



UNIVERSITY EXAMINATIONS

FIRST SEMESTER 2025/2026 ACADEMIC YEAR

**SECOND YEAR EXAMINATION FOR THE DEGREES OF
BACHELOR OF EDUCATION (SCIENCE) AND BACHELOR
OF SCIENCE (GENERAL)**

PHYS 213: ELECTRICITY AND MAGNETISM I

STREAMS: R

TIME: 2 HRS

DAY: WEDNESDAY [8.30 – 10.30 A.M]

DATE: 04/02/2026

THIS QUESTION PAPER CONSISTS OF FOUR (4) PAGES

PLEASE DO NOT OPEN UNTIL THE INVIGILATOR SAYS SO.

INSTRUCTIONS TO CANDIDATES

Read the question paper and the questions carefully and then answer question **ONE (40 marks – Compulsory)** and any other **TWO (15 marks each)**

Where necessary,

Take the mass of hydrogen $= 1.66 \times 10^{-27} \text{ kg}$.

Copper resistivity $1.7 \times 10^{-8} \Omega \text{ m}$

$\varepsilon = 8.988 \times 10^9$

QUESTION ONE (40 MARKS)

(a) Define the terms,

- (i) Electrostatics
- (ii) Electric charge
- (iii) Electric field
- (iv) Gauss's law
- (v) Capacitance

(5 Marks)

(b) Two plates of a parallel plate capacitor are 6cm apart and each has an area of 4cm^2 . Given the potential difference between the plates is 100V, calculate the capacitance of the capacitor.

(2 Marks)

(c) Differentiate between capacitor and capacitance

(2 Marks)

(d) The electron and proton in a hydrogen atom are 52.9cm apart. What is the magnitude of the electric force between them?

(2 Marks)

(e) Two free point charges $+q$ and $-4q$ are at a distance x apart. A third charge is placed such that the entire system is in equilibrium.

Find,

- (i) the location
- (ii) magnitude
- (iii) sign of the third charge

(4 Marks)

(f) Draw the electric field lines of force for two differently charged point charges.

(2 Marks)

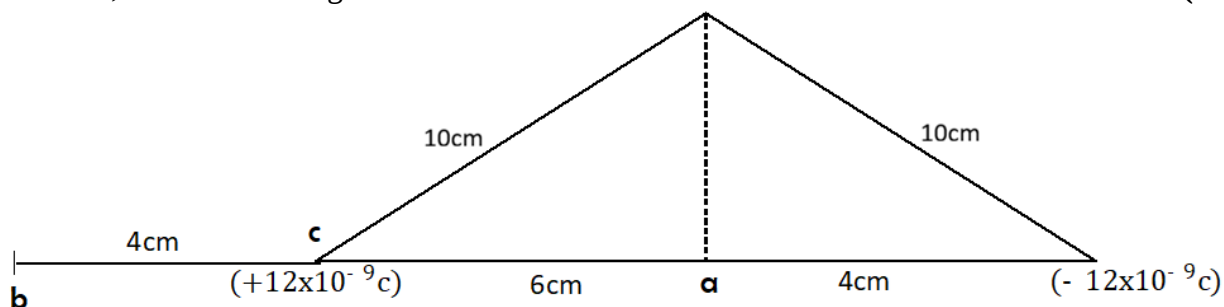
(g) Find the separation between two point charges of $9\mu\text{C}$ and $5\mu\text{C}$, if the Coulomb force between them is 1.62N.

(2 Marks)

