CS/B.TECH (OLD)/SEM-2/PH-201/2012

2012

ENGINEERING PHYSICS

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) How fast a particle must travel so that its mass becomes twice of its rest mass ?

   a) 0·5 C

   b) 3C

   c) $\dfrac{\sqrt{3}C}{2}$

   d) 0·25C.

ii) If visible light is used to study the Compton scattering then Compton shift will be

   a) Negative

   b) more positive than what is observed with X-ray

   c) zero

   d) positive but not detectable in the visible window.

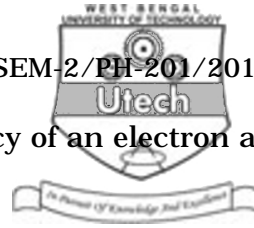iii) Emissive power of a black body kept at an abslute temperature T is proportional to

   a) T^2 b) T^4

   c) T^5 d) T^{-1}.

iv) Which of the following wave functions is the solution of Schrödinger equation ?

   a) $A \sec x$ b) $A \tan x$

   c) $A \exp(-x^2)$ d) $A \exp(x^2)$.

v) In B-E statistics each quantum state can accommodate

   a) only one particle   b) one or more particle

   c) two particles   d) none of these.

vi) For $T > 0$, the probability of occupancy of an electron at Fermi level is

a) $\dfrac{1}{2}$

b) 1

c) 0

d) $\dfrac{1}{3}$.

vii In Ruby LASER the host crystal is

a) Al_2O_3

b) MnO_2

c) $CaCO_3$

d) Al_2SO_4.

viii) In He-Ne lasing action, the red laser beam is trapped as it lies in

a) visible region

b) infrared region

c) gamma region

d) radio wave region.

ix) Two sources of light are said to be coherent when the waves produced by them have the same

a) wavelength

b) amplitude

c) wavelength and constant phase difference

d) amplitude and same wavelength.

3

[Turn over

x) When monochromatic light is replaced by white light in Fresnel's biprism experiment the central image is

a) Dark b) White

c) Coloured d) None of these.

xi) A diffraction pattern is obtained by using a beam of red light. What happens if the red light is replaced by the blue light ?

a) No change

b) Diffraction band become narrower and crowded to gather

c) Bands become broader and further apert

d) Bands disappear.

xii) In the propagation of light wave the angle between the plane of polarization is

a) 0° b) 90°

c) 45° d) 180°.

xiii) In case of a simple cubic crystal the effective number of atoms per unit cell is

a) 2 b) 1

c) 1 d) none of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.   3 × 5 = 15

2. Distinguish between single slit and double slit diffraction patterns. What is grating element ? How is it related to the order number of grating in diffraction ?   2 + 2 + 1

3. What are the different types of polarized light ? Draw the representative diagrams.   2 + 3

4. a) 3 distinguishable particles, each of which can be in one of the E, 2E, 3E, 4E energy state have total energy 6E. Find all possible distribution of particles in the energy states.   3

   b) Find the number of microstates in each case.   2

5. a) What do you mean by population inversion ?   2

   b) Draw the energy level diagram in He-Ne laser transition.   3

6. What are the charcteristics of crystalline solid ? Explain the terms 'lattice' and 'basis' in relation to crystal structure.

        3 + 2

7. If an electron and a positron annihilate and produce two photons, then calculate the frequency of a photon.

   [Rest mass of electron = $9·1 \times 10^{-31}$ kg]

   A material body can never attain velocities which are equal to or greater than the velocity of light. Why ?   3 + 2

8. Discuss the important characteristics of nuclear force. Slow neutrons are used in nuclear reactor. Why ?   3 + 2

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

9. a) Two independent sources of light of same wavelength cannot produce interference. Justify.   3

   b) Explain why extended source of light is required for fringes in Newton's ring experiment. In place of monochromatic light when white light is used, what change is expected, if any ? $3 + 2$

   c) Can you measure the refractive index of a liquid by Newton's ring experiment ? Explain.   3

   d) The diameters of 5th and 15th dark rings are measured to be 0·336 cm and 0·590 cm in Newton's ring experiment. Find the radius of curvature of the Planoconvex lens when the source of light has wavelength 5890 Å.   4

10. a) Write down the B-E distribution function and F-D distribution function.   3

   b) Calculate the total number of particles in a fermionic gas in terms of the Fermi level at absolute zero.   3

   c) Consider a two particle system each of which can exist in states E, 2E, 3E. What are the possible states if the particles are (i) bosons (ii) fermions.   5

   d) Determine the numerical aperture of a step index fibre when the core refractive index $n_c = 1 \cdot 5$ and that of cladding $n_d = 1 \cdot 48$. Find the maximum angle for entrance of light if the fibre is placed at air.   4
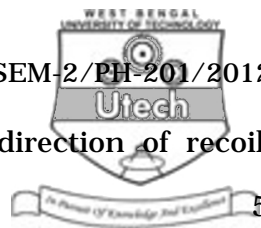
11. a) Find the expression of energy and direction of recoil electron due to Compton scattering. 5

   b) In a lasing process the ratio of population of two energy levels out of which upper one corresponds to metastable state is $1 \cdot 005 \times 10^{-24}$. Find the wavelength of LASER beam at 300 K. 4

   c) Explain with suitable diagram the variation of binding energy per nucleon with mass number. 4

   d) Establish the relation between Relativistic Energy and Momentum. 2

12. a) Why *X*-rays are used in the study of crystal diffraction ? State Bragg's law in such study. 2 + 2

   b) Find the intercepts on the three axes of a cubic crystal by the plane (323). 3

   c) Calculate the interplaner spacing (*d*) of the planes (111) and (100) for a simple cubic lattice of side *a*. 3

   d) A beam of *X*-rays having wavelength 0·842 Å is incident on a crystal at glancing angle 8° 35 $^{\prime}$ for the first order reflection. Find the value of the glancing angle for the third order reflection. 5

2265 7 [Turn over

13. a) If an electron is subjected to a potential difference of v volts then prove that the corresponding de-Broglie wavelength, $\lambda = \dfrac{12 \cdot 26}{\sqrt{v}}$ Å. 3

b) On the average, an exited state of a system remains in the state for 10^{-11} s. What is the minimum uncertainty in the energy of an excited state. 3

c) State the position-momentum Heisenberg uncertainty principle. 2

d) What is the value of $\left[\dfrac{\partial}{\partial x}, \dfrac{\partial}{\partial t} \right]$? 3

e) When a particle moves with a velocity much less compared to the velocity of light in free space, then show that the relativistic expression of K.E. approaches the classical limit. 4

14. a) What is the difference between unpolarised light and polarized light ? Explain how polarized light can be obtained from unpolarised light. 2 + 2

b) What are plane of vibration and plane of polarization ? 2

c) Discuss the phenomenon of double refraction. Distinguish between O-ray and E-ray. 2 + 4

d) A ray of light is incident at the polarizing angle on the surface of a glass plate having refractive index 1·5. Find the angle of refraction of the ray. 3

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