# On nuclear physics

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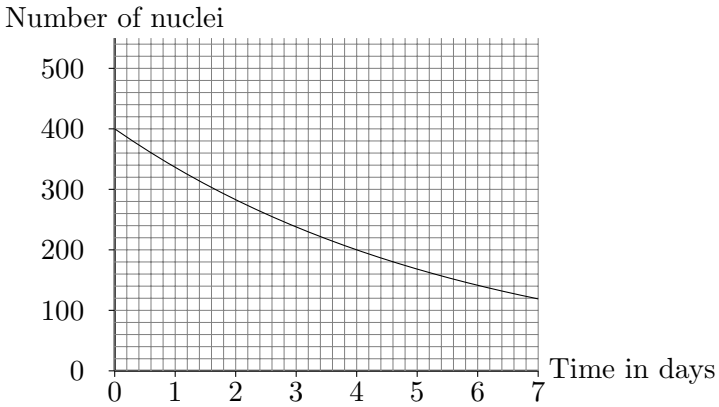
## Warm-up problems

1. Draw a diagram to show the basic structure of an atom, showing the relative masses and electric charges of protons, neutrons and electrons.
2. Which type of radioactive emission
   (a) is positively charged?
   (b) is not deflected by magnetic fields?
   (c) is the most penetrative?
   (d) is the most intensely ionizing?
   (e) cannot pass through cardboard?
   (f) does not cause a change in mass number or atomic number?
   (g) has the greatest mass?
3. What is meant by the *half-life* of a radioactive isotope?

## Regular problems

4. Uranium-235 and uranium-238 are isotopes of uranium, and they both have the proton number 92.
   (a) What do the numbers 235 and 238 represent?
   (b) What does 92 tell you about the nucleus of uranium?
   (c) What else does 92 tell you about the atom?
   (d) In which two ways are the two isotopes different?
5. Complete the following equations for radioactive decay:
   (a) Radon gas decays via $\alpha$ decay:
   $$^{222}_{86}\mathrm{Rn} \longrightarrow$$
   (b) Iron-59 is an unstable isotope of iron which decays via $\beta$ emission:
   $$^{59}_{26}\mathrm{Fe} \longrightarrow$$
6. Paul says 'an ion is a bit like an isotope, it has one two few or one too many particles'. Explain whether Paul is right in thinking this, and how could you improve his understanding?
7. The graph below shows how, in a sample of air, the number of radon-222 nuclei change with time.




(a) Why might $\alpha$-emitting radioactive substances be particularly harmful if they are inhaled?

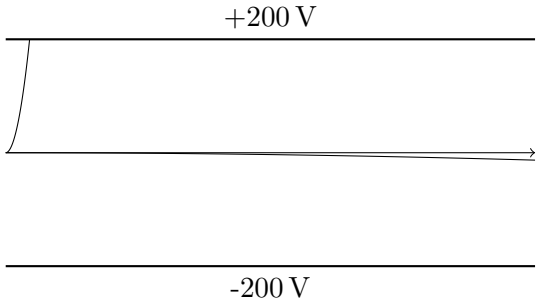
(b) Use the graph to find the half life of radon-222. Show clearly how you work out your answer.

(c) How many radon-222 nuclei would you expect to remain after 16 days?

8. Following the work of Geiger and Marsden, the 'plum pudding' model of the atom was replaced by the 'nuclear model' of the atom. Explain why it is sometimes necessary for scientists to replace a scientific model.

## Extension problems

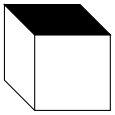
9. The diagram below shows the path of three different types of radiation between two charged metal plates.




(a) Sketch a copy of the diagram above, and label the three paths followed by the various radiations.

(b) Explain the differences in the paths in terms of the relative mass and charge of each kind of radiation.

10. Design an experiment to model the decay of a radioactive isotope using a collection of dice with one face painted black. How could you model the effects of background radiation?



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