Alpha

Beta

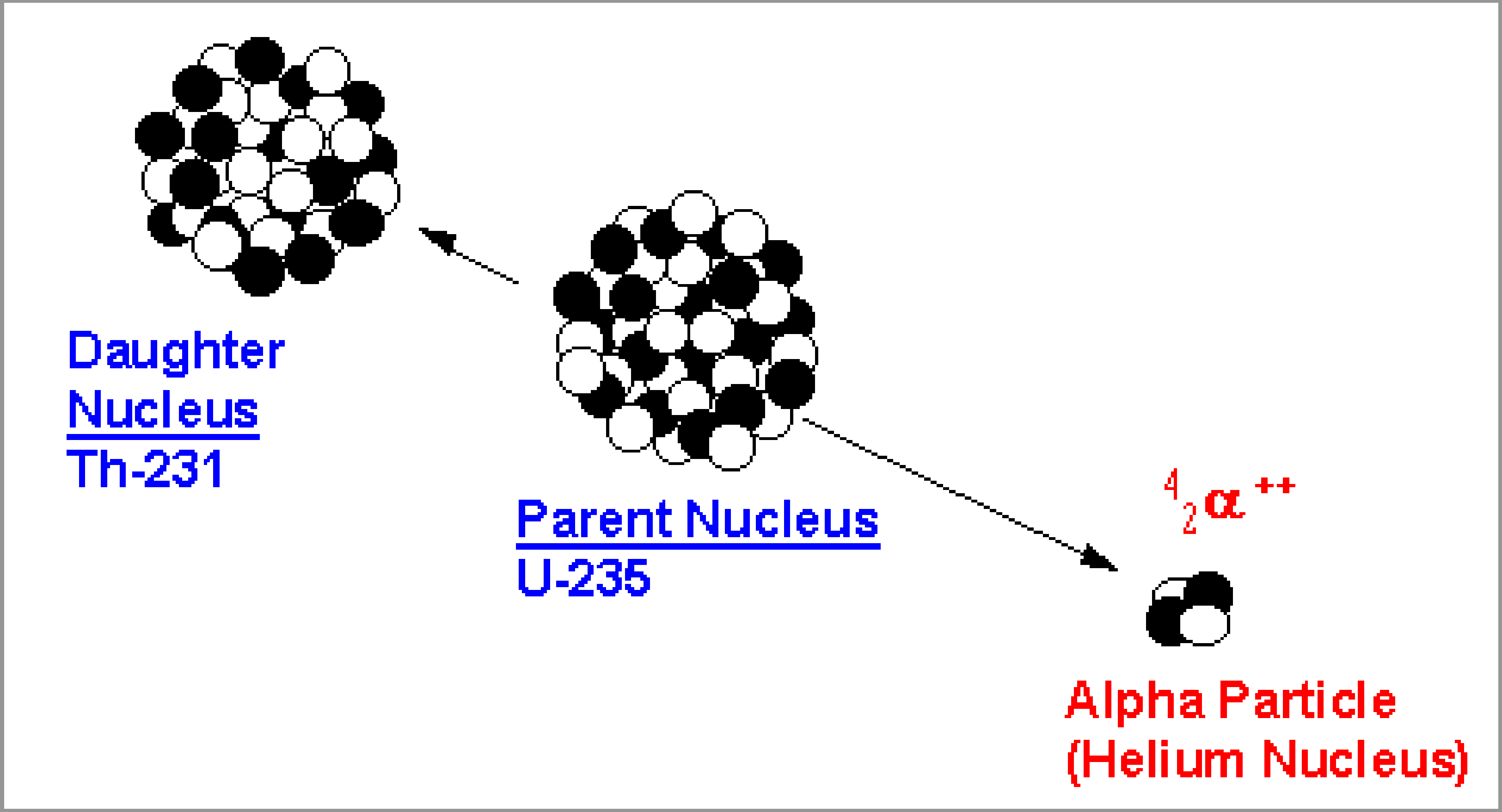
Gamma

Lesson Contents

1. Physical properties of α, β and γ
2. Penetrating power of α, β and γ
3. N v Z graphs
4. Decay laws

Alpha Radiation

Alpha particles contain two protons and two neutrons



Alpha Radiation

α has the same constitution as a helium nucleus

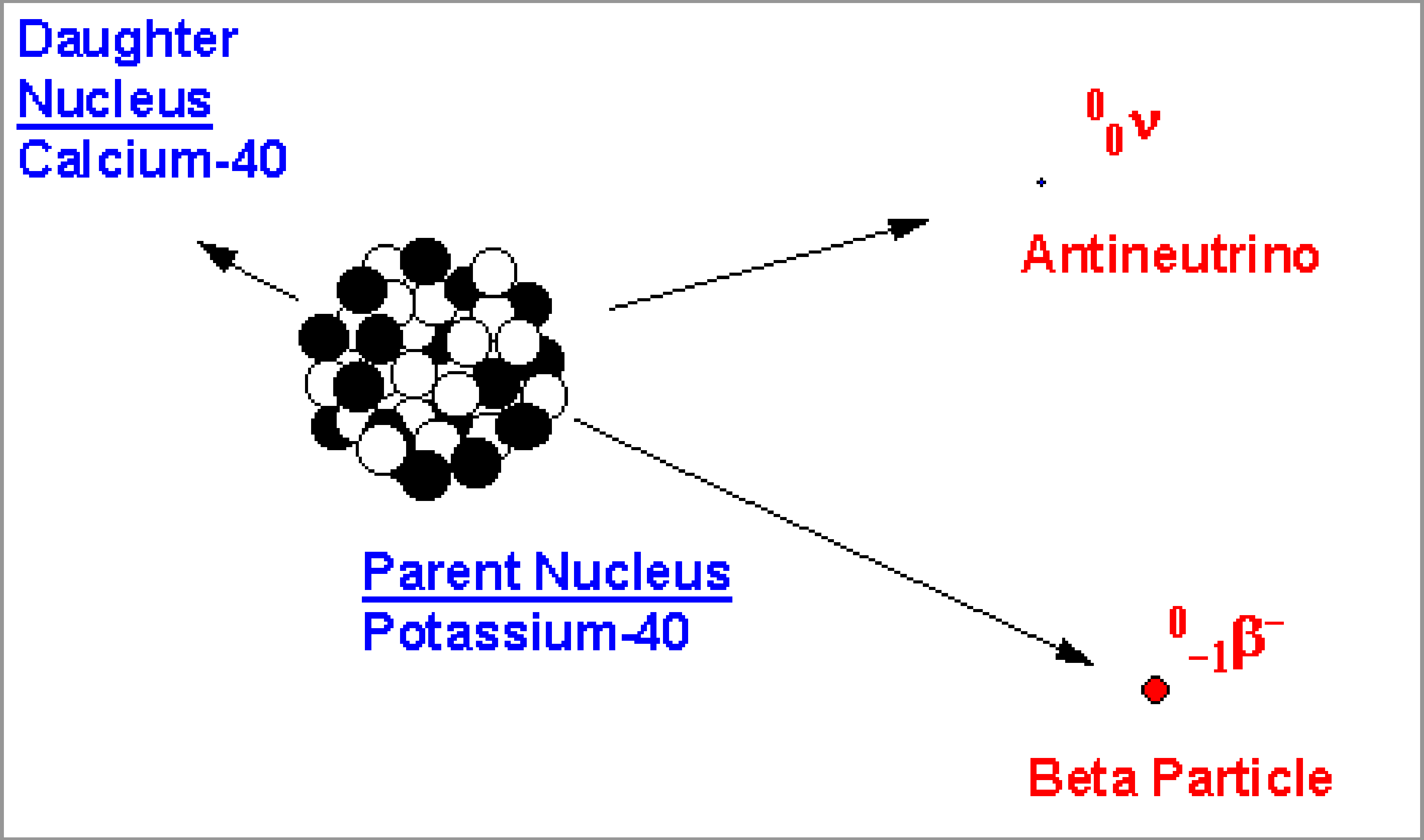
Alpha particles may be written as

