$$\Leftrightarrow \boxed{T_{\frac{1}{2}} = \frac{\ln 2}{\lambda}} \quad \text{PUOLIINTUMISAIKA}$$

$$N = N_0 e^{-\lambda t} = N_0 e^{-\frac{\ln 2}{T_{1/2}} t} = N_0 \left(e^{\ln 2^{-1}}\right)^{\frac{t}{T_{\frac{1}{2}}}} = N_0 \left(\tfrac{1}{2}\right)^{\frac{t}{T_{\frac{1}{2}}}}$$

$$\Rightarrow \boxed{N = N_0 \left(\tfrac{1}{2}\right)^{\frac{t}{T_{\frac{1}{2}}}}}$$

## Aktiivisuus A

– ilmoittaa montako ydintä hajoaa sekunnissa

$$A = \left|\frac{\Delta N}{\Delta t}\right| = -\frac{\Delta N}{\Delta t} = \lambda N = \underbrace{\lambda N_0}_{A_0} e^{-\lambda t} = A_0 e^{-\lambda t} = A_0 \left(\tfrac{1}{2}\right)^{\frac{t}{T_{\frac{1}{2}}}}$$

$$\boxed{\begin{aligned} A &= \lambda N \\ A &= A_0 \left(\tfrac{1}{2}\right)^{\frac{t}{T_{\frac{1}{2}}}} \end{aligned}} \quad \text{AKTIIVISUUS}, \quad [A] = \frac{1}{s} = \text{Bq (Becquerel)}$$

K25. a) Puoliintumisaika $T_{1/2}$ on kyseisen lyhyt (25,5 h ... 75 432,6 a) muille isotoopeille verrattuna 232 Th-isotoopin $1{,}405 \cdot 10^{10}$ a. Siten muut isotoopit ovat epävakaampia ja hajoavat.

b) $^{232}_{90}\text{Th} \xrightarrow{\alpha} {}^{228}_{88}\text{Ra} + {}^{4}_{2}\text{He}$

c) $\lambda = \frac{\ln 2}{T_{\frac{1}{2}}} = \frac{\ln 2}{1{,}405 \cdot 10^{10} \cdot 365{,}25 \cdot 24 \cdot 60 \cdot 60\ s} \approx 1{,}563 \cdot 10^{-18}\ \frac{1}{s}$

d) $A = \lambda N = \lambda \frac{m}{m(^{232}\text{Th})} = 1{,}563 \cdot 10^{-18}\ \frac{1}{s} \cdot \frac{2{,}0 \cdot 10^{-3}\ \text{kg}}{232{,}038 \cdot 1{,}66054 \cdot 10^{-27}\ \text{kg}}$

$\approx 8114{,}59\ \frac{1}{s} \Rightarrow$ n. 8100 ydintä

e) $N = N_0 \left(\tfrac{1}{2}\right)^{\frac{t}{T_{1/2}}} = 0{,}8 N_0 \quad | : N_0$ ← hajonnut 20 % → jäljellä 80 %

$\Leftrightarrow \left(\tfrac{1}{2}\right)^{\frac{t}{T_{1/2}}} = 0{,}8 \quad | \ln$

$\Leftrightarrow \frac{t}{T_{1/2}} \ln\frac{1}{2} = \ln 0{,}8 \quad | \cdot \frac{T_{1/2}}{\ln\frac{1}{2}}$

$\Leftrightarrow t = \frac{\ln 0{,}8 \cdot T_{1/2}}{\ln\frac{1}{2}} = \ldots \approx 4{,}5 \cdot 10^9\ \text{a} \approx$ maan ikä

f) $A = 0{,}8\, A_0 = 0{,}8 \cdot 8114{,}59\ \text{Bq} \approx 6{,}5\ \text{kBq}$