Question Paper

Exam Date & Time: 19-Apr-2018 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
SECOND SEMESTER B.Sc (APPLIED SCIENCE)
END-SEMESTER THEORY EXAMINATIONS APRIL - 2018
DATE: 19 APRIL 2018
TIME: 9:30AM TO 12:30PM
Physics - II [IPH 121]

Marks: 100 **Duration: 180 mins.**

Answer 5 out of 8 questions.

Speed of light in vacuum = 3.00×10^{8} m/s, Electron charge = 1.60×10^{-19} C, Mass of proton / neutron = 1.67×10^{-27}kg, Electron mass = 9.11×10^{-31} kg, Boltzmann constant = 1.38×10^{-23} J/ K, Planck's constant = 6.63×10^{-34} J-s, Permittivity of vacuum = 8.85×10^{-12} F/m, Permeability of vacuum = $4\pi\times10^{-7}$ H/m, Avogadro constant = 6.02×10^{23} /mol.

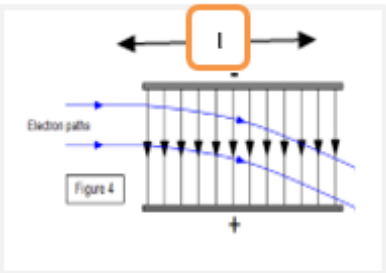
Any missing data may suitably be assumed. Write the correct question nos. at the margin clearly

1) A) State Coulomb's Law and write its mathematical form. What is the force of repulsion between two electrons separated by a distance10.0 pm? (4)

B) a) Obtain an expression for the electric field at a point along the perpendicular bisector of a line of charge.
b) Arrive at an expression for the torque acting on a dipole placed in a uniform electric field and hence obtain an expression for the energy of field and dipole system. (8)

C) (a) Two equally charged particles, held 3.20 mm apart, are released from rest. The initial acceleration of the first particle is observed to be 7.22 m/s^2 and that of the second to be 9.16 m/s^2. The mass of the first particle is 6.31×10^{-7} kg. Find (a) the mass of the second particle and (b) the magnitude of the common charge.
(b) An electron enters the region of a uniform electric field produced by a capacitor of length 0.1 m perpendicular to E, with an initial velocity 3×10^{6} m/s and E = 200 N/C. (8)

Calculate the acceleration and the time of its travel while it is in the field.



2) Explain "electric flux" giving example and write its mathematical form. (4)

A)

B) State Gauss' Law and prove Coulomb's Law using Gauss' Law. Prove that the electric field near a non-conducting sheet of charge is $E = \frac{\sigma}{2\epsilon_0}$ (8)

C) (a) Two charged, concentric, thin, spherical shells have radii of 10.0 cm and 15.0 cm. The charge on the inner shell is 40.6 nC and that on the outer shell is 19.3 nC. Find the electric field **(a)** at r = 12.0 cm, **(b)** at r = 22.0 cm, and **(c)** at r = 8.18 cm from the center of the shells. (8)
(b) A proton orbits with a speed 294km/s just outside a charged sphere of radius 1.13cm. Find the charge on the sphere.

3) (a) Define electrical potential at a point in an electric field. How does it differ from potential energy? (4)

A)
(b) State why the potential along a line perpendicular bisector of an electrical dipole is zero at every point

B) a) Arrive at an expression for the potential at a point near a uniform line of charge of length 'L' perpendicular to its length. (8)
b) Obtain an expression for the potential on an axial point of a circle formed by bending a uniformly charged wire.

C) (a) Two parallel, flat conducting surfaces of spacing d = 1.0 cm have a potential difference DV of 10.3 kV. An electron is projected from one plate directly toward the second. What is the initial velocity of the electron if it comes to rest just at the surface of the second plate? Ignore relativistic effects. (8)
(b) Two objects one with mass 2.2g, charge +32μC and other second with mass 3.9g, having charge -18μC are initially at a distance 4.6 cm apart. One object held in its fixed position and the second object is released from rest. What is the speed of second object when the separation between them is 2.3 cm? Assuming both the objects acts

like point charges.

4) A) Define the terms drift speed and current density and derive a relation between them. (4)

B) a) Prove that resistivity $\rho = m/(nq^2\tau)$ wherein symbols have usual meanings (8)

b) Arrive at an expression for the capacity of a cylindrical capacitor.