$$^{4}_{2}\mathrm{He} \text{ or } ^{4}_{2}\alpha$$

They have a double positive charge and a mass of 4 u

Beta-minus Radiation

Beta-minus particles are electrons



Beta-minus Radiation

β^- is produced when a neutron decays

Beta-minus particles may be written as

$${}^{0}_{-1}\beta^{-} \text{ or } {}^{0}_{-1}e^{-}$$

They have a negative charge and a mass of $^{1}/_{1800}$ u

Beta-minus Radiation

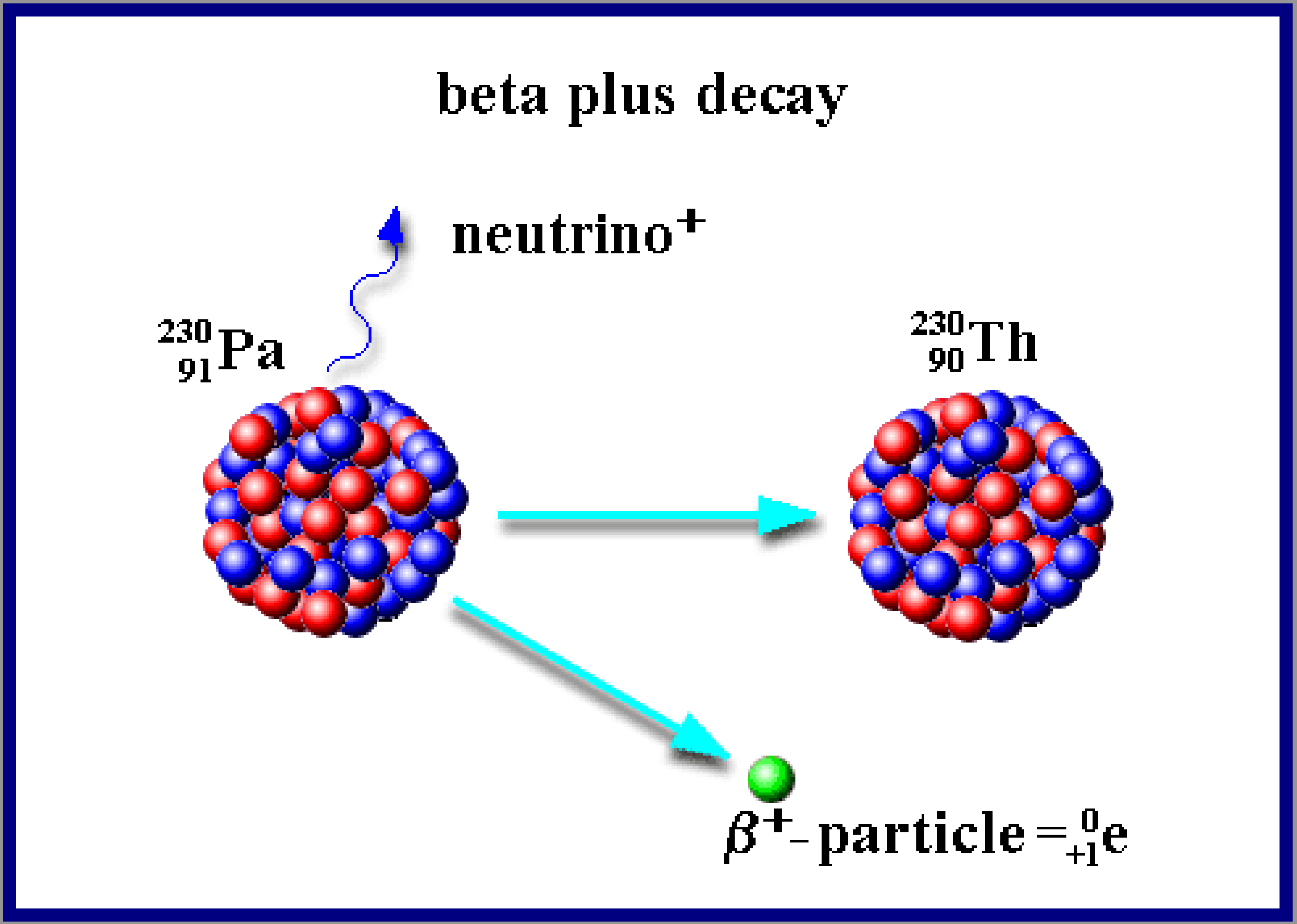
β^- is produced when a neutron decays

$$^{1}_{0}\mathrm{n} \rightarrow {}^{1}_{1}\mathrm{p} + {}^{0}_{-1}\beta^{-}$$

The surplus mass is released as kinetic energy in the β^- and as an antineutrino

Beta-plus Radiation

β+ particles are positrons



Beta-plus Radiation

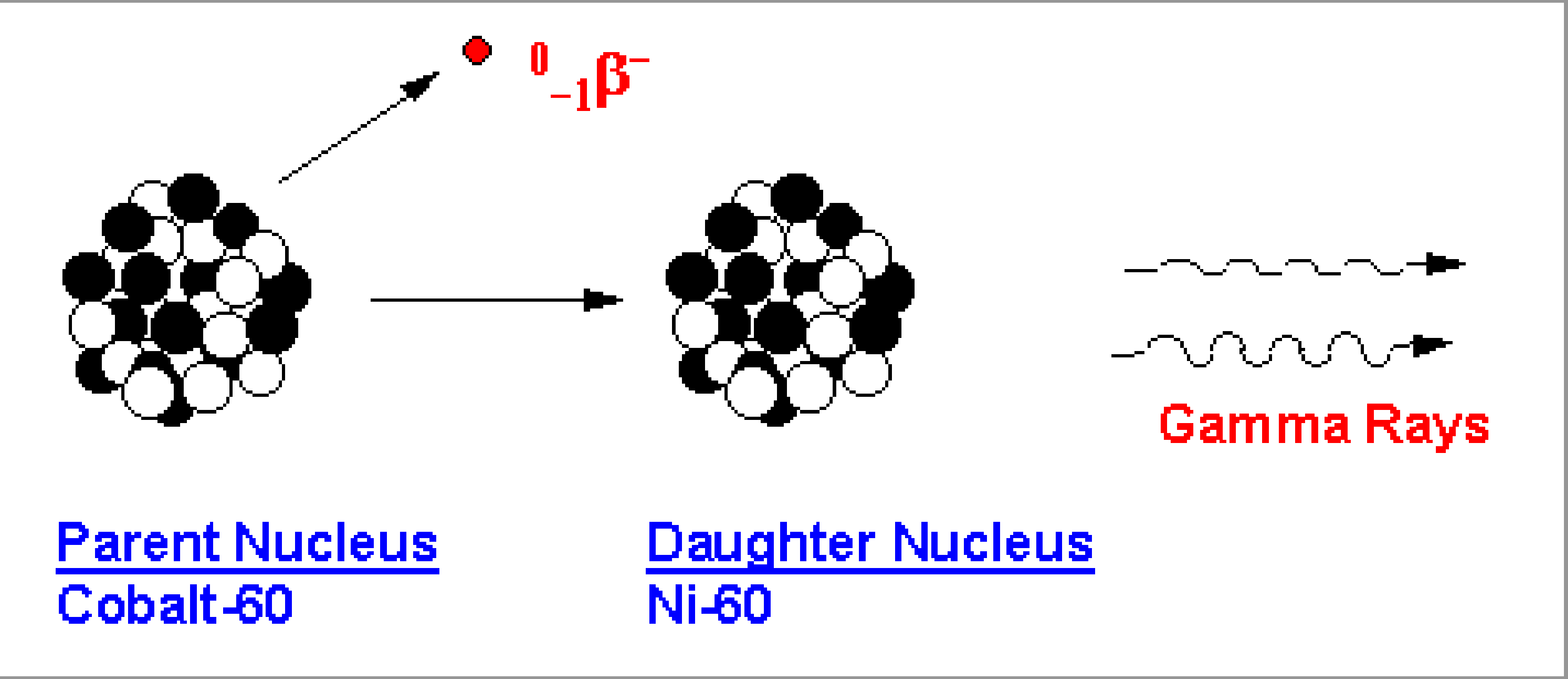
β^+ is produced when a proton decays

$$ {}_{1}^{1}\mathbf{p} \rightarrow {}_{0}^{1}\mathbf{n} + {}_{+1}^{0}\beta^{+} $$

The surplus mass is released as kinetic energy in the β^+ and as a neutrino

Gamma Radiation

Gamma rays are a form of electro-magnetic radiation



Gamma Radiation

- γ release is often associated with α or β decay
- Gamma rays remove energy from an unstable nucleus

