Nuclear

1. Nov 01

8 (a) One isotope of gold is represented as $_{79}Au^{197}$. State the number of neutrons in one nucleus of this isotope. number = ... [1]

(b) In an α-particle scattering experiment, an α-particle approaches an isolated gold nucleus, as illustrated in Fig. 8.1.

Fig. 8.1

Complete Fig. 8.1 to show the path of the □-particle as it passes by, and moves away from, the gold nucleus. [2]

(c) The α-particle in (b) is replaced by one having greater initial kinetic energy.

State what change, if any, will occur in the final deviation of the α-particle. [1]

2. May 02

9 The radiation from a radioactive source is detected using the apparatus illustrated in Fig. 9.1.

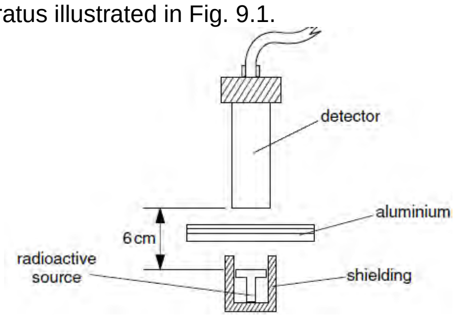

Fig. 9.1

Different thicknesses of aluminium are placed between the source and the detector. The count rate is obtained for each thickness. Fig. 9.2 shows the variation with thickness *x* of aluminium of the count rate.

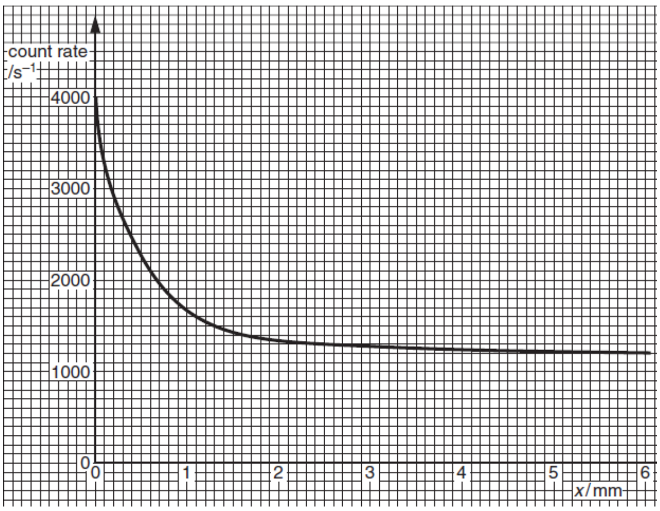

Fig. 9.2

(a) Suggest why it is not possible to detect the presence of the emission of α-particles from the source. [1]

(b) State the evidence provided on Fig. 9.2 for the emission from the source of

(i) α-particles, (ii) γ-radiation.[4]

3. Nov 02

8 A nucleus of an atom of francium (Fr) contains 87 protons and 133 neutrons.

(a) Write down the notation for this nuclide.

…………

Fr

………… [2]

(b) The nucleus decays by the emission of an α-particle to become a nucleus of astatine (At).

Write down a nuclear equation to represent this decay. [2]

4. May 03

6 (a) A student is provided with a freshly prepared sample of a radioactive material and the count rate C from the source is found to vary with time t as shown in Fig. 6.1 (a).

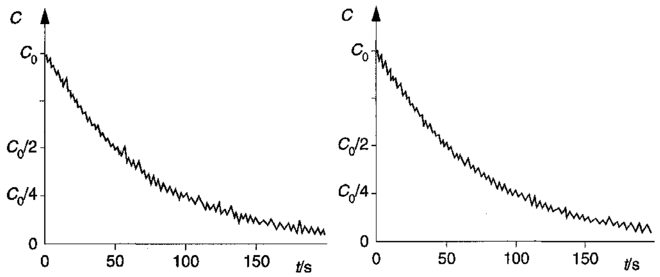

Fig. 6.1 (a) Fig. 6.1 (b)

A second similar sample of the radioactive material is then prepared and the student repeats the experiment, but with the sample at a higher temperature. The variation with time of the count rate for the second sample is shown in Fig. 6.1 (b).

State the evidence that is provided by these two experiments for (i) the random nature of radioactive decay,

(ii) the spontaneous nature of radioactive decay. [2]

(b) The radioactive source in (a) is an isotope of radon ($_{86}Rn^{220}$) emits α-radiation to become polonium (Po).

(i) State the number of neutrons in one nucleus of radon-220. number=... [1]

(ii) Write down a nuclear equation to represent the radioactive decay of a nucleus of radon.

....

$^{220}_{86}Rn \rightarrow$ Po + ...

....

