(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER
SUPPLEMENTARY/SPECIAL EXAMINATIONS

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

COURSE CODE: SPH 210

COURSE TITLE: ELECTRICITY AND MAGNETISM.

EXAM DURATION: 2 HOURS

DATE: 09/10/2018 TIME: 8:00-10:00AM

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.

KIBU observes ZERO tolerance to examination cheating.

The following constants 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) Distinguish the following terms; resistance and resistivity, conductance and conductivity.

(2 marks)

b) 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)

c) 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)

d) 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)

e) 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)

f) An electron in a television picture tube moves towards the front of the tube with a speed of 8×10^6 m/s along x – axis surrounding the neck of the tube are coils of wires that create a magnetic field of magnitude 0.025T directed at an angle of 60^0 to the x-axis and lying in x-y plane. Calculate the magnetic force on the electron. (4 marks)

g) 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)

h) 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)

i) **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) 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)

d) State and explain four factors that affect the magnitude of force on a current carrying conductor placed in a uniform magnetic field. (4 marks)

QUESTION THREE (20 MARKS)

a) A parallel plate capacitor whose plates have an area $1.0^2 m^2$, 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. (8 marks)

iv) Two charges + $50\mu C$ and + $100\mu C$ are placed 100 cm apart find the force of repulsion between them and the electric field at appoint mid-way between them caused by + $50\mu C$ charge on + $100\mu C$ charge. (6 marks)

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

QUESTION FOUR (20 MARKS)

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

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

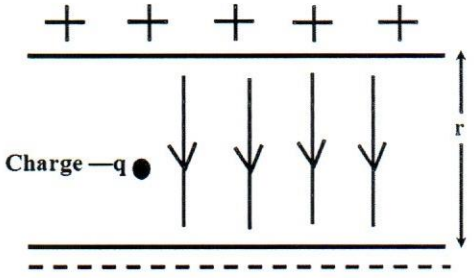
c) A solenoid is 0.5 m long has 5 layers of windings of 850 turns each and carries a current of 5.0A. Determine the magnetic field at its centre. (4 marks)

d) An electron of charge e enters into a uniform magnetic field **B** with velocity v at an angle θ. Derive an expression of the field acting on it. (5 marks)

QUESTION FIVE (20 MARKS).

a) What are equipotential lines? (1 mark)

b) Consider a uniform electric field inside a parallel plate capacitor as shown; 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 particle starts moving with velocity u. Ignoring the effect of gravitational force, show that the vertical displacement y covered is given by; $y = \frac{1}{2}\left(\frac{q}{m}\right)Et^2$ where t is time taken to reach the plate. (6 marks)

c) i) State Biot – Savart law (1 mark)

ii) Show that the magnetic field at the centre of a coil of turns N, radius r and carrying current I is given by $\mathbf{B} = \frac{\mu_0 NI}{2r}$. (6 marks)

d) A capacitor has two dielectric materials of relative permittivity ε_1 and ε_2. If the plate has area of overlap A, compute the capacitance of the capacitor in two alternative ways. (6 marks)