Question Paper

Exam Date & Time: 28-Nov-2019 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
END SEMESTER THEORY EXAMINATION NOVEMBER/DECEMBER 2019
II SEMESTER B.Sc.(Applied sciences) in engg.
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} Js, Permittivity of vacuum = 8.85×10^{-12} F/m, Permeability of vacuum = $4\pi \times 10^{-7}$ H/m, Avogadro constant = 6.02×10^{23} /mol.

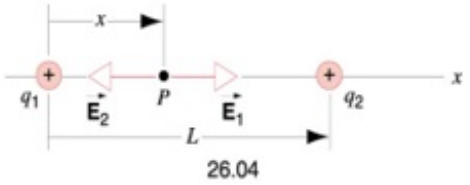
Any missing data may suitably be assumed. Write the correct question nos. at the margin clearly

1) A) Write Coulomb's Law in vector form. Explain the law with the help of proper diagrams. (4)

B) Obtain an expression for the field on an axial point of a uniformly charged disc. (6)

C) The average distance r between the electron and the proton in the hydrogen atom is 5.3 x 10^{-11} m. (i) What is the magnitude of the average electrostatic force that acts between these two particles? (ii) What is the magnitude of the average gravitational force that acts between these two particles? Given : G = 6.67 x 10^{-11} N m^2/kg^2 (5)

D) Following figure shows a charge q_1 of + 1.5 μC and a charge of q_2 = + 2.3 μ C. The first charge is at the origin of an x-axis and the second is at a position x = L where L=13 cm. At what point P along the x-axis is the electric field is zero? (5)

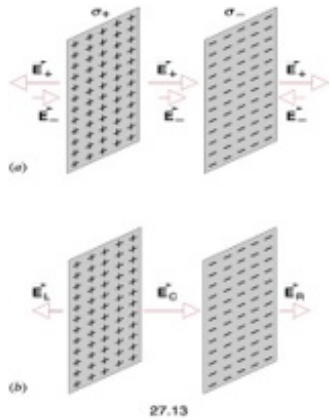


2) State and derive Gauss' law. (5)

A)

B) Write down the properties of a conductor in electrostatic equilibrium. (5)

C) Following figure shows a portions of two large sheets of charge with uniform surface charge densities of $\sigma_+ = +6.8\,\mu C/m^2$ and $\sigma_- = -4.3\,\mu C/m^2$. Find the electric field $\vec{E}$ to the left of the sheets and between the sheets. (6)



D) The magnitude of the average electric field normally present in the Earth's atmosphere just above the surface is 150 N/C, directed radially inward towards the center of the Earth. What is the total net surface charge carried by the Earth? Assume Earth to be a conductor. Given : Radius of the Earth = 6.37×10^6 m. (4)

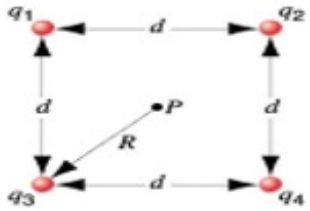
3) Define electrical potential at a point in a region of electric field. Draw equipotential surfaces in case of a single positive charge and a line of positive charges. (4)

A)

B) Explain any one application of electrostatics. (6)

C) Two objects one with mass 2.2g, charge +32μC and other with mass 3.9g, having charge -18μC are initially at a distance 4.6 cm apart. One object held in a 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? Assume both the objects acts like point charges. (6)

D) Calculate the potential at point P, located at the center of the square of point charges shown in the fig: (4)



Assume d = 1.3m and the charges are q_1 = 12 nC , q_2 = - 24 nC , q_3 = 31 nC and q_4 = 17nC.