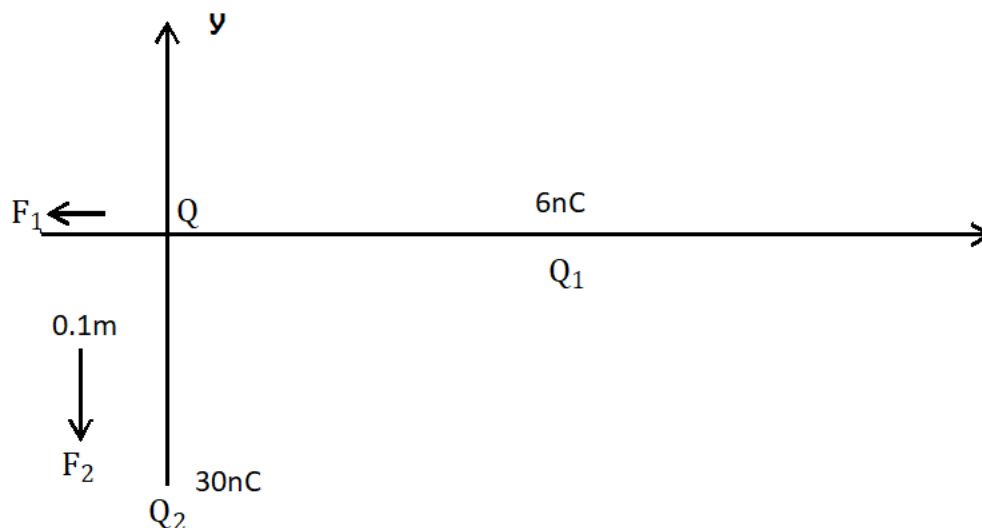
(h) How far away an electron be kept from the nucleus of hydrogen atom where the coulomb's force on the electron is equal to its weight?

(3 Marks)

- (i) Find current drawn by a 60W incandescent lamp rated for 120V operation. Also find the current drawn by a 150W, 120V lamp and a 300W, 120V lamp. As voltage increases what happens to the current? **(4 Marks)**
- (j) Find the power consumed by a fixed 25Ω resistor for each of the following currents, 3A, 6A, and 1.5A. What effect does a change in current have on the amount of power dissipated by a fixed resistor **(4 Marks)**
- (k) A point charge $+12 \times 10^{-9}\text{C}$ and $-1.2 \times 10^{-9}\text{C}$ are placed 10cm apart. Compute the potentials at points a, b and c in the figure below. **(3 Marks)**



- (l) Determine the point other than infinity at which the total electric field is zero for two charges - $4.0\mu\text{C}$ and $9.0\mu\text{C}$ that are 1m apart. **(3 Marks)**
- (m) Three charges are arranged as shown.



Find the magnitude and the direction on the electrostatic force on the charge at the origin **(4 Marks)**

QUESTION TWO (15 MARKS)

- (a) Two protons in a molecule are 3.8×10^{-10} m apart.
- Find the electrical force exerted by one proton on the other. **(3 Marks)**
 - State how the magnitude of this force compared with the magnitude of the gravitational force exerted by one proton on the other. **(4 Marks)**
 - What must be the particles charge to mass ratio if the magnitude of the gravitational force between two of these particles is equal to the magnitude of electrical force between them? **(5 Marks)**
- (b) Find the total charge in Coulombs of 75kg of electrons. **(3 Marks)**

QUESTION THREE (15MARKS)

- (a) A uniformly charged, straight filament 7.00m in length has a total positive charge of 2.00C. An uncharged cardboard cylinder 2.00cm in length and 10.0cm in radius surrounds the filament at its center, with the filament as the axis of the cylinder. Using reasonable approximations find,
- The electric field at the surface of the cylinder** **(4 Marks)**
 - The total electric flux through the cylinder **(4 Marks)**
- (b) A 5 μ F capacitor is charged to a potential of 200V and isolated. It is then connected in parallel to a 10 μ F capacitor.
- Find,
- The resultant potential **(2 Marks)**
 - The energy stored before connection **(2 Marks)**
 - Energy in the two capacitors after connection. **(2 Marks)**
 - Is the energy conserved? Explain your answer. **(1 Mark)**

QUESTION FOUR (15 MARKS)

- (a) A sphere of radius 'a' has a uniform volume charge density J (c/m³).
- Determine,
- Total charge in the volume
 - Electric field at radius 'r' where, $r > a$, $r = a$ and $r < a$ **(6 Marks)**
- (b) The radius of copper wire is 1.63mm. a potential difference of 60V is applied across a 20m length of this wire.
- Find,
- Its resistance **(3 Marks)**
 - The current **(3 Marks)**
 - The electric field **(3 Marks)**