KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2015/2016 ACADEMIC YEAR

FIRST YEAR SECOND SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF B.ED (SCIE), BSC (COMP SCIE), BSC (IT), BSC (PHYS), BSC (CHEM) & BSC (REN ENERGY)

COURSE CODE: SPH 111

COURSE TITLE: FUNDAMENTAL OF PHYSICS II

DURATION: 2 HOURS

DATE: FRIDAY 13TH MAY 2016 **TIME:** 11.30 – 1.30PM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of **5** printed pages. Please Turn Over

KIBU observes ZERO tolerance to examination cheating

You may use the following constants

- Electronic charge, $e = 1.6 \times 10^{-19} C$
- Permeability of free space, $\mu_0 = 4\pi \times 10^{-7} N/A^2$
- Unified atomic mass unit, $1u = 1.6606 \times 10^{-27} kg = 931 MeV$
- Mass of a proton, $M_P = 1.007267u$
- Mass of a neutron, $M_n = 1.008665u$
- Becquerel $1Bq = 1decay/Sec$
- Refractive index of air = 1.00
- Refractive index of water = 1.33
- Curie $1Ci = 3.70 \times 10^{10} Bq = 3.70 \times 10^{10} decay/Sec$
- Rydberg constant $R = 1.097 \times 10^7 m^{-1}$
- Speed of light $c = 3.0 \times 10^8 m/s$
- Mass of the electron $m_e = 9.11 \times 10^{-31} Kg$

QUESTION ONE(30 MARKS) - COMPULSORY

(a) Draw the variation of the magnetic intensity B with the applied field H for a typical magnetic material taken through a complete cycle of magnetization. Use the diagram to define,

(i) Saturation point for the material
(ii) Remanance
(iii) Coercive force of the specimen **(4marks)**

(b) Show that the current density J in a wire of cross sectional area, A and n free electrons per unit volume which are drifting with a velocity V is $J = neV$ **(3marks)**

(c) What are the majority and minority charge carriers in a p-type semiconductor? **(1mark)**

(d) Define the half life of a radioactive sample. How long does it take for 60% of a sample of radon to decay? Half-life of radon is 3.8 days **(4marks)**

(e) (i) Show that the work done in increasing the charge in a capacitor C which is connected to a potential difference V is $W = \frac{1}{2}CV^2$ **(3marks)**

(ii) A 370 μF capacitor in a photoflash unit is charged to a potential difference of 330 V. How much charge and energy is stored on the capacitor .**(2mark)**

(f) When an R-L-C circuit is driven in resonance, what is the impedance? **(1mark)**

(g) (i) With the aid of clearly labeled diagrams distinguish between concave and convex lenses. **(2marks)**

(ii) A converging lens has two surfaces with radii of curvature $R_1 = 80cm$ and $R_2 = 36cm$ to the left of the lens for which n=1.63. Find the power of the lens. **(2 marks)**

(iii) Why is that white light sources are not used in Young's double slit experiment **(1mark)**

(h) Explain why n-p-n transistors are most widely used and especially so for high frequency applications as opposed to p-n-p transistors **(1mark)**

(i) Mention any two uses of cathode rays **(2 marks)**

(j) State any two properties of x-rays **(2 marks)**

(k) Show that if a network has only two resistors in parallel R_1 and R_2 then the effective resistance is