4) Obtain an expression for the i) capacity of a parallel plate capacitor ii) energy stored in the electric field of a capacitor and hence the energy density. (6)

A)

B) Obtain an expression for the equivalent capacitance for capacitors connected in parallel. (4)

C) (i) The space between the conductors of a long co-axial cable has an inner radius a = 0.15 mm and an outer radius b = 2.1 mm. What is the capacitance per length of this cable? (ii) What is the capacitance of the Earth, viewed as an isolated conducting sphere of radius R = 6370 km? (5)

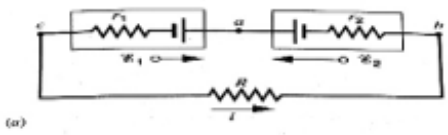
D) A parallel plate capacitor whose capacitance C is 13.5pF has a potential difference of ΔV = 12.5V across its plates. The charging battery is now disconnected and a porcelain slab (k_e = 6.5) is slipped between the plates. What is the stored energy of the unit, both before and after the slab is introduced? (5)

5) Explain - i) Electromotive force ii) Electric current, iii) Ohm's law (microscopic form) (6)

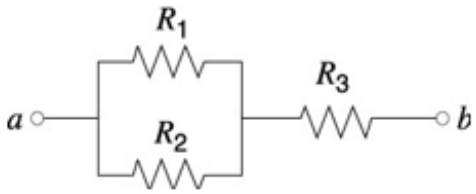
A)

B) Derive an expression for the conductivity of a metal. (4)

C) What is the current **i** in the circuit given below. The emfs and resistors have the following values : $\varepsilon_1 = 2.1\ V$, $\varepsilon_2 = 4.4\ V$, $r_1 = 1.8\ \Omega$, $r_2 = 2.3\ \Omega$, and R = 5.5 Ω. (5)



D) (i) Find the equivalent resistance of the combination in the circuit shown. Take R_1=4.6 Ω, R2= 3.5 Ω and R_3 = 2.8 Ω
(ii) What is the value of the current through R1 when a 12.0 V battery is connected across points a and b? (5)



6) Derive an expression for the torque acting on a current loop kept in a uniform magnetic field. (6)

A)

B) Explain any one application of motion of charged particles in E and B fields. (4)

C) In a Hall experiment, a current of 3.2A a lengthwise in a conductor 1.2 cm wide, 4.0 cm long and 9.5 μm thick produces a transverse Hall voltage (across the width) of 40 μV when a magnetic field of 1.4 T acts perpendicular to the thin conductor. Find i) the drift velocity of the carriers and ii) number density of the carriers. (5)

D) In a nuclear experiment, a proton with kinetic energy K_p moves in a uniform magnetic field in a circular path. What energy must a)an alpha particle and b) a deuteron have if they are to circulate in the same orbit? Given : mass of (5)

alpha particle = 4u, and q= +2e and that of deuteron = 2u, and q = +e. (1 u = 1.66 x10^{-27} kg).

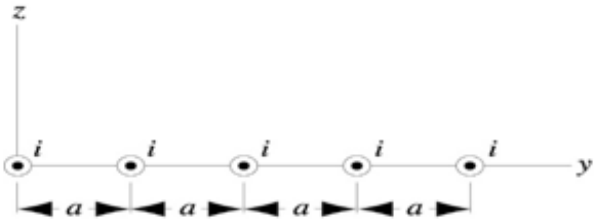
7) i) Biot- Savart law (5)
ii) Ampere's law.

A)

B) Obtain an expression for the magnetic field due to a solenoid. (5)

C) A long straight wire carries a current 48.8 A. An electron traveling at 1.08x10^{7} m/s is 5.2 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). (5)

D) Figure given below shows five long, parallel wires in the xy-plane. Each wire carries a current i = 3.22 A in the positive x-direction. The separation between the adjacent wires is a = 8.30 cm. Find the magnetic force per meter, magnitude and direction, exerted on each wire of these five wires. (5)



33.48

8) What is motional emf ? Obtain an expression for the motional emf. Show that the rate at which work is done in creating motional emf is equal to the internal energy produced in the circuit. (6)

A)

B) Explain i) Self inductance and ii) Mutual inductance. (4)

C) In a purely inductive AC circuit, L = 25mH and V_{max} = 220 V at a frequency of 50 Hz. Calculate the reactance and rms value of the current. If the frequency is increased to 6.0 kHz what is the rms value of the current? (5)

D) A circular coil has a 10.3 cm radius and consists of 34 closely wound turns of wire. An externally produced magnetic field of 2.62 mT is perpendicular to the coil.(a) If no current is in the coil, what is the number of flux linkages? (b) When the current in the coil is 3.77A in a certain direction, the net flux through the coil is found to vanish. Find the inductance of the coil. (5)

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