



# THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

**A. M. E. C. E. A**

P.O. Box 62157  
00200 Nairobi - KENYA  
Telephone: 891601-6  
Fax: 254-20-891084  
E-mail: academics@cuea.edu

**MAIN EXAMINATION**

**JANUARY – APRIL 2018 TRIMESTER**

**FACULTY OF SCIENCE**

**DEPARTMENT OF PHYSICS**

**REGULAR PROGRAMME**

**PHY 102: ELECTRICITY AND MAGNETISM I**

**Date: APRIL 2018**

**Duration: 2 Hours**

**INSTRUCTIONS: Answer Question ONE and any other Two Questions**

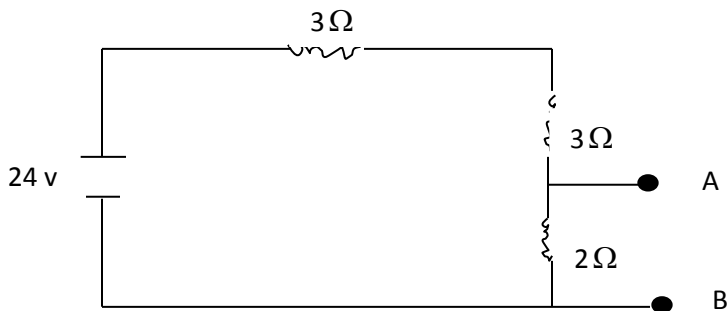
You may use the following constants

- Electronic charge,  $e = 1.6 \times 10^{-19}$  C
- Mass of Electron  $m_e = 9.11 \times 10^{-31}$  kg
- Permittivity of Vacuum  $\epsilon_0 = 8.85 \times 10^{-12}$  Fm
- Permeability of vacuum  $\mu_0 = 4\pi \times 10^{-7}$  Hm<sup>-1</sup>
- Planck's constant  $h = 6.63 \times 10^{-34}$  Js
- Rydberg's constant  $R = 0.011$  nm<sup>-1</sup>
- Speed of light in a vacuum  $c = 3.0 \times 10^8$  m/s

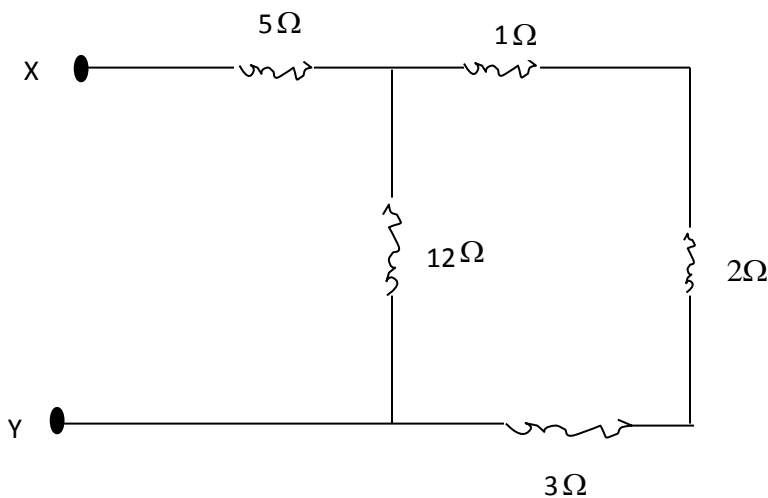
- Q1. a) i) State coulombs law both in words and in mathematical form **(2marks)**
- ii) Calculate the force between an electron and a proton separated by a distance of  $1.5 \times 10^{-9}$  m **(3 marks)**
- b) state any two methods of charging a conductor **(2 marks)**
- c) with the aid of a well labeled diagram, show that the equivalent capacitance  $C_{eq}$  of three capacitors  $C_1$ ,  $C_2$  and  $C_3$  connected in series is given by:
- $$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \quad \textbf{(3 marks)}$$
- d) i) State Ampere's law **(2 marks)**

- ii) A straight conductor carries a current of 15A. Calculate the magnetic field at a distance 10cm from the wire **(3 marks)**
- e) i) State ohms Law **(1mark)**
- ii) Differentiate between ohmic and non ohmic conductors **(2marks)**
- iii) Draw a current-voltage curve for an ohmic conductor **(2 marks)**
- f) The electron in hydrogen atom  $5.3 \times 10^{-11}\text{m}$  away from the protons in the nucleus of the atom. How strong is the electric field the electron experiences. **(4 marks)**
- g) Electrons gun is one of the very important part of cathode ray tube. List any THREE components of the electron gun and their functions **(6marks)**