$R_e = R_1R_2 / R_1 + R_2$ **(3 marks)**

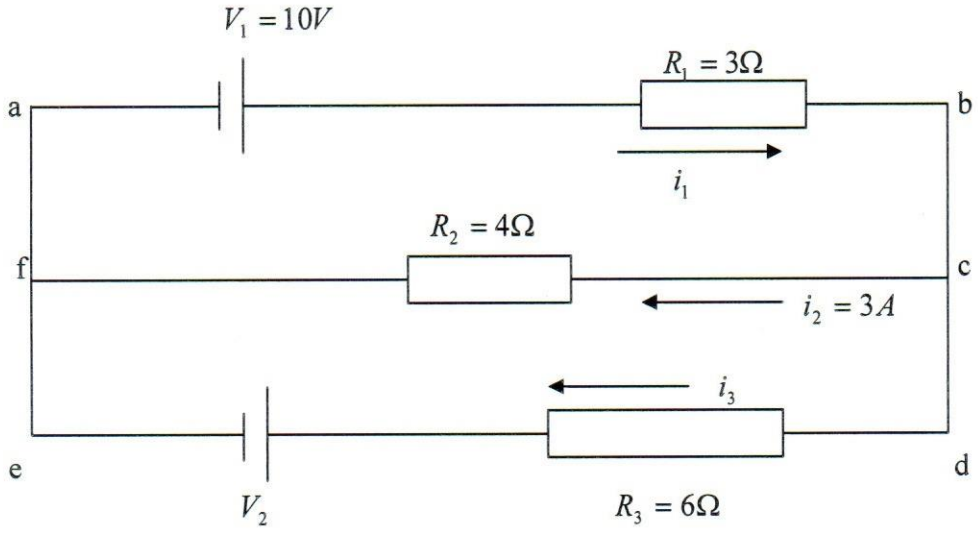
QUESTION TWO

(a) (i) A toroid of length 100cm has 1500 turns and cross sectional area of $60cm^2$. If it carries a current of 1.5A, compute B and H giving the appropriate units for each. **(2marks)**

(ii) If the total flux density B in the toroid mentioned in (a)(i) above is measured to be $3.83 \times 10^{-3} T$, Find the magnetization M, the relative permeability μ_r and the magnetic moment, m for the whole toroid due to surface current. **(5marks)**

(b) (i) State Kirchhoff's current and voltage laws **(1mark)**

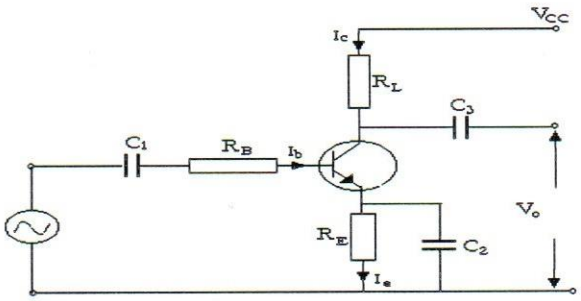
(ii) Determine the values of the currents, i_1, i_3 and V_2 in figure below, assuming that the batteries have negligible internal resistance



(4 marks)

(c) Distinguish between intrinsic and extrinsic conduction in semiconductors. Explain the terms donor impurity and acceptor impurity. Explain the effect of an increase in temperature on intrinsic conduction. How does this differ from the effect of an increase in temperature on a metallic conductor? **(4 marks)**

(d) The diagram below shows a common emitter transistor connection. Given R_B=1MΩ, V_{BB}=30V, V_{CC}=30V, R_E=10KΩ, R_C=5KΩ and β=100. Calculate Ie, Ic, Ib, V_C, V_E and V_{CE}. **(6 marks)**



QUESTION THREE (20 MARKS)

(a) Sketch the circuit diagram of a full wave rectifier and explain how it operates. Show the input and output waveforms **(2 marks)**

(b) A $10\mu F$ capacitor is connected into a charging circuit with a power supply of 12V and a resistor of 100Ω. Find,

(i) The time constant for the circuit

(ii) The maximum charge on the capacitor

(iii) If the charge on the capacitor at any given time t is, $Q = Q_0\left(1 - e^{\frac{-t}{RC}}\right)$, how long does it take for the capacitor to be charged to 90% of its maximum charge? **(4marks)**

(c) An L-R-C series circuit has a resistance $R = 250\Omega$, inductance $L = 0.60H$ and capacitance $C = 3.50\mu F$ is connected to a voltage source $V(t) = 150\sin(377rad/s)t$. Determine the,

(i) Impedance Z.

