E.3 Radioactive decay

Checklist

What you should know

After studying this subtopic, you should be able to:

- Outline what isotopes are and that some isotopes are unstable.
- Describe the changes to the nucleus that occur during alpha decay, beta decay and gamma decay and use radioactive decay equations.
- Know that neutrinos and antineutrinos exist.
- Outline how background radiation affects the count rate of a source of nuclear radiation.
- Describe the penetrating and ionising abilities of alpha particles, beta particles and gamma rays.
- Explain that radioactive decay is random and spontaneous.
- Describe half-life and use values of half-life to describe the changes in activity and count rate during radioactive decay.
- Describe the strong nuclear force, nuclear binding energy and mass defect.
- Outline how binding energy per nucleon varies with nucleon number.
- Explain mass-energy equivalence and use the equation:

$$E = mc^2$$

Higher level (HL)

- Explain that the radiation spectrums for alpha decay and gamma decay are evidence for discrete nuclear energy levels.
- Describe how the continuous spectrum of beta decay is evidence for the neutrino.
- Outline the decay constant and know that it only approximates the probability of decay in a unit time.
- Explain the radioactive decay law and use the equation:

$$N = N_0 e^{-\lambda t}$$

- Describe activity as the rate of decay and use the equation:

$$A = \lambda N$$
$$= \lambda N_0 e^{-\lambda t}$$

- Describe the relationship between the decay constant and half-life and use the equation:

$$T_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$$

- Describe evidence for the existence of the strong nuclear force.
- Explain the shape of the binding energy curve above a nucleon number of 60.
- Explain how the neutron to proton ratio relates to the stability of a nucleus.

Practical skills

Once you have completed this subtopic, go to Practical 9: Determining the half-life of random processes as a simulation of radioactive decay (https://app.kognity.com/study/app/physics/sid-423-cid-762593/book/determining-the-half-life-of-random-processes-id-46753/) in which you will collect and analyse large data sets as a model for radioactivity.