JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION

1ST YEAR 2ND SEMESTER 2016/2017

MAIN REGULAR

COURSE CODE: SPH 3121

COURSE TITLE: PHYSICS 2

EXAM VENUE: LAB 2

STREAM: (B.Ed Sc, Building, Mg. Renewable, Water and Agriculture)

DATE: 09/04/2017

EXAM SESSION: 8.00 A.M. – 10.00 A.M.

TIME: 2:00 HRS

INSTRUCTIONS:

1. **Attempt question 1 (compulsory) and ANY other two questions.**
2. **Candidates are advised not to write on the question paper.**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

Useful constants

velocity of light in free space $= 3.0 \times 10^{8}$ m/s
mass of an electron $= 9.11 \times 10^{-31}$ kg
Planck's constant $= 6.63 \times 10^{-34}$ J s
electron charge $= -1.6 \times 10^{-19}$ C
1 eV $= 1.6 \times 10^{-19}$ J
Avogadro's number $= 6.02 \times 10^{23}$ mol^{-1}
Diameter of the sun $= 1.4 \times 10^{6}$ km
Distance from the sun to the Earth $= 1.5 \times 10^{8}$ km
1 atomic mass unit $= 1.66 \times 10^{-27}$ kg
1 curie $= 3.7 \times 10^{10}$ events/s

Question 1

(a) Name materials, one in each case, which is suitable for making

(i) a permanent magnet.

(ii) the core of an electromagnet.

Explain, in terms of their magnetic properties, why these materials are used.

(4 Marks)

(b) When an AC generator is connected across a 12.0 Ω resistor, the rms current in the resistor is 8.00 A. Find

(i) the rms voltage across the resistor,

(ii) the peak voltage of the generator,

(iii) the average power delivered to the resistor.

(6 Marks)

(c) The photoelectric work function of potassium is 2.0 eV. What potential difference would have to be applied between a potassium surface and the collecting electrode in order to just prevent the collection of electrons when the surface is illuminated with radiation of wavelength 350 nm?

(5 Marks)

(d) In an experiment used to demonstrate Newton's rings, a plano-convex lens is placed on a flat glass plate, as in Fig.1 (not drawn to scale). If the wavelength of light used is 550 nm,

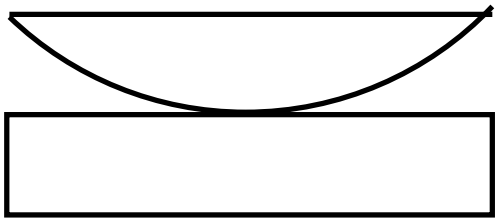

Figure 1: Newton's rings experiment apparatus.

find the thickness of the air gap at

(i) the second dark ring.

(ii) the third bright ring.

(4 Marks)

(e) **(i)** Explain what is meant by the statement that *a beam of light is plane-polarized.*

(ii) Explain why the phenomenon of polarization is encountered when dealing with light waves, but not when studying sound waves.

(iii) The refractive index of diamond for sodium light is 2.417. Find the angle of incidence for which the light reflected from diamond is completely plane-polarized.

(5 Marks)

(f) **(i)** Explain how line spectra are used in analysis for the identification of elements.

(ii) Fig. 2 represents the lowest energy levels of the electron in the hydrogen atom. Values of the principal quantum number n and the corresponding energy are as indicated. Why are the energies assigned negative values?

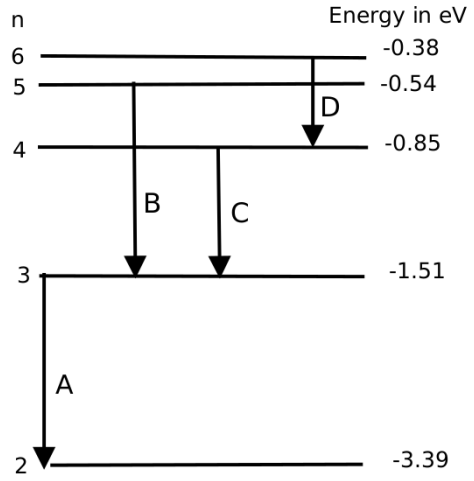

Figure 2: Energy levels in the hydrogen atom.

