HPAS (Main)—2012

PHYSICS

Paper II

Time : 3 Hours   *Maximum Marks : 150*

Note :— Question No. 1 is compulsory. Attempt any *four* questions from the rest. *All* questions carry equal marks.

1. Answer the following :

    (a) A small quantity of arsenic is doped in pure germanium crystal. How is the number of electrons and holes affected ?   6

    (b) When does the avalanche breakdown occur in a p-n junction ? Name a device based on it.   6

    (c) Two big metallic plates of area 1 m^2 each is placed 1 m apart. The charge on the surface of the plates are equal and opposite. If the electric field between two plates is 5 N/C, then find the charge on each plate.   6

(d) A condenser of capacity 0.5 μF is charged through a resistance of 10 MΩ. How much time will it take to discharge to half of its charge ? ($\log_e 2 = 0.6931$) 6

(e) What is meant by the depth of modulation ? Explain the meaning of cent-percent modulation. 6

2. (a) A gas has two specific heats, why ? Differentiate them and explain why is the molar specific heat of gas at constant pressure C_P greater than the molar specific heat at constant volume C_V. 10

(b) Use law of equipartition of energy to obtain an expression for the molar specific heat of a diatomic gas at constant volume. How does the theoretical value differ from the experimental value ? Explain. 10

(c) Explain the quantum theory of rotational motion of a diatomic gas and find the contribution to specific heat.   10

3. (a) An isolated atom has its discrete energy levels. But when these atoms form a crystal, the energy levels form a band. Explain why ?   10

(b) In the common base mode of a NPN transistor, the input resistance is 50 Ω and current gain is 0.96. If the load resistance in the output circuit is 5 kΩ, calculate its voltage and power gains.   10

(c) What is the Bark-Hausen's criterion for an oscillator ? In which mode and how is transistor used for an oscillator ?   10

4. (a) Obtain an expression for the energy of an electron and wave number in a mono-valent atom according to the Bohr's model.   10

    (b) Discuss the different series obtained in the spectrum of hydrogen atom on the basis of Bohr's model. What are the facts which could not be explained by this model ?   10

    (c) On the basis of the concept of de-Broglie waves, explain the stationary electron orbits of Bohr's atomic model.   10

5. (a) In an experiment, the measured values of a variable are respectively 1, 2, 3 and 4; and the probabilities corresponding to them are respectively $\frac{1}{4}, \frac{1}{4}, \frac{1}{4}$ and $\frac{1}{4}$. Find the expectation values of x and x^2.   10

(b) Discuss the interpretation of matter wave function as given by Schrödinger and Max Born. How do the two concepts differ ? Which concept is more correct and why ? 10

(c) What is meant by normalisation of a wave function ? Obtain the condition of normalisation of a wave function. 10

6. (a) Give the probabilistic intepretation of the wave function Ψ. 10

(b) Explain the meaning of particle in a box with the help of potential diagram. If for the position $0 \leq x \leq a$, one-dimensional potential field is $V_x = 0$, obtain the solution of Schrödinger equation. Normalise the wave function. 10

(c) Calculate the transmission coefficient of a particle through a potential step of height V_0, if the energy of the particle is E when :

(i) $E > V_0$

(ii) $E < V_0$.   10

7. (a) Show that the value of electronic polarization in vacuum is zero.   10

(b) Explain the concept of electrical susceptibility with the help of a capacitor filled with a dielectric medium and establish the relationship between dielectric constant and electrical susceptibility.   10

(c) What do you understand by sharpness of resonance in series resonant circuit ? Find the expression for Q-factor of the circuit.   10

8. (a) Explain the meaning of chain reaction in nuclear

        fission, with an example. Is the fission process self

        chain reaction ? If not, how can it be made a chain

        reaction ?   10

    (b) Distinguish between the nuclear fission and nuclear

        fusion with examples. By which of the two processes

        energy is obtained in :

        (i)   nuclear reactor,

        (ii) in stars ?

        Why is fusion reaction comparatively more

        superior ?   10

    (c) A nuclear reactor produces 30 mega watt electrical

        energy. If 200 MeV energy is released per fission,

Calculate :

(i) The number of U^{235} nuclei fissioning per second,

(ii) The mass of U^{235} required to produce electricity for 1000 hours.

(Avogadro number = 6.02×10^{23} per gm atom). 10