5.2 Half-life & Radioactive Dating

December 17, 2018 9:53 AM

5.2 : HALF-LIFE + RADIOACTIVE DATING

Half-Life

- ☐ The amount of time it takes for half of the radioactive nuclei in a sample to decay is called its half - life
  - ☐ Some isotopes decay at a low rate and have long half-lives
    - ☐ ***Example:*** U-238 = 4.5 billion years!) 4 500 000 000 years
  - ☐ Others decay at a high rate and have short half-lives
    - ☐ ***Example:*** Astatine-213 =125 nanoseconds)

$125 \times 10^{-9} = 0.000\ 000\ 125\ s$

Graphing Radioactive Decay

Half-lives	Amount Remaining
0	100 %
1	50%
2	25%
3	12.5%
4	6.25%
5	3.125%

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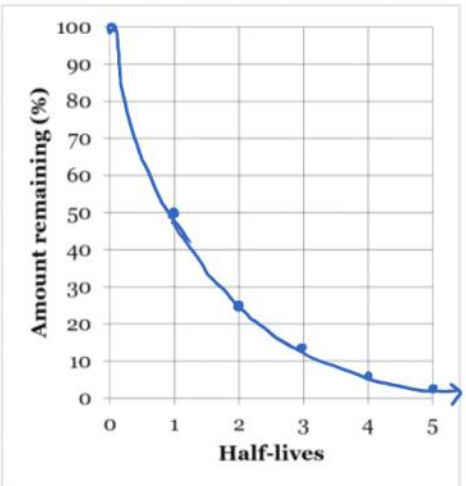

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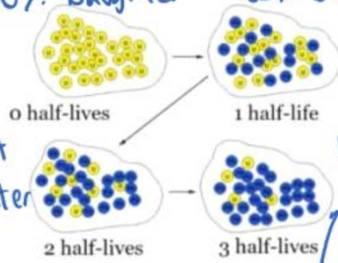
100 % Parent
0% Daughter

50% Parent
50% Daughter



25% Parent
75% Daughter

100%

12.5% Parent
87.5% Daughter

100%

The amount of parent isotope decreases and the daughter isotope increases

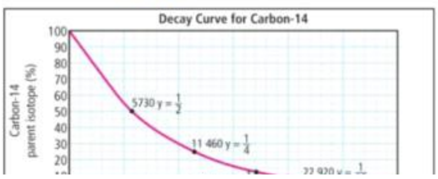
$100\% - 12.5\% = 87.5\%$

1

$^{14}_{6}C \rightarrow ^{0}_{-1}\beta + ^{14}_{7}N$

Radioactive Dating: carbon-14

- ☐ **Living** organisms contain constant amounts of carbon-14
- ☐ When they die, the carbon-14 begins to decays into nitrogen - 14 with a half-life of 5730 years.
- ☐ By analyzing how much carbon-14 remains in a sample compared to how much carbon-12, you can accurately date the organism's death
- ☐ After 50 000 years so little carbon-14 remains that dating becomes impossible



[How Does Radiocarbon Dating Work? - Instant Egghead #28](#)

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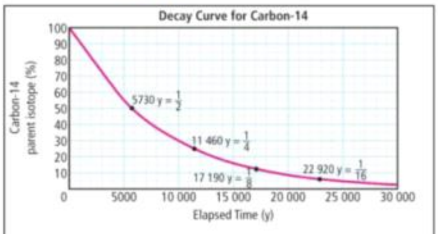


How much of an 80 g sample of carbon-14 would be left after 15,000 years?

Between 10 g & 20 g

1 half life → 40 g
2 half life → 20 g
3 half life → 10 g

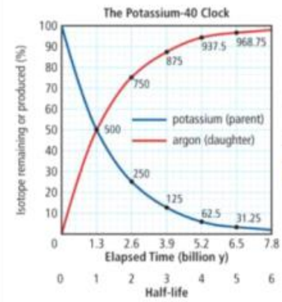
$\frac{1}{2^{2.6}}$

15000
÷ 5730
2.6178 half lives.

$^{40}_{19}K \rightarrow ^{40}_{18}Ar + \boxed{}$

Radioactive Dating: potassium-40 Clock

- ☐ When molten rock cools it contains a certain amount of radioactive potassium-40
- ☐ Over time the potassium-40 decay into argon-40, with a half-life of 1.3 billion years
- ☐ The formation of these rocks can be dated by sampling the ratio of the two isotopes
- ☐ Other isotope pairs allow us to accurately date rocks that are younger or older



How much potassium-40 and argon-40 would be found in a rock 1.3 billion years old?

1.3 billion years = 1 half live

50% potassium-40
50% argon-40.

⇒ See Data Page for common isotope pairs.

This info will be in their Data Booklet & given on any tests.

[How Does Radiocarbon Dating Work? - Instant Egghead #28](#)

[The Truth Behind Radioisotope Dating](#)

COMMON ISOTOPE PAIRS CHART

Isotope		Half-life of Parent (years)
Parent	*Daughter*	
Carbon-14	Nitrogen-14	5730
Uranium-235	Lead-207	710 million
Potassium-40	Argon-40	1.3 billion
Uranium-238	Lead-206	4.5 billion
Thorium-235	Lead-208	14 billion
Rubidium-87	Strontium-87	47 billion

RADIOACTIVITY SYMBOLS

$^{4}_{2}\alpha$, $^{4}_{2}He$	$^{0}_{-1}\beta$, $^{0}_{-1}e$	$^{0}_{0}\gamma$
$^{1}_{0}n$	$^{1}_{1}p$, $^{1}_{1}H$	

Solving Half-Life Problems

Solving Half-Life Problems

- ☐ Half-life problems involve three variables:
  1. Number of Half lives of the parent isotope (0, 1, 2, etc.)
  2. Time elapsed (hours, days, years)
  3. Amount of the parent isotope remaining (g, kg, or %)

- ☐ A half-life problem will identify two of the three, you will need to calculate the third
- ☐ Make sure that you ALWAYS START AT 0 for half-life and time, and at 100% for the amount of the parent isotope

Half-Life	Time	Amount
0	0	100%
1	1 half-life	50%
2	2 half-lives	25%
3	3 half-lives	12.5%
etc.	etc.	etc.

⇒ Remember: % Parent + % Daughter = 100%.

Practice: If 50 grams of carbon-14 were present in a sample of bone, state how many grams would be left after 17 190 years?

From the data table, half-life of carbon-14 is 5730 years

Half-life	Time (years)	Mass (g)
0	0	50
1	5730	25
2	+5730 11460	12.5
3	+5730 17 190	6.25

↓ ÷2
↓ ÷2
↓ ÷2

6.25 g of carbon-14 would remain after 17,190 years.