Question Paper

Exam Date & Time: 25-Apr-2019 (02:00 PM - 05:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIECES
II SEMESTER B.Sc. (APPLIED SCIENCES) IN ENGINEERING
END SEMESTER THEORY EXAMINATION-APRIL/MAY 2019
PHYSICS - II [IPH 121 - S2]

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

Answer 5 out of 8 questions.

PHYSICAL CONSTANTS

Elementary charge, e	:	**1.602×10^{-19}C**
Electron mass, me	:	**9.11×10^{31}kg**
Proton mass, me	:	**1.67×10^{27}kg**
Boltzmann constant	:	**1.38×10^{23}J/K**
Planck's constant	:	**6.626×10^{-34}J.s**
Electric constant(permittivity) ?o	:	**8.85×10^{8} F/m**
Magnetic constant(permeability) ?o	:	**1.26×10^{6} H/m**
Speed of light in vacuum	:	**3.0×10^{8}m/s**

Note: Any missing data may be suitably assumed.

1) Obtain an expression for the electric field at a point on the perpendicular bisector of an electric dipole. (4)

A)

B) Find the electric field due to a uniformly charged ring at a point on its axis and hence derive the expression for electric field due to a charged disk at a point on its axis. (6)

C) A uniformly charged conducting sphere of 1.22 m radius has a surface charge density of 8.13 μC/m^2. (a) Find the charge on the sphere. (b) What is the total electric flux leaving the surface of the sphere? (c) Calculate the electric field at the surface of the sphere. (6)

D) It is found experimentally that the electric field in a certain region of the Earth's atmosphere is directed vertically down. At an altitude of 300 m the field is 58 N/C and at an altitude of 200 m it is 110 N/C. Find the net amount of charge contained in a cube 100 m on edge that is located at an altitude between 200 m and 300 m. Neglect the curvature of the Earth. (4)

2) Show that Coulomb's law can be deduced from Gauss's law. (4)

A)

B) Obtain an expression for the capacitance of a cylindrical capacitor. (6)

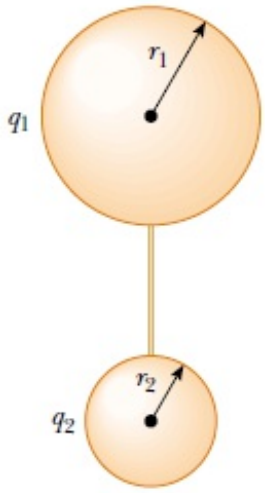
C) A parallel- plate capacitor has a plate separation d and plate area A. An (5)

uncharged metallic slab of thickness a is inserted midway between the plates. Find the capacitance of the device. If the metallic slab is not midway between the plates, then how does this affect the capacitance?

D) A parallel-plate capacitor has plates of dimension 2.0 cm by 3.0 cm separated by a 1.0mm thickness of paper. Find its capacitance and maximum charge that can be placed on it. The dielectric constant and the dielectric strength of paper are 3.7 and 16×10^6 V/m respectively. (5)

3) Two spherical conductors of radii r_1 and r_2 are separated by a distance much greater than the radius of either sphere. The spheres are connected by a conducting wire, as shown in the figure given below. The charges on the spheres in equilibrium are q_1 and q_2, respectively, and they are uniformly charged. Find the ratio of the magnitudes of the electric fields at the surfaces of the spheres. (4)

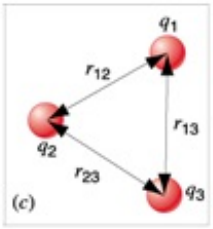
A)



B) An insulating solid sphere of radius R has a uniform positive volume charge density and total charge Q. Find the electric potential at (a) a point outside the sphere, (b) at the surface of the sphere and (c) at a point inside the sphere. (6)

C) Two objects, one with mass m_1 =0.0022kg and charge q_1 =+32μC and the other with mass m_2 =0.0039kg and charge q_2 =- 18μC, are initially a distance 4.6 cm apart. With object 1 held in fixed position, object 2 is released from rest. What is the speed of object 2 when the separation between the objects is 2.3cm? Assume that the objects behave like point charges. (5)

D) In the system shown in the figure below, assume that $r_{12} = r_{13} = r_{23}$ =d=12cm, and that q_1 =+q, q_2 = - 4q and q_3 =+2q, where q=150 nC. What is the potential energy of the system? (5)



4) State ohm's law. From ohm's law arrive at the following relationship: R=Δ (4)

A) V/I. What factors affect the resistance of a conductor.

