Marks 5

- How does the ratio of the number of neutrons to the number of protons in a stable or long-lived radionuclide change as the atomic number increases?

The proton to neutron ratio slowly increases from 1 (for deuterium) to ~1.5 for bismuth.

For light elements, the ratio is approximately 1. As the number of protons grows, increasing numbers of neutrons are needed to stabilise the nucleus.

After ^{208}Pb, all nuclei are unstable.

The generation of energy in a nuclear reactor is largely based on the fission of certain long-lived radionuclides (usually ^{235}U or ^{239}Pu). The fission products include every element from zinc through to the *f*-block. Explain why most of the radioactive fission products are β-emitters.

The optimal ratio between the number of neutrons, *n*, and the number of protons, *p,* increases as *Z* increases.

Simply splitting a large nucleus in two will produce nuclides with similar *n*:*p* ratios to the parent, which will now be too high. They will emit negative charge to convert neutrons to protons, bringing about a more satisfactory *n*:*p* ratio. *i.e.* they will be β emitters.

Two of the more common isotopes produced in nuclear reactors are ^{131}I (half-life of 8.02 days) and ^{137}Cs (half-life of 30 years). Both are β-emitters. If you were exposed to equal concentrations of both isotopes for 1 hour, which isotope, ^{137}Cs or ^{131}I, would do more damage? Explain your reasoning.

^{131}I would do more damage.

It has the shorter half-life so undergoes more disintegrations and produces more radiation in a given time period.