(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF B.ED (SCIENCE)&BSC (PHYSICS).

COURSE CODE: SPH 210

COURSE TITLE: ELECTRICITY AND MAGNETISM.

EXAM DURATION: 2 HOURS

DATE: 19TH JANUARY 2018 **TIME: 9 – 11AM**

INSTRUCTIONS TO CANDIDATES

- Answer question one and any other two questions two (2) questions. Question one is compulsory and carries 30 marks, the other questions carry 20 marks each.

The following physical quantities may be useful.

- $M_e = 9.11 \times 10^{-31}$Kg
- 1eV = 1.6×10^{-19}J
- $q = e = 1.6 \times 10^{-19}$C
- $\varepsilon_0 = 8.85 \times 10^{-12} C^2/N.m^2$
- $\mu_0 = 4\pi \times 10^{-7} m/A$
- $K = 9 \times 10^9 Nm^2/C^2$

Question ONE (30 marks)

a) State Ampere's law. (1 mark)

b) Distinguish the following terms; resistance and resistivity, conductance and conductivity. (2 marks)

c) An ideal infinitely long solenoid has n turns per unit length and carries a current I. Use Ampere's law to find the magnetic field at the centre of the solenoid. (4 marks)

d) A cell of e.m.f, ϵ and internal resistance r is connected to a resistor R. For what value of R will the power supply to the load resistor be maximum? (4 marks)

e) Two long parallel conductors 3.5m apart are each carrying 1.5A of current. Find:

i) The magnetic field exerted by one conductor on the other.

ii) The force per unit length this field exerts. (4 marks)

f) Consider a rectangular coil of length l and breadth b in magnetic field **B** at an angle $\emptyset$ to the coil and carrying a current I. Show that such a coil of N turns experiences a torque, τ given by: $\boldsymbol{\tau = NAIBcos\emptyset}$ where A is cross section area of the coil. (4 marks)

g) Three identical positive charges of charge Q are placed at the corners of an equilateral triangle of side a. Show that the net force on any charge Q is given by $F = \frac{\sqrt{3}KQ^2}{a^2}$ (5 marks)

h) An electron enters into a magnetic field of magnitude 44T with a velocity of 305m/s perpendicular to the field. Calculate the force in the electron. (3 marks)

i) Show that the electric force field given by $\boldsymbol{F} = by^3\hat{\imath} + 3bxy^2\hat{\jmath} + cz^2\hat{k}$ is conservative. (3 marks)

QUESTION TWO (20 MARKS).

a) Define magnetic field intensity, **B.** (1 mark)

b) i) A positive charge of mass m is shot into a magnetic field $\boldsymbol{B}$ with velocity v. It is observed that it moves in a circular path. Derive an expression of its period of rotation. (5 marks)

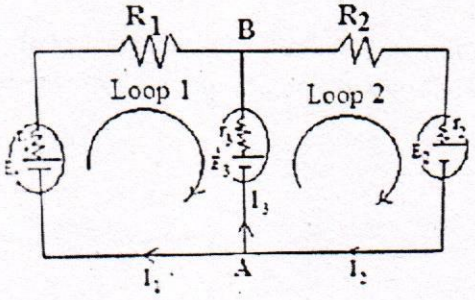
ii) An electron with kinetic energy 10^3eV moves perpendicular to a field of 10^{-4}T. Calculate the period and radius of its orbit. (6 marks)

c) Using Gauss's law, prove that the capacitance of a parallel plate capacitor with plate separation distance, d and plate area A is $\boldsymbol{C} = \frac{\epsilon_0 A}{d}$ (4 marks)

d) An electron has a velocity of 10^6**j**m/s in magnetic field of 0.05**k** T. Find the magnitude and direction of the force acting on the electron. (4 marks)

QUESTION THREE (20 MARKS)

a) State Kirchhoff's voltage and current laws (2 marks)



b) Using the circuit a bove, determine the currentsI_1, I_2, I_3, given that $r_1 = r_2 = 2\Omega$, $r_3 = 2\Omega$, $R_4 = 4\Omega$, $R_2 = 3\Omega$, $E_1 = 15\text{V}$, $E_2 = 6\text{V}$, $E_3 = 4\text{V}$. (6 marks)

c) Compute V_{BA}. (2 marks)

d) A parallel plate capacitor whose plates have an area 1.0^2m^2, which are separated by 2mm is connected across the terminals of 100V. Calculate.

i) The electric field between the plates.

ii) The magnitude of **charge density** between the plates.

iii) The capacitance of the system. (10 marks)

QUESTION FOUR (20 MARKS)

a) State the superposition theory of electrostatics. (1 mark)

b) An elemental charge ***dQ*** along a wire of continuous charge distribution exerts a force on an isolated charge Q at a perpendicular distance ***a*** given by; $\boldsymbol{dF} = \frac{KQ\lambda dl}{r^2}$ where λ is the line density of charge and ***r*** is the distance between a length element ***dl*** and the isolated charge. Show that the total force on the isolated charge is $\boldsymbol{dF} = \frac{2KQ\lambda}{a}$. (10 marks)

c) Two charges $+50\mu$C and $+100\mu$C are placed 1m apart on a straight line. Find electric field at a point midway between the charges and the force acting on $+20\mu$C charge placed midway between the two charges(9 marks)

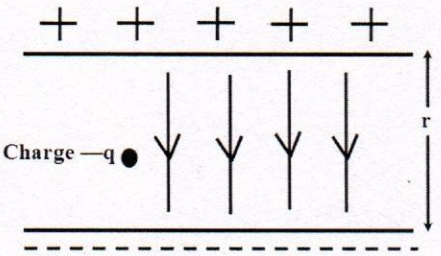
QUESTION FIVE (20 MARKS).

a) What are equipotential lines? (1 mark)

b) State Gauss's law and give its mathematical expression. (2 marks)

c) A potential is given by; $V = 3XY\ V/m$. Given that $\mathbf{E} = -\nabla V$, find the components of the electric field **E**. (3 marks)

d) Consider a uniform electric field inside a parallel plate capacitor as shown below;



If a charged particle of charge q is stationary between the plates, show that *p.d, V* across the plates is given by $V = \frac{mgr}{q}$ where m is the mass of the charged particle. Now the particlestarts moving with velocity u. Ignoring the effect of gravitational force, show that the vertical displacement y covered if given by; $y = \frac{1}{2}\left(\frac{q}{m}\right)Et^2$ where t is time taken to reach the plate. (5 marks)

e) A capacitor has 2 dielectric materials of relative permittivity $\epsilon_1$and ϵ_2. If the plate area is A, derive an expressionfor its capacitance if the dielectric materials are connected in parallel. (3 marks)