12. In a sample the molar ratio between As-78 (β^-, $t_{½}$ = 1.5 h) and Se-78 (stable) is measured to be

As-78/Se-78 = 3.84732.

What will the ratio be an hour after the measurement?

Time	As-78	Se-78
t=0	3.84732	1
t=1 h	$N=N_0e^{-\lambda t}$ = 2.42366	All As-78 has decayed to Se-78 = 1 + (3.84732-2.42366) = 2.42366

The ratio is 1

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13. The activity of the standard was 237.3 kBq 7+7/12 years before the measurement.

The activity at the measurement was then $A=A_0e^{-\lambda t}$ = 31.5 kBq

The measured activity ratio between the sample and the standard is 53 324/23940 and the activity of the sample is then 31.5 × 53324 / 23940 = 70.16 kBq.

The specific activity of the sample = 70.16Bq/4.32g = 16.2 kBq/g

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14. Ratio K-40 : Ar-40 : Ar-36 is 21157 : 4557 : 1

Some Ar-40 originates from an air bubble. The abundance of Ar-40 is 99.6003 % and that of Ar-36 is 0.3365 %. The ratio between Ar-40 and Ar-36 is then 295.99, meaning that for each Ar-36 found there is 295.99 Ar-40.

⇨ The “real” ratio (without air bubbles) between K-40 and Ar-40 is 21557 : 4261

All Ar-40 that is found in the sample (not considering the air bubbles) is formed from the decay of K-40. But K-40 decays to Ca-40 (88.8%) and to Ar-40 (11.2%), so at t_0 there will be not only extra K-40 that decayed to Ar-40 but also K-40 that decayed to Ca-40.

At t_0 the amount of K-40 was hence 21557 (what we find today) + 4261 / 11.2% (K-40 that has decayed to Ca-40 and Ar-40).

N_0 = 21 557 + 38 044.7 = 59 601.7

Today we have N = 21 557

$$N = N_0 e^{-\lambda t}$$

⇨ $t = -\frac{1}{\lambda}\ln\left(\frac{N}{N_0}\right) = \frac{t_{½}}{\ln 2}\ln\left(\frac{N_0}{N}\right) = 1.88\times10^{9}\text{ years}$