o) = 0.005$. 1 + 2
- e) Find the state of polarization when the x and y components of the electric field are given by $E_x = E_0 \sin(\omega t + kz)$ and $E_y = E_0 \cos(\omega t + kz)$. 2
10. a) What are positive and negative crystals ? Describe the construction of Nicol prism. 4
- b) Explain Fraunhofer diffraction by a single-slit with necessary theory. Point out also the graphical representation of intensity distribution. 7
- c) The diameter of the n th Newton's ring changes from 1.2 to 1 cm, when the air space between the lens and the plate is replaced by a transparent liquid. Find the refractive index of the liquid. 4

CS/B.Tech (NEW)/SEM-2/PH-201/2013

11. a) Define plane of vibration and plane of polarization. 3
- b) Describe an experiment to prove that light waves are transverse. 3
- c) The displacement of a particle of mass 0.2 kg executing S.H.M. is indicated by $y = 10 \sin \left(\frac{\pi}{3}t - \frac{\pi}{12} \right) m$. Calculate
- amplitude
 - the angular velocity
 - the time period
 - the maximum velocity
 - maximum acceleration. 5
- d) Calculate the atomic packing fraction and atoms per unit cell in crystals having body centred cubic structure considering the atoms as hard sphere. 4
12. a) Illustrate spontaneous emission and stimulated emission. Describe in brief why stimulated emission generates highly intense coherent beam. 3 + 2
- b) A beam of X-rays of wavelength 0.842 \AA is incident on a crystal at a glancing angle of $8^\circ 35'$ when first order Bragg's reflection occurs. Calculate the distance between two consecutive crystal planes. 2

CS/B.Tech (NEW)/SEM-2/PH-201/2013

- c) Derive an expression for lattice constant of a crystal in terms of its molecular weight, density and number of atoms per unit cell. 3
- d) Find out the number of photons required to be emitted per second to give output power 2 mW corresponding to wavelength 632.8 nm. 3
- e) The primitives of a crystal are 1.2 \AA , 1.8 \AA , 2 \AA along the three axes. A plane with Miller indices (231) cuts intercepts 1.2 \AA along X-axis. What will be the lengths of intercepts along Y and Z axes ? 2
-