(iii) Calculate the wavelengths associated with transitions A and B, and the frequencies associated with C and D.

(6 Marks)

Question 2

(a) State two ways in which the relative permeability of a ferromagnetic material can be caused to change.

(2 Marks)

(b) The data in table 1 refer to two ferromagnetic materials:

Material	Average value of *relative permeability*	*Saturation flux density* (T)	*Coercive force* (A m^{-1})	*Remanence* (T)
A	8000	2.0	80	1.4
B	500	1.7	1200	1.2

Table 1:

(i) With the aid of a suitable sketch graph, explain what is meant by

(I) a hysteresis loop. **(II)** the italicized terms in the column headings on the table.

(6 Marks)

(ii) (I) From the data given in the table, sketch on a common graph the likely shapes of the hysteresis loops for the two materials.

(II) Given that the two materials are soft iron and steel, identify which one is which.

(III) State, with reasons, which of the materials A and B you would use to make the core of a transformer.

(7 Marks)

(iii) Draw a labelled diagram of a three pin plug. Explain any two safety features of the plug.

(5 Marks)

Question 3

(a) When an atom of uranium-235 undergoes fission in a reactor, about 200 MeV of energy is liberated. Suppose that a reactor using uranium-235 has an output of 800 MW and is 25% efficient. Evaluate:

(i) The usable energy per fission in joules.

(ii) The number of fissions necessary per day in order to yield the required energy.

(iii) The mass of uranium consumed per day.

(8 Marks)

(b) The half-life of the alpha-emitter $^{210}_{84}$Po is 138 days. Find the mass of $^{210}_{84}$Po needed for a 10 mCi source.

(6 Marks)

(c) Light of frequency 5.0×10^{14} Hz liberates electrons with energy 2.31×10^{-19} J from a certain metallic surface. What is the wavelength of ultra-violet light which liberates electrons with energy 8.13×10^{-19} J from the same surface?

(6 Marks)

Question 4

(a) (i) Sketch and label a ray diagram to show how the image of a small object which is placed infront of a convex mirror, on the principal axis of the mirror and at a distance greater than the radius of curvature, is formed.

(ii) A man standing 1.52 m in front of a shaving mirror produces an inverted image 18.0 cm in front of it. How close to the mirror should he stand if he wants to form an upright image of his chin that is twice the chin's actual size?

(8 Marks)

(b) (i) Find the diameter of the image of the sun formed on the film used in a camera with a lens of focal length 50 mm.

(ii) A -4.0 diopter lens is held 15.0 cm from an ant 1.5 mm high. Find the position and height of the image. Describe the nature of the image as fully as you can.

(6 Marks)

(c) (i) What is meant by normal adjustment for an astronomical telescope? Why is the telescope used in this way?

(ii) An astronomical telescope in normal adjustment is required to have an angular magnification of 15. An objective lens of focal length 900 mm is available. Calculate the focal length of the eyepiece required.

(6 Marks)

Question 5

(a) Sketch a graph showing the x-ray spectrum produced from a metal target. Explain the salient features of the graph.

(3 Marks)

(b) The K series of the discrete spectrum of tungsten contains wavelengths of 0.018 5 nm, 0.020 9 nm, and 0.021 5 nm. The K-shell ionization energy is 69.5 keV. Determine the ionization energies of the L and N shells. Explain the variation in the ionization energies from one shell to another.

(10 Marks)

(c) (i) Find an estimate of the radius of the ${}^{11}_{5}\mathrm{B}$ nucleus.

(ii) It is given that the atomic mass of ${}^{11}_{5}\mathrm{B}$ is 10.82 u. Neglecting the masses and binding energies of the electrons, find the density of the ${}^{11}_{5}\mathrm{B}$ nucleus.

(iii) Ordinary boron is a mixture of the ${}^{10}_{5}\mathrm{B}$ and ${}^{11}_{5}\mathrm{B}$ isotopes. Find the percentage of each isotope present in ordinary boron.

(7 Marks)