## Radioactivity

1. A radioactive substance **X** decays by emission of two alpha particles and one beta particle.

   Write a balanced equation of this emission.

## Radioactivity

1. (a) Define radioactive decay

(b) A radioactive element decays to $^{1}/_{128}$ of its original activity after 49 days. Determine its
half –life

2. (a) You are provided with the following:-
- One diode
-A load resistor
- An a.c. source
- One transformer

(i) Using the above apparatus draw a circuit arrangement for half wave rectification

(ii) Explain how the circuit drawn in **(a)(i)** above achieves half wave rectification

(b) (i) Determine the value of **x** and **y** in the nuclear equation below:-

$$^{238}_{92}U \longrightarrow {}^{y}_{x}Z + 4\beta$$

(ii) The half life of a radioactive element is 20minutes. The mass of the element after 120
minutes is 0.03125g. Determine the original mass of the element

(iii) What evidence supports the fact that gamma rays are not charged

(iv) Alpha particles have low penetrating power as opposed to beta particles. Give a reason
for this

v) A manufacturer wishes to check the thickness of steel sheets he produces. Explain how
this can be done using a radioactive source and a counter

3. a) What is meant by radio active decay?

b) Uranium 235 was bombarded with a neutron and fission took place in the following manner:

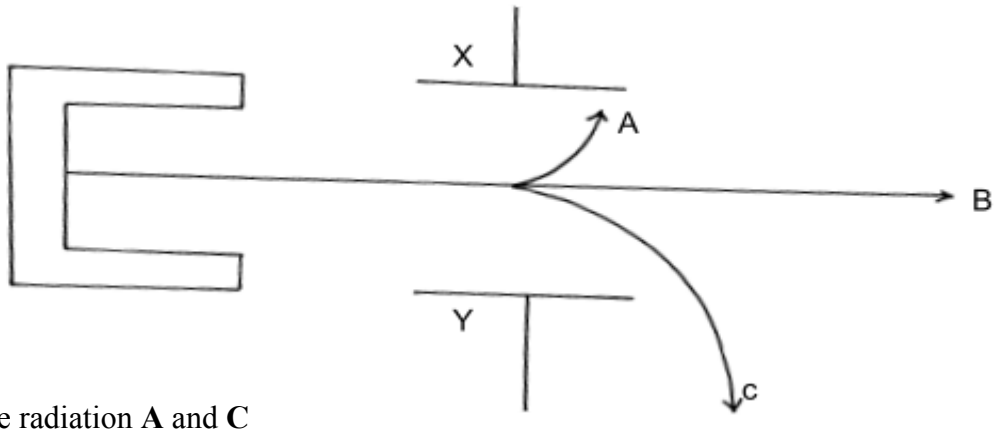
$$^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{90}_{38}Rn + {}^{a}_{b}X + 10({}^{1}_{0}h)$$

Determine the values of **a** and **b**

c) When carrying out experiments with radio active substance one is instructed that the source

should never held with bare hands but with forceps. Give a reason for the instruction

d) The diagram below shows the paths taken by three radiations **A, B** and **C** from a radio
active isotope through an electric field




i) State the

ii) Identify the radiation **A** and **C**

iii) Give a reason why **C** deviates move **A**

e) $_{90}^{233}Th$ disintergrates into radium (Ra) by emission of two alpha and two beta particles as
in equation $_{90}^{233}Th \longrightarrow {}_{Z}^{A}Ra + 2({}_{2}^{4}He) + 2({}_{-1}^{0}e)$

State:

i) The atomic number of the daughter nuclide

ii) The mass number of the daughter nuclide

f) One of the application of Beta emission (B) is controlling thickness gauge. Explain how they are used for this purpose?

4. The following is a nuclear reaction for a fusion process resulting from the reaction of polonium with loss of beta particles

$$^{210}_{81}\xrightarrow{3\ \beta\text{decay}}{}^{S}_{84}\xrightarrow{\text{decay}}{}^{T}_{82}$$

(i) Determine the values of **S** and **T**

(ii) State the source of the energy released

5. The expression below is an equation for radioactive element **A.** Element **B** and **C** are the daughter nuclides. **A, B** and **C** are not the actual symbols of any of the elements

$$^{238}_{92}\mathbf{A} \longrightarrow {}^{234}_{90}\mathbf{B} + \mathbf{C}$$

X
Y

(a) State what type of radioactive decay this is.

(b) What is the value of:

**X…… Y……**

6. Arrange the following in order of increasing frequency: Red light, Infrared radiation, X-rays,
UV radiation, Short –radio waves, TV and Fm radio waves, Am radio waves and Long radio
waves.

7. Radium -222 is a radioactive element with a half-life period of 38 sec. What fraction of the mass
of a sample of this element remain after 380 sec.

8. (a) Define the term half-life of a radioactive material

(b) (i) Use the table below to plot a graph of activity against time

| Activity (Disintegration/seconds) | 680 | 567 | 474 | 395 | 276 | 160 | 112 | 64 |
|---|---|---|---|---|---|---|---|---|
| Time **t** (days) | 0 | 1 | 2 | 3 | 5 | 8 | 10 | 14 |

(ii) Find the half-life of the material in days

(c) The half-life of a radio-active substance is 138 days. A sample of the substance
has $8 \times 10^{10}$ un-decayed nuclei at time t = 0. How many un-decayed nuclei will
be left after 690 days?

