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7 Uranium-236 ($^{236}_{92}U$) and Uranium-237 ($^{237}_{92}U$) 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.

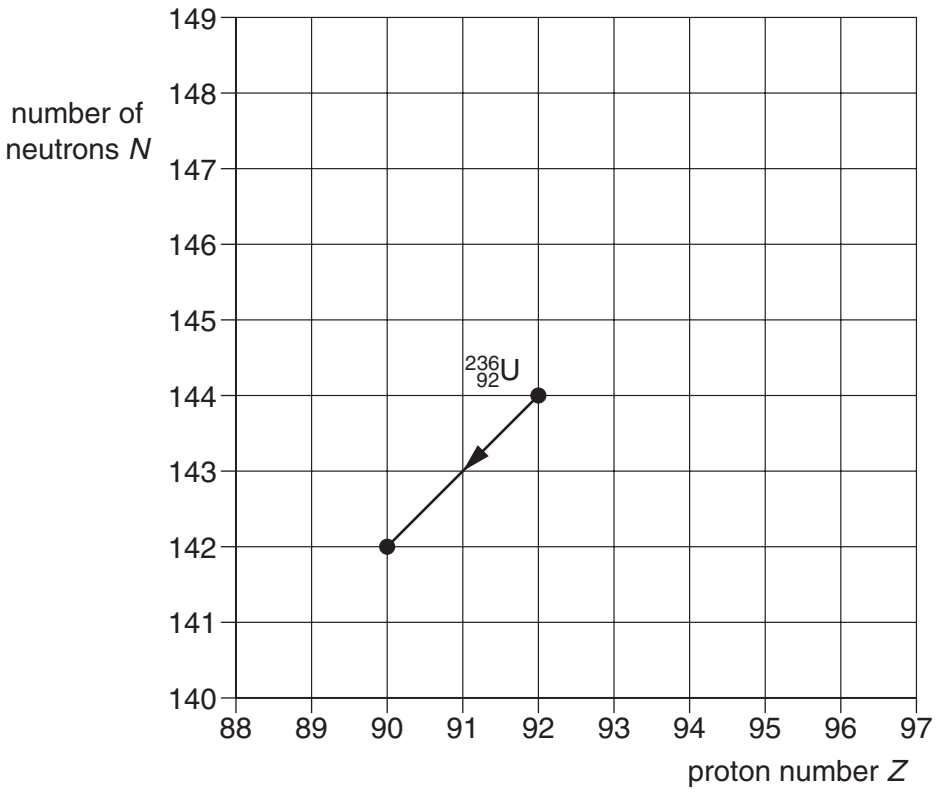

Fig. 7.1

7 **(a)** Evidence for the nuclear atom was provided by the α-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]

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

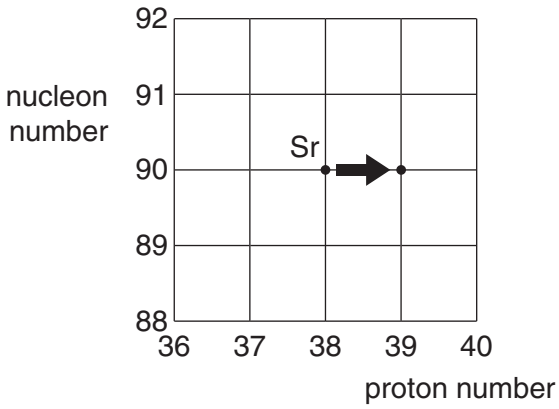

Fig. 7.1

(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]

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

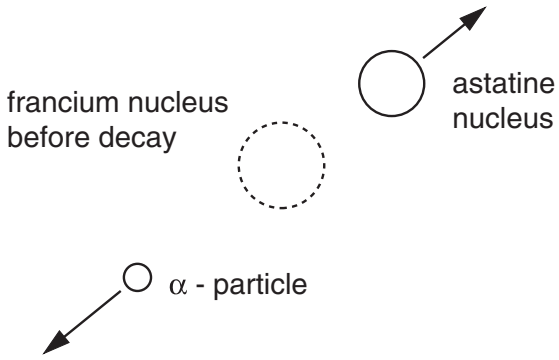

Fig. 3.1

(a) State the nature of an α-particle.

