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Total No. of Questions : 6] [Total No. of Printed Pages : 4

[4061]-109

F. E. Examination - 2011

APPLIED SCIENCE - II

(PHYSICS)

(2008 Pattern)

Time : 2 Hours] **[Max. Marks : 50**

Instructions :

(1) All questions are compulsory.

(2) Black figures to the right indicate full marks.

(3) Neat diagrams must be drawn wherever necessary.

(4) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.

(5) Assume suitable data, if necessary.

Q.1) (A) Classify the following characteristics of DeBroglie Waves into **true** and **false** : **[06]**

(a) DeBroglie Waves are probability waves.

(b) The wavelength of DeBroglie Waves is inversely proportional to the momentum of the particle.

(c) The Group Velocity of the DeBroglie Waves is given $v_g = v_{particle}$.

(d) DeBroglie Waves are significant for subatomic particles.

(e) DeBroglie Waves associated with bounded particles are quantized.

(f) DeBroglie Waves are associated only with moving material particles.

(B) Calculate the Wavelength of a Photon and an Electron both having an energy 1.0 eV.

(Given : Planck's Constant $h = 6.63 \times 10^{-34}$ J-s

Mass of Electron $= 9.1 \times 10^{-31}$ kg.) **[04]**

(C) Obtain the wavefunction for a particle moving in a rigid box. Also obtain the expression for its quantized energy. Highlight the step at which quantization begins to occur. **[6+1=07]**

OR

Q.2) (A) State Schrödinger's Time Independent and Time Dependant Equations and state any one difference between them. What are the basic requirements for solution of the Schrödinger's Equation to be acceptable ? **[3+4=07]**

(B) Identify and mark which of the following statement of the Heisenberg's Uncertainty Principle are incorrect. In front of the incorrect statement write the corrected statements :

$\Delta x \Delta P_y \geq h$

$\Delta \theta \Delta P_x \geq h$

$\Delta x \Delta E \geq h$

$\Delta x \Delta P_x \leq h$

$\Delta x \Delta t \geq h$ **[05]**

(C) Assuming Atomic Nucleus to be a rigid box (infinite potential well), calculate the ground state energy of an electron if it existed inside the nucleus. (Given Planck's Constant = 6.63×10^{-34} J-s, Mass of the Electron = 9.1×10^{-31} kg. and size of the nucleus $\sim 10^{-15}$m. Using this result, argue that electron cannot exist inside the nucleus. Given, maximum binding energy per nucleon = 8.8 MeV) **[05]**

Q.3) (A) Define following concepts : **(Any Three)** **[3x2=06]**

(a) Spontaneous Emission

(b) Stimulated Emission

(c) Metastable State

(d) Population Inversion

(e) LASING

(B) Following paragraph gives 6 statements regarding BCS Theory. Rewrite the statements and underline if they are incorrect : **[06]**

(a) BCS Theory indicates electron-lattice-electron interaction through a quantum of lattice vibration called Phonon.

(b) An electron, while passing through lattice distorts it, and another electron while passing across the distorted lattice gets attracted due to accumulated positive charge in the distorted lattice.

(c) Two electrons cannot exist together despite the presence of phonons.

(d) Cooper pairs are Bosons and thus any number of Cooper pairs can be accommodated in single low energy state.

(e) This leads to coherent propagation of the Cooper pairs with lowest possible speeds and thus hindrances are minimized. This leads to the superconducting state.

(f) BCS Theory explains why superconductivity is a high temperature, high magnetic field phenomenon.

(C) Differentiate between Type I and Type II Superconductors, on the basis of their response to the magnetic field and exhibition of the Meissner Effect. Support your explanation with the figures. **[04]**

OR

Q.4) (A) State and explain advantages of Diode/Semiconductor Laser over He Ne Laser. **[04]**

(B) Draw a block diagram of the Fiber Optics Communication System and explain the role of any four components in the system. **[2+4=06]**

(C) Explain Josephson Effect. What is Josephson Junction ? Draw its neat labelled diagram. State any one application of the Josephson Effect. **[2+1+2+1=06]**

Q.5) (A) Classify the following properties of Nano-particles in to optical, electrical and mechanical ones : **[06]**

(a) Nano-particles exhibit change in colour, which changes with the change in their size.

(b) When nano-particles are embedded in plastics, the strength is enhanced.

(c) Gold, when synthesized in nano-particle from, appears red.

(d) The I-V characteristics of nano-particles is not linear but is like a staircase.

(e) Nano-particles may acquire Superconducting State under some conditions.

(f) When Polycrystalline Magnesium is converted into Nano-crystalline Magnesium, the Young's Modulus decreases from 4100 N/m^2 to 3900 N/m^2.

(B) State any seven distinct applications of Nano-technology. **[07]**

(C) Intrinsic Silicon is doped with Phosphorus, with the atomic ratio of 10^8 (Si) : 1 (P). Calculate the conductivity of N type of Silicon thus formed. Given mobility of electrons in Silicon $\mu_e = 1400\ cm^2Vs^{-1}$. Atomic weight of intrinsic Silicon = 28.085, Avogadro's Number = 6.022×10^{23} atoms per mole, Density of Silicon = 2.33 gm/cm^3. **[04]**

OR

Q.6) (A) Write the formula for the Fermi Dirac Probability Distribution Function. Draw in the same figure the Fermi Dirac Probability versus Electron Energy at T = 0K, T_1 and T_2 (where $T_2 > T_1 > 0K$). Explain the significance of the figure. **[1+3+2=06]**

(B) A specimen having length 1.00 cm, width 1.00 mm and thickness 0.1 mm is made to conduct with 1.00 mA current and is placed in a magnetic field of 1.0 Wb/m^2, acting along the thickness. Calculate the Hall Voltage in case of (i) N type semiconductor with Hall Coefficient of $-3.44 \times 10^{-8}\ m^3/C$ and (ii) Aluminum with Hall Coefficient of $-0.3 \times 10^{-10}\ m^3/C$. Which of these materials is more sensitive to Hall Effect ? Why ? **[4+1=05]**

(C) State any four methods used for synthesis of nano-particles and describe any one method. **[06]**
