

CS/B.Tech-odd.Sem-Ist/PH-101/2014-15

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*

GROUP A
(Multiple Choice Type Questions)

1. Answer any *ten* questions. 10 × 1 = 10
 - (i) Superposition of two mutually perpendicular SHMs of equal time period and equal amplitude and phase difference π form

(A) ellipse	(B) circle
(C) straight line	(D) parabola
 - (ii) The amount of power supplied to a system is equal to the rate of dissipation of energy in

(A) forced vibration	(B) damped vibration
(C) simple harmonic motion	(D) oscillatory motion
 - (iii) For large values of damping constant the Q-factor

(A) increases	(B) decreases
(C) remains same	(D) becomes zero
 - (iv) Dispersive power of grating increases with increase of

(A) number of lines per centimeter	(B) order number
(C) number of lines and order number	(D) intensity of incident light

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(v) In Young's double slit experiment using two identical slits, the intensity of the maximum at the centre of the screen is I . What will be the intensity at the centre of the screen if one of the slits is closed?

- (A) I (B) $2I$
(C) $\frac{I}{4}$ (D) $\frac{I}{2}$

(vi) A nicol prism can act as a

- (A) polarizer (B) both polarizer and analyzer
(C) analyzer (D) laser

(vii) Emission of photon due to transition of an electron from higher to lower energy level caused external energy is known as

- (A) stimulated absorption (B) spontaneous emission
(C) stimulated emission (D) population inversion

(viii) In Ruby laser the host crystal is

- (A) CaCO_3 (B) MnO_2
(C) Al_2O_3 (D) Fe_2O_3

(ix) The Compton shift is maximum when scattering angle is

- (A) 45° (B) 90°
(C) 180° (D) 60°

(x) In holography, three dimensional image of the object may be produced

- (A) by using single lens (B) by using a mirror and a lens
(C) by using two lenses (D) without using lens

(xi) de Broglie wavelength of a gas molecule at temperature T is

- (A) $\frac{h}{\sqrt{3mkT}}$ (B) $\frac{2h}{\sqrt{3mkT}}$
(C) $\frac{h^2}{\sqrt{3mkT}}$ (D) $\frac{h}{\sqrt{3mkT}}$

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(xii) The Compton shift and Compton wavelength λ_c of a particle are equal if the angle of scattering is

- (A) 0° (B) 90°
(C) 180° (D) 45°

(xiii) According to Rayleigh-Jean's Law, the energy density of a blackbody radiation is

- (A) inversely proportional to the fourth power of wavelength
(B) directly proportional to the fourth power of wavelength
(C) inversely proportional to the fifth power of wavelength
(D) directly proportional to the fifth power of frequency

(xiv) If a and r be respectively the lattice constant and radius of an atom in a BCC structure then,

- (A) $r = \frac{\sqrt{3}}{4}a$ (B) $r = \frac{\sqrt{2}}{4}a$
(C) $r = a$ (D) $r = \frac{a}{2}$

(xv) If λ_L and λ_K are characteristic wavelengths belonging to L and K lines in X ray spectrum, then

- (A) $\lambda_L > \lambda_K$ (B) $\lambda_L < \lambda_K$
(C) $\lambda_L \sim \lambda_K$ (D) $\lambda_L = 4\lambda_K$

GROUP B

(Short Answer Type Questions)

Answer any three questions

3 × 5 = 15

- 2 (a) What are Miller Indices? Find the Miller Indices of a crystal plane whose intercepts are $[a, 2b, c]$ in simple cubic crystal
(b) What is ultraviolet catastrophe?

