10 Americium-241 is a radioactive isotope used in smoke detectors.

It has the symbol

$$^{241}_{95}\mathrm{Am}$$

(a) (i) How many protons are in an americium-241 nucleus?

(1)

- ☒ **A** 95
- ☒ **B** 146
- ☒ **C** 241
- ☒ **D** 336

(ii) How many neutrons are in an americium-241 nucleus?

(1)

- ☒ **A** 95
- ☒ **B** 146
- ☒ **C** 241
- ☒ **D** 336

(iii) How many electrons are in a neutral americium-241 atom?

(1)

- ☒ **A** 95
- ☒ **B** 146
- ☒ **C** 241
- ☒ **D** 336

(b) When americium-241 decays, it emits alpha particles to form neptunium-237.

Np is the symbol for neptunium.

Complete the nuclear equation for the decay of americium-241.

(3)

$$^{241}_{95}\text{Am} \longrightarrow {}^{237}_{\ \ }\text{Np} + {}^{\ \ }_{\ \ }\alpha$$

(c) After the decay, the neptunium-237 nucleus emits gamma radiation.

State what happens to the number of protons and neutrons in a nucleus as a result of gamma emission.

(2)

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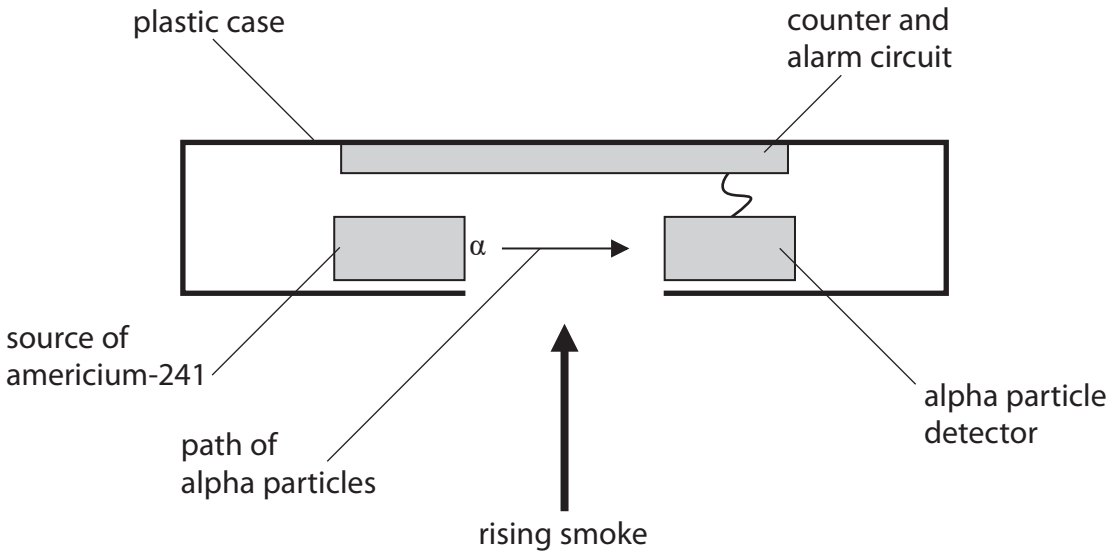
(d) The diagram shows a cross-section through a smoke alarm.



In normal operation, the count rate measured by the counter is 100 counts per second.

If the count rate falls below 80 counts per second, the alarm sounds.

Explain how the rising smoke causes the alarm to sound.

(2)

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(e) Americium-241 has a half-life of 430 years.

(i) Describe what is meant by the term **half-life**.

(2)

(ii) Americium-242 has a half-life of 16 hours and is a beta emitter.

Explain why americium-242 is not suitable for use in the smoke detector.

(3)

(Total for Question 10 = 15 marks)