(d) An element x (uranium) decays by emitting two alpha particles and a beta particle
to yield element Y

(i) State the atomic number and mass number of Y

(ii) Write down the decay equation

9. a) What is meant by radioactive decay?

b) A radioactive source placed 12cm from the detector produced a constant count rate
of 5 counts per minute. When the source is moved close to 3cm, the count rate varies
as follows;

| **Time** | 0 | 20 | 40 | 60 | 80 |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| **Count rate** | 101 | 65 | 43 | 29 | 21 |

i) State the type of radiation emitted.

ii) Explain the constant count rate when the source is 12cm away.

iii) Plot a graph of count rate against time (Use graph paper)

iv) Use the graph to estimate the half life of the element

10. State **one** advantage of:

i) A lead-acid accumulative over a dry cell

ii) A dry cell over lead-acid accumulator

## *Radioactivity*

*1. a) Radioactive decay is the spontaneous random emission of particles from the nucleus of an unstable nuclide*

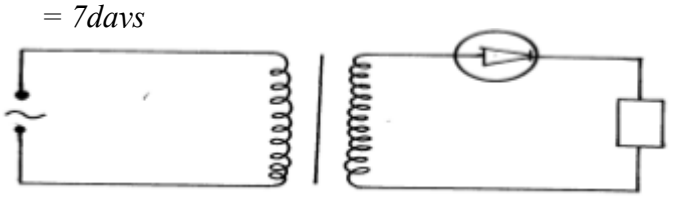
*(b) There are 7 half lives ( $t_{½}$ )*

$7t_{½} = 49$ days

$t_{½} = \frac{49}{7}$

$= 7$davs

*2. (a)(i)*



*Position of diode*

*Indication of a.c source*

*Complete and correct circuit*

*(ii) During the first half cycle, the diode is forward biased so it conducts.*

*- Current flows through $R_2$ building a voltage which decreases as the first half cycle comes to an end.*

*- During the second half cycle, the diode is traverse biased so it does not conduct.*

*(b) (i) y =238-4(1) = 242*

*X = g2*

*(ii) $\frac{120}{20}$ = 6 half lives*

*0.03125 x 26 = 2g*

*(iii) They are deflected by both electric and magnetic fields*

*(iv) Alpha particles are heavy (massive)*

*(v) – The sheets are brought in turns between radioactive source and the counter.*

*- The count rate is a measure of the thickness of the metal sheet.*

*3. a) Spontaneous disintegration of unstable atoms in order to gain stability*

*b) i) a = 236 – 91= 145*

*ii) b = 92- 38 = 54*

*c) radioactive substances are harmful to the body when ingested*

*d) i) Negative*

*ii)A – Beta radiation C – Alpha radiation*

*iii) C – more massive than A*

*e) i) A = 233 – 8 = 225*

*ii) Z = 90 – [(2 x2) + (2x – 1)]*

*= 90 – (4 – 2)*

*= 90 – 2 = 88*

*f) – a beta source is placed on one side of a moving sheet of paper and a G.N detector*

*on the other side*

*- If the material is too thin, the count rate at the detector will be too high and*

*vice versa*

*4. (i) S – 210 1 T – 206*

*(ii) The splitting of a heavy nuclide to lighter particles 1 (fission process)*

*5. State what type of radioactive decay this is. - Alpha decay*

*a) X…4 Y…2*

*6. Long radio waves, AM radio waves, T.V and FM Radio waves, short Radio waves, infra red*

*radiation, red-light , Uv radiation and X-rays.*

*7. No. of half lifes = 380 = 10*

*38*

$N = N_o (½)^{1/t}$

$\frac{380}{38} = (½)^{10} = \frac{1}{1024}$

*8. (a) Time taken for the activity of a sample of a radioactive material to reduce to half*

*of the original value*

*(b) (i) S – scale – simple and uniform / consistent*

*p – Plotting at least 4 points correct*

*C – Line must pass through at least 3 points*

*(ii) -Half-life 319 ±0.1 days (1mk)*

*-Readings –off from the graph clearly*

*(c)*

| *Time* | *Nuclei* |
|---|---|
| *0* | $8 \times 10^{10}$ |
| *138* | $4 \times 10^{10}$ |
| *276* | $2 \times 10^{10}$ |
| *414* | $1 \times 10^{10}$ |
| *552* | $0.5 \times 10^{10}$ |
| *690* | $0.25 \times 10^{10}$ |

(1mk)

*Therefore Nuclei remaining un-decayed*

$^{T}/_{t} = 2.5 \times 10^{9}$ *(1mk)*

*OR* $N = No (½)^{½}$

$N = 8 \times 10^{10}(½)$

$= 0.25 \times 1010 = 2.5 \times 10^{9}$ *(2mks)*

*(d) (i) mass number = 228 a.m.u (1mk)*

*Atomic number = 89 a.m.u (1mk)*

*(ii)*