KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2020/2021 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER
SPECIAL/SUPPLEMENTARY EXAMINATIONS

FOR THE DEGREE OF B.ED (SCIENCE) AND BSC (PHYSICS)

COURSE CODE: SPH 221

COURSE TITLE: ELECTRICITY AND MAGNETISM

DURATION: 2 HOURS

DATE: 21/1/2022 **TIME: 8-10AM**

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of **3** printed pages. Please Turn Over

Question One

(a) State the law of charges and the law of currents. (2 marks)

(b) Differentiate between transient current and steady current. (2 marks)

(c) State the Coulomb's law. (2 mark)

(d) Estimate the force due an electron at a distance of 50pm from the proton (electron charge is $-1.6\text{x}10^{-19}\text{C}$, proton charge is $+1.6\text{x}10^{-19}\text{C}$ while the permittivity of free space is $1.257\text{x}10^{-7}$). (3 marks)

(e) Define an Ohm. (1 mark)

(f) A metal rod of length l, cross-sectional area A, and electrical conductivity σ is clamped between two points that have a potential difference of V between them. Derive the Ohm's law. (4 marks)

(g) Define capacitance. (2 mark)

(h) We have a capacitor whose plates are each of area A, separation d, and the medium between the plates has permittivity ε. It is connected to a battery of EMF V, so the potential difference across the plates is V. Show that $C = \varepsilon A/d$. (3 marks)

(i) State the Kirchhoff's rules (2 mark).

(j) The circuit in Figure 1 shows a network of resistors connected to a 24 V battery with negligible internal resistance.

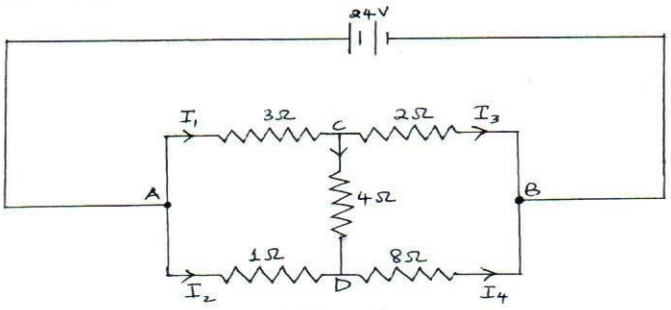


Figure 1

Form all the equations that are required to evaluate the currents I_1, I_2, I_3, I_4 and I_5. (4 marks)

(k) Define an electric dipole. State the assumption made for an ideal electric dipole. (2 marks)

(l) Three equal charges each of magnitude Q are placed at the corners of a square of side x. Find the resultant electric field at the fourth corner where there is no charge. (2 marks)

(m) Define the intensity B of a magnetic field. (1 mark)

Question Two

(a) A plane circular sheet of radius b has a charge distributed uniformly over its surface with a density of σ per unit area. A charge Q is situated perpendicularly at a distance, a, from the centre of the sheet;

i) Find the force on the charge. (10 marks)

ii) What would the force become as $b \to 0$ and $b \to \infty$? (4 marks)

(b) Four equal charges each of magnitude 2 Coulombs are placed at the four corners of a square of side 1cm. Find the resultant force on any of the charges. (6 marks)

Question Three

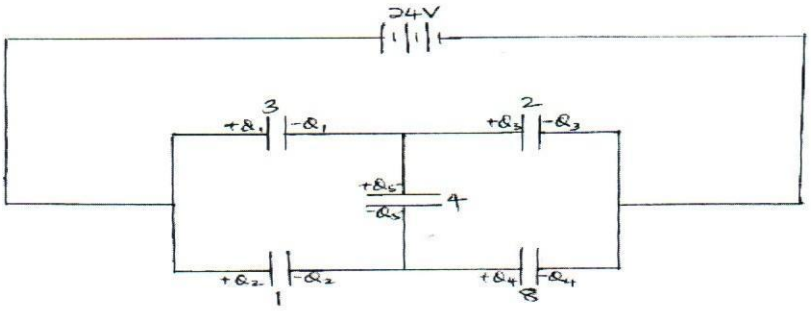
a) Find the components of $\vec{E}$ given that $\vec{E} = 2xy$ and $\vec{E} = r^2 \cos\theta$ (8 marks)

b) A plane circular sheet has a circular hole of radius b at its centre and has a charge distributed uniformly over its surface with a density of σ per unit area. A charge Q is situated perpendicularly at a distance, a, from the centre of the sheet. Find the electric field on the charge. (12 marks)

Question Four

(a) Starting with two spheres are of inner and outer radii a and b, with a potential difference V between them, with charges $+Q$ and $-Q$ on the inner and outer spheres respectively, show that the capacitance of an isolated sphere of radius a is given by $C = 4\pi\varepsilon a$. (10 marks)

(b) Calculate the charge held in each capacitor. (10 marks)



Question Five

a) State the Biot Savart law (pg. 132). (2 marks).

b) Derive the equations of magnetic field

i) near a long, straight, current-carrying conductor (4 marks)

ii) on the axis and in the plane of a plane circular current-carrying coil. (8 marks)

iii) on the axis of a long solenoid. (6 marks)