Question Paper

Exam Date & Time: 01-Jun-2018 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
II SEMESTER B.Sc.(Applied Sciences) DEGREE MAKE UP- EXAMINATION - MAY / JUNE 2018
DATE: 1 JUNE 2018
TIME : 9.30 AM TO 12.30 PM
Physics - II [IPH 121]

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

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 = $4\pi \times 10^{-7}$ H/m, Avogadro constant = 6.02×10^{23} /mol.

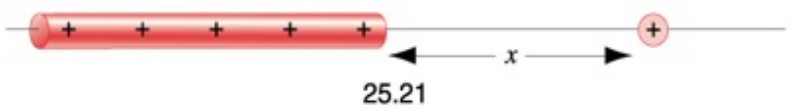
Answer any FIVE FULL questions.
Any missing data may suitably be assumed.

1) What is an electric field? What was the need of introducing the concept of field? In quantifying the electric field why is it necessary to specify that the test charge is very small and positive? (5)

A)

B) Obtain an expression for the field on an axial point of a uniformly charged disc. Discuss various cases. (5)

C) Find the force on a positive point charge **q** located at a distance **x** from the end of the rod of length **L** with uniformly distributed positive charge **Q** as shown in the figure: (5)



25.21

D) An electric dipole consists of charges +2e and -2e separated by 0.78 nm. It is in an electric field of strength 3.4 x 10^6 N/C. Calculate the magnitude of the torque on the dipole when the dipole moment is a) parallel, b)at right angle and c) opposite to the electric field? (5)

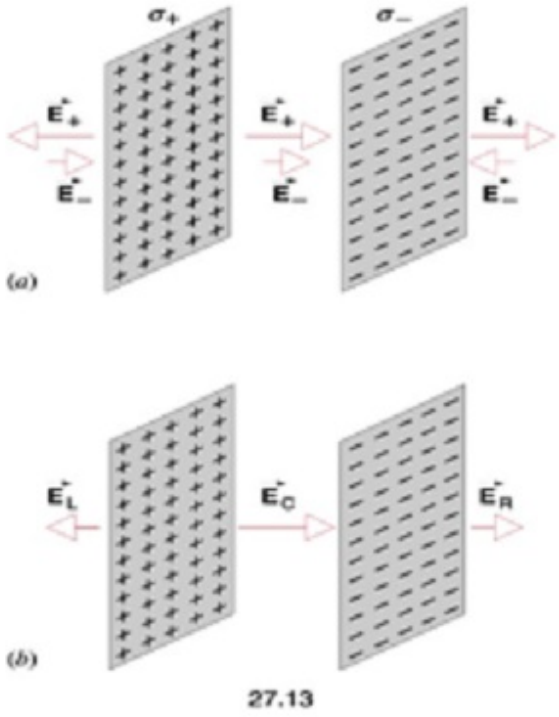
2) State and derive Gauss' law. (5)

A)

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

C) What is the electric flux through a sphere that has a diameter of 90 cm and carries a charge of + 2.00 μC at its center? If the radius of the sphere is changed to 1m what happens to the flux through the sphere and magnitude of electric field at the surface? (5)

D) 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. (5)



27.13

3) A) Obtain an expression for the potential difference in an uniform electric field. Comment on the result. Define the unit of potential difference. (5)

B) Explain any one application of electrostatics. (5)

C) An infinite sheet of charge has a charge density σ =0.12 μ C/m^2. How far apart are the equi-potential surface whose potential difference is 48V. (5)

D) A charge q1 = 2 μC is located at the origin and another charge q2 = -6 μC is located at (0,3)m. Find (a)the total electric potential due to these charges at (4,0)m. (b) Find the change in the potential energy of the system of two charges plus a charge of q3 = 3 μC as the latter charge moves from infinity (5)

to (4,0).

4) Obtain an expression for the energy stored in a capacitor and hence calculate the energy density. (5)

A)

B) In a RC circuit $\mathbf{q(t)= \epsilon C(1- e^{\frac{-t}{RC}})}$. Obtain expressions for $V_C(t)$, $V_r(t)$ and $U_c(t)$ Comment on the result. (5)

C) A parallel plate capacitor has plates of dimensions2cm by 3cm separated by a 1mm thickness of paper. Find a) its capacitance b) What is the maximum charge that can be placed on the capacitor? Given : For paper : k_e = 3.7, dielectric strength = 16 MV/m. (5)

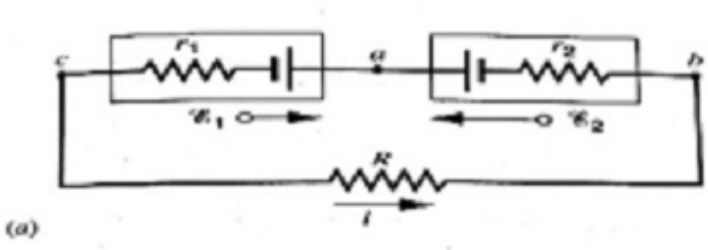
D) Find the capacitance of a cylindrical capacitor of length 15cm, inner radius 3.6 cm and outer radius 3.8cm with Pyrex glass as a dielectric media. Given : dielctric constant of Pyrex is 4.7. If the dielectric strength of the pyrex is 14 MV/m, find the break down potential. (5)

5) Explain - i)Electric current, ii) drift velocity of the carriers, iii) Ohm's law (microscopic form) (6)

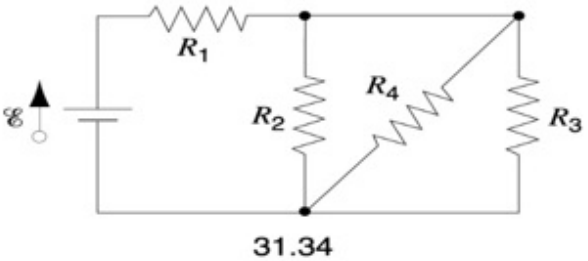
A)

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

C) What is the current **i** in the circuit given below. The emfs and resistors have the following values : $\epsilon_1 = 2.1V, \epsilon_2 = 4.4\ V$, r_1 = 1.8 Ω, r_2 = 2.3 Ω, and R = 5.5 Ω. (5)



D) i) In the following figure, find the equivalent resistance of the network. ii) Calculate the current in each resistor. Take R_1 = 112 Ω, R_2 = 42 Ω, R_3 = 61.6 Ω, R_4 = 75 Ω and ϵ= 6.22V. (5)



31.34

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 mm 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 alpha particle = 4u, and q= +2e and that of deuteron = 2u, and q = +e. (1 u = 1.66 x10^{-27} kg) (5)

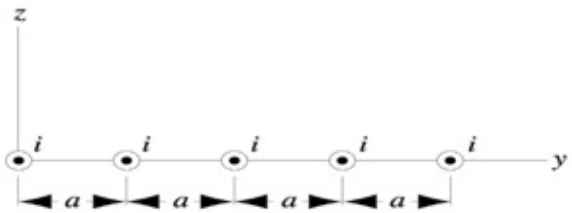
7) Explain - i) Biot- Savart law ii) Ampere's law. (5)

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 (5)

the rms value of the current?

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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