.....

..... [1]

(b) Show that the initial speed of an α-particle after the decay of a francium nucleus is approximately 1.8×10^7 m s^{-1}.

[2]

(c) **(i)** State the principle of conservation of linear momentum.

.....

.....

..... [2]

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(ii) The Francium-208 nucleus is stationary before the decay. Estimate the speed of the astatine nucleus immediately after the decay.

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speed = ... $m\,s^{-1}$ [3]

(d) Close examination of the decay of the francium nucleus indicates that the astatine nucleus and the α-particle are not ejected exactly in opposite directions.

Suggest an explanation for this observation.

.....

.....

..... [2]

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5 **(a)** Distinguish between the structure of a metal and of a polymer.

metal: .....

.....

.....

polymer: .....

.....

..... [4]

(b) Latex is a natural form of rubber. It is a polymeric material.

(i) Describe the properties of a sample of latex.

.....

.....

..... [2]

(ii) The process of heating latex with a small amount of sulphur creates cross-links between molecules. Natural latex has very few cross-links between its molecules.

Suggest how this process changes the properties of latex.

.....

.....

..... [2]

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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]

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2 The Brownian motion of smoke particles in air may be observed using the apparatus shown in Fig. 2.1.

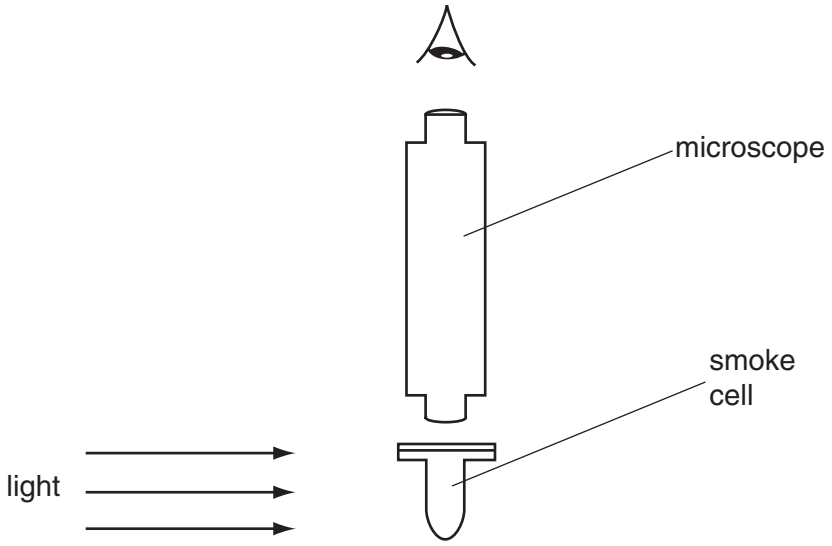

Fig. 2.1

(a) Describe what is seen when viewing a smoke particle through the microscope.

.....

.....

.....[2]

(b) Suggest and explain what difference, if any, would be observed in the movement of smoke particles when larger smoke particles than those observed in **(a)** are viewed through the microscope.

.....

.....

.....[2]

