

CS/B.Tech/Odd/Sem-1st/PH-101/2015-16



MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY,  
WEST BENGAL

PH-101

PHYSICS – I

Time Allotted: 3 Hours

Full Marks: 70

*The questions are of equal value  
The figures in the margin indicate full marks.  
Candidates are required to give their answers in their own words as far as practicable.  
All symbols are of usual significance.*

**GROUP A**  
**(Multiple Choice Type Questions)**

1. Answer any ten questions.

10×1 = 10

(i) Time period of a simple pendulum having infinite length will be

- (A) finite non-zero value (B) infinite  
(C) zero (D) cannot be estimated

(ii) The quality factor Q for an L-C-R circuit is

- (A)  $\frac{\omega R}{L}$  (B)  $\frac{\omega L}{R}$   
(C)  $\frac{\omega}{LR}$  (D)  $\frac{R}{\omega L}$

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(iii) According to Moseley's law, frequency of a spectral line depends on

- (A) mass (B) atomic number  
(C) atomic weight (D) molecular weight

(iv) The energy relaxation time ( $\tau$ ) of a damped oscillator with damping coefficient ( $k$ ) is

- (A)  $\tau = 1/k$  (B)  $\tau = 1/2k$   
(C)  $\tau = k$  (D)  $\tau = 2k$

(v) In Young's double slit experiment the two coherent sources are produced by

- (A) division of wave front (B) division of amplitude  
(C) all of these (D) none of these

(vi) The resolving power of a grating having number of rulings  $N$ , of order  $n$  is

- (A)  $n/N$  (B)  $n^2/N$   
(C)  $n \times N$  (D)  $nN$

(vii) When a white light is incident on a plane diffracting grating the central maxima will be

- (A) Dark (B) White  
(C) Blue (D) Red

(viii) Newton's ring experiment is based on

- (A) division of amplitude (B) division of wave front  
(C) division of frequency (D) division of phase angle

(ix) According to Wien's displacement law

- (A)  $\lambda_m T$  - Constant (B)  $\frac{\lambda_m}{T} = \text{Constant}$   
(C)  $\lambda_m T^2$  - Constant (D)  $\frac{\lambda_m}{T^2} = \text{Constant}$

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- (xi) Polarization conclusively proves that light waves are  
 (A) longitudinal (B) progressive  
 (C) stationary (D) transverse
- (xii) The relativistic energy momentum relation is  
 (A)  $p = E/c + m_0 c^2$  (B)  $E^2 = p^2 c^2 + m_0^2 c^4$   
 (C)  $E^2 = p^2 + m_0^2 c^4$  (D)  $p^2 = E^2 c^2 + m_0^2 c^4$
- (xiii) An  $\alpha$ -particle is 4 times heavier than a proton. If a proton and an  $\alpha$ -particle are moving with the same velocity how their De-Broglie wavelengths are related?  
 (A)  $\lambda_p = \lambda_\alpha$  (B)  $\lambda_p = \lambda_\alpha / 2$   
 (C)  $\lambda_p = \lambda_\alpha / 4$  (D)  $\lambda_p = 4\lambda_\alpha$
- (xiv) Assuming that the atoms in a crystal are spheres of equal size and touching each other, it can be shown that the atomic radius of BCC lattice is equal to  
 (A)  $\frac{a}{\sqrt{2}}$  (B)  $\sqrt{3} \frac{a}{2}$   
 (C)  $\sqrt{3} \frac{a}{4}$  (D)  $\frac{a}{2\sqrt{2}}$
- (xv) In lasing action, the spontaneous emission does not depend on  
 (A) the number of atoms present in the excited state  
 (B) the intensity of the incident light  
 (C) both of (A) and (B)  
 (D) none of these
- (xvi) If we measure the energy of a particle accurately then the uncertainty of the measurement of time becomes  
 (A) 0 (B)  $\pi$   
 (C)  $\frac{\pi}{2}$  (D)  $\infty$