(ii) Phase angle ϕ.

(iii) Current in the circuit i(t).

(iv) Current at t=1.24s.

(v) Potential drops $V_R(t)$, $V_L(t)$ and $V_C(t)$ **(8 marks)**

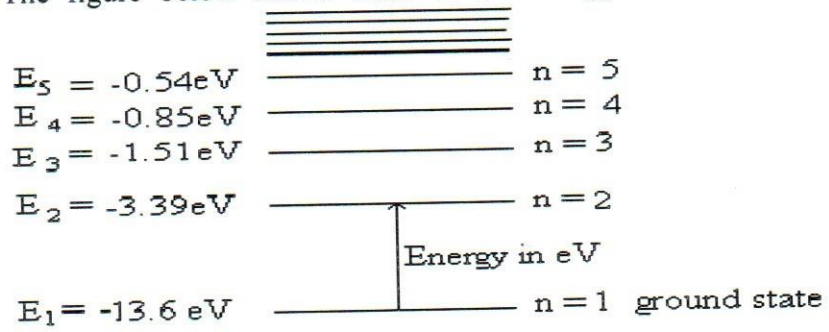
(d) Sketch the apparatus used in the production of x-rays and hence explain how they are produced. **(3 marks)**

(e) Define the Binding energy of a radionuclide. Find the binding energy per nucleon of deuterium ${}^{2}_{1}H$ given that the measured mass of a deuterium nucleus is 2.0141 u **(3 marks)**

QUESTION FOUR (20 MARKS)

(a) Starting with the activity law of a radioisotope that $R = R_0e^{-\lambda t}$, show that the time taken by an ancient item that died many years ago is $t = \frac{1}{\lambda}\ln\left(\frac{R_0}{R}\right)$ where the symbols have their usual meanings. **(2 marks)**

(b) The figure below shows some of the energy levels for the hydrogen atom



(i) Find the wavelength of the lines due to electron transitions from n=2 to n=1, given that the Rydberg constant is $R = 10973731.534m^{-1}$. In which series does this spectrum lies? **(2marks)**

(ii) What is the ionization energy of the hydrogen atom? **(1mark)**

(iii) Why are the energies given as negative numbers? **(1mark)**

(c) (i) Define the focal point of a spherical mirror **(1mark)**

(ii) An object is placed 20cm from a diverging lens of focal length 15cm. Calculate the image position and magnification **(4marks)**

(d) With the aid of a clearly labeled diagram, show that the magnification of an astronomical telescope at normal adjustment is $M = \frac{f_0}{f_e}$, where f_0 is the focal length of the objective lens and f_e is the focal length of the eye piece lens. **(4marks)**

(e) (i)Using a well labeled diagram, show that the condition for minima in a single slit experiment is $a\sin\theta = m\lambda$ where a is the size of the slit, λ is the wavelength of the light used and m is the order of the spectra. **(3marks)**

(ii) A single slit has a width of $2.1\times10^{-6}m$ and is used to form a diffraction pattern. Find the angle that locates the second dark fringe when the wavelength of the light used is 430nm. **(2 marks)**

QUESTION FIVE (20 MARKS)

(a) Explain with a well labeled diagram the working of a CRO **(6 marks)**

(b) Light of wavelength 580nm is incident on al slit of width 0.300mm. The viewing screen is 2.00m from the slit. Find the positions of the first dark fringes and the width of the central bright fringe **(4 marks)**

(c) Distinguish between Fresnel diffraction and Fraunhoffer diffraction **(2 marks)**

(d) A layer of ice, having parallel sides floats on water. If light is incident on the upper side of the ice at an angle of 30.0°, what is the angle of refraction in the water? **(4 marks)**

(e) Electrons are accelerated from rest onto a target in an x-ray tube of p.d. 100KV. Find the velocity of electrons reaching the target and the energy converted at the target per second if the electron beam current is 15mA. **(4 marks)**