JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THEDEGREE OF BSc. WATER RESOURCE AND MANGT, SOIL SCIENCE, CONSTRUCTION ENGINEERING AND ENVIROMENTAL SCIENCE. JAN-MAY 2023

2022/2023 EXAMINATION

MAIN

REGULAR

COURSE CODE: SPB 9108

COURSE TITLE: ELECTRICITY AND MAGNETISM I

EXAM VENUE: **STREAM: (BED SCI)**

DATE: **EXAM SESSION:**

TIME: 2:00HRS

Instructions:

1. **Answer question 1 (Compulsory) in Section A and ANY other 2 questions in Section B.**
2. **Candidates are advised not to write on the question paper. Maintain uniform font style.**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

Take

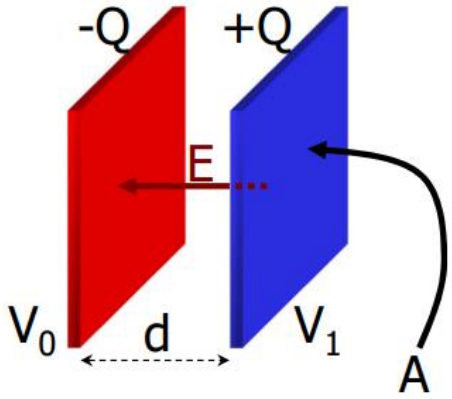
1. $h = 6.63 \times 10^{-31} js$
2. $m_e = 9.11 \times 10^{-31} kg$
3. $\varepsilon_0 = 8.85x10^{-12} Fm^{-1}$
4. $\mu_0 = 4\pi \text{ x}10^{-7}$ T·m/A

SECTION A

QUESTION ONE (Compulsory) (30 Marks)

a. Define electric field and state it's SI unit (2marks)

b. See the parallel plate capacitor below.



Show that the Capacitance of a parallel plate capacitor of plate areas A and separation distance d is given by $C = \frac{\varepsilon_0 A}{d}$ (4marks)

c. calculate the capacitance of a capacitor whose plates are 16 cm x 4 cm and are separated by a 1.0 mm air gap. (4marks)

d. An electron in a hydrogen atom orbits the nucleus at a mean distance of 5.29×10^{-11} m. The nucleus (a proton) has a mass of 1.67×10^{-27} kg and the electron has a mass of 9.11×10^{-31} kg. Calculate the electrostatic force of the electron (4marks)

e. Define Magnetic flux ϕ_M (2marks)

f. Show that the magnetic field for a long straight wire carrying current *I* and at a distance r is given by $\vec{B} = \frac{\mu_0 I}{2\pi r}$ (4marks)

g. An electron moving perpendicular to a magnetic field of 4.80 x 10^{-3} T follows a circular path of radius 2.40 mm. What is the electron's speed? (4marks)

h. What is the magnetic field at a distance of 80 cm from a long straight wire carrying current of 2A. (4marks)

i. State Kirchoff's Law for electric current (2marks)

SECTION B

QUESTION TWO (20 Marks)

a. A particle with a charge of -1.6×10^{-19} C and mass 9.11×10^{-31} kg moves along the positive x-axis from left to right. It enters a 3 T **B**-field is in the x-y plane and points at 45° above the positive x-axis.

i. What is the direction of the force on the particle? (4 marks)

ii. After it has been in the B-field, the particle moves in a circle. If the radius of its path is 2×10^{-10} m, what is the speed of the particle? (4 marks)

iii. What is the magnitude of the force on the particle? (4 marks)

b. 2 m wire is in a 2×10^{-6} T magnetic field pointing into the page. It carries 2 A of current flowing up. What is the force on the wire? (4 marks)

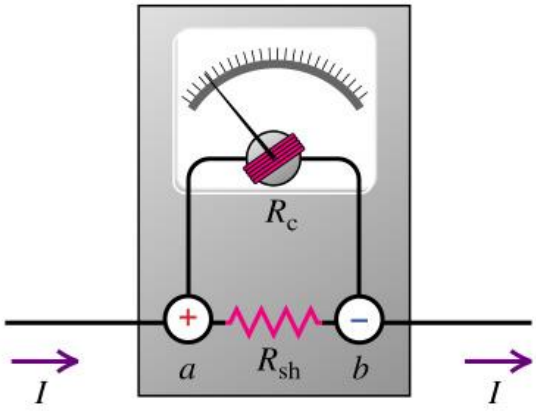
c. Derive the Faraday's Law of Electromagnetism (4 marks)

QUESTION THREE (20 Marks)

a. Discuss any two factors that determines the magnitude of magnetic flux (4 marks)

b. Discuss the working principles of a Galvanometer (4 marks)

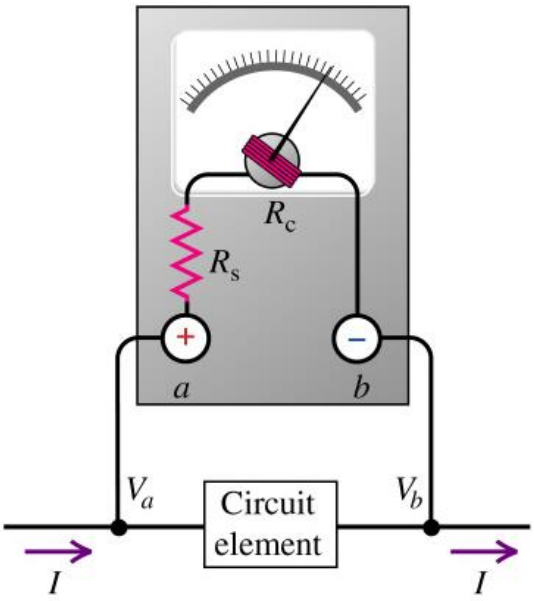
c. A galvanometer can be used to measure currents higher than its full scale current as seen in the figure below



If R_C=10 Ω and I_{fs}=1 mA

i. What shunt resistance should be used to convert the galvanometer to an ammeter with a full scale deflection of the needle 100 mA? (4 marks)

ii. What multiplier resistance should be used to convert the galvanometer to a voltmeter with full scale deflection of the needle V_{fs} = 10 V? (4 marks)



d. A bar magnet is moved rapidly towards a 20-loop coil of wire. As the magnet moves, the magnetic flux through the coil increases from 1.2 X 10^{-5}T.m^2 to 2.4 X 10^{-3} T.m^{-2} in 0.3 s. (4 marks)

QUESTION FOUR (20 Marks)

A parallel plate capacitor has circular plates of 21 cm radius separated by 1.4mm of air. They are connected to a 240V power supply and allowed to charge up before being disconnected.

i. Calculate the capacitance of this capacitor. (5marks)

ii. What charge will appear on the plates? (5marks)

iii. What is the electrical energy stored between the plates? (5marks)

iv. If the plates are pulled apart to a separation of 2.4 mm without affecting the charge distribution, what happens to the electric field between the plates? (5marks)

QUESTION FIVE **(20 Marks)**

A singly charged positive ion has a mass of 3.6×10^{-26} kg. After being accelerated through a potential difference of 240 V, the ion enters a magnetic field of 1.2 T, in a direction perpendicular to the field.

i. Calculate the radius of the path of the ion in the field (5marks)

ii. After passing through the accelerating potential, what is the kinetic energy of the electron in joules? (5marks)

iii. Calculate the speed of the electron just before it enters the magnetic deflecting field (5marks)

iv. Estimate the radius of curvature of its path in the field (5marks)