B) Show that a charged particle moving in a uniform magnetic field will describe a circle in a plane perpendicular to the magnetic field. Obtain an expression for its radius and time period. Describing construction and working of cyclotron obtain the expression for energy obtainable. (6)

C) A coil of nichrome wire is 25.0 m long. The wire has a diameter of 0.400 mm and is at 20.0°C. If it carries a current of 0.500 A, what are (a) the magnitude of the electric field in the wire, and (b) the power delivered to it? (c) If the temperature is increased to 340°C and the voltage across the wire remains constant, what is the power delivered? Resistivity and temperature coefficient of nichrome are $1.5\times10^{-6}\Omega$-m and 4.0×10^{-4} /°C respectively. (5)

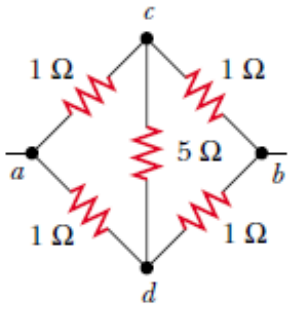
D) The 12-gauge copper wire in a typical residential building has a cross-sectional area of 3.31×10^{-6} m^2. If it carries a current of 10.0 A, what is the drift speed of the electrons? Assume that each copper atom contributes one free electron to the current. The density of copper is 8.95 g/cm^3. Molar mass of copper is 63.5 g/mol. Avogadro's number is 6.02×10^{23}. (5)

5) Draw the schematic diagram of a mass spectrometer and explain its principle. (4)

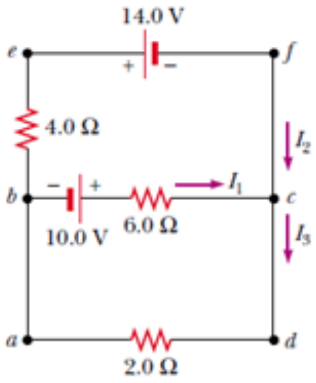
A)

B) Obtain the expression for magnetic force on a current-carrying wire and hence show that two parallel wires carrying currents in the same direction attract each other. (6)

C) Find the equivalent resistance between a and b in the following circuit: (4)



D) Find the currents I_1, I_2, and I_3 in the circuit shown in figure below: (6)



6) Using Biot - Savert law obtain an expression for magnetic field at a point on the perpendicular bisector of a straight wire segment carrying current. (5)

A)

B) State Ampere's law. Find the magnetic field inside an ideal solenoid using Ampère's law. (5)

C) A long, horizontal, rigidly supported wire carries a current of 96 A. Directly above it and parallel to it is a fine wire that carries a current of 23A and weighs 0.073 N/m. How far above the lower wire should this second wire be strung if we hope to support it by magnetic repulsion? (5)

D) Consider a long cylindrical wire of radius R carrying a current I distributed uniformly over the cross section. At what two distances from the axis of the wire is the magnetic strength, due to current, equal to one half the value at the surface. (5)

7) State Faraday's and Lenz's laws. Derive the integral form of Faraday's law. (5)

A)

B) Obtain an expression for the power required to withdraw a closed conducting loop from a magnetic field. Show that the work done by the external agent is dissipated as Joule heating of the loop. (5)

C) An oscillating LC circuit consisting of a 1.13nF capacitor and a 3.17mH coil has a peak potential drop of 2.87 V. Find (a) the maximum charge on the capacitor, (b) the peak current in the circuit, and (c) the maximum energy stored in the magnetic field of the coil. (6)

D) The inductance of a closely wound N-turn coil is such that an emf of 3.0 mV is induced when the current changes at a rate of 5.0 A/s. A steady current of 8.0 A produces a magnetic flux of 40 μWb through each turn. (a) Calculate the inductance of the coil.(b)How many turns does the coil have? (4)

8) Obtain an expression for the inductance of an inductor and hence arrive at the expression for the inductance of solenoid. (5)

A)

B) Derive expressions for growth and decay of current in an L - R circuit. (5)

C) In a series L-C-R circuit R=160 Ω, C=15μF, L=230mH, f=60Hz and $\mathscr{E}_m$ =36V. Find (a) the inductive reactance, (b) the capacitive reactance (c) the impedance, (d) the current amplitude and (e) phase constant. (5)

D) Consider again the circuit of previous problem(8C) and using the same values of R, C, L and f and $\mathscr{E}_m$ find (a) the rms emf, (b) the rms current (c) power factor (d) average power dissipated in the resistor and (e) average power supplied by the emf. (5)

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