Penetrating power

α has a high mass

It is stopped by a few centimetres of air

β has a small mass

It is stopped by a few millimetres of aluminium

γ has zero mass

It is stopped by thick lead or concrete

Penetrating power

α has a high charge

It is dangerous if swallowed

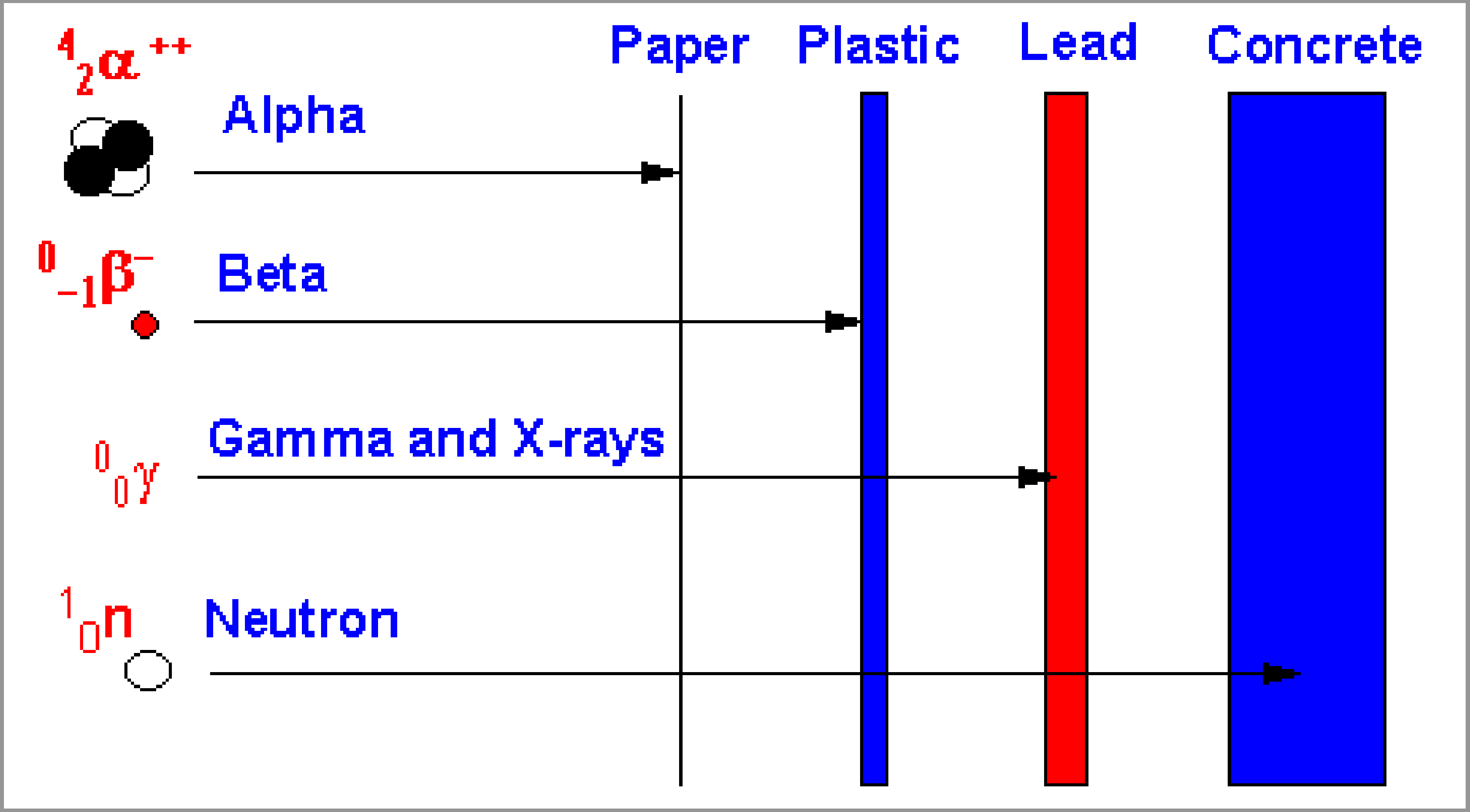
β has a small charge

It is dangerous at medium range

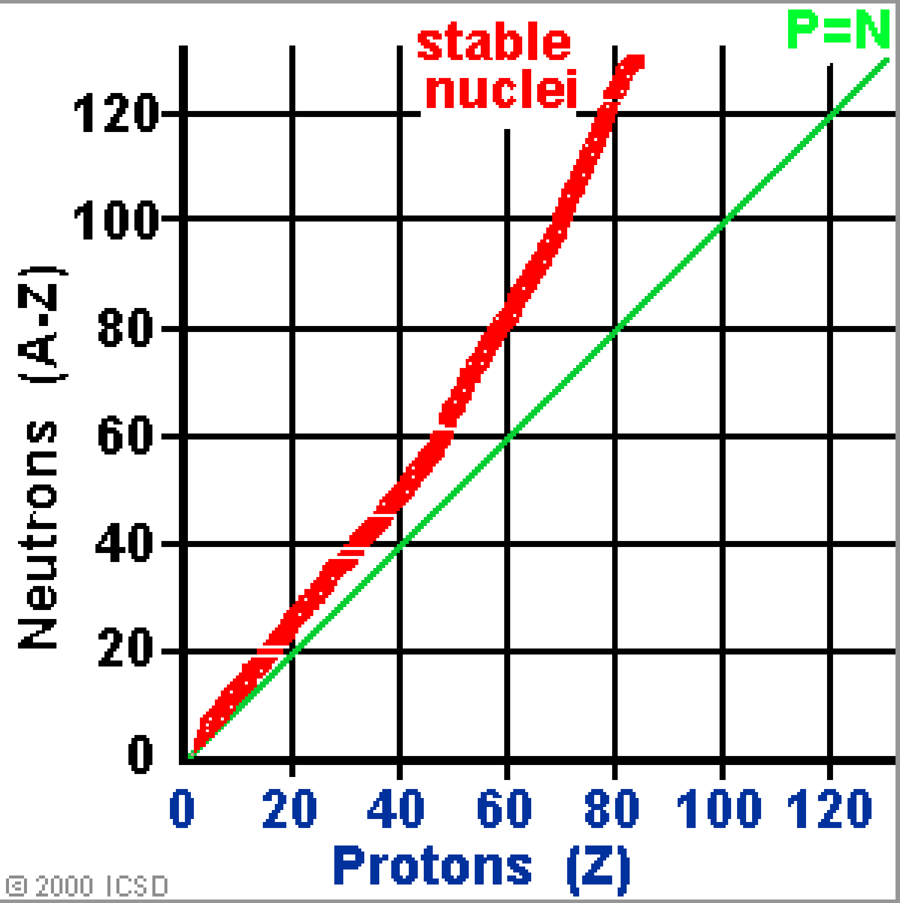
γ has high energy

