Test your knowledge answers Topic 4 Atomic Structure and Radioactivity

4.1 Atomic Structure

1. How many of the following are there in an atom of oxygen $^{16}_{8}O$?

   Protons 8 Neutrons 8

   Nucleons 8 Electrons 8

2. An atom of carbon has 6 protons and 12 nucleons.

   How many electrons does it have ? 6

   How many neutrons does it have ? 6

3. An atom of sodium has 11 electrons and 23 nucleons.

   How many protons does it have ? 11

   How many neutrons does it have ? 12

4. An electron is removed from a hydrogen atom.

   Give two names for what remains proton

   positive ion

5. An electron adds onto a chlorine atom.

   What would we call the resulting particle ? negative ion

6. The commonest isotope of Uranium is $^{238}_{92}U$

   How many electrons, protons and neutrons does it have ?

   e 92 p 92 n 146

7. Repeat for an isotope of Uranium $^{235}_{92}U$ e 92 p 92 n 143

4.2 Radioactivity

1. The radiation in a room was measured three times. The number of counts recorded each minute was

46 54 53

(a) Why were three measurements made ? radioactivity is a random process
we can work out an average

(b) What was the average background radiation in Becquerel ? 51 counts per min
= 0.85 Bq

2. A radioactive source was then brought out into the room and the radiation measured 1cm away from it. The number of counts recorded each minute was

824 850 834

(a) What was the average radiation in Becquerel ? 836 counts per min = 13.9 Bq

(b) Work out the average radioactivity of the source, accounting for background radiation 13.9Bq – 0.85Bq = 13.05 Bq

3. The radioactivity was then measured :-

A 5cm away from the source
B 1cm away but with 3mm of aluminium in between source and detector
C 1cm away but with 5mm of lead in between source and the detector

The readings obtained were

A 826
B 160
C 51

Explain how the results show that the source was emitting beta and gamma radiations beta because the aluminium stopped some of the radiation
gamma because the aluminium didn't stop all of it

4. A similar experiment was performed with a different radioactive source
The readings obtained were

A 195
B 196
C 52

What radiation was this source emitting ? alpha and gamma

4.2.2 Nuclear equations

1. Which nuclear equation is correct ?

D $^{238}_{92}U \rightarrow {}^{4}_{2}\alpha + {}^{234}_{90}Th$ this one is correct

2. Which nuclear equation is correct ?

B $^{1}_{0}n \rightarrow {}^{1}_{1}p + {}^{0}_{-1}e$ this one is correct

3. Yttrium, Y , has atomic number 39
Barium, Ba , has atomic number 56
Neptunium, Np , has atomic number 93

Write nuclear equations for the following radioactive decays

(a) Alpha decay from Americium-241, Am, element number 95

$$^{241}_{95}Am \rightarrow {}^{4}_{2}\alpha + {}^{237}_{93}Np$$

(b) Beta decay from Strontium-90, Sr, element number 38

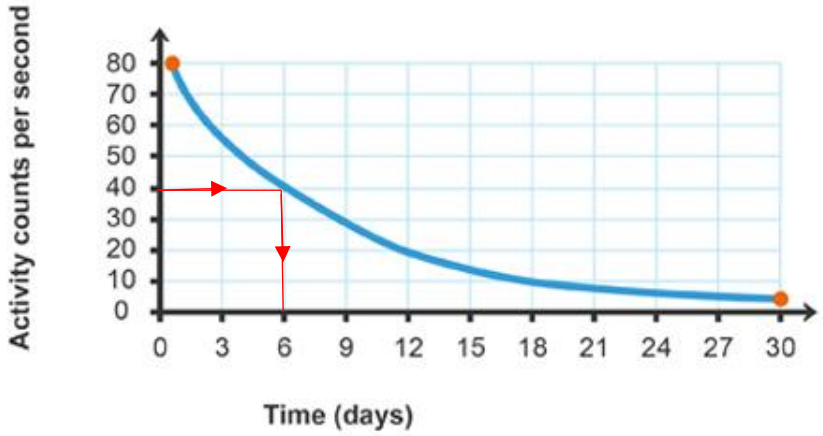
$$^{90}_{38}Sr \rightarrow {}^{0}_{-1}\beta + {}^{90}_{39}Y$$

(c) Beta and gamma decay from Caesium-137, Cs, element number 55

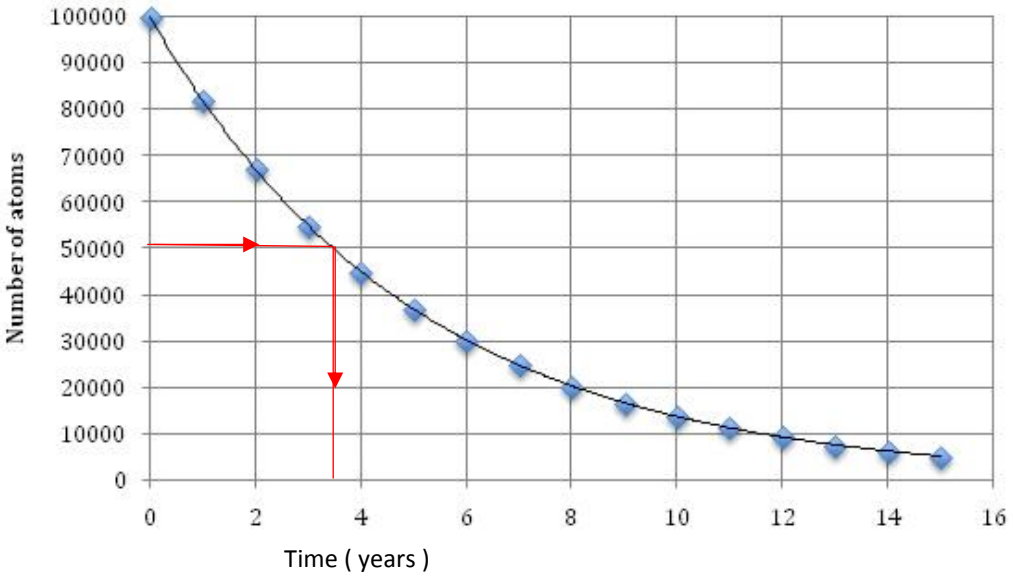
$$^{137}_{55}Cs \rightarrow {}^{0}_{-1}\beta + {}^{137}_{56}Ba + \gamma$$

4.2.3 Half life

Determine the half life of the following substances :-



6 days



3.5 years

4.3 Uses for radiation

Explain the following :-

1. An alpha emitting radioactive source is required in a smoke detector.
   Beta or Gamma would be no good
   Alpha is stopped by smoke, beta and gamma aren't

2. Beta radiation is required for a paper thickness monitor. Alpha or Gamma would be no good
   Beta can pass through paper with some absorption depending on thickness
   Alpha won't penetrate. Gamma will penetrate with no absorption

3. Gamma radiation is required for medical diagnosis or treatment. Alpha or Beta would be no good
   The radiation has to enter or leave the body. Alpha and Beta can't

4. For radioactive 'tracing' a source with a relatively short half life is desirable.
   Need to send patient home by the end of the day

5. Compare the waste products of coal-fired power stations with nuclear power stations. What advantages and disadvantages do each type of power station provide ?
   Coal : greenhouse gases (CO_2) and gases causing acid rain (SO_2)
   Fission : radioactive waste

6. Compare the waste products of fission and fusion reactions. Why would it be desirable to replace fission reactors with fusion ones ?
   Fusion produces harmless waste products