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.

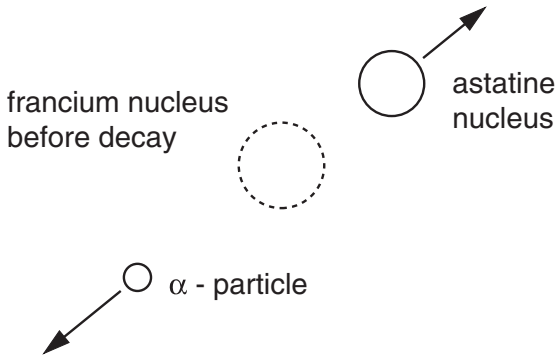

Fig. 3.1

(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]

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

For Examiner's Use

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]

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]

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]

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

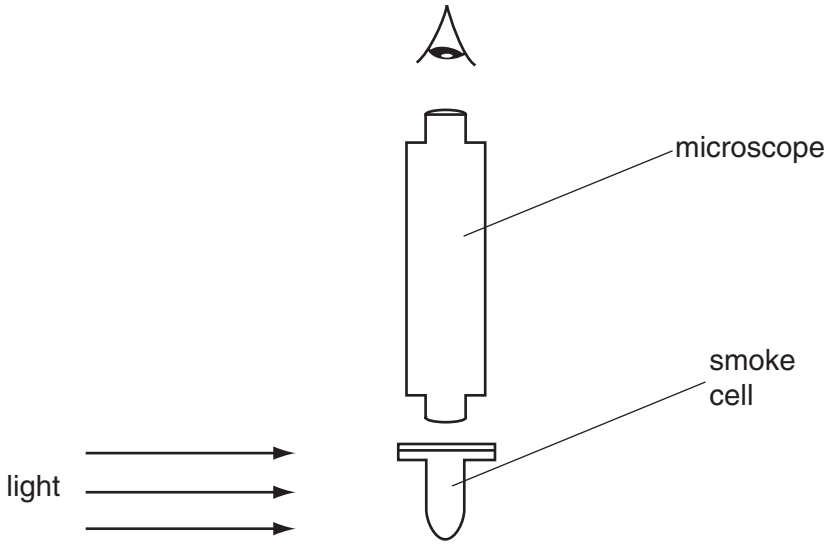

Fig. 2.1

(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]

[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*.

For Examiner's Use

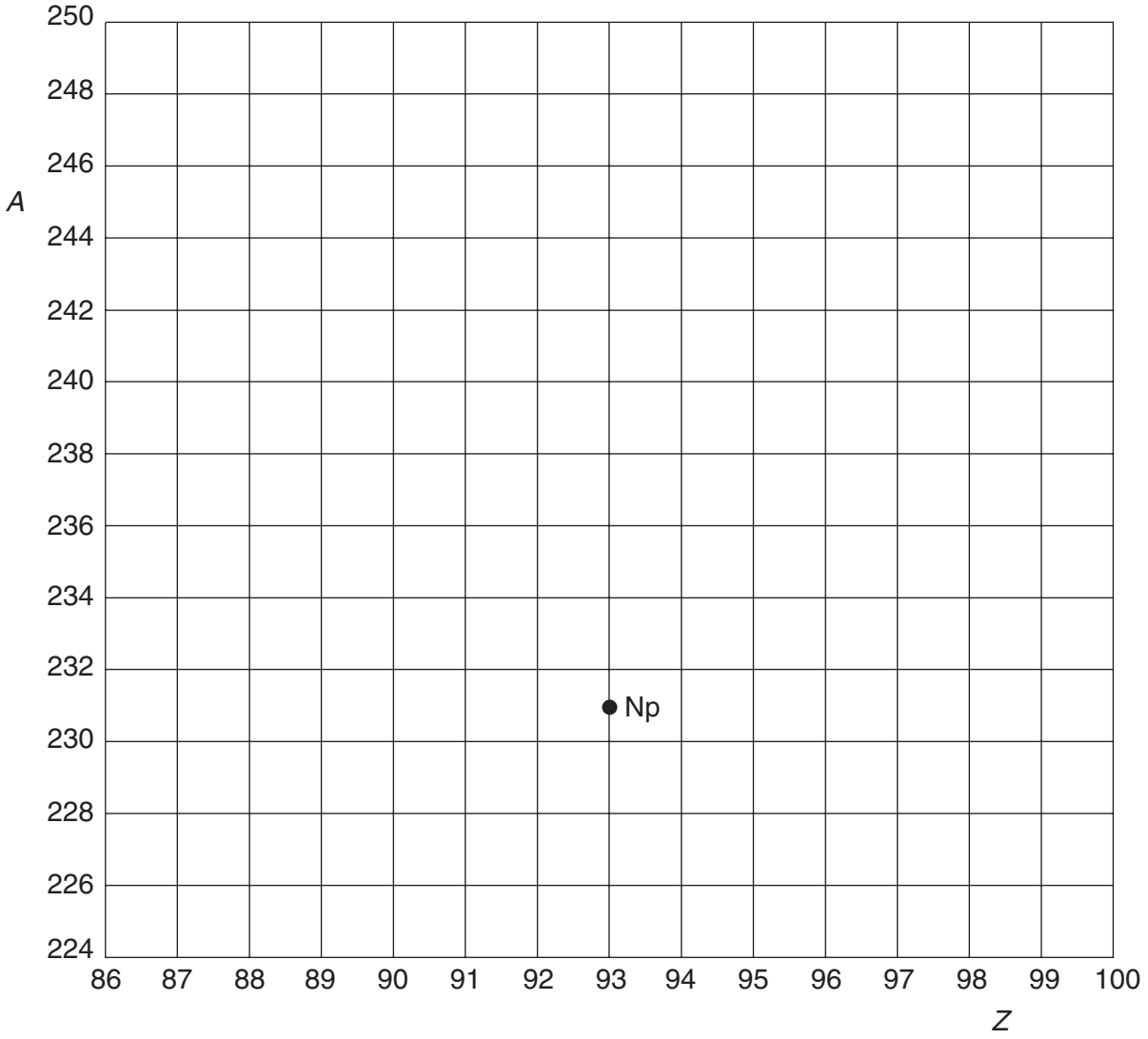

Fig. 8.1

(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]

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

For Examiner's Use

(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]