

Energy

Ability to do work

$$\Delta E = \frac{\Delta KE + \Delta PE}{T}$$

Attractive forces

+ / -
↓ PE

Stabilizing

Repulsive forces

+ / +
↑ PE

Destabilizing

Associated w/
bonding

"nucleons"
↓
↓

protons + neutrons

NUCLEUS

Held together by "strong force"

neutrons / neutrons attract \leftarrow lowers energy, \rightarrow stable
neutrons / protons attract
proton / proton repel

BAND OF STABILITY \rightarrow ratio of protons / neutrons.

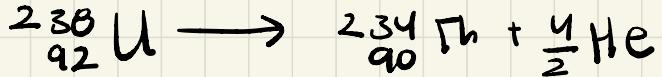
\uparrow protons \rightarrow \uparrow neutron ratio bc more protons = more repulsion so we need more neutrons

\uparrow protons \leftarrow less + less stable nuclei \rightarrow will decay \rightarrow repulsion will dominate (Past B3)

Nuclear equations

Parent nuclide

Daughter nuclide



Radioactive
Decay

\nearrow
changes mass



radioactive particle
+ energy produced
(exothermic process)

Decay → Increases net attraction in nucleus (more stable)

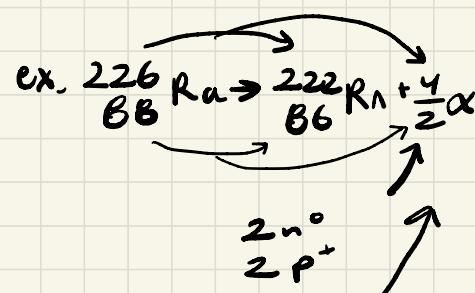
Proton

$\uparrow q \downarrow q \downarrow q$
 $\frac{2}{3} \quad \frac{2}{3} \quad -\frac{1}{3}$ → +1 charge
 charge

Neutrons

$\downarrow q \downarrow q \uparrow q$ ← "quark"
 $-\frac{1}{3} \quad -\frac{1}{3} \quad \frac{2}{3}$ → 0 charge
 Neutrons are heavier
 ↓ quarks are heavier

Alpha Decay → $\frac{2}{2} n^0$ split off
 parent nucleus $\frac{2}{2} p^+$
 Alpha Particle Daughter Nucleus



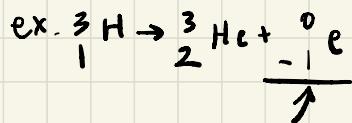
A_X Atomic mass = # p^+ + # n^0
 $Z = \#p^+$

(ENERGY IS A PRODUCT)

Usually more common w/ lighter nuclei;
Beta Decay → Add a proton

neutron → proton change the quark
 of a neutron

$\uparrow \downarrow \downarrow$ $\uparrow \uparrow \downarrow$
 shifts into an up quark

