Nuclear decay

Radioactive decay involves conversion of atoms of one isotope (parent isotope) to another (daughter isotope). This leads to a smaller number of nuclei of the parent isotope and a larger number of nuclei of the daughter isotope. Some isotopes, such as uranium-235, go through several decay stages, known as a decay chain, before finally reaching a stable daughter state.

In this activity you will explore the rate of decay of various radioactive isotopes. Locate and open the *Nuclear decay simulator*, and select **Start**.

1. Select an isotope for investigation and complete the following:

   N_0 (number of atoms selected) .....

   Parent isotope .....

   Daughter isotope .....

- Select **Start** to begin the decay process, then adjust the **Timescale** until a useable graph of the decay process appears in the graphing box.

2. Sketch the graph of decay below.

number of nuclei

time

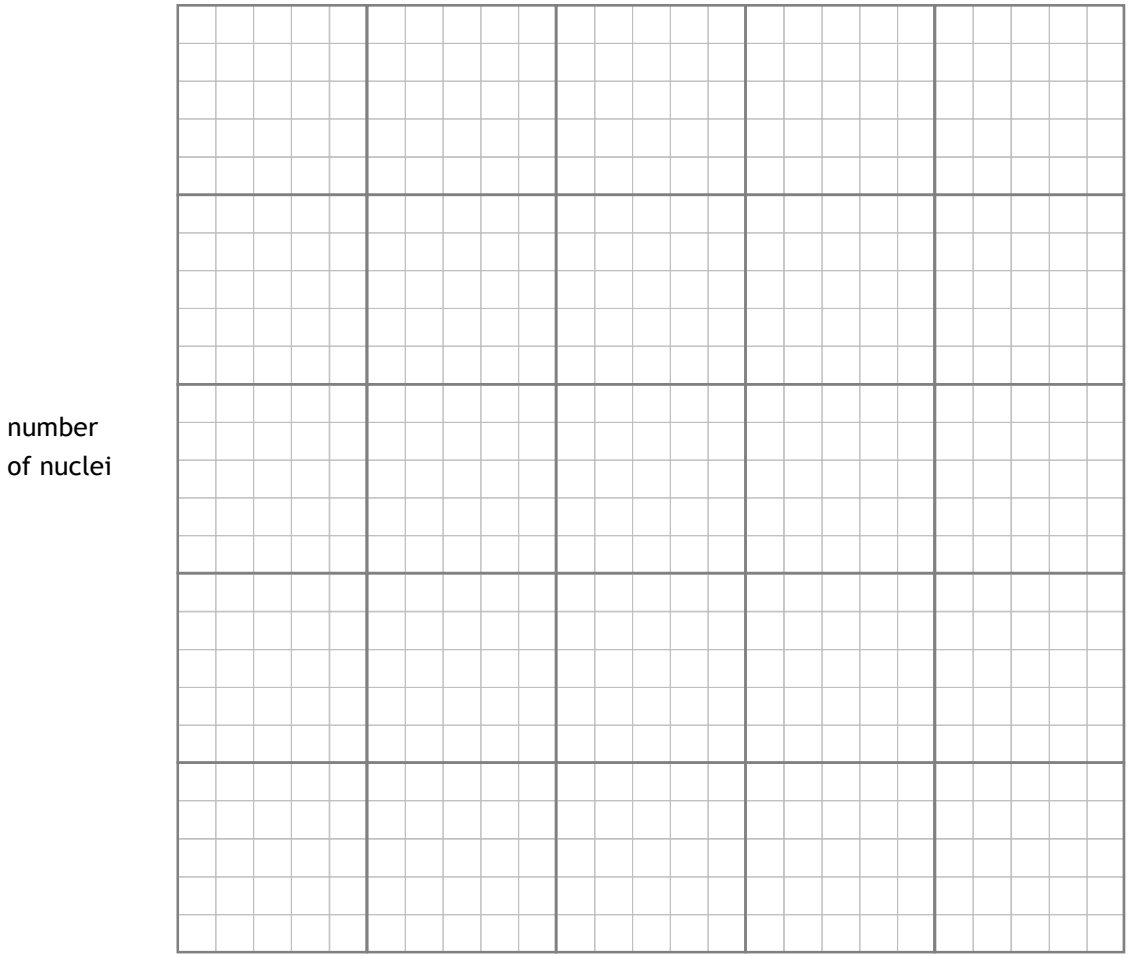
Isotopes are usually compared using their half-life. The half-life of an isotope is the time taken for the number of nuclei to decrease (decay) to half the initial number. For example from 100 to 50 nuclei, or 2400 to 1200 nuclei.

3. Using the *Nuclear decay simulator* determine the half-life of the isotope and then the second half-life, which is the time taken to reduce from a half to a quarter of the initial number.

   Half-life $t_{1/2}$ = ...

   Second half-life $t_{1/4}$ = ...

4. Complete the activity again, using the same isotope, but with a different number of initial atoms. Sketch the graph of decay below and record half-life and second half-life.



From your investigation answer the following questions:

5. What is the half-life and second half-life of your isotope?

   Half-life $t_{1/2}$ = ...

   Second half-life $t_{1/4}$ = ...

6. Does an isotope's half-life depend on the initial number of atoms? Explain your reasoning.

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7. What is the general shape of the decay curve? What type of function does this curve represent?

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8. Starting with 100 000 nuclei of your selected isotope, how long will it take to reduce to:

50 000 nuclei .....

25 000 nuclei .....

6250 nuclei .....

9. What does *n* represent in the following relationship:

$$N = N_0(\tfrac{1}{2})^n$$

where N = number of nuclei remaining and N_0 = number of initial nuclei.

Extension activity

- An additional option in the *Nuclear decay simulator* enables you to investigate graphically growth of the daughter isotope in addition to decay of the parent isotope.
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