



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

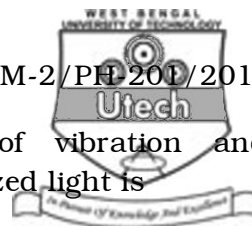
- |             |                   |
|-------------|-------------------|
| a) finite   | b) zero           |
| c) infinite | d) none of these. |

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. |



- iii) If  $v_g$  be the group velocity of the wave group representing a particle moving with velocity  $v$ , then
- a)  $v_g > v$                       b)  $v > v_g$   
c)  $v_g = v$                         d)  $v_g = \frac{1}{v}$ .
- iv) For SC structure atomic packing factor is
- a) 74%                                b) 52%  
c) 68%                                d) 47%.
- v) Which one of the following is a biaxial crystal ?
- a) Calcite                            b) Quartz  
c) Argonite                         d) None of these.
- vi) Young's double slit experiment is based on
- a) division of wavefront  
b) division of amplitude  
c) division of both amplitude and wavefront  
d) none of these.
- vii) When interference takes place at some region, light energy is
- a) created                            b) destroyed  
c) redistributed                      d) none of these.
- viii) The central spot of a Newton's ring experiment with a monochromatic light is
- a) bright                              b) dark  
c) white                                d) none of these.



- ix) The angle between the planes of vibration and polarization of a beam of plane polarized light is
- a)  $90^\circ$     b)  $45^\circ$   
 c)  $0^\circ$     d)  $180^\circ$ .
- 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)  $h\nu/c^2$   
 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.



**GROUP – B**

**( Short Answer Type Questions )**

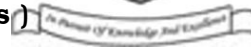
Answer any *three* of the following.  $3 \times 5 = 15$

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 ?  $1 + 2 + 2$



**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  $\lambda$  and relaxation time  $\tau$ . 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
- i) the number of electrons striking per second the target material,
- ii) minimum wavelength of the X-ray produced.  $2 + 2$

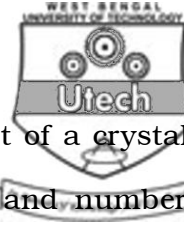


9. a) What is missing order in case of double slit diffraction pattern ? 2
- b) A diffraction grating, 2 cm wide is just able to resolve sodium *D*-lines ( having wavelengths 589 nm and 589.6 nm ) in second order. Find the number of rulings per mm. 3
- c) Obtain an expression for resultant intensity 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



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  $0.842 \text{ \AA}$  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

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- 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 Å, 1.8 Å, 2 Å along the three axes. A plane with Miller indices ( 231 ) cuts intercepts 1.2 Å along X-axis. What will be the lengths of intercepts along Y and Z-axes ? 2
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