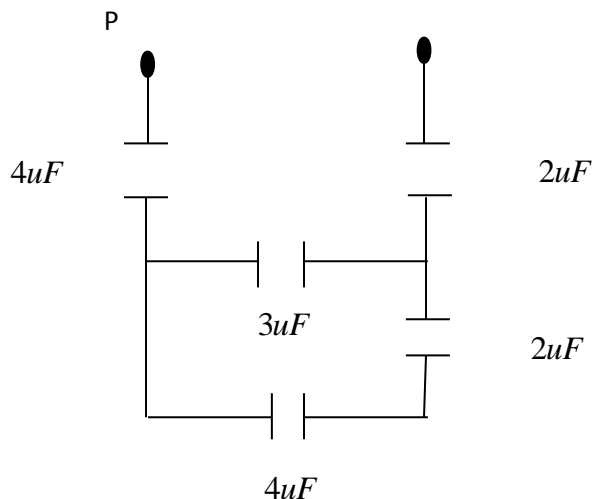
- Q2. a) Use the figure below to find :
- i) The total current supplied by the battery **(6 marks)**
- ii) The voltage between point A and B in the circuit **(4 marks)**



- b) Find the equivalent resistance between points X and Y in the figure below **(4 marks)**



- c) The circuit below present a network of capacitors determine the equivalent capacitance between point P and Q **(3 marks)**



- d) A  $6\mu F$  capacitor and  $8\mu F$  capacitors are connected in series across 20V battery. A  $5\mu F$  capacitor is also connected directly across the battery terminals. Find the total charge that the battery delivers to the capacitors. **(3 marks)**

- Q3. a) i) define the term resistivity and show its unit of measurement **(3 marks)**

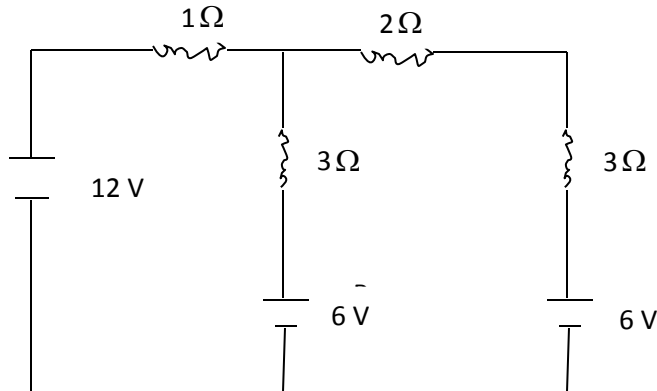
- iii) Three resistors ( $R_1$ ,  $R_2$  and  $R_3$ ) made from the same material have the dimensions as shown in the table below.

| Resistor             | $R_1$ | $R_2$ | $R_3$ |
|----------------------|-------|-------|-------|
| Cross-sectional area | A     | 2A    | A     |
| Length               | L     | L     | 2L    |

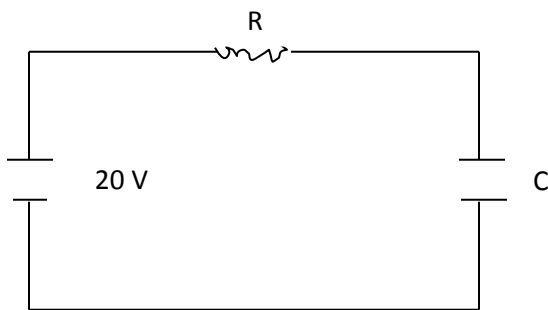
The current  $I_1$  through resistor  $R_1$  is 10A for a given voltage V. for the same voltage applied separately across  $R_2$  and  $R_3$ , determine current  $I_2$  and  $I_3$  **(10 marks)**

- b) A galvanometer with a full sensitive of 1mA requires a 9000V series resistor to make it a voltmeter reading a full scale when 10V is applied across the terminals. Find
- The resistance required to convert the same galvanometer into a 12V full scale voltmeter **(5 marks)**
  - The resistance require to convert the same galvanometer into a 10A ammeter **(5 marks)**

- Q4. a) i) State Kirchoff's voltage and current laws **(2 marks)**  
 iii) Use Kirchoff's rules to find the magnitude and direction of the current in each branch in the figure below **(10 marks)**



- b) In the figure below  $C = 10\mu F$ ,  $R = 100\Omega$ ,  $V = 20V_{dc}$ . Determine



- i) Time constant of the circuit **(2 marks)**  
 ii) Time at which capacitor voltage  $V_c = 15V$  **(6 marks)**
- Q5. a) i) What is capacitance **(1 mark)**  
 ii) State the SI unit of capacitance **(1 mark)**  
 iii) Give any three applications of capacitors **(3 marks)**
- b) i) Show that equation governing discharging of capacitors is given by **(7 marks)**  

$$Q = Q_0 e^{-t/RC}$$
  
 ii) Sketch charge –time graph representing discharging **(2 marks)**

- c) Three capacitors whose capacitance are  $2\mu F$  ,  $4\mu F$  and  $5\mu F$  are connected in series across a 12V battery. Find the charge on each capacitor and the potential difference across it. **(6 marks)**

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