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[Turn over

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

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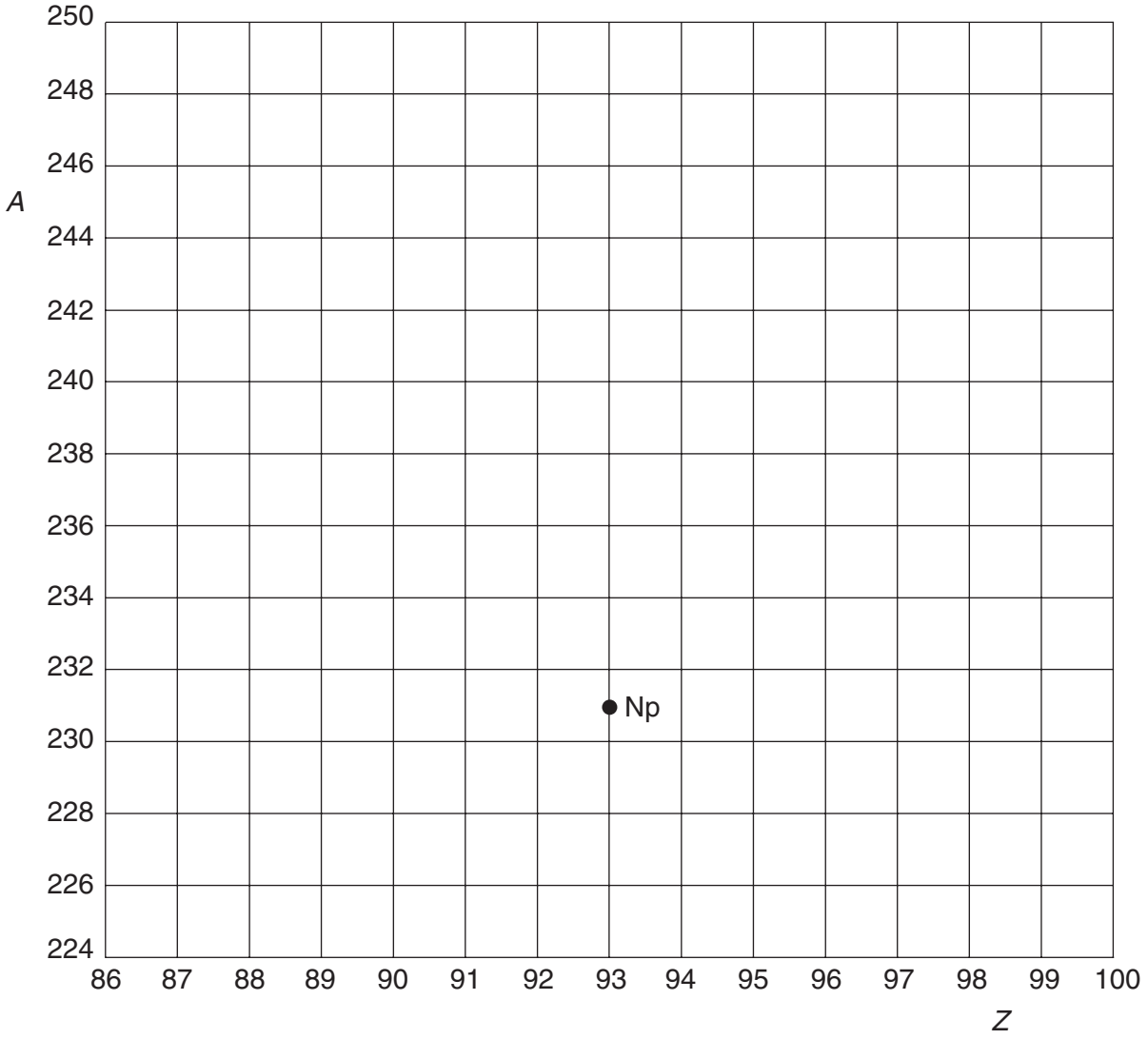

Fig. 8.1

(a) Neptunium-231 decays by the emission of an α-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 ($^{243}_{94}$Pu) decays by the emission of a β-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]

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

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(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]

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(b) During the time for which the charge is moving, 1.1×10^5 J of energy is dissipated in the 45 Ω resistor.

(i) Determine the energy dissipated in the 15 Ω resistor during the same time.

energy = ... J

(ii) Suggest why the total energy provided is greater than that dissipated in the two resistors.

.....

.....