It is dangerous at distance

Penetrating power

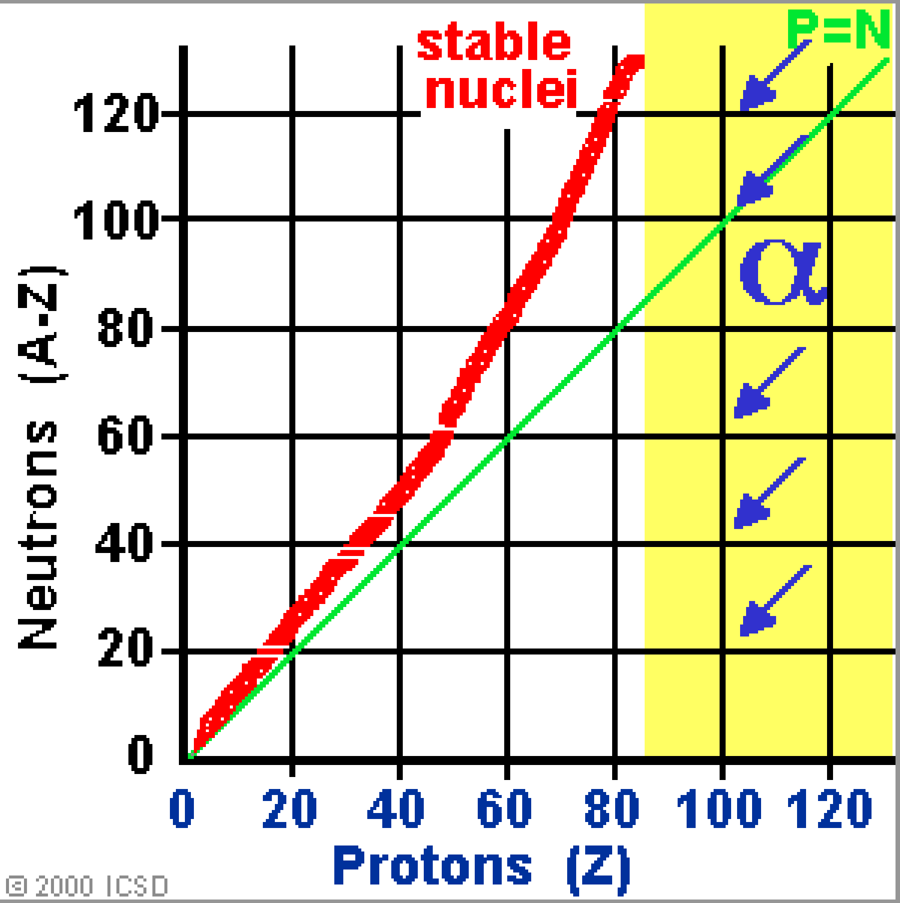


N v Z graphs



A Graph of neutron number (N) against proton number (Z) helps to predict whether an isotope will emit α or β^- radiation

