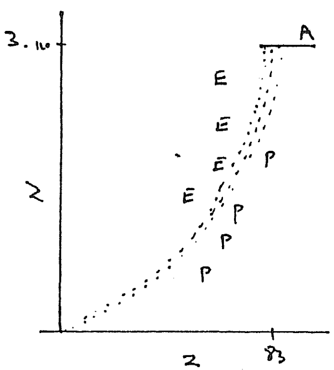
1. As the number of protons increases the coulombic repulsion between the protons increases ∴ more neutrons, that can supply a nuclear force to overcome the coulombic force, are required. The ratio of neutrons to protons increases

2. . Alpha decay – emits α particles.
. Beta minus decay – emits an electron
. Beta plus decay – emits a positron
. Spontaneous fission

3.



(4) There are no stable nuclei above Z = 83.

4.
$Ra^{226}_{88} \rightarrow He^4_2 + Rn^{222}_{86}$

5. (1) X
(2) Z
(3) Y.

6. (1)
$mass_U = 3.851816 \times 10^{-25}$

$mass\ Th = 3.785277 \times 10^{-25}$
$+\ mass\ He = 6.64489 \times 10^{-27}$

Total = $3.8517259 \times 10^{-27}$ kg

∴ loss of mass $= M_U - M_{Total}$

$\Delta m = 0.00009 \times 10^{-27}$
$= 0.9 \times 10^{-31}$ kg

(2) $E = \Delta m c^2$
$= 0.9 \times 10^{-31} \times (3.0 \times 10^8)^2$
$= 8.1 \times 10^{-15}$ J.

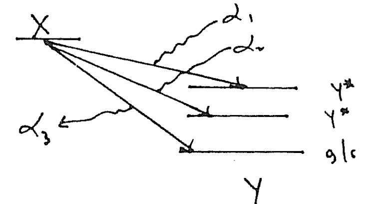
(3) The ratio of the energies is inverse to the ratio of their masses.
mass (Th) > mass α
∴ $K_\alpha > K_{Th}$.

$\frac{K_\alpha}{K_{Th}} = \frac{m_{Th}}{m_\alpha} = \frac{378.5277 \times 10^{-27}}{6.64489 \times 10^{-27}}$

$\approx \frac{57.0}{1}$

7. The electrons come from a break-down of a nucleon (ie a proton or neutron)
(see β^- + β^+ decay).

8. When an unstable nucleus decays by α decay, the resulting nucleus could be left in the ground state or excited states eg.
$[X \rightarrow \alpha + Y]$



Thus the energy of the emitted alpha particles will be different.
∴ They will travel different distances in a cloud chamber before they stop ∴ different length tracks.

9. (1) $U^{238} \longrightarrow Pb^{206}$
each α decay reduces the mass # by 4
∴ $238 - 206 = 32$
∴ 8 α decays.

(2) atomic # drops by 10 – but 8 α decays will reduce it by 16. Now each β^- decay increases the atomic # by 1.
∴ 6 β^- decays must occur.

10.
$Po^{216}_{84} \longrightarrow Pb^{212}_{82} + He^4_2$

∴ α particle emitted.

11. (1) Z reduces by 2
A reduces by 4
(2) Z increases by 1
A constant
(3) Z decreases by 1
A constant.
(4) A & Z constant.

12.
$n + Th^{232}_{90} \longrightarrow Th^{233}_{90}$.

. $Th^{233}_{90} \xrightarrow{\beta^-} Pa^{233}_{91} + e^- + \bar{\nu}$

. $Pa^{233}_{91} \xrightarrow{\beta^-} U^{233}_{92} + e^- + \bar{\nu}$

13. • Increasing your distance from the source
• Reducing your exposure time
• Shielding yourself from the source.

14 (1) β^- decay (ie e^0_{-1})
$O^{18}_8 \rightarrow F^{18}_9 + e^0_{-1} + \bar{\nu} + \gamma$

(2) β^+ decay (ie e^0_{+1} positron)

$C^{10}_6 \rightarrow B^{10}_5 + e^0_{+1} + \nu + \gamma$

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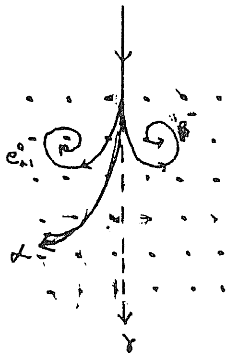

1. Spontaneous nuclear fission is the process in which a very large nucleus splits into two smaller nuclei.

Induced fission is caused by the capture of a nucleon (neutron) that causes instability and the eventual split of the large nucleus. (ie forced fission)

2. See text

3. Mass reactants:

$n = 1.675 \times 10^{-27}$ kg

$U = 3.9017 \times 10^{-25}$ kg

$\therefore$ mass $= 3.91845 \times 10^{-27}$ kg

mass products:

$Ba = 2.28922 \times 10^{-25}$

$Kr = 1.57534 \times 10^{-25}$

$3n = 5.025 \times 10^{-27}$

$\therefore$ mass $= 3.91481 \times 10^{-27}$ kg

$\therefore$ mass defect $= m_R - m_P$

$= 0.00364 \times 10^{-27}$

$= 3.64 \times 10^{-30}$ kg

$\therefore E = \Delta m c^2$

$= 3.64 \times 10^{-30} \times (3 \times 10^8)^2$

$= 3.276 \times 10^{-13}$ J.

En of gamma photon $= 3.276 \times 10^{-14}$ J.

$\therefore E = hf$

$\therefore f = E/h = \dfrac{3.276 \times 10^{-14}}{6.63 \times 10^{-34}}$

$= 4.9 \times 10^{19}$ Hz.

4. $n^1_0 + U^{235}_{92} \rightarrow Sn^{132}_{50} + Mo^{108}_{42} + 3n^1_0$

Conserved: (1) mass / Energy
(2) nucleons
(3) charge
(4) momentum.

5. The fission of a U^{235} nucleus produces about 230 MeV.
230 MeV is equivalent to 3.7×10^{-11} Joules.
This is about 10^7 times the amount of chemical energy given out by the combustion of methane.

6. Fission gives out huge amounts of energy for small amounts of mass compared with methane burnt in oxygen.
Fossil fuels use too much mass & produce too much waste (CO / CO_2).
The amount of waste produced by fission is very much less.