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INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

II SEMESTER B.S. DEGREE EXAMINATION – JUNE 2016

SUBJECT: PHYSICS – II (PH 121)

(COMMON TO ALL BRANCHES)

(OLD SCHEME)

WEDNESDAY, 8th JUNE, 2016

Time: 3 Hours **Max. Marks: 100**

- ✓ **Answer ANY FIVE FULL Questions.**
- ✓ **Any missing data may be suitably assumed**

PHYSICAL CONSTANTS

Speed of light in vacuum: 3×10^{8} m/s
Electron mass m_o : 9.11×10^{-31} Kg
Avogadro constant: 6.02×10^{23} mol^{-1}
Acceleration due to gravity : 9.8 m/s^2
Elementary charge :1.60×10^{-19} C
Planck's constant: 6.626×10^{-34} J.s
Permittivity of free space ε_0: 8.85×10^{-12} N/m^2.C

1.

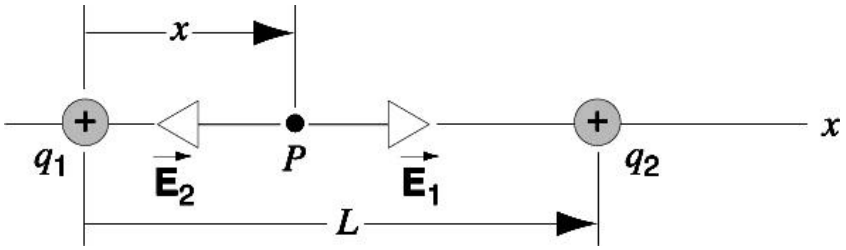
A. (i) A free electron and a free proton are released in identical electric fields. Then the electron will have much larger acceleration than that of proton. Justify. [2]

(ii) When it is valid to approximate a charge distribution by a point charge. [2]

B. What is an electric dipole? Obtain an expression for the electric field at a point on the perpendicular bisector of an electric dipole. How this expression gets modified when the distance of the point of interest on the perpendicular bisector is very large compared to the separation between the charges of an electric dipole? [8]

C. (i) Two equally charged particles, held 3.2 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. [4]

(ii) Figure shows a charge q_1 of +1.5 μC and a charge q_2 of +2.3 μC. The first charge is at the origin of an 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 zero? [4]



2

A. (i) State two important properties of a uniformly charged spherical shell. [2]
(ii) Sate Gauss Law and define flux of electric field. [2]

B. Find the electric field due to a uniformly charged ring at a point on its axis (the z axis) and hence find an expression for the electric field due to a charged disc at a point on the axis. [8]

C. (i) 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. [4]

(ii) Three charges of +122 mC each are placed on the corners of an equilateral triangle, 1.72 m on a side. If energy is supplied at the rate of 831 W, how many days would be required to move one of the charges onto the midpoint of the line joining the other two? [4]

3

A. (i) A potential of zero at a point does not necessarily mean that the electric force is zero at that point. Explain. [2]

(ii) State Kirchhoff's first and second law. [2]

B. (i) Write a note on equipotential surface. [2]
(ii) Find the potential due to a uniform line of positive charge at a distant point on its perpendicular bisector. [6]

C. (i) Two parallel, flat conducting surfaces of spacing d = 1.0 cm have a potential difference ΔV 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. [4]

(ii) In the two intersecting storage rings of circumference 950 m at CERN, protons of kinetic energy 28.0 GeV formed beams of current 30.0 A each. (a) Find the total charge carried by the protons in each ring. Assume that the protons travel at very nearly the speed of light. (b) A beam is deflected out of a ring onto a 43.5-kg copper block. By how much does the temperature of the block rise? Specific heat capacity (C) is 385 J/Kg/^{o}C [4]

4

A. (i) A capacitor can store more charge with the dielectric present than it can when it is empty. Justify [2]

(ii) Equivalent capacitance of the series combination is always smaller than the smallest individual capacitances in series. Why? [2]

B. Define capacitance. Obtain expressions for the capacitance of (i) a parallel plate capacitor (ii) spherical capacitor, and (iii) cylindrical capacitor. [8]

C. (i) A 6μF capacitor is connected in series with a 4μF capacitor; a potential difference of 200V is applied across the pair. (a) Calculate the equivalent capacitance . (b) What is the charge on each capacitor ? (c) What is the potential difference across each capacitor?