[4]

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]

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

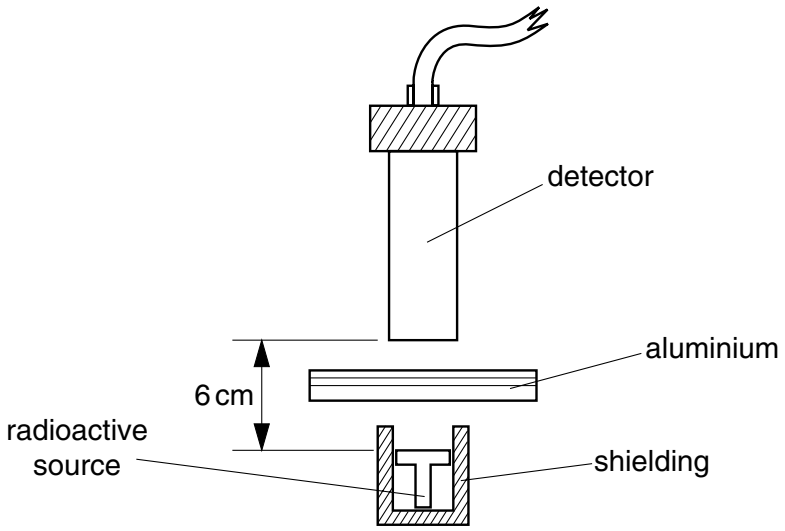

Fig. 9.1

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.

