LAIKIPIA UNIVERSITY

# UNIVERSITY EXAMINATIONS

## 1ST SEMESTER 2022/2023 ACADEMIC YEAR

## SECOND YEAR EXAMINATION FOR THE DEGREES OF BACHELOR OF EDUCATION (SCIENCE)/BACHELOR OF SCIENCE (GENERAL)

## PHYS 213: ELECTRICITY AND MAGNETISM I

***STREAM: R*** ***TIME: 2 HRS***

***DAY: THURS [14.30 – 16.30]*** ***DATE: 08/12/2022***

**THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES**

**PLEASE DO NOT OPEN UNTIL THE INVIGILATOR SAYS SO.**

**INSTRUCTIONS TO CANDIDATE:**

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i. **Answer Question ONE (compulsory) and any other TWO questions**

ii. Question one comprises **30 marks** and the rest **20 marks** each

***iii. You may need the following;***

Mass of an electron, $M_e = 9.109 \times 10^{-31}\ kg$

Mass of a proton, $M_p = 1.67 \times 10^{-27}\ kg$

charge of an electron/proton$_e = 1.602 \times 10^{-19}\ C$

Permitivity of free space, $\varepsilon_0 = 8.85 \times 10^{-12} C^2/Nm^2$

Universal Gravitational constant, $k_g = 6.67 \times 10^{-11} Nm^2 kg^{-2}$

Electrostatic constant, $k_e = 8.99 \times 10^9\ Nm^2 C^{-2}$

**QUESTION ONE (40 mks)**

(a) (i) In a single statement state what is meant by electrostatics. (1 mark)

(ii) State Coulombs law of electrostatics. (2 marks)

(iii) Sketch the electric field lines and equipotential lines associated with an isolated negative charge (2 marks)

(b) (i)A charge of 4.5 µC is located 0.5 m from a charge of -3.8 µC. Find the electrostatic force exerted by the charges or each other (2 marks)

(ii)A -3nC charge A is placed on the x-axis at x=0.9 m. point P is located on the x-axis at x=0.8 m. Determine the magnitude and direction of the electric field at point P due to charge A. (3mks

(c) The potential at a certain distance from a point charge is 600 V, and the electric field is 200N $C^{-1}$ (i) What is the distance to the point charge (2 marks)

(ii) What is the magnitude of the charge (2 marks)

(d) The plates of a parallel plate capacitor have an area of 0.0002 $m^2$. The two plates are separated by a distance of 0.03 m. if the capacitor is in air, calculate its capacitance.

(3 marks)

(e) The parallel combination of an 8 µF and a 21 µF capacitors is connected in series with a 25 µF capacitor. And then the combination is connected to a potential difference of 50 V. Calculate the potential difference across the 25 µF capacitor (4 marks)

(f)A battery of emf 20 V and internal resistance 2 Ω is connected to an external resistance of 48 Ω. Calculate the current in the circuit and the potential difference across the terminal of the battery. (4 marks)

(g) A 5m long silver wire whose cross-sectional radius of 0.002 m has a resistivity of $1.59 \times 10^{-8}\ \Omega m$. If it's connected to a potential difference of 0.006 V, calculate the resistance of the wire and current through the wire. (4 marks)

(h) A moving – coil meter has a resistance of 5.0Ω and full – scale deflection is produced by a current of 1.0 m A. How can this meter be adapted for use as a voltmeter reading up to 10V and as ammeter reading up to 2A? (4 marks)

(i) (i) State Faraday's law of electromagnetic induction. (2 marks)

(ii) State two factors which determine the magnitude of an induced e.m.f in a conductor. (2 marks)

(iii)A solenoid is 0.5 m long. It has 5 layers of winding of 850 turns each and carries a current of 5A. Determine magnetic field at its centre.

**QUESTION TWO (15mks)**

(a). Define electric field strength and potential at a point in an electric field. State how these quantities are related. (3 marks)

(b) (i) State Gauss's law (1 mark)

(ii)Suppose that positive charge is uniformly distributed throughout a spherical volume of radius R, the charge per unit volume being ρ. Use Gauss's law to prove that the electric field inside the volume, at a distance r from the centre is

$$E = \frac{\rho r}{3\varepsilon_0}$$ (3 marks)

(c)An α – particle is a nucleus of doubly ionized Helium. It has a mass in m of 6.68 x $10^{-27}$

kg and a charge q of +2 e or 3.2 x $10^{-19}$C. Compute the force of electrostatics repulsion between two α – particles and the force of gravitation at a distance of 5.2 x $10^{-11}$m between them.