N v Z graphs

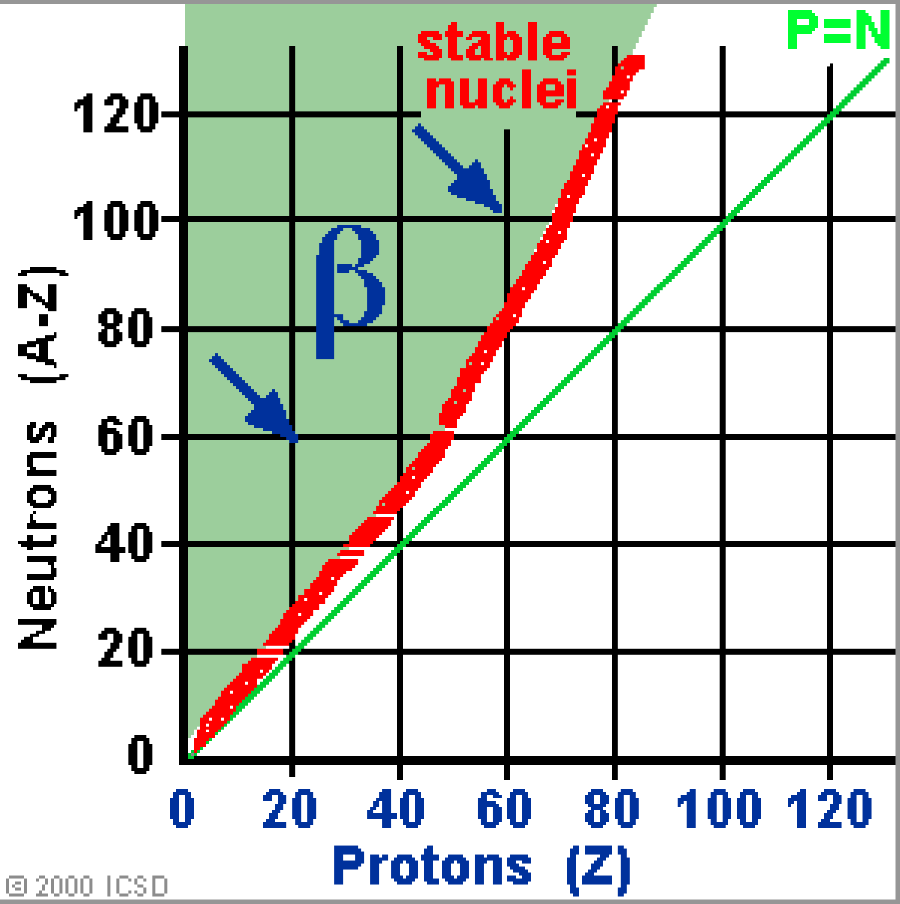


Isotopes in this region emit α particles to become more stable.

N decreases by 2

Z decreases by 2

N v Z graphs



Isotopes in this region emit β particles to become more stable.

N decreases by 1

Z increases by 1

Decay laws - alpha

When an isotope emits an α particle

- Its nucleon number decreases by 4
- Its proton number decreases by 2

For example:

$$^{238}_{92}U \rightarrow ^{234}_{90}Th + ^{4}_{2}\alpha$$

Decay laws – beta-minus

When an isotope emits a β^- particle

- Its nucleon number is unchanged
- Its proton number increases by 1

For example:

$$^{234}_{90}\text{Th} \rightarrow \, ^{234}_{91}\text{Pa} + \, ^{0}_{-1}\beta^-$$

Decay laws – beta-plus

When an isotope emits a β^+ particle

- Its nucleon number is unchanged
- Its proton number decreases by 1

For example:

$$^{230}_{91}\mathrm{Pa} \rightarrow ^{230}_{90}\mathrm{Th} + ^{0}_{+1}\beta^{+}$$

Decay laws

Try writing the nuclear equations for the decay of these isotopes

$^{226}_{88}Ra$ by α emission

$^{214}_{83}Bi$ by β^- emission

$^{210}_{84}Po$ by α emission

Decay laws

Answers

$$^{226}_{88}\mathrm{Ra} \rightarrow {}^{222}_{86}\mathrm{Rn} + {}^{4}_{2}\alpha$$

$$^{214}_{83}\mathrm{Bi} \rightarrow {}^{214}_{84}\mathrm{Po} + {}^{0}_{-1}\beta^{-}$$

$$^{210}_{84}\mathrm{Po} \rightarrow {}^{206}_{82}\mathrm{Pb} + {}^{4}_{2}\alpha$$

Alpha

Beta

Gamma