UNIVERSITY OF NAIROBI

SPECIAL/SUPPLEMENTARY EXAMINATIONS 2013/2014

FIRST YEAR EXAMINATIONS FOR THE DEGREE OF BACHELOR OF SCIENCE IN ENGINEERING

FEE 102 : ELECTRICAL & ELETRONIC ENGINEERING
FCE 132 : CIVIL ENGINEERING
FME 112: MECHANICAL ENGINEERING
FGE 176 : GEOSPATIAL ENGINEERING

PHYSICS 1B

DATE: JANUARY 9, 2015 **TIME: 2.00 P.M. – 4.00 P.M.**

INSTRUCTIONS

- **This paper has THREE sections, A,B, & C.**
- **Answer ONE question from each section.**
- **Begin A new Question on a fresh page.**

SECTION A

Answer ONLY ONE Question from this section.

Q.1.a) i) State the two types of charges. (2 marks)

ii) What is the law of charges? (1 mark)

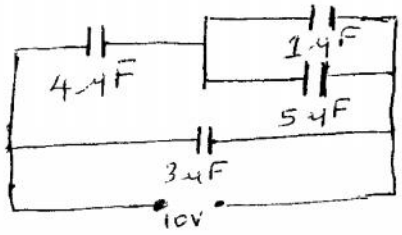
iii) Sketch the electric field lines for the three scenarios below:

(a) (b) (c)

(3 marks)

b) i) Three capacitors, C_1, C_2 and C_3 are connected in series. Show that the total capacitance C_T is given by $\frac{1}{C_T}=\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}$ (5 marks)

ii) Calculate the total capacitance in the figure below.

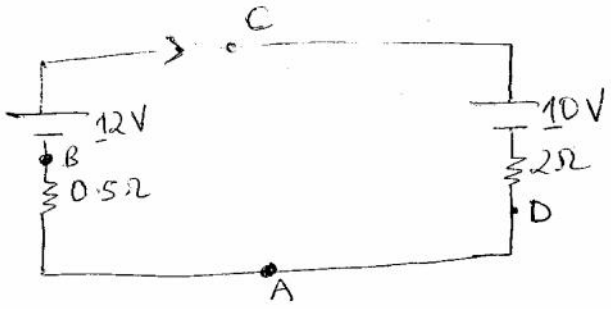


(3 marks)

c) i) State Kirchoff's two rules. (2 marks)

ii) Calculate the potential difference between AB and AD below:

(4 marks)



Q.2.a) i) What is a Cathode Ray Oscilloscope? (1 mark)

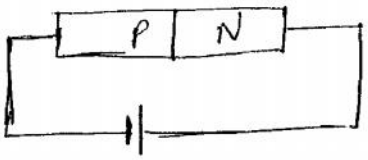
ii) List five uses of a Cathode Ray Oscilloscope. (5 marks)

b) i) Explain the difference between extrinsic and intrinsic semi inductors. (2 marks)

ii) What electrical device is developed using a P-N junction? (1 mark)

iii) Explain the term "Depletion layer". (1 mark)

iv) The diagram below shows a P-N junction device connected to a power source.



a) Is the device above forward or reverse biased?

b) Under the connection in (a) above, do you expect the depletion layer to widen up or narrow down?

c) Under (b) above is the resistance highest or lowest?

(3 marks)

v) Explain using clear diagrams how full wave rectification can be achieved using a 2-diode system. (7 marks)

SECTION B

Answer ONLY ONE question from this section.

Q.3. a) The fusion of deterium nuclei can be expressed by the equation

$$ {}_{1}^{2}H + {}_{1}^{2}H = {}_{2}^{4}He $$

Calculate the energy relevant by this reaction.

(2 marks)

b) Electrons are accelerated through ap.d of 1500 V in a vacuum. They collide with a thin film of graphite.

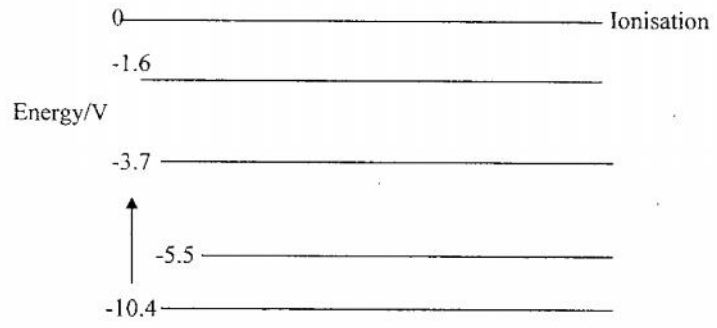
i) Show that the speed of the electrons before impact is 2.3×10^7 m/s. (2 marks)

ii) Calculate the wavelength of the electrons in b(i). (2 marks)

iii) Explain why the electrons would be diffracted through an appreciable angle by the graphite. (2 marks)

iv) Electron diffraction can be used to measure nuclear radii. Explain why the electrons used in such measurements would need to have much greater kinetic energy than those in the question above. (2 marks)

c) The diagram shows some of the other energy levels of the mercury atom.



i) Calculate the ionization energy in J for an electron in -10.4eV level. (2 marks)

ii) An electron has been excited to the -1.6eV. On the diagram, show all the possible ways it can return to -10.4 eV level. (3 marks)

iii) Which change in energy levels will give rise to a yellowish line ($\lambda \approx 600\,nm$) in the mercury? (5 marks)

Q.4. a) Briefly describe the Rutherford's model of an atom. (4 marks)

b) Show that for a radioactive material, the number of atoms N after a.time t is given by

$$N = N_o e^{-\lambda t}$$

where No is the no of atoms at the start of the activity and λ the radioactive decay constant.

(10 marks)

c) State ANY THREE applications of χ – rays. (6 marks)

SECTION C

Answer ONLY ONE question from this section.

5.a) What is the relationship between the magnitude and direction of the magnetic force exerted on a particle moving in a magnetic field to the charge and the speed of the particle? (2 marks)

b) State two right-hand rules for determining the direction of the magnetic force acting on a particle with charge q moving with velocity υ, in a magnetic field B. (4 marks)

c) Define magnetic dipole moment of a loop and state its SI units. (2 marks)

d) State six properties of electromagnetic waves. (12 marks)

6.a) State Faraday's law of induction and give its equation. (2 marks)

b) Define Self Inductance and mutual inductance. (2 marks)

c) A wire carrying a current of 10A and 2 metres in length is placed in a field of flux density 0.15T (Wbm^{-2}).

What is the force on the wire if it is placed?

i) at right angle to the field (2 marks)
ii) at 45^0 to the field (2 marks)
iii) along the field (2 marks)

d) Sketch a curve of the instantaneous current i_R and instantaneous voltage ΔV_R as functions of time for a resistor in an AC circuit. (4 marks)

e) i) Find the time constant of the circuit shown in the figure below. (3 marks)
ii) The switch is closed at t = 0. Calculate the current in the circuit at t = 2.00 ms. (3 marks)