# MACHAKOS UN TY COLLEGE

**(A Constituent College of Kenyatta University)**
**University Examinations for 2015/2016 Academic Year**

**SCHOOL OF PURE AND APPLIED SCIENCES**

**DEPARTMENT OF PHYSICAL SCIENCES**

**FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN POPULATION HEALTH**

**SPH 0204: ATOMIC, NUCLEAR PHYSICS AND ELECTRONICS**

**DATE: SCHOOL BASED** **TIME:**

---

**INSTRUCTIONS. Answer Question One and Any Other Two Questions**

**QUESTION 1 (30 MARKS)**

a) Differentiate between a nuclear fussion and nuclear fission. (2 marks)

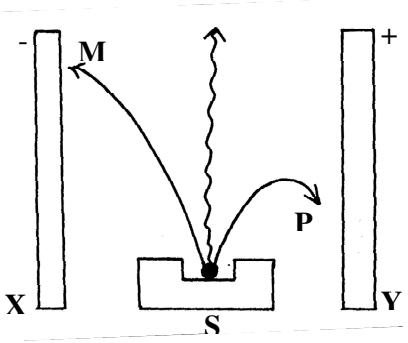
b) The equation below represents a nuclear reaction.

$$^{218}_{84}\mathbf{P_o} \longrightarrow {}^{218}_{85}\mathbf{A} + {}^{q}_{p}\mathbf{Y}$$

i. Determine the values of **p** and **q.** (2 marks)

ii. Identify **Y** (1 mark)

c) The figure below represents deflection of various radiations from a radioactive source S placed in electric field between two plates **X** and **Y.**



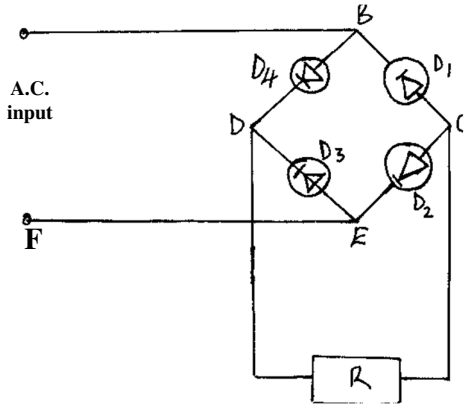
Identify the radiations marked with letters **M** and **P.** state two properties of each.

(5 marks)

d) What do you understand by the term 'Random decay' (1 mark)

e) A sample of radioactive substance initially has $8x10^{25}$ particles. The half life of the sample is 98 seconds. Determine the number of particles that will have decayed after 294 seconds. (4 marks)

f) The figure below shows a bridge rectifier.




i. Define the term rectification. (1 mark)

ii. Describe how the illustrated rectifier works. (5 marks)

iii. State the modification that can be made on the arrangement to improve the quality of the output. (1 mark)

iv. Sketch on the areas below how the improved output is displayed on a C.R.O screen. (2 marks)

g) Using a well labelled diagram explain the composition of an atom according to bohr model (5 marks)

h) What is an isotope (1 mark)

**QUESTION 2 (20 MARKS)**

a) Explain what is meant by

i. Half-life. (1 mark)

ii. Background radiation. (1 mark)

b) At a certain instant the corrected count-rate registered on a detector placed close to an alpha particle emitter is 200 per second and this falls to 50 per second in 12 minutes. Determine the half-life of the source. (3 marks)

c) The following represents part of a re radioactive series in which the chemical symbols

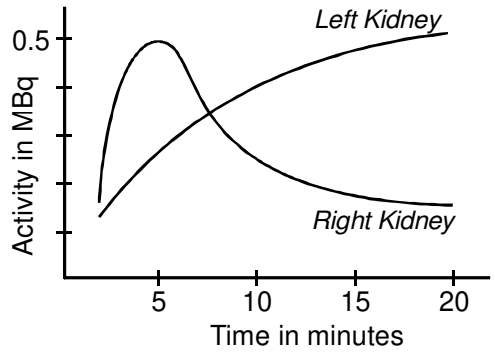
have been replaced by letters.

$$^{234}_{90}90 \xrightarrow{i} {}^{234}_{91}B \xrightarrow{(ii)} {}^{234}_{92}C \xrightarrow{(iii)} {}^{230}_{90}D$$

i. Name the particles emitted in the three changes. (3 marks)

ii. Write down the two letters which represent isotopes. (1 mark)

d) A doctor suspects that one of the kidneys of a patient is not working properly. The doctor injects him with a radioactive impurity, 1MBq of iodine-131 (half-life 8 days) which travels to his kidneys. A normal kidney gradually removes all impurity from the blood in about 20 minutes. The radioactivity in his kidney is monitored. using gamma ray detectors. The graph below shows the results.




