MACHAKOS UNIVERSITY COLLEGE

(A Constituent College of Kenyatta University)
University Examinations for 2015/2016 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES
DEPARTMENT OF PHYSICAL SCIENCES

FIRST/SECOND SEMESTER EXAMINATION FOR DIPLOMA IN EDUCATION SCIENCE

SPH 101: ELECTRICITY AND MAGNETISM 1

DATE:SCHOOL BASED **TIME:**

INSTRUCTIONS:

Answer question **ONE** which is compulsory and any other **TWO**

Laws should be stated and their mathematical meaning given. The following constants may be useful $\mu_o = 12.56\times10^{-7}$ $\varepsilon_o = 8.85\times10^{-12}$,$G = 6.67\times10^{-11}\ m^3kg^{-1}s^{-2}$, mass of a proton , $m_p = 1.67\times10^{-27}$kg, mass of an electron $m_e = 9.1\times10^{-31}$kg, Charge $q = 1.6\times10^{-19}$C

QUESTION ONE

a) State three findings of Charles Coulomb (1736-1836) regarding Coulomb's law of electrostatic force between charged particles. (3 marks)

b) Explain characteristics of a conductor in electrostatic equilibrium (4 marks)

c) Derive the expression for

i) Gravitational Potential Energy between a big body of mass M and a small body of mass m at a distance r. (3 marks)

ii) Electric Potential Energy between a big body fixed in space of charge Q and a small charge q at a distance r (3 marks)

d) Sketch a diagram showing a circuit that can be used to charge a capacitor (2 marks)

e) A galvanometer of internal resistance 30Ω and full scale deflection of 0.4mA is to be made into a voltmeter of full scale deflection 5volts. How can it be modified to measure the voltage? (4 marks)

f) State Ampere's law (2 marks)

g) Give two importance of a dielectric in a capacitor (2 marks)

h) A 200μF capacitor is made of two parallel plates of area 120cm^2. The plates are separated by a dielectric of thickness 8.0x10^{-6} m. Find dielectric constant. (4 marks)

i) A parallel plate capacitor has an area A = 2 x 10^{-4}m^2 and a capacitance of 2.5 F. Find the plate separation distance (d). (3 marks)

QUESTION TWO

a) Consider three point charges located at the corners of a right triangle as shown in **Figure 1.** Where q_1 =4 μC q_3= 6 μC q_2= - 2 μC and a = 6 cm. Find resultant force exerted on q_3. (8 marks)

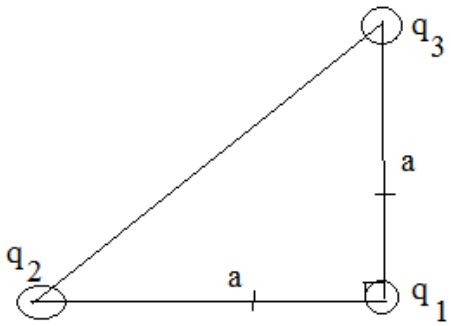

Figure 1

b) Show that the effective capacitance for capacitors arranged in series connection is given by (5 marks)

$$C = \frac{C_1 C_2}{C_1 + C_2}$$

c) i) State Kirchhoff's voltage rule (2 marks)

ii) In the circuit shown in Figure 2, resistances and Emf of the battery are indicated. Calculate current through the battery (5 marks)

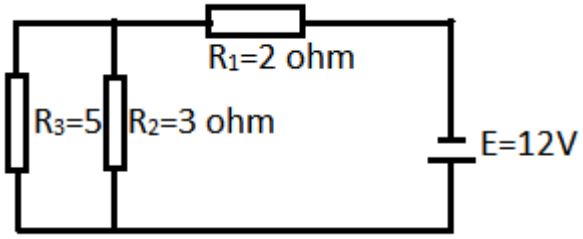

Figure 2

QUESTION THREE

a) Two identical charged spheres, each of charge 50.4×10^{-8} C hang in equilibrium as shown **Figure 3.** The length of each string is 20 cm and the displacement angle ∅ is 5°. Find their masses. (10 marks)

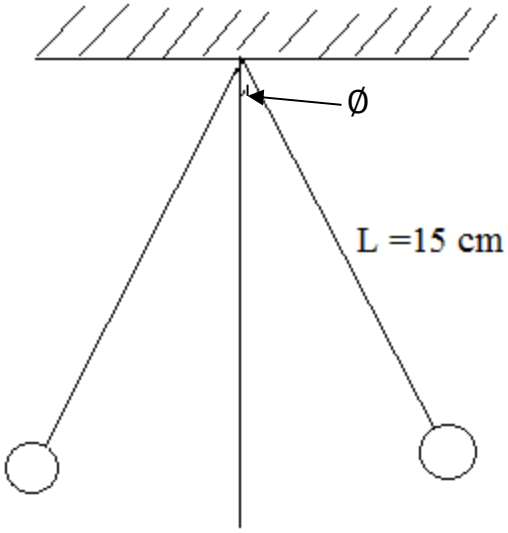

Figure 3

b) A charge $q_1 = 4\mu C$ is located at origin and $q_1 = 6\ \mu C$ is located at (x , y) = (0, 0.4) metres. Find

i) The resultant electric field (6 marks)

ii) Its direction and (2 marks)

iii) Its magnitude (2 marks)

QUESTION FOUR

a) A galvanometer of internal resistance 30Ω and full scale deflection of 0.4mA is to be made into a voltmeter of full scale deflection 5volts. How can it be modified to measure the voltage? (8 marks)

b) The e.m.fs and resistances of a circuit are given as$\mathcal{E}_1 = 6\,V, \mathcal{E}_2 = 3\,V, R_1 = 2\Omega,$ $R_2 = 3\Omega,\ R_3 = 0.5\,\Omega$**Figure 4**. Find current in each of the resistors by application of Kirchhoff's current rule. (12 marks)

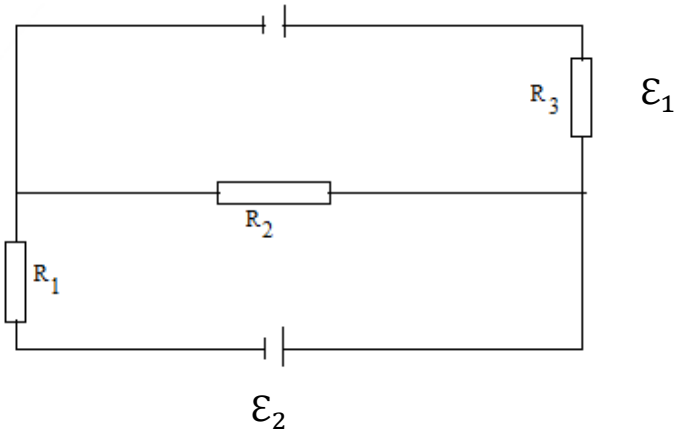

Figure 4

QUESTION FIVE

a) The electric force between an electron and proton in a hydrogen atom is 4.6 x 10^{-6} N. Find

i) the distance between them (4 marks)

ii) Gravitational force between them (4 marks)

iii) Comment on the answer i) and ii) above (2 marks)

b) During a capacitor charging process, the charge and current at time t is given by $q(t) = Q(1 - e^{-t/RC})$ and $I(t) = \frac{\mathcal{E}}{R}e^{-t/RC}$ respectively. Derive the two expressions. (10 marks)