7.2b Radiocarbon Dating and the Potassium Clock
Science 10 Notes

Radiocarbon Dating

- When an organism dies, carbon stops being replenished and the carbon-14 starts to decay
- The ratio of carbon-14 to nitrogen-14 is measured.
  - carbon-14 is the parent isotope
  - nitrogen-14 is the daughter isotope

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

parent = reactant
daughter = decay product.

- Carbon dating only works for times less than 50 000 years

at the time that organism dies, it has the same % of carbon-14 as the atmosphere.

Carbon-14
½ life = 6000 years

now	100g
6000yrs	50g
12000	25
18000	12.5
24000	~6
30000	~3
36000	~1.5
42000	~.75
48000	~.38

Common Isotope Pairs

- Since Radiocarbon dating only works for times less than 50000 years we can use other radioisotopes to measure older ages, because they have longer. half lives

Table 7.6 Common Isotope Pairs Chart

Isotope		Half-Life of Parent (years)	Effective Dating Range (years)
Parent	Daughter		
carbon-14	nitrogen-14	5730	up to 50 000
uranium-235	lead-207	710 million	> 10 million
potassium-40	argon-40	1.3 billion	10 000 to 3 billion
uranium-238	lead-206	4.5 billion	> 10 million
thorium-235	lead-208	14 billion	> 10 million
rubidium-87	strontium-87	47 billion	> 10 million

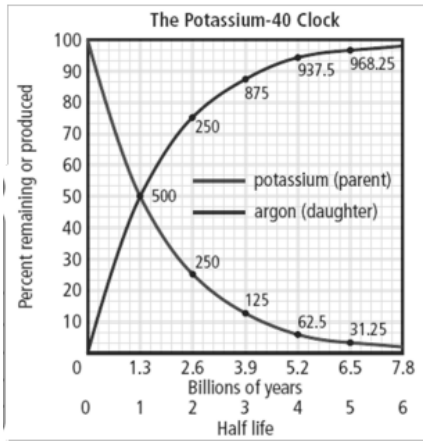
$^{40}_{21}K \rightarrow {}^{40}_{20}Ar + {}^{0}_{-1}e$

The Potassium Clock

parent ↓ daughter ↓

- Measures the ratio of Potassium-40 and Argon-40.

- shows both K and Ar



Age in ½ lives	Fraction of K	Fraction of Ar	Ratio
0	$\frac{1}{1}$	$\frac{0}{1}$	1:0
1	$\frac{1}{2}$	$\frac{1}{2}$	1:1
2	$\frac{1}{4}$	$\frac{3}{4}$	1:3
3	$\frac{1}{8}$	$\frac{7}{8}$	1:7

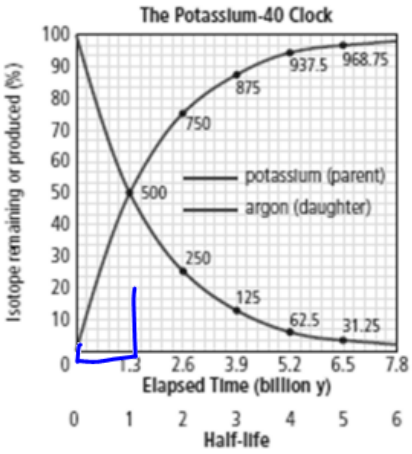


Figure 7.17 The blue line shows that the parent isotope is decaying. The red line shows that the daughter isotope is being produced.

Table 7.7 The Decay of Potassium-40

Number of Half-Lives	Elapsed Time (billion y)	Amount of Potassium-40 Present	Amount of Argon-40 Present	Ratio of Argon-40 to Potassium-40
0	0	1000 g	0	0:1
1	1.3	500 g	500 g	1:1
2	2.6	250 g	750 g	3:1
3	3.9	125 g	875 g	7:1
4	5.2	62.5 g	937.5 g	15:1

Practice Problems

Try the following radioisotope dating problems yourself. You may wish to use Table 7.7 and Figure 7.17 on page 308.

1. What is the ratio of argon-40 to potassium-40 two half-lives after the rock has formed?
2. What ratio of argon-40 to potassium-40 remains 3.9 billion years after the rock formed?
3. (a) When there is more parent isotope present in a sample than there is daughter isotope, what does this tell you about the age of the sample in terms of half-lives?
   (b) For how many years after the start of the potassium-40 clock is there more parent material than daughter material?

Argon-40 : Potassium = 3:1

7:1

less / younger than one half life.

∴ when amount parent = daughter that is exactly one half life.

1.3 billion years, or one half life.