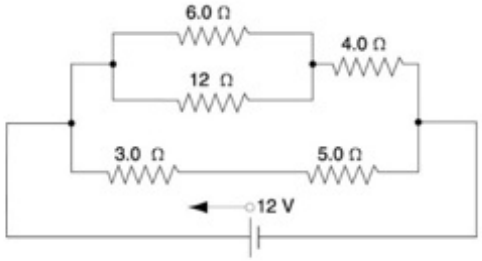
C) a) A wire 4.0 m long and 6.0 mm in diameter has a resistance of 15 mΩ. A potential difference of 23 V is applied between the ends. (a) What is the current in the wire? (b) Calculate the current density. (c) Calculate the resistivity of the wire material. (8)

b) A parallel-plate, air-filled capacitor having area 42.0 cm^2 and spacing of 1.30 mm is charged to a potential difference of 625 V. Find (a) the capacitance, (b) the magnitude of the charge on each plate, (c) the stored energy, (d) the electric field between the plates, and (e) the energy density between the plates.

5) A) A battery with an internal resistance 'r' is connected to an external load resistance 'R'. Whether the voltage across the load 'R' and the applied emf will have the same value? Justify your answer. Assuming the emf of the battery to be 12.0V, internal resistance of the battery is 10mΩ, load resistance 2.5Ω, calculate the current through the circuit and the voltage across each of the resistance and the battery. (4)

B) Arrive at an expression for the instantaneous charge and current through a circuit containing R and C in series with an emf source when the capacitor is in the process of discharging. Draw the relevant graphs indicating the variation of potential difference across the circuit components with time. Write the significance of RC time constant in a circuit. (8)

C) a) A circuit containing five resistors connected to a 12-V battery is shown in Figure. Find the potential difference across the 5.0-Ω resistor. (8)



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b) An electric heater is constructed by applying a potential difference of 120 V to a Nichrome wire that has a total resistance 8.0 Ω. Find the current carried by the wire and the power rating of the heater. If the heater is now connected to a 240 V power supply, what will be the current and the power rating?

6) The magnetic force acting on a charged particle is maximum when it travel perpendicular to the uniform magnetic field. Justify the statement and hence define the one Tesla. (4)

A)

B) Explain the term Hall effect and derive an expression for the Hall coefficient. Write a short note on mass spectrometer. (8)

C) a) An electron is accelerated from rest through a potential difference of 350V. It then enters a region of transverse magnetic field and travel along a curved path of radius 7.5 cm. What is the magnitude of the magnetic field and the angular speed of electron? (8)
b) A 1.22 keV electron circulating in a plane right angle to a magnetic field with a radius 24.7cm what is the a) frequency of revolution, b) period of the motion.

7) State Ampere's Law and Biot-Savart's Law and write their mathematical expressions. (4)

A)

B) a) Using Ampère's Law, arrive at an expression for the magnetic field due to a) a long straight wire both at a point outside and at its interior. Plot a graph of 'B' verses 'r' the radius of the wire. (8)

b) Using Ampère's Law, Prove that the magnetic field inside a solenoid is = $\mu_0 ni$, where 'n' is the number of turns per unit length

C) a) A long straight wire carries a current 50.8 A. An electron traveling at 1.10 x 10^7 m/s is 5.0 cm from the wire. Calculate the force on it if the velocity of electron is directed a) towards the wire b) parallel to the current and c) at right angles to the directions defined by a) and b) (8)

b) A long horizontal rigidly supported wire carries a current

of 96A. Directly above it and parallel to it is a fine second wire that carries a current 23A and its weight per length is 0.073N/m. How far this above the lower wire should this second wire be strung if we hope to support it by magnetic repulsion.

8) Explain in brief the Faraday's experiments on electromagnetic induction (4)

A)

B) Explain the term self inductance of a coil and prove that the self inductance of a solenoid per unit length is = $\mu_0 n^2 A$ (8)

where symbols have usual meanings. Write one application each of self and mutual inductance.

C) a) A coil consists of 200 turns of wire. Each turn is a square of side 18cm and uniform magnetic field directed perpendicular to the plane of the coil is turned on. If the field changes linearly from zero to 0.5 T in 0.8 seconds, what is the magnitude of the induced emf in the coil and the induced current if the resistance of the coil is 2.0 Ω. (8)

b) A 45.2 mH inductor has a reactance of 1.28kΩ at certain frequency. a) Find the frequency. b) What is the capacitance of a capacitor with the same reactance at that frequency? c) If the frequency is doubled, what are the reactances of inductor and capacitor?

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