Nuclear Chem Continued

On Friday we learned about how radioactive isotopes go through α β & γ decay to maintain nuclear stability.

- As you might guess it takes <u>time</u> for this process to be achieved, but scientists can use mathematical predictions about the age of materials, or how long until nuclear stability will be achieved using <u>half-life</u>

- As we introduced in our dice activity, half-life is a concept that utilizes the time for a quanta of radioactive isotope nuclei to exist in 1/2 of its original quantity

ex) carbon-14 has a half-life of <u>5730 years</u>

so, in 5,730 yrs an original quantity of 100g of C-14 will decay to 50g.

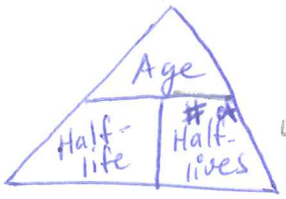
$100\text{g} \xrightarrow{①} 50\text{g} \xrightarrow{②} 25\text{g} \xrightarrow{③} 12.5\text{g}$

How long to reach a quantity of 12.5 g?

3 half-lives × 5,730 = 17,190 yrs

# of half lives X half-life of isotope

* Always start by counting the # of times the original quantity has been halved, then multiply by the years of the isotope's half-life.



cover up what you are solving for

ex) The half-life of Radium-226 is 1,600 yrs

How old is a sample of Ra-226 that has decayed from 1,000 mg to 62.5 mg?

1,000 → 500 → 250 → 125 → 62.5
(1) (2) (3) (4)

4 × 1,600 = 6400 yrs old

ex) What is the half-life of an isotope that is 15,200 yrs old & has been through 4 half-lives?

$\frac{\text{Age}}{\#\text{ of HL}}$ $\frac{15,200}{4}$ = 3800 yrs

ex) How many half lives has an isotope been through if it said to be 5,230 yrs old and has a half life of 1,700 yrs?

$\frac{\text{Age}}{\text{H.L.}}$ $\frac{5230}{1700}$ = 3.1 H.L.'s

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To wrap up our conversation about nuclear chem. it is important to stress the conservation of energy & mass.

- Since nuclear reactions give off γ rays, the changing of mass yields energy (either taken in or given off).

- If you think about breaking a cookie - there is always crubs released - in nuclear chem. it's energy

The energy given off demonstrates that mass & energy exist in tandem & can't be destroyed, only transformed

- Einstein gave us the eqn. $E=mc^2$, which supports this notion in that energy obtain from mass is immense.

E = energy
m = mass
c = speed of light

converting 1 lb. of mass into energy →

ex) $E = mc^2$

$E = (1\,kg)(3.0\times10^8\,m/s)^2 = 9.0\times10^{16}\,J$,

where 100 J would be needed to light a 100 Watt bulb for 1 second!

- This means 1 lb. of matter converted to energy would light a light bulb for 28,538,813 years!

Obviously, scientists are trying to find safe ways to harness this energy to help us in energy production - but it's tricky!

Nuclear power gets it's energy from this sort of process.

- harnessing the γ energy given off in decay.