(4 marks)

(d) Two charges of +1μC each are 8 cm apart in air. Find the magnitude and direction of the force exerted by these charges on a third charge of+5.0 x $10^{-2}$μC that is 5 cm distant from each of the first two charges (4 marks)

**QUESTION THREE (15 mks)**

(a) An air-filled capacitor consists of two parallel plates, each with an area of 7.60$cm^2$ and separated by a distance of 1. 80mm.If a 20.0Vpd is applied to these plates, Calculate the

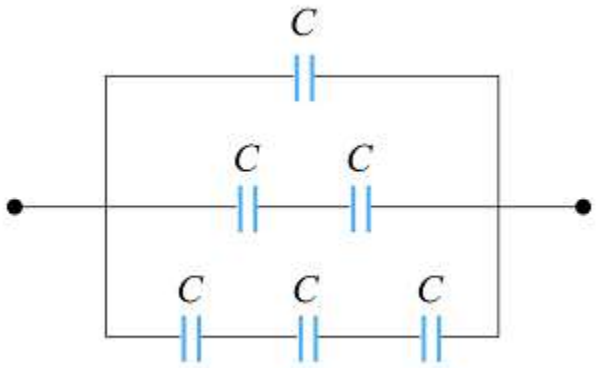
(i) Electric field between the plates. (2 marks)

(ii) Capacitance. (1 mark)

(iii) Charge on each plate. (2 marks)

(iv) Energy stored in the capacitor (2 marks)

(b) Consider the configuration shown in Figure 1 below. Find the equivalent capacitance, assuming that all the capacitors have the same capacitance C.




(4 marks)

(c) Points A and B are 1m apart. A point charge of + 3.0 μC is placed at A and a point charge of -1.0μC is placed at B.

(i)X is the point on the straight line through A and B. between A and B, where the electric potential is zero. Calculate the distance AX. (2 marks)

(ii)Determine the point other than infinity at which the total electric field is zero.

(2 marks)

**QUESTION FOUR (15 mks)**

(a) (i) In mutual induction, state two ways of increasing the size of induced emf in the secondary coil. (2 marks)

(ii) State three ways in which power is lost in a transformer (3 marks)

(b) An ideal transformer has 900 turns on the primary coil and 180 turns on the secondary coil. A resistor of 500 Ω is connected across the secondary coil and an alternating p.d of value 50 V is applied to the primary coil .Calculate;

(i) The p.d across the secondary coil (2 marks)

(ii) The current in the resistor (2 marks)

(iii) the current flowing in the primary coil (2 marks)

(c) An electron is moving with a speed of $1.5 \times 10^{7}$ m/s perpendicular to a magnetic field having a uniform flux density of 0.0012T.

(i) Calculate the force on the electron (2 marks)

(ii)Calculate the radius of the circular path followed by the electron (2 marks)

**QUESTION FIVE (15 mks)**

(a)(i)State the Kirchhoff's voltage law and Kirchhoff's current law. (2 marks)

(ii)Using the Kirchhoff's Voltage circuital laws on loops abcfa and cdefc, and Kirchhoff's current law at junction f, determine $i_1$, $i_2$, and $i_3$ in Figure 1.

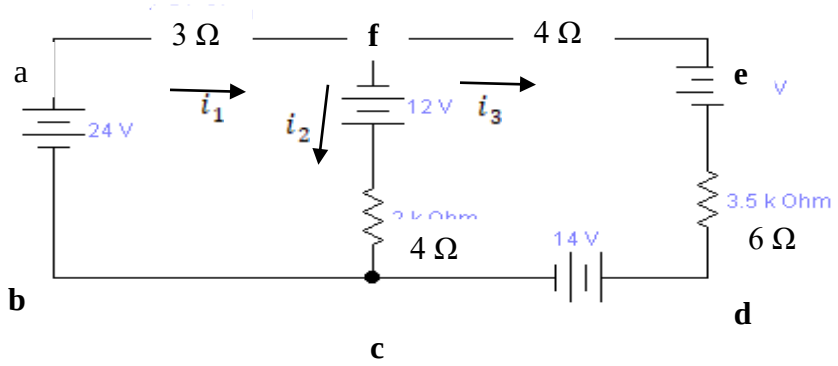



**Figure 1** (7 marks)

(b) Two resistors are connected in parallel. Each draws 2.0 A of current. If the total voltage is 12 V, find $R_1$ and $R_2$ (3 marks)

(c) When 81 cm of a wire with a cross – sectional area of 3.1 x $10^{-7}$ $cm^2$ is connected a cross a 2.0V cell a current of 1.6A flows in the wire. Find the resistivity of the material of the of the wire. (3 marks)