Edexcel IAL Physics A-Level

Topic 5.2 - Nuclear Decay

Flashcards

What is the instability in an atom caused by?

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- Too many neutrons.
- Too many protons.
- Too many nucleons in total.
- Too much energy in the nucleus.

What are the four types of radiation?

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Alpha - release of a particle made of 2 protons and 2 neutrons, has a relative charge of +2 and a relative mass of 4.

Beta-minus - release of an electron with -1 charge and negligible mass.

Beta-plus - release of a positron with +1 charge and negligible mass.

Gamma - release of a short wavelength, high frequency electromagnetic wave, with no charge or mass.

What are the properties of alpha radiation?

What are the properties of alpha radiation?

Alpha radiation has a strong ionising ability but a slow speed. It has a small penetration range of a few cm of air/sheets of paper and can be affected by a magnetic field (alpha particles are charged).

What are the properties of beta-minus radiation?

What are the properties of beta-minus radiation?

Beta radiation has a weak ionising ability but a fast speed. It has a medium penetration range of a few mm of aluminium and can be affected by a magnetic field.

What are the properties of gamma radiation?

What are the properties of gamma radiation?

Gamma radiation is very weakly ionising, however travels at the speed of light. It has a large penetrative range of many cm of lead or several m of concrete. It is not affected by magnetic fields.

What is the Decay Constant and Activity?

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The decay constant is the probability that a given nucleus will decay per second.

Activity is the number of nuclei that decay per second.

Activity = decay constant x no. of undecayed nuclei

What is half life?

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It is the average time it takes for the number of undecayed nuclei to halve. In practice, it's the time it takes for the activity or count rate to halve.

What is the equation linking decay constant and half life?

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Decay constant = ln2 / half life

What is the mass deficit equal to?

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Mass deficit is equal to the nuclear binding energy. As nucleons bind the total mass decreases, this lost mass is released as energy.

$$E=mc^2$$

What is the equation for binding energy per nucleon?

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Binding energy per nucleon = Binding energy / nucleon number

Why does nuclear fission occur?

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When a thermal neutron is absorbed by U-235 fission occurs because the U-235 nucleus is now even more unstable so it fissions (splits) into 2 daughter nuclei and more neutrons.

Define the atomic mass unit, u.

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The mass of 1/12 of an atom of carbon 12.

$1u = 1.661 \times 10^{-27}$ kg, 931.5 MeV

What is nuclear fusion?

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Fusion is when 2 small nuclei join to form a larger nucleus with a higher average binding energy per nucleon.

Draw a graph of average binding energy per nucleon against nucleon number.

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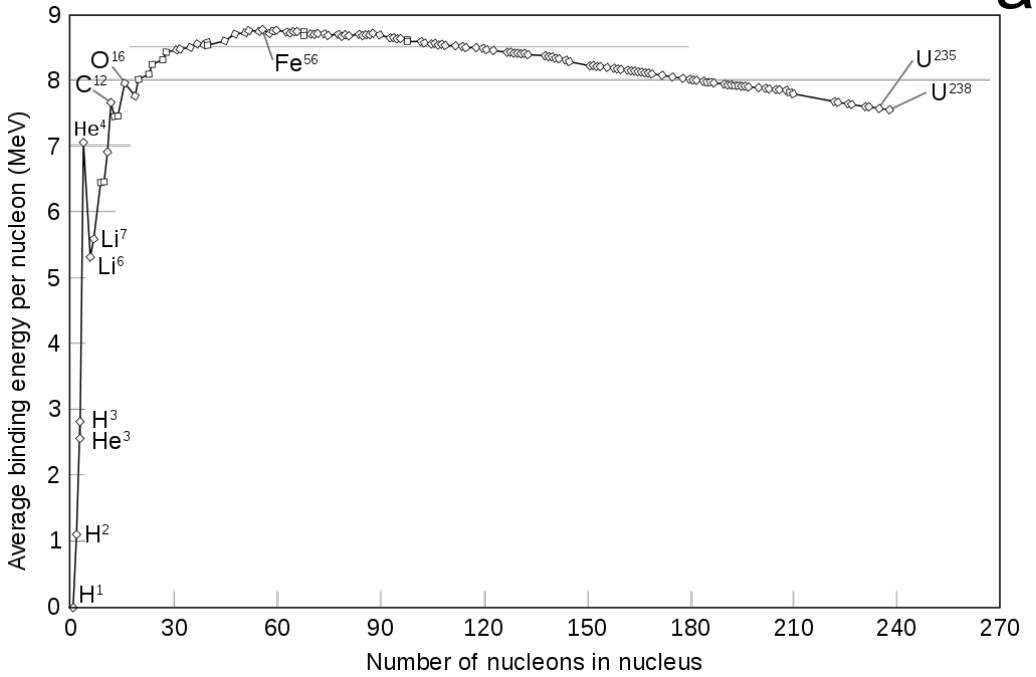

Before Fe fusion is energetically favourable and past it fission is energetically favourable.

Why is fusion difficult to make energetically favourable on earth?

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Nuclei are positively charged so have a strong electrostatic repulsion, this must be overcome using high temperatures and densities of matter so they can be close enough for the strong force to take over.

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They haven't accounted for background radiation.

State the equations used to represent the exponential nature of nuclear decay.

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

$$A = A_0 e^{-\lambda t}$$

N is the number of unstable nuclei remaining and N_0 is the original number, A means activity.