1 Most elements have some *isotopes* which are *radioactive*.

What is meant by the term radioactive?

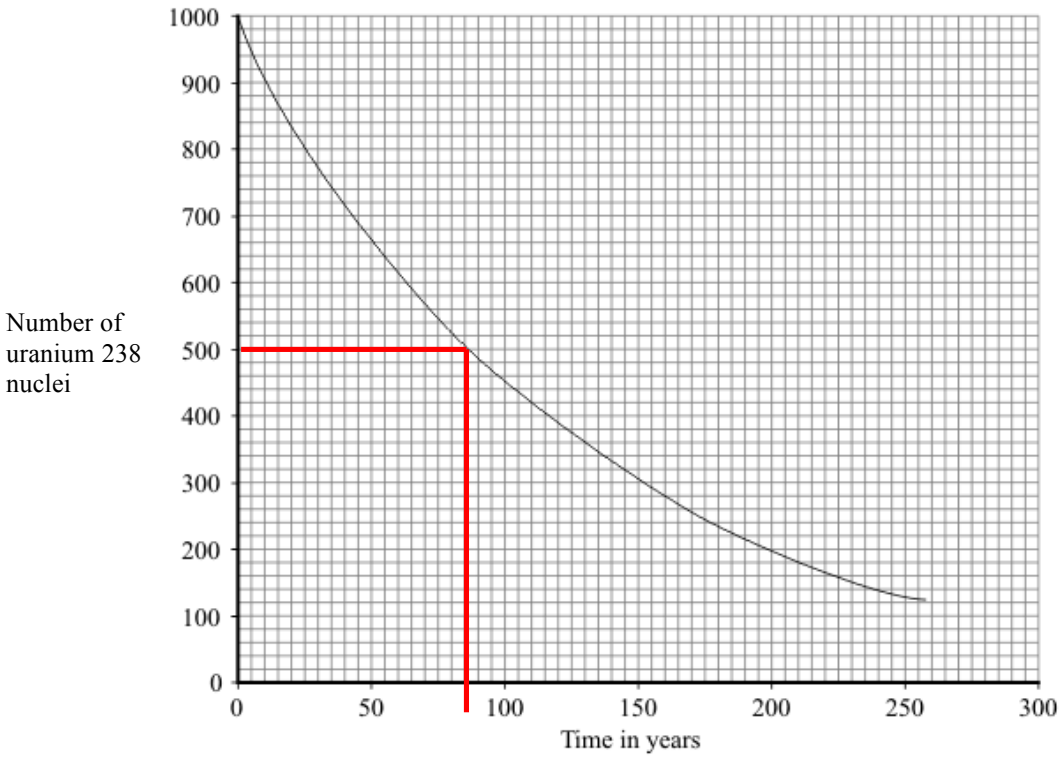
An unstable nucleus **or** atom **or** isotope

Or nucleus has too much energy

or An atom **or** nucleus **or** isotope which decays [1 mark]

(1 mark)

1 (a) The graph shows how the number of nuclei in a sample of the radioactive isotope Uranium-238 changes with time.



1 (a) (i) Use the graph to find the half-life of uranium-238.

Show clearly on the graph how you obtain your answer.

Half-life = 85 years

(2 marks)

1 mark for the correct line on the graph. there is usually some leeway with the answer when reading off a graph. In this case about 83 to 87.

This question continues on the next page.

1 (a) (ii) Complete the following table for an atom of uranium-238.

$^{238}_{92}U$ $^{234}_{90}Th$

Mass number	238
Number of protons	92
Number of neutrons	**146**

1 (a) (iii) An atom of uranium-238 decays to form an atom of thorium-234

What type of radiation, alpha, beta or gamma, is emitted by uranium-238?

Alpha [1 mark]

(1 mark)

1 (a) (iv) Why does an atom that decays by emitting alpha or beta radiation become an atom of a different element?

Proton number changes or atomic number changes [1 mark]

(1 mark)

The answer must only refer to a change in proton number, not neutrons or mass number (remember mass number includes protons plus neutrons.

1 (b) An atom of actinium-228 decays by emitting a beta particle, β. A neutron in the nucleus changes into a proton and an electron. The electron is ejected, while the neutron remains.

An isotope of thorium is left behind.

Complete the equation for this decay.

$$^{228}_{89}Ac \longrightarrow \ ^{228}_{90}Th + \beta$$

(2 marks)

(Total 7 marks)