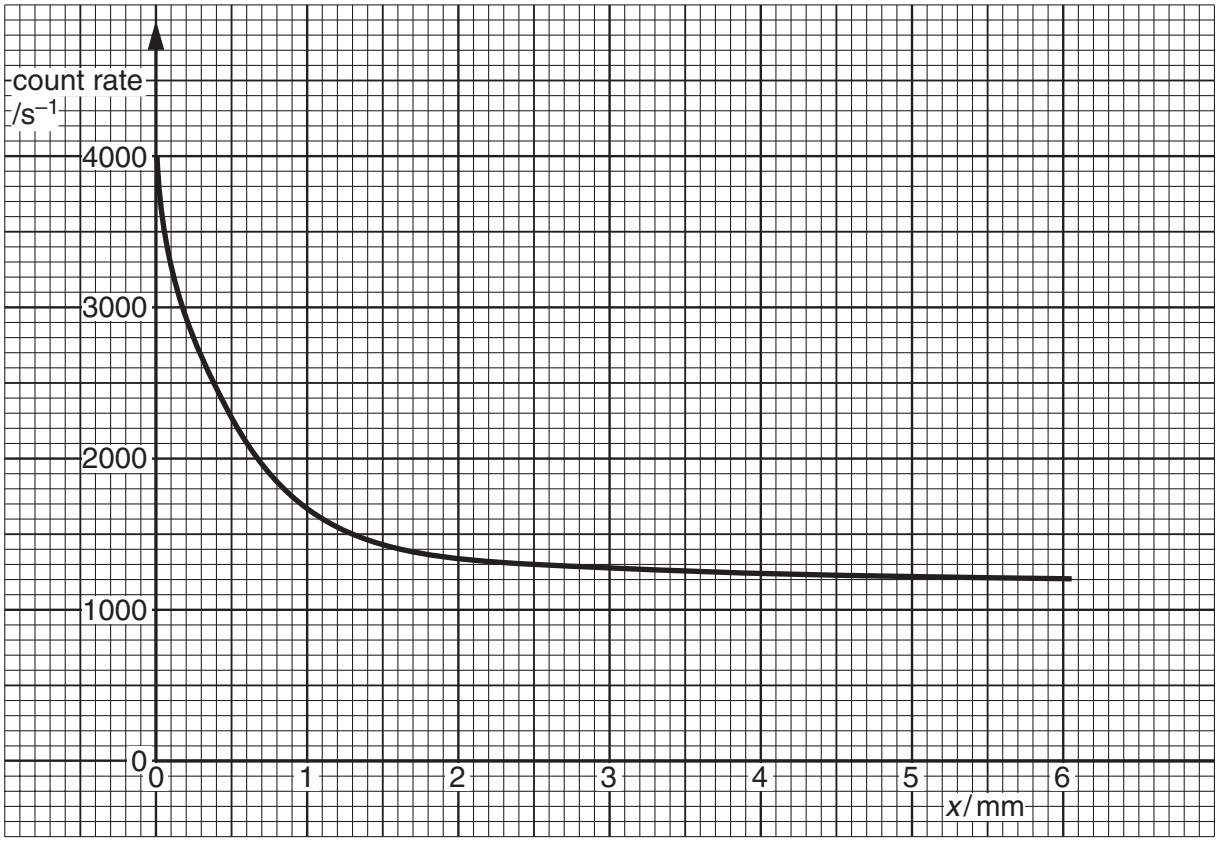

Fig. 9.2

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5 **(a)** In the following list of solids, underline those materials which are crystalline.

rubber copper nylon glass aluminium [2]

(b) The three graphs A, B and C of Fig. 5.1 represent the variation with extension *x* of the tension *F* in specimens of three different materials. One of the materials is polymeric, one is brittle and the other is ductile. They are not shown in that order in Fig. 5.1.

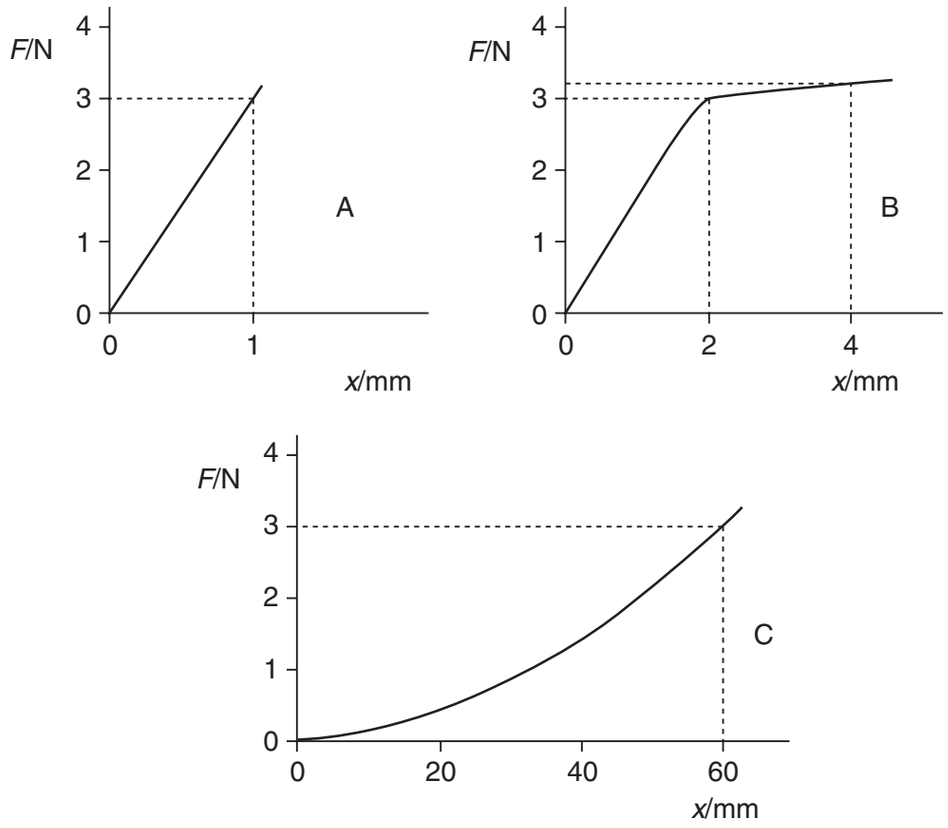

Fig. 5.1

(i) State the type of material which would produce the line shown in each graph.

Graph A is for a ..... material.

Graph B is for a ..... material.

Graph C is for a ..... material. [2]

(ii) Use graph B to estimate the work done in stretching the specimen from 0 to 4 mm.

work done = ... J [3]

[Turn over

8 **(a)** One isotope of gold is represented as

$$^{197}_{79}\text{Au}.$$

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 α-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]