# Question Paper

Exam Date & Time: 20-Dec-2019 (08:30 AM - 11:30 AM)

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

FIRST SEMESTER B.TECH END SEMESTER MAKE UP EXAMINATIONS, DECEMBER 2019

**Engineering Physics [PHY 1051 - 2018 -PHY]**

**Marks: 50** **Duration: 180 mins.**

**A**

**Answer all the questions.**

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1) Obtain an expression for linear position of bright fringes and fringe width in the case of double-slit interference. Sketch the plot of intensity versus path difference. (5)

A)

B) Light of wavelength 540 nm passes through a slit of width 0.200 mm. (a) The width of the central maximum on a screen is 8.10 mm. How far is the screen from the slit? (b) Determine the width of the first bright fringe to the side of the central maximum. Calculate the intensity on the screen at a point 2.1 mm from the central maximum. (3)

C) Mirror $M_1$ in Michelson Interferometer is moved through a certain displacement. During this displacement, 250 fringe reversals are counted. The light being used has a wavelength of 632.8 nm. Calculate the displacement of the mirror $M_1$. (2)

2) Explain photoelectric effect. What are the observations in the experiment on photoelectric effect. Sketch schematically the following graphs with reference to the photoelectric effect: (a) photoelectric current vs applied voltage (b) kinetic energy of most-energetic electron vs frequency of incident light. (5)

A)

B) Distinguish between unpolarized and linearly polarized light. Explain Malus law. (3)

C) A 0.880 MeV photon is scattered by a free electron initially at rest such that the scattering angle of the scattered electron is equal to that of the scattered photon. Determine the scattered electron and photon angles. Electronic charge=$1.6\times10^{-19}$ C ; Mass of an electron is $9.1\times10^{-31}$ Kg ; speed of light in vacuum = $3\times10^{8}$ m/s; Planck's constant=$6.63\times10^{-34}$ Js; Avagadro number = $6.023\times10^{23}$ / mol; Boltzmann constant=$1.38\times10^{-23}$ J/K (2)

3) By solving the Schrödinger equation, obtain the wave-functions for a particle of mass m in a one-dimensional "box" of length L. (5)

A)

B) Electrons are incident on a pair of narrow slits 0.060 μm apart. The 'bright bands' in the interference pattern are separated by 0.40 mm on a 'screen' 20.0 cm from the slits. Determine the potential difference through which the electrons were accelerated to give this pattern. Electronic charge=$1.6\times10^{-19}$ C ; Mass of an electron is $9.1\times10^{-31}$ Kg; speed of light in vacuum = $3\times10^{8}$ m/s; Planck's constant=$6.63\times10^{-34}$ Js; Avagadro number = $6.023\times10^{23}$ / mol; Boltzmann constant=$1.38\times10^{-23}$ J/K (3)

C) For a H-atom, determine the number of allowed states corresponding to the principal quantum number n = 2, and calculate the energies of these states. (2)

4) The wave function for H-atom in ground state is $\psi_{1S}(r) = \frac{1}{\sqrt{\pi a_0^3}} \exp\left(-\frac{r}{a_0}\right)$. Obtain an (5)

A)

expression for the radial probability density of H-atom in ground state. Sketch schematically the plot of this vs. radial distance.

B) Obtain an expression for vibrational energy of a diatomic molecule. Sketch schematically these vibrational energy levels. Obtain expression for vibrational transition photon energies. (3)

C) A $K^+$ ion and a $Cl^-$ ion are separated by a distance of $5.00 \times 10^{-10}$ m. Assuming the two ions act like point charges, determine (a) the force each ion exerts on the other and (b) the potential energy of the two-ion system in electron volts. Electronic charge=$1.6 \times 10^{-19}$ C; Mass of an electron is $9.1 \times 10^{-31}$ Kg ; speed of light in vacuum = $3 \times 10^{8}$ m/s; Planck's constant=$6.63 \times 10^{-34}$ Js; Avagadro number = $6.023 \times 10^{23}$ / mol; Boltzmann constant=$1.38 \times 10^{-23}$ J/K (2)

5) Sketch schematically the plots of Fermi-Dirac distribution function for zero kelvin and for temperature above zero kelvin. Derive an expression for density-of-states. (5)

A)

B) An HCl molecule is excited to its first rotational energy level, corresponding to J = 1. If the distance between its nuclei is $r_o$ = 0.1275 nm, what is the angular speed of the molecule about its center of mass ? Electronic charge=$1.6 \times 10^{-19}$ C; Mass of an electron is $9.1 \times 10^{-31}$ Kg ; speed of light in vacuum = $3 \times 10^{8}$ m/s; Planck's constant=$6.63 \times 10^{-34}$ Js; Avagadro number = $6.023 \times 10^{23}$ / mol; Boltzmann constant=$1.38 \times 10^{-23}$ J/K (3)

C) Most solar radiation has a wavelength of 1 μm or less. What energy gap should the material in solar cell have in order to absorb this radiation ? Is silicon ($E_g$= 1.14 eV) appropriate? Electronic charge=$1.6 \times 10^{-19}$ C ; Mass of an electron is $9.1 \times 10^{-31}$ Kg ; speed of light in vacuum = $3 \times 10^{8}$ m/s; Planck's constant=$6.63 \times 10^{-34}$ Js; Avagadro number = $6.023 \times 10^{23}$ / mol; Boltzmann constant=$1.38 \times 10^{-23}$ J/K (2)

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