**GROUP B**  
**(Short Answer Type Questions)**

- Answer any *three* questions 3 × 5 = 15
- 2 (a) Draw and explain the electrical equivalent circuit corresponding to damped vibration. 2  
 (b) What is critical damping? 1  
 (c) Establish the relation between the logarithmic decrement and quality factor of a damped oscillatory system. 2
- 3 (a) What is missing order in double slit diffraction pattern? - Explain graphically. 2  
 (b) What do you mean by resolving power for plane transmission grating? 2  
 (c) Why the Newton's rings are circular in nature? 1
- 4 (a) The refractive indices of double refracting crystal for ordinary and extraordinary rays are 1.584 and 1.592 respectively, for wavelength  $\lambda = 5600 \text{ \AA}$ . Determine the thickness of the crystal to produce half wave plate. 2  
 (b) Describe briefly the principle of operation of a laser. 3
- 5 (a) What is Compton effect? 1  
 (b) Calculate the Compton shift in wavelength for an electron. Explain the origin of unmodified lines in Compton scattering. 3+1
- 6 (a) Calculate atomic radius for a FCC crystal. What is Bravais lattice? 1+1  
 (b) The interplaner spacing of a plane in a crystal is  $1.2 \text{ \AA}$  and the angle for the first-order Bragg's reflection is  $30^\circ$ . Determine the energy of the X-ray beams in eV. 3

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**GROUP C**  
 (Long Answer Type Questions)

Answer any *three* questions.

3 × 15 = 45

7. (a) An oscillator executing S.H.M. has zero displacement at time  $t = 0$ . If the displacement are 0.1 cm and 0.15 cm at instant  $t = 0.1$  and 0.2 seconds respectively, calculate the frequency and amplitude of oscillation. 3
- (b) If a particle executing simple harmonic motion simultaneously at two perpendicular directions with the same amplitude and frequency then find out the condition that the Lissajous figure will be a circle. 4
- (c) Write down the differential equation for a series L-C-R circuit driven by a sinusoidal voltage. Identify the natural frequency of this circuit. Find out the condition that this circuit will show an oscillatory decay and find out the relaxation time. 4
- (d) Show that at velocity resonance, the velocity is in phase with the driving force. 4
8. (a) If the distance between two coherent sources of light with wavelength  $\lambda$  is  $d$  and  $D$  is the source screen distance then show that fringe width separation  $x = \frac{D\lambda}{d}$ . 4
- (b) State the condition to be fulfilled for the production of sustained interference fringes. 3
- (c) Show that in Newton's Ring experiment the radii of bright fringes are proportional to the square roots of odd natural numbers. 4
- (d) In a Newton's ring experiment, the diameter of 5<sup>th</sup> dark ring is 0.336 cm and the diameter of the 15<sup>th</sup> dark ring is 0.590 cm. Find the radius of the Plano-convex lens if the wavelength of the light used is 5890 Å. 4
9. (a) What is the difference between single-slit and double-slit diffraction pattern? 2
- (b) Show that the intensity of secondary maxima formed by single-slit Fraunhofer diffraction process is nearly 4.5% of the principal maxima. 4
- (c) A parallel beam of light of wavelength 5890 Å falls normally on a plane transmission grating having 4250 line/cm. Find the angle of diffraction for maximum intensity in first order. 3

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- (c) Calculate the polarizing angle for a light ray travelling from water of refractive index 1.33 to glass of refractive index 1.53.
- (e) Discuss briefly how Nicol prism can be used as a polarizer.

10. (a) What is the basic principle behind holography? 3
- (b) Discuss the process of construction and reconstruction of hologram.
- (c) In a He-Ne laser transition from  $E_1$  to  $E_2$  level gives a laser emission of wavelength 632.8 nm. If the energy of  $E_2$  level is  $15.2 \times 10^{-19}$  J, how much pumping energy is required, if there is no energy loss? (Given that Planck's constant  $h = 6.625 \times 10^{-34}$  J).
- (d) What is the role of optical resonators in LASER?
11. (a) Show that in a cubic lattice of side 'a', the interplaner spacing between consecutive parallel planes of Miller indices (h k l) is

$$d_{hkl} = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$$

- (b) Explain the origin of characteristics of X-rays. 3
- (c) Copper has FCC structure and atomic radius of 0.1278 nm. Calculate its density and the interplaner spacing for (3 2 1) planes. Take the atomic weight of copper as 63.50.
- (d) State Moseley's law.