Total No. of Printed Pages—7

RP–IX–XII–64

PHYSICS

SECOND PAPER

Full Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer **all** questions

Use of non-programmable calculators allowed

GROUP—A

1. *(a)* State and explain Gauss' theorem in electrostatics. When a point charge lies outside a closed surface, find the total electric flux from the surface. 4+4=8

(b) Find the field due to an infinitely long charged straight wire, using Gauss' theorem. 8

Or

Apply Gauss' theorem to find the electric field strength at a close point of an infinite plane conductor.

(c) Write the significance of the line integral of an electrostatic field $\vec{E}$. 4

Or

Establish Coulomb's law using Gauss' theorem.

2. (a) Calculate the electric potential, and hence the electric field intensity, at a point on the axis of a uniformly charged circular disc. 10

Or

Obtain an expression for the potential due to a uniformly charged thin spherical shell at an *(a)* external point and *(b)* internal point.

(b) Explain, with necessary theory, how an attracted disc electrometer could be used to measure a difference of potential. In an attracted disc electrometer, the lower and upper discs, 0·5 cm apart, have an area 10 cm^2. When a potential of 1 kV is applied between them, what will be the force of attraction between them? 10

Or

Find an expression for capacity of a parallel plate condenser of separation d when a dielectric slab of thickness t $(t < d)$ is introduced. A capacitor is

(Continued)

initially charged and then disconnected from the source. Establish that potential between the plates is reduced when a dielectric slab is introduced.

7+3=10

3. *(a)* Define magnetic permeability and susceptibility. Obtain a relation between them. 5

(b) What is a hysteresis loop? How are the values of remanence and coercivity determined from such a loop? 10

(c) An iron bar of length 10 cm and area of cross section 2 cm^2 is placed horizontally in the magnetic meridian and is found to be uniformly magnetised by the earth's field. Two neutral points are found on the perpendicular bisector of the bar at a distance of 2·0 cm from its mid-points. Find the intensity of magnetisation and the magnetic susceptibility of the bar. (Given, H = 0·32 oersted) 5

Or

A magnetic field of 100 gauss generates a flux of 2600 maxwells in a long bar of iron having a uniform area of cross section of 2 cm^2. Calculate the permeability and intensity of magnetisation of the bar.

4. *(a)* Describe the experimental arrangement to measure thermo-e.m.f. in a thermo-couple, and state the type of galvano-meter suitable for the arrangement. 8

Or

How would you demonstrate experi-mentally Peltier and Thomson effects?

(b) Define Peltier coefficient and thermo-electric power. Prove that the Peltier coefficient for a pair of metals is the product of the absolute temperature and the thermoelectric power. 4+8=12

5. *(a)* Explain the terms 'reactance' and 'impedance'. Obtain an expression for the voltage and current in an AC circuit containing resistance and capacity.

An alternating e.m.f. of 200 volts, 50 Hz is applied to a condenser in series with a 20 volts, 5 watt lamp. Find the capacity of the condenser. 2+8+4=14

(b) What are *(i)* series resonant circuit and *(ii)* parallel resonant circuit? Distinguish between the two. 6

Or

What is resonance in a series *L-C-R* circuit? Find an expression for resonance frequency. What is the value of impedance at resonance? Will the resonance frequency change with change of resistance? Explain.

GROUP—B

6. *(a)* Describe the apparatus and give the theory for experimental determination of the ratio of charge to mass (e/m) for the electron.

In J. J. Thomson's experiment, a magnetic field of 100 oersted is used. To make the path straight through the tube, a potential difference of 600 volts is applied to the deflection plates which are 0·5 cm apart. Find the velocity of the electron beam. (Given, $\mu_0 = 4\pi \times 10^{-7}$ henry/m) 5+5=10

Or

Describe Millikan's method of determining the charge on an electron. Outline the importance of this method.

A water drop of radius 10^{-5} cm is charged with one electron. Determine the electric field required to keep it stationary. (Given, $e = 1{\cdot}6 \times 10^{-19}$ coulomb, $g = 9{\cdot}8$ m/sec^2) 5+5=10

(b) Find an expression for total energy of an electron revolving around the nucleus of a hydrogen atom.

Find the limits of the Balmer series if $R = 1{\cdot}07 \times 10^7$ m^{-1}. 8+2=10

7. *(a)* Describe the production of X-rays in a Coolidge tube. What are the parameters of the tube on which the penetrating power of X-rays depend upon? What are the types of rays, of which the secondary radiations produced when X-rays are incident on matter, consist of? 5+2+3=10

Or

What are characteristic X-rays? Describe their productions. What is the minimum wavelength produced by an X-ray tube? 2+5+3=10

(b) Explain how Bohr's theory accounts for the observed spectrum of hydrogen. 10

8. *(a)* Show that in a radioactive transformation, $N = N_0 e^{-\lambda t}$, where the symbols have their usual meanings. If the half-life of radon is 3·8 days, after how many days will 1/10th of a radon sample be left behind? 8+4=12

(b) Outline the neutrino theory of β-decay. How does it explain the continuous energy spectrum in β-decay? 8

Or

Describe, with examples, different types of β-emission and discuss the conditions under which these occur.

9. *(a)* Describe, giving the theory, the working of a cyclotron. 10

Or

Describe a linear accelerator, and obtain expressions for the energy of a particle in terms of the constants of the apparatus.

(b) Distinguish between nuclear fission and fusion. Explain the principle on which the atomic reactor is constructed. Mention some of its uses. 4+4+2=10

10. *(a)* Define thermionic emission and work function. Write Richardson's equation, stating the meaning of each term. What conclusions could be drawn from this equation? 4+2+2=8

(b) Explain the necessity of modulation in radio transmission. Obtain the expression for the amplitude-modulated wave, and state the meaning of each of the terms in the expression. What is percentage modulation? Draw the diagram of an amplitude-modulated wave. 3+5+2+2=12

Or

Discuss frequency modulation. What are its merits? 8+4=12

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