(ii) You are given an isolated conducting sphere of 13-cm radius. One wire carries a current of 1.0000020 A into it. Another wire carries a current of 1.0000000 A out of it. How long would it take for the sphere to increase in potential by 980 V? [4+4]

5. A. (i) What is the principle of velocity selection? Mention any one application. [2]

(ii) List differences between electric and magnetic forces. [2]

B. What is Hall effect? Derive and expression for density of charge carriers of a semiconductor using Hall effect. [8]

C. (i) A solar cell generates a potential difference of 0.10 V when a 500-Ω resistor is connected across it and a potential difference of 0.16 V when a 1000-Ω resistor is substituted. What are (a) the internal resistance and (b) the emf of the solar cell? (c) The area of the cell is 5.0 cm^2 and the intensity of light striking it is 2.0 mW/cm^2. What is the efficiency of the cell for converting light energy to internal energy in the 1000-Ω external resistor?

(ii) A single turn current loop, carrying a current of 4.00 A, is in the shape of a right triangle with sides 50 cm, 120 cm, and 130 cm. The loop is in the uniform magnetic field of magnitude 75.0 mT whose direction is parallel to the current in the 130-cm side of the loop. (a) Find the magnetic force on each of the three sides of the loop. (b) Show that the total magnetic force on the loop is zero. [4+4]

6.

A. (i) Is the magnetic field inside a toroid uniform? Explain. [2]

(ii) Explain Faraday's law of induction. [2]

B. State Biot-Savart's law. Using this law, obtain an expression for magnetic field at a point on the perpendicular bisector of a straight wire segment carrying current. [8]

C. (i) The 25-kV electron gun in a TV tube fires an electron beam 0.22 mm in diameter at the screen, 5.6×10^{14} electrons arriving each second. Calculate the magnetic field produced by the beam at a point 1.5 mm from the axis of the beam.

(ii) You are given 52.5 cm of copper wire (diameter=1.1 mm). It is formed into a circular loop and placed at right angles to a uniform magnetic field that is increasing with time at the constant rate of 9.82 mT/s. At what rate is the internal energy generated in the loop? Given: resistivity of copper is 1.69×10^{-8} ohm-m. [4+4]

7.

A. (i) Show that work we need to do in pulling the loop through a magnetic field appears as thermal energy in the loop. [2]

(ii) What happens when the rotational speed of a generator coil is increased? [2]

B. State Ampere's law. Find the magnetic field inside an ideal solenoid (b) the magnetic field inside, outside and in the central cavity of an ideal toroid. [8]

C. (i) A uniform magnetic field is perpendicular to the plane of the circular loop 10.4 cm in diameter made of copper wire (diameter = 2.50 mm). (a) Calculate the resistance of the wire. (b) At what rate must the magnetic field change with time if an induced current of 9.66 A is to appear in the loop? Given: resistivity of copper = 1.69×10^{-8} Ω.m.

(ii) You are assigned the job of designing generator that will produce an emf of amplitude 150 V rotated at 60 rev/s in a 0.50- T magnetic field. (a) If you used a single-turn loop, how large an area would you need? (b) If instead you used a loop of 100 turns, what area would be required? [4+4]

8.

A. (i) Distinguish paramagnetic and diamagnetic materials. [2]

(ii) Write a resonance condition for LCR circuit. Mention its significance. [2]

B. With a necessary diagram, derive an expression for power in a series RLC circuit. [8]

C. (i) A coil is connected in series with a 10.4-kΩ resistor. When a 55.0-V battery is applied to the two, the current reaches a value of 1.96 mA after 5.20 ms. (a) Find the inductance of the coil. (b) How much energy is stored in the coil at this same moment?

(ii) A coil of inductance 88.3mH and unknown resistance and a 937 nF capacitor are connected in series with an oscillator of frequency 941 Hz. The phase angle ϕ between the applied emf and current is 75^{o}. Find the resistance of the coil. [4+4]