This question paper contains 8 printed pages]

H.P.A.S. (Main)—2011

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 parallel plate capacitor, with plates of area A and separation d between them, has a charge q. Calculate the force of attraction between the plates of the capacitor. 6

   (*b*) Giving some examples, how can you explain that current is not used up as it flows through a resistor ? What is lost in this case ? What do you mean by non-ohmic resistor ? 6

P.T.O.

(c) Show that the tangential velocity of an electron in the Bohr's stationary orbit is $v = ze^2/2\varepsilon_0 nh$. 6

(d) If a radioactive element has a half-life of 20 days, calculate the disintegration constant and the average life. 6

(e) The forbidden energy gap in intrinsic germanium is 0.7 eV. Find out the ratio of the electron densities at 127°C and 27°C. (Boltzmann constant $k = 8.62 \times 10^{-5}$ eV/K). 6

2. (a) What do you mean by modulation ? Why are the high frequency carrier waves required for transmission ? Explain the principle of amplitude modulation. 10

(b) What do you mean by signal side band transmission ? Explain with the help of block diagram how does a single side band obtained from an amplitude modulated carriers wave ? What ate the advantages and disadvantages of this transmission ? 10

(c) A carrier voltage of peak value 10 volt and frequency 2.0 MHz is used to modulate the audio single of frequency in range 20 Hz to 20 kHz with a modulation depth 60%. Which frequency components will contain the modulating signal ? What will be the amplitude of these components ? What be the channel width required for transmission of this amplitude modulated wave ? 10

3. (*a*) Give an account of the discovery and properties of neutron. Describe how the mass of the neutron has been determined ? 10

(*b*) What is nuclear fission ? What are fission products ? What are the features of nuclear fission reaction which make it different from any other types of nuclear reaction ? 10

(*c*) State the conservation law or laws that are violated in the following nuclear disintegration which are forbidden :

(*i*) $L \rightarrow \pi^+ + \pi^-$

(*ii*) $K^+ \rightarrow \pi^+ + \pi^- + \pi^0$

(*iii*) $p \rightarrow n + e^+ + \upsilon$

(*iv*) $n \rightarrow e^- + e^+ + \upsilon$. 10

4. (a) Calculate the radius of the first Bohr orbit and velocity of electron for slightly ionized helium atom. 10

(b) Explain what is meant by the fine structure of spectral line ? Can Bohr's theory explain the fine structure ? 10

(c) Use the Pauli's principle, to show that the resultant angular momenta, associated with quantum number s and j are each equal to zero for a closed atomic sub-shell. 10

5. (a) Derive an expression for de-Broglie wavelength in terms of the accelerating potential V. 10

(b) A pendulum has a length of L meter and a bob of mass 0.1 kg. Find its zero point energy. 10

(c) In a magnetic field of flux density 2 tesla, the $^1D_2 - {}^1P_1$ calcium line at $\lambda = 732.6$ nm splits into components separated by 2.8×10^{10} Hz. Estimate the ratio of charge to mass of an electron. 10

6. (a) How are energy bands formed in a solid ? Explain the behaviour of empty, filled and partially filled bands towards the conduction. 10

(b) A diode (resistance $r = 10\ \Omega$) is used as half wave rectifier. If the rated output current is 80 mA and the rms value of voltage across the transformer is 230 volt, calculate voltage regulation, rectifier efficiency and current corresponding to the output maximum power. 10

(c) A diode detector is used to detect an amplitude modulated wave of 60% modulation by using a condenser of capacity 250 pico-farad in parallel with a load resistance 100 kΩ. Find the maximum modulation frequency which could be detected by it. 10

7. (a) Give a detailed outline of the theoretical consideration which led to the concept of wave particle duality. 10

(b) An electron beam has a de-Broglie wavelength of 0.15 Å. Compute the phase and group velocities of the de-Broglie waves. [Hint : $\lambda = \frac{h}{mu}$, $u_g = u$, $u_p = c^2u$] 10

(c) If a battery, of emf 100 volts, is connected in series with an induction of 10 mH, a capacitor of 0.05 μF and a resistance of 100 Ω, find the frequency of the oscillatory current, the logarithmic decrement and the final capacitor voltage. 10

8. (a) Explain the phenomena of thermionic emission. 10

(b) According to Einstein's theory how does the atomic specific heat of a solid vary with the temperature at low temperatures ? 10

(c) Differentiate between the Einstein's and Debye's theories of specific heat of solids. 10