INTERNATIONAL CENTRE FOR APPLIED SCIENCES
MAHE, MANIPAL
B.Sc. (Applied Sciences) in Engg.
End – Semester Theory Examinations – MAY 2021
I SEMESTER - PHYSICS - I (IPH 111) – Repeaters - 2018 Batch
(Branch: Common to all)

Time: 3 Hours **Date: 27 May 2021** **Max. Marks: 100**

- ✓ **Note: Answer Any FIVE full questions.**
- ✓ **Write specific and precise answers. Missing data may suitably be assumed.**
- ✓ **Draw neat sketches wherever necessary with axes shown properly.**

Useful constants

Planck's constant h = 6.63 x 10^{-34} Js, Velocity of light c = 3x 10^{8} ms^{-1}.
Charge on electron = 1.6x10^{-19} C. Mass of electron = 9.1 x 10^{-31} kg. Mass of proton = 1.67 x 10^{-27} kg. Boltzmann constant: 1.38 x 10^{-23} J/K
Stefan-Boltzmann Constant: 5.67 x 10^{-8} W/m^2K^4

1A. What is interference of light waves? With neat diagrams, write the necessary condition for the constructive and destructive interference of two light waves in terms of phase difference. **(6)**

1B. Obtain an expression for the radius of m^{th} order bright ring in the case of Newton's rings. **(6)**

1C. In a double-slit experiment, the distance between slits is 5.22mm and the slits are 1.36mm from the screen. Two interference patterns can be seen on the screen, one due to light with wavelength 480nm and the other due to light with wavelength 612nm. Find the separation on the screen between the third order interference fringes of the two different patterns. **(4)**

1D. A disabled tanker leaks kerosene (n_K = 1.20) into the Persian Gulf, creating a large slick on top of the water (n_W = 1.33). (a) If you are looking straight down from an airplane on to a region of the slick where thickness is d= 460 nm, for which wavelengths of visible light is the reflection the greatest? (b) If you are scuba diving directly under this same region of the slick, for which wavelengths of visible light is the transmitted intensity the strongest? **(4)**

2A. How to produce linearly polarized light by (a) selective absorption, (b) reflection, and (c) double refraction. Explain. **(6)**

2B. Obtain an expression for the intensity of light in double-slit interference using phasor-diagram. **(6)**

2C. A converging lens of diameter (d = 32 mm has a focal length f = 24 cm. (a) What angular separation must two distant point objects have to satisfy Rayleigh's criterion? (θ_R=?) Assume that λ = 550 nm. (b) How far apart (Δx=?) are the centers of the diffraction patterns in the focal plane of the lens? **(4)**

2D. In a double slit experiment, the distance of the screen from the slit is 52cm, the wavelength is 480nm, the slit separation is 0.12mm and slit width is 0.025mm. (a) What is spacing between adjacent fringes? (b) What is the distance from the central maximum to the first minimum of the fringe envelope? **(4)**

3A. Obtain the locations of single slit diffraction minima and maxima qualitatively. **(4)**

3B. Explain Rayleigh's criterion for resolving images due to a circular aperture. **(4)**

3C. The first-order diffraction maximum is observed at 12.6° for a crystal having a spacing between planes of atoms of 0.250 nm. (a) What wavelength x-ray is used to observe this first-order pattern? (b) How many orders can be observed for this crystal at this wavelength? **(4)**

3D. We wish to use a plate of glass (n=1.50) in air as a polarizer. Find the polarizing angle and the angle of refraction. **(4)**

3E. A diffraction grating has 200 rulings/mm and a principal maximum is noted at 28°. What are the possible wavelengths of incident white light? **(4)**

4A. Write the assumptions made in Planck's hypothesis of blackbody radiation. How Planck's law successful to explain complete blackbody radiation spectrum? **(6)**

4B. Explain Einstein's photoelectric equation. Which are the features of photoelectric effect-experiment explained by photoelectric equation? **(4)**

4C. A blackbody at 7500 K consists of an opening of diameter d = 0.050 mm, looking into an oven. Find the number (n) of photons per second escaping the hole and having wavelengths between 500 nm and 501 nm. **(6)**

4D. X- rays having an energy of 300 keV undergo Compton scattering from a target. Find i) The Compton shift at an angle of 37° and ii) the energy of scattered x-ray. **(4)**

5A. What is Compton effect ? Derive the Compton shift equation. **(6)**

5B. Explain (a) group speed (b) phase speed, of a wave-packet. Show that the group speed of a wave-packet is not same as phase speed in dispersive medium. **(6)**

5C. A 0.500 kg baseball is confined between two rigid walls of a stadium that can be modelled as a box of length 100m. Calculate i) the minimum speed of the ball ii) If the ball now moves with a speed of 150m/s determine the quantum number of the state in which the baseball resides. **(4)**

5D. An electron and a bullet (m= 20gm) each have a velocity of 500m/s accurate to within 0.010%. Within what limits could we determine the positions of the objects along the direction of the velocity? **(4)**

6A. Explain – i) Normalisation of wave functions ii) the mathematical features of a wave function. **(6)**

6B. Solve Schrodinger equation for the wave function of a particle confined in an infinite potential well of one dimension. **(6)**

6C. A free electron has a wave function, $\psi(x) = A\, e^{i(5.0\times10^{10}\, x)}$ where x is in meters. Find (a) its de Broglie wavelength and (b) its momentum. **(4)**

6D. A photon with wavelength is absorbed by an electron confined to a box. As a result, the electron moves from state n =1 to n =4. (a) Find the length of the box. (b) What is the wavelength of the photon emitted in the transition of that electron from the state n = 4 to the state n = 2? **(4)**

7A. Explain the origin of (i) orbital quantum number (ii) magnetic orbital quantum number and write the relation between them. **(6)**

7B. Describe the construction and working of He-Ne laser. **(6)**

7C. Calculate the most probable value and average value of the position for an electron in the ground state of the hydrogen atom. **(4)**

7D. A ruby laser emits light at a wavelength of 694.4 nm. If a laser pulse is emitted for 12.0 ps and the energy release per pulse is 150 mJ, (a) what is the length of the pulse, and (b) how many photons are there in each pulse ? **(4)**

8A. Obtain an expression for rotational energy of a diatomic molecule. Sketch schematically these rotational energy levels. **(6)**

8B. Derive the density-of-states function. **(6)**

8C. Determine the current generated in a superconducting ring of niobium metal 2.00 cm in diameter when a 0.0200-T magnetic field directed perpendicular to the ring is suddenly decreased to zero. The inductance of the ring is 3.10×10^{-8} H. **(4)**

8D. Sodium is a monovalent metal having a density of 971 kg/m^3 and a molar mass of 0.023 kg/mol. Use this information to calculate (a) the density of charge carriers and (b) the Fermi energy. **(4)**

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