i. Which kidney do you think is not working properly? Explain your answer. (1 mark)

ii. Why do you think that a gamma ray emitter was used as the injected impurity instead of a beta emitter? (1 mark)

iii. Why would it be less suitable to use as an impurity a material with a very short half-life? (1 mark)

e) Sketch and label important sections of an IV curve characteristic of a diode (4 marks)

f) Explain how a p type semiconductor is formed (4 marks)

**QUESTION 3 (20 MARKS)**

a) The table below shows how the activity of a radioactive nuclide varies with time.

| Time in minutes | 0 | 1 | 2 | 3 | 5 | 6 | 8 | 11 |
|---|---|---|---|---|---|---|---|---|
| Count rate per minute | 420 | 341 | 285 | 230 | 162 | 131 | 85 | 50 |
| Activity per minute | | | | | | | | |

b) Give that the background radiation count is 10 counts per minute complete the table.

(2 marks)

i. Plot a graph of activity against time. (5 marks)

ii. From the graph determine the half life of the sample. (2 marks)

c) A radioactive element X of half-life of 28 days decay to element Y. A sample of X of mass 16g is kept in a container. Assuming Y is stable; determine the mass of Y that will be found in the containers after 112 days. (4 marks)

d) In terms of energy band theory state the difference conductors and semiconductors.

(2 marks)

e) explain how an n-type and p-type semiconductors are formed (5 marks)

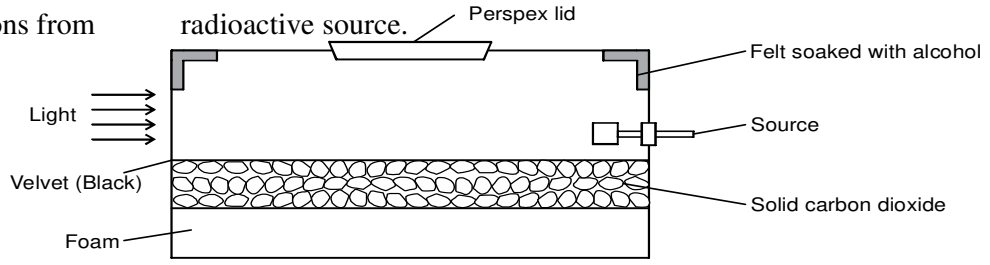
**QUESTION 4 (20 MARKS)**

a) Explain why carbon -14 ${}^{14}_{6}C$ is radioactive while Carbon -12 ${}^{12}_{6}C$ is not. (2 marks)

b) A radioactive isotope showed a count rate of 82 counts per second initially. After a time of 210 seconds, the count rate dropped to 19 counts per second. The average background count remained constant at 10 counts per second. What is the half life of the material?

(3 marks)

c) The figure below shows features of a diffusion cloud chamber used for detecting radiations from radioactive source.




a) Explain how the chamber works when a radioactive particle is introduced at the source.

(2 marks)

b) What is the purpose of solid carbon dioxide? (1 mark)

c) Using a well labelled diagram describe a GM tube as a detector of radioactive radiations

(6 marks)

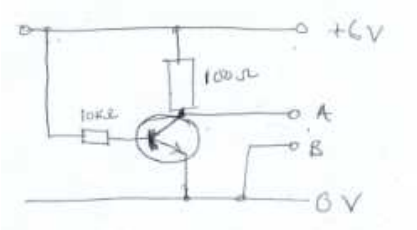
d) The initial mass of a radioactive substance is 20g. The substance has a half -life of 5 years. Determine the mass remaining after 20 years. (3 marks)

e) Boron has two naturally occurring isotopes, $^{10}B$ and $^{11}B$. We know that 80.22% of its atoms are $^{11}B$, atomic weight 11.009 u. From the natural atomic weight given on the inside front cover, calculate the atomic weight of the $^{10}B$ isotope. (3 marks)

**QUESTION 5 (20 MARKS)**

a) using band gap theory explain the difference in insulators, metals and non-metals

(6 marks)




b) In the circuit below assume $V_{BE}$ =0.75V and that $h_{FE}$ = 80.

Calculate

i. the base current (2 marks)

ii. the collector current (2 marks)

c) ${}^{4}_{2}He$ is the most abundant isotope of helium. Its mass is 6.6447x 10-27kg. What is

i. The mass defect? (4 marks)

ii. The binding energy of the nucleus in joules? (3 marks)

iii. The binding energy of the nucleus in electron volts? (3 marks)