1 × 2 = 2

- 3 (a) Distinguish between spontaneous and stimulated emission?
(b) State Moseley's Law

3 × 2

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4. (a) What do you mean by Q-factor of a damped oscillator? Derive the relation between Q-factor and relaxation time. 3+
- (b) If the natural angular frequency of a simple harmonic oscillator of mass 2g is 0.8 rad.s^{-1} it undergoes critically damped motion when taken to a viscous medium. Find the damping force on the oscillator when its speed is 0.2 cm.s^{-1} .
5. (a) In a Newton's ring experiment the diameter of 5th dark ring is 0.366 cm and the diameter of the 15th dark ring 0.590 cm. Find the radius of the plano-convex lens if the wave length of light used is 5890 \AA . 2+
- (b) A monochromatic radiation of wavelength $2 \times 10^{-12}\text{ m}$ is incident on free stationary electrons. What is the wavelength of the beam which is scattered directly backwards? What is the energy gained by the scattered electron?
6. (a) State Malus' law. 2+2+
- (b) In damped harmonic motion, calculate the time in which the energy falls to e^{-1} times of its initial value.
- (c) Draw the amplitude resonance curves for different values of damping.

GROUP C
(Long Answer Type Questions)

Answer any three questions.

3×15=4

7. (a) Prove that the intensity of secondary maxima formed for Fraunhofer diffraction at a single slit are of decreasing order. 4+3+4+
- (b) Explain missing order in N-slit diffraction.
- (c) State Rayleigh criterion. Write a short note on resolving power of a grating.
- (d) A mica sheet of refractive index 1.58 is introduced in one of the interfering beams and the central fringe gets shifted by 0.2 cm. The distance between the sources is 0.1 cm and the screen is placed at a distance 50 cm from the sources. Determine the thickness of the mica sheet.
8. (a) What do you mean by black body? State Kirchhoff's law of blackbody radiations. 4+3+4+
- (b) Establish Newton's law of cooling from the Stefan-Boltzmann law of Blackbody radiation.
- (c) Starting from de Broglie's hypothesis show that the group velocity associated with a particle is the same as the particle velocity.
- (d) If an electron is subjected to a potential difference of V volts then prove that the corresponding de Broglie wavelength is $\frac{12.27}{\sqrt{V}}\text{ \AA}$.

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9. (a) A particle is subjected to a harmonic restoring force and a damping force. Its equation of motion is given. 5+3+3+4

$$\frac{d^2x}{dt^2} + 2b\frac{dx}{dt} + \omega_0^2 x = 0$$

Under the condition of small damping, find the expression for displacement as a function of time.

- (b) Draw the displacement - time graph for large and critical damping, and compare their relative shift.
- (c) Two simple harmonic oscillators of different masses oscillate separately under the action of same restoring force at frequencies 3Hz and 5Hz. Calculate the ratio of their masses.
- (d) Find the amplitude, phase and instantaneous velocity of the vibrational motion represented by

$$x = a \cos \omega t + \frac{a}{2} \cos(\omega t + \frac{\pi}{2}) + \frac{a}{4} \cos(\omega t + \pi) + \frac{a}{8} \cos(\omega t + \frac{3\pi}{2})$$

10. (a) What is holography? Give the differences between ordinary photography and holography. 5+6+2+2
- (b) Define Einstein's A and B co-efficients and obtain a relation between them.
- (c) What is optical pumping?
- (d) A tube of 20 cm length filled with a solution of 15g of cane sugar in 100cc of water placed in the path of a polarized light. Find the angle of rotation of the plane of polarization if the specific rotation of cane sugar is 65° .

11. (a) Define lattice constant in case of crystal system. 1+2+3+3+2+4

- (b) What is the physical significance of Miller indices?
- (c) Deduce the interplanar spacing of a simple cubic lattice of side 'a'.
- (d) The distance between (d₁₀₀) plane in BCC structure is 0.335 nm. What is the size of the unit cell?
- (e) What is the difference between crystal grating and optical grating? Write Bragg's equation in crystal structure.
- (f) A beam of X-rays is incident on NaCl crystal with lattice spacing 0.282 nm. Calculate the wavelength of X-rays if the first order Bragg's reflection is observed at a glancing angle of 8.35° . Also find the maximum order of diffraction possible.

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