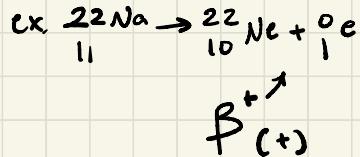


β particle
 $(-)$

negligible mass

Positron Emission → proton shifts into neutron

\nearrow
 Need to let go of a positive



Avogadro's Number

Microscopic

kg/atom

Atomic Mass Unit

AMU

Macroscopic

g/mol

$6.022 \times 10^{23} \text{ atom}$

$$\text{ex } 12 \text{ g/mol} = 12 \text{ amu}$$

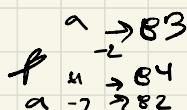
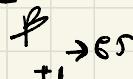
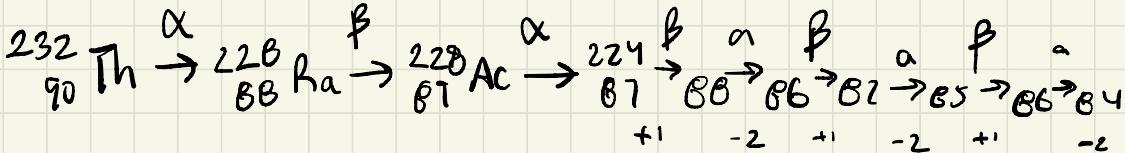
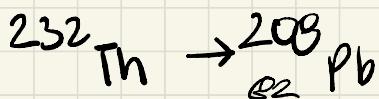
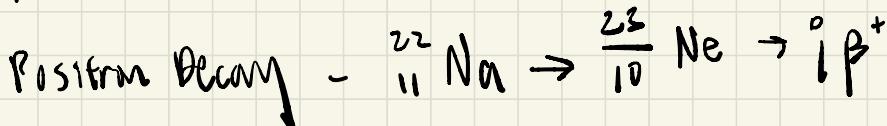
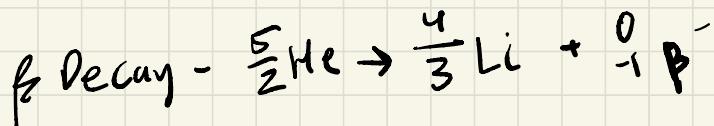
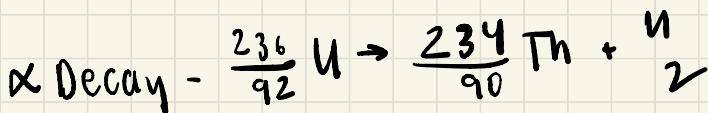
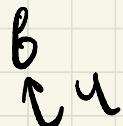
$$\text{Macroscopic } 1 \text{ g/mol} = 1 \text{ amu}$$

$$\text{Microscopic } 1 \text{ amu} = 1.66 \cdot 10^{-27} \text{ kg/atom}$$

$$1 \text{ amu} \rightarrow 1 \text{ hydrogen} \rightarrow 1 \text{ g/mol}$$

$$\downarrow \\ 1.66 \cdot 10^{-27} \text{ kg}$$

$$90 \rightarrow 82$$



Gain Stability \rightarrow exothermic

Nuclear rxns DON'T conserve mass $E=mc^2$

You ALWAYS lose mass

m = mass lost in a nuclear process

$$c = 2.998 \times 10^8 \text{ m/s}$$

Fe-56 Binding energy \rightarrow energy released when atoms are formed from protons and neutrons to form nucleus

Free proton / Free neutron - unstable/no stabilizing attraction

Calculate the mass defect in Fe-56 if the mass of an Fe-56 nucleus is 55.921 amu. The mass of a proton is 1.00728 amu and the mass of a neutron is 1.008665 amu.

measured mass

$$\begin{aligned} \text{Fe-56} - 26p^+ + 30n^0 &= 26(1.00728 \text{ amu}) + 30(1.008665 \text{ amu}) \\ &= \underline{\underline{56.44923 \text{ amu}}} \\ &\quad \uparrow \text{greater value than actual} \end{aligned}$$

$$\begin{aligned} \Delta m &= 55.921 \text{ amu} - 56.44923 \text{ amu} \\ \text{mass defect} &= -0.528 \text{ amu} \end{aligned}$$

\uparrow Represents mass converted to energy

$$E = (-0.528 \text{ amu}) \left(\frac{1.66 \times 10^{-27} \text{ kg/atom}}{1 \text{ amu}} \right) \left(\frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mol}} \right) \left(2.998 \times 10^8 \frac{\text{m}}{\text{s}} \right)^2$$

Look for J/mol , $\frac{\text{kg}}{\text{mol}}$, $\frac{\text{J}}{\text{mol}}$ $E = -4.746 \times 10^{13} \frac{\text{J}}{\text{mol}}$ \leftarrow ~~bc if released~~

Nuclear rxns + energy released



$$\Delta m = (\text{mass of products}) - (\text{mass of reactants})$$
$$\Delta m = (235.86769 \text{ amu}) - (236.05258 \text{ amu})$$

$$= -0.18489 \text{ amu} \quad \rightarrow E = mc^2$$

$$E = (-0.18489 \text{ amu}) \left(\frac{1.66 \cdot 10^{-27} \text{ kg}}{1 \text{ amu}} \right) \left(\frac{6.022 \times 10^{23} \text{ atoms}}{\text{mol}} \right) (c)^2$$

$$= -1.66 \cdot 10^{13} \text{ J/mol}$$

$$J = \frac{\text{Kg m}^2}{\text{s}^2}$$

ν = frequency \rightarrow waves/second (Hz)