[3]

5. Nov 03

6 One isotope of iron may be represented by the symbol $_{26}Fe^{56}$.

(a) State, for one nucleus of this isotope,

(i) the number of protons, (ii) the number ol neutrons.

(b) The nucleus of this isotope of iron may be assumed to be a sphere of radius 5.7×10^{-15}m.

Calculate, for one such nucleus,

(i) the mass, (ii) the density. [4]

(c) An iron ball is found lo have a density of 7900 kg m^{-3}. By the reference to your answer in (b)(ii), suggest what can be inferred about the structure of an atom of iron. [2]

Nov 04

7 The α-particle scattering experiment provided evidence for the existence of a nuclear atom.

(a) State what could be deduced from the fact that

(i) most α-particles were deviated through angles of less than 10°, [2]

(ii) a very small proportion of the α-particles was deviated through angles greater than 90°. [2]

(b) Fig. 7.1 shows the path AB of an α-particle as it approaches and passes by a stationary gold nucleus.

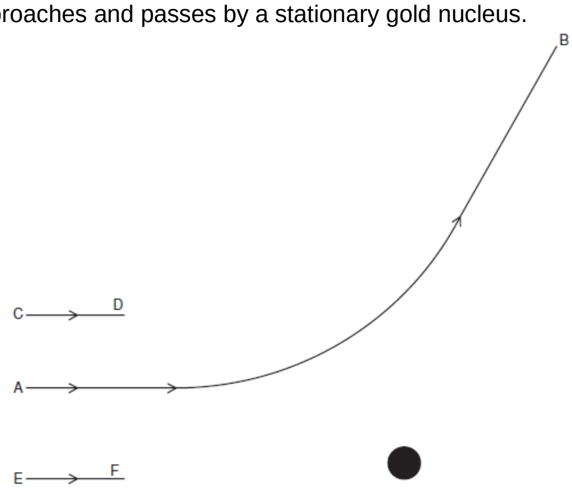

Fig. 7.1

On Fig. 7.1, draw lines (one in each case) to complete the paths of the □-particles passing by the gold nucleus when the initial direction of approach is
(i) along line CD, **(ii)** along line EF. [3]

May 05

8 Fig. 8.1 shows the position of Neptunium-231 ($_{93}Np^{231}$) on a diagram in which nucleon number (mass number) *A* is plotted against proton number (atomic number) *Z*.

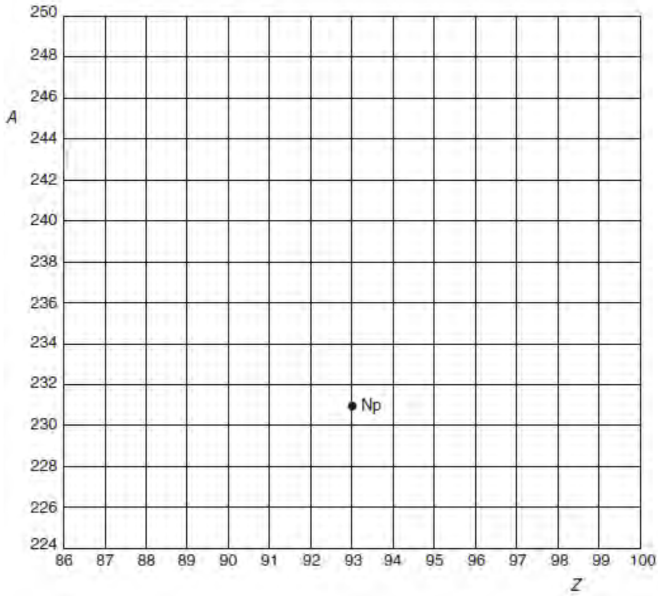

Fig. 8.1

(a) Neptunium-231 decays by the emission of an □-particle to form protactinium.
On Fig. 8.1, mark with the symbol Pa the position of the isotope of protactinium produced in this decay. [1]
(b) Plutonium-243 ($_{94}Pu^{243}$) decays by the emission of a □-particle (an electron).
On Fig. 8.1, show this decay by labelling the position of Plutonium-243 as Pu and the position of the daughter product as D. [2]

May 06

8 The radioactive decay of nuclei is both spontaneous and random.
Explain what is meant by
(a) *radioactive decay* of a nucleus, [2]
(b) *spontaneous* decay, [2]
(c) *random* decay. [2]

Nov 06

3 Francium-208 is radioactive and emits □-particles with a kinetic energy of 1.07×10^{-12} J to form nuclei of astatine, as illustrated in Fig. 3.1.

