

Radiogenic Dating

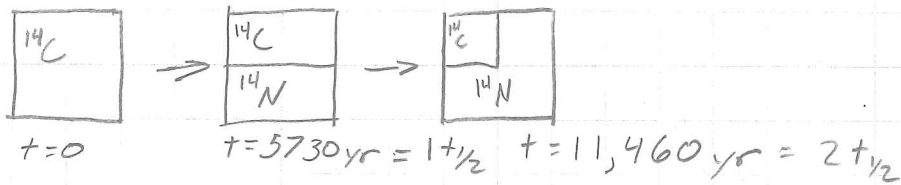
3 cases

"gas trapping" "Natural Ratio"

"Fresh start"

no decay products at start

ex \Rightarrow Carbon to Nitrogen in organic matter



how do you determine age from composition?

$$N(0) = N(0)$$

$$N(1+t_{1/2}) = N(0) \cdot \frac{1}{2}$$

$$N(2+t_{1/2}) = N(0) \cdot \frac{1}{2} \cdot \frac{1}{2}$$

$$N(3+t_{1/2}) = N(0) \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \Rightarrow N(t) = N(0) \left(\frac{1}{2}\right)^{t/t_{1/2}}$$

so solve for t

$$\ln \frac{N(t)}{N(0)} = \left(\frac{1}{2}\right)^{t/t_{1/2}}$$

$$\ln \left(\frac{N(t)}{N(0)} \right) = \ln \left(\left(\frac{1}{2}\right)^{t/t_{1/2}} \right) = \frac{t}{t_{1/2}} \ln \left(\frac{1}{2} \right)$$

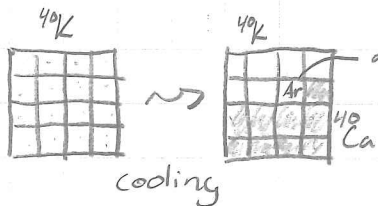
$$t_{1/2} \frac{\ln \left(\frac{N(t)}{N(0)} \right)}{\ln \left(\frac{1}{2} \right)} = t \Rightarrow \frac{-t_{1/2} \ln \left(\frac{N(t)}{N(0)} \right)}{\ln(2)} = t$$

$$t \approx -1.443 t_{1/2} \ln \left(\frac{N(t)}{N(0)} \right)$$

"Gas trapping"

Parent decays into gas and solid

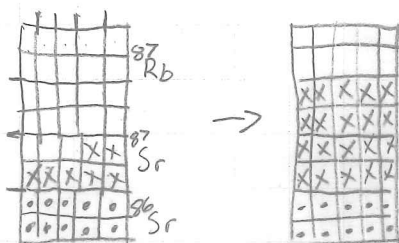
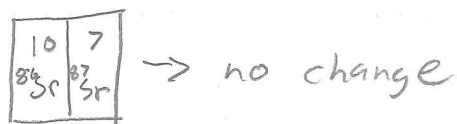
ex \Rightarrow $^{40}\text{K} \rightarrow 10\% \text{ } ^{40}\text{Ar} \text{ } 90\% \text{ } ^{40}\text{Ca}$ $t_{1/2} = 1.248 \text{ Gyr}$



to get $N(0)$ find how much ^{40}Ar , multiply by 9 and add to ^{40}K

"Natural ratio"

depends on natural ratio of stable elements
 ex $\Rightarrow {}^{87}\text{Rb} \rightarrow {}^{87}\text{Sr}$ where $\frac{{}^{86}\text{Sr}}{{}^{87}\text{Sr}}$ is known at formation



step 1 look at how much ${}^{86}\text{Sr}$ there is 10

2 at the 10:7 ratio determine how much ${}^{87}\text{Sr}$ there was originally 7 $\frac{10}{} = \frac{{}^{86}\text{Sr}}{{}^{87}\text{Sr}}$

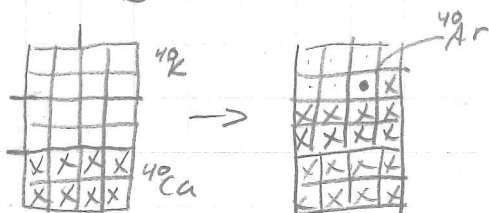
3 subtract that number from current ${}^{87}\text{Sr}$ 13

4 add this number to current ${}^{87}\text{Rb}$ 23

so $N(t) = 23$

$N(t) = 10$ for ${}^{87}\text{Rb}$

'gas trapping' steps



step 1 look at how much ${}^{40}\text{Ar}$ there is 1

2 at the 9:1 ratio determine how much ${}^{40}\text{Ca}$ was produced 9 $\frac{9}{} = \frac{{}^{40}\text{Ca}}{{}^{40}\text{Ar}}$

3 add these numbers 10

4 add this to current ${}^{40}\text{K}$ 16

so $N(t) = 16$
 $N(t) = 6$