Question Paper

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MANIPAL ACADEMY OF HIGHER EDUCATION

DEPARTMENT OF PHYSICS
MIT MANIPAL
APPLIED PHYSICS FOR ENGINEERS [PHY 1072-PHY]

Marks: 30   **Duration: 90 mins.**

A

Answer all the questions.   Section Duration: 20 mins

Any missing data can be suitably assumed with proper reasoning.
The maximum duration to answer this section is 20 minutes.

1)   A particle of mass m is confined in a one-dimensional infinite potential well of width L. What happens to the energy levels if the width of the well is doubled?

(1)

| The energy levels decrease by a factor of 4. | The energy levels remain unchanged. | The energy levels increase by a factor of 4. | The energy levels decrease by a factor of 2. |

2)   A metal surface is illuminated with monochromatic light of wavelength λ, causing the emission of photoelectrons. The stopping potential required to halt the most energetic photoelectrons is measured as V_1. If the wavelength of the incident light is halved, which of the following statements is correct regarding the new stopping potential V_2?

(1)

$V_2 > 2V_1$ $V_2 < 2V_1$ $V_2 = 2V_1$ $V_2 = V_1/2$

3)   What is the minimum uncertainty in velocity of an electron if uncertainty in its position is 50 pm?

(1)

Zero 1.16×10^6 m/s 1.05×10^{-24} m/s 5.27×10^{-35} m/s

4)   Choose the wrong statement from the following.

(1)

| A single mode step index optical fibre consists of a core having a uniform refractive index. | A multi mode step index optical fibre consists of a core having a uniform refractive index. | Diameter of core is more for single mode step index optical fibre as compared to that of multi mode step index optical fibre. | Material dispersion in optical fiber is due to wavelength dependence of refractive index of the core. |

5)   Which of the following is NOT a method to achieve population inversion?

(1)

Optical pumping   Electrical discharge   Thermal equilibrium   Electrical injection of carriers

B

Answer all the questions.

Any missing data can be suitably assumed with proper reasoning.

6)   **(a)** Sketch a schematic graph of **photoelectric current vs. applied voltage** for the photoelectric effect. Explain the significance of the point where the graph intersects the **x-axis**. **(b)** Sketch a schematic graph of the **maximum kinetic energy of emitted electrons vs. the frequency of incident light**. Explain the significance of the **slope** and **y-intercept** of the graph.

(4)

7)   (a) What are the mathematical features of a wave function? (b) Write the mathematical expression that ensures the total probability of finding the particle in all space is 1.

(3)

8)   A ruby laser delivers a 10 ns pulse of 1 MW average power. If the photons have a wavelength of 694.3 nm, how many are contained in the pulse? What is the length (spatial) of the pulse?

(3)

9)   You use a radiometer to measure thermal radiation from an object at 1278 K. The radiometer is set to detect peak emission and the radiometer records radiation in a wavelength interval of 12.6 nm. What is the radiation intensity within this range?

(3)

10)   After a 0.800 nm x-ray photon scatters from a free electron, the electron recoils at 1.40×10^6 m/s. What is the Compton shift in the photon's wavelength? (You can treat the electron non-relativistically)

(3)

11)   With necessary diagram, derive an expression for angle of acceptance and numerical aperture.

(3)

12)   A wavefunction is given by $\psi(x) = A$ for $0 \leq x \leq L$ and zero elsewhere. Find the normilization constant A.

(2)

13)   0.50 kg baseball is confined between two rigid walls of a stadium that can be modelled as a "box" of length 100 m. Calculate the minimum speed of the baseball.

(2)

14)   With reference to OFC, what is material dispersion? Briefly explain.

(2)