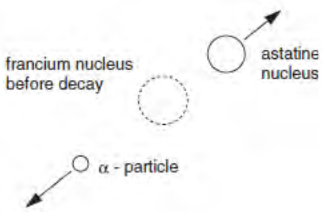

Fig. 3.1

(a) State the nature of an □-particle. [1]
(b) Show that the initial speed of an □-particle after the decay of a francium nucleus is approximately 1.8×10^{7} ms^{-1}. [2]
(c)(i) State the principle of conservation of linear momentum.[2
(ii) The Francium-208 nucleus is stationary before the decay. Estimate the speed of the astatine nucleus immediately after the decay. speed = ……………………….. ms^{-1} [3]
(d) Close examination of the decay of the francium nucleus indicates that the astatine nucleus and the □-particle are not ejected exactly in opposite directions.
Suggest an explanation for this observation. [2]

May 07

7 The radioactive decay of a strontium (Sr) nucleus is represented in Fig. 7.1.

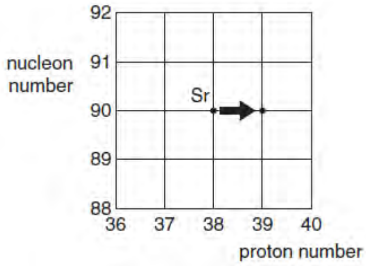

Fig. 7.1

(a) State whether Fig. 7.1 represents α-decay, β-decay or γ-decay. [1]
(b) One type of radioactive decay cannot be represented on Fig. 7.1.
Identify this decay and explain why it cannot be represented. [2]

Nov 07

7 (a) Evidence for the nuclear atom was provided by the a-particle scattering experiment.
State the results of this experiment. [2]
(b) Give estimates for the diameter of
(i) an atom, [1] **(ii)** a nucleus. [1]

May 08

7 Uranium-236 ($_{92}U^{236}$) and Uranium-237 ($_{92}U^{237}$) are both radioactive.
Uranium-236 is an α-emitter and Uranium-237 is a β-emitter.
(a) Distinguish between an α-particle and a β-particle. [4]
(b) The grid of Fig. 7.1 shows some proton numbers *Z* on the *x*-axis and the number *N* of neutrons in the nucleus on the *y*-axis.

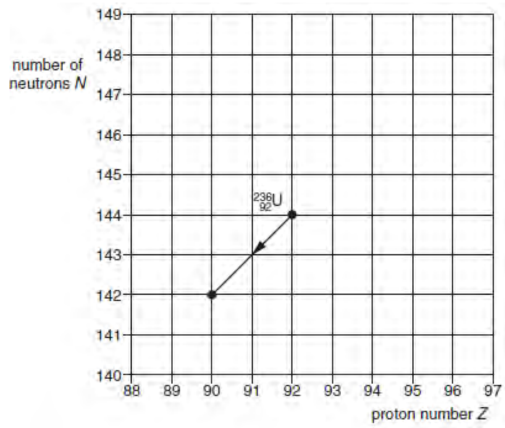

Fig. 7.1

The α-decay of Uranium-236 ($_{92}U^{236}$) is represented on the grid. This decay produces a nucleus of thorium (Th).
(i) Write down the nuclear equation for this α-decay. [2]
(ii) On Fig. 7.1, mark the position for a nucleus of
1. Uranium-237 (mark this position with the letter U),
2. Neptunium, the nucleus produced by the β-decay of Uranium-237 (mark this position with the letters Np). [2]

Nov 08

8 Thoron is a radioactive gas. The variation with time *t* of the detected count rate *C* from a sample of the gas is shown in Fig. 8.1.

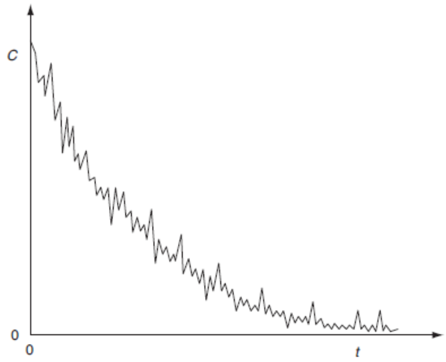

Fig. 8.1

Radioactive decay is said to be a random and spontaneous process.

(a) Explain, by reference to radioactive decay, what is meant by a *random* process. [2]

(b) State the feature of Fig. 8.1 which indicates that the process is

(i) a decay process, [1] **(ii)** random. [1]

(c) A second similar sample of thoron is prepared but it is at a much higher temperature. The variation with time of the count rate for this second sample is determined.

State the feature of the decay curves for the two samples that suggests that radioactive decay is a spontaneous process.[1]

May 09

8 The spontaneous and random decay of a radioactive substance involves the emission of

either α-radiation or β-radiation and/or γ-radiation.

(a) Explain what is meant by *spontaneous* decay. [2]

(b) State the type of emission, one in each case, that

(i) is not affected by electric and magnetic fields, [1]

(ii) produces the greatest density of ionisation in a medium, [1]

(iii) does not directly result in a change in the proton number of the nucleus, [1]

(iv) has a range of energies, rather than discrete values. [1]