Zero-order

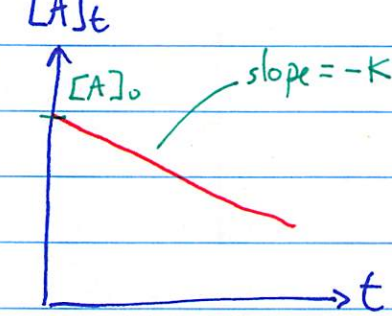
$A \rightarrow P$, $\text{rate} = K[A]^0$
$= K$

$$-\frac{\Delta[A]}{\Delta t} = K$$

calculus

$$\boxed{[A]_t = -Kt + [A]_0}$$

$$y = m\,x + b$$



Half-life, $t_{\frac{1}{2}}$

time for $\frac{1}{2}$ of reactants to be used up
- can calculate from integrated rate law ~ depends upon order

1st order, $t_{\frac{1}{2}}$

$@\ t=0,\ [A]=[A]_0$
$@\ t=t_{\frac{1}{2}},\ [A]=\frac{1}{2}[A]_0$

$$\ln\frac{[A]_t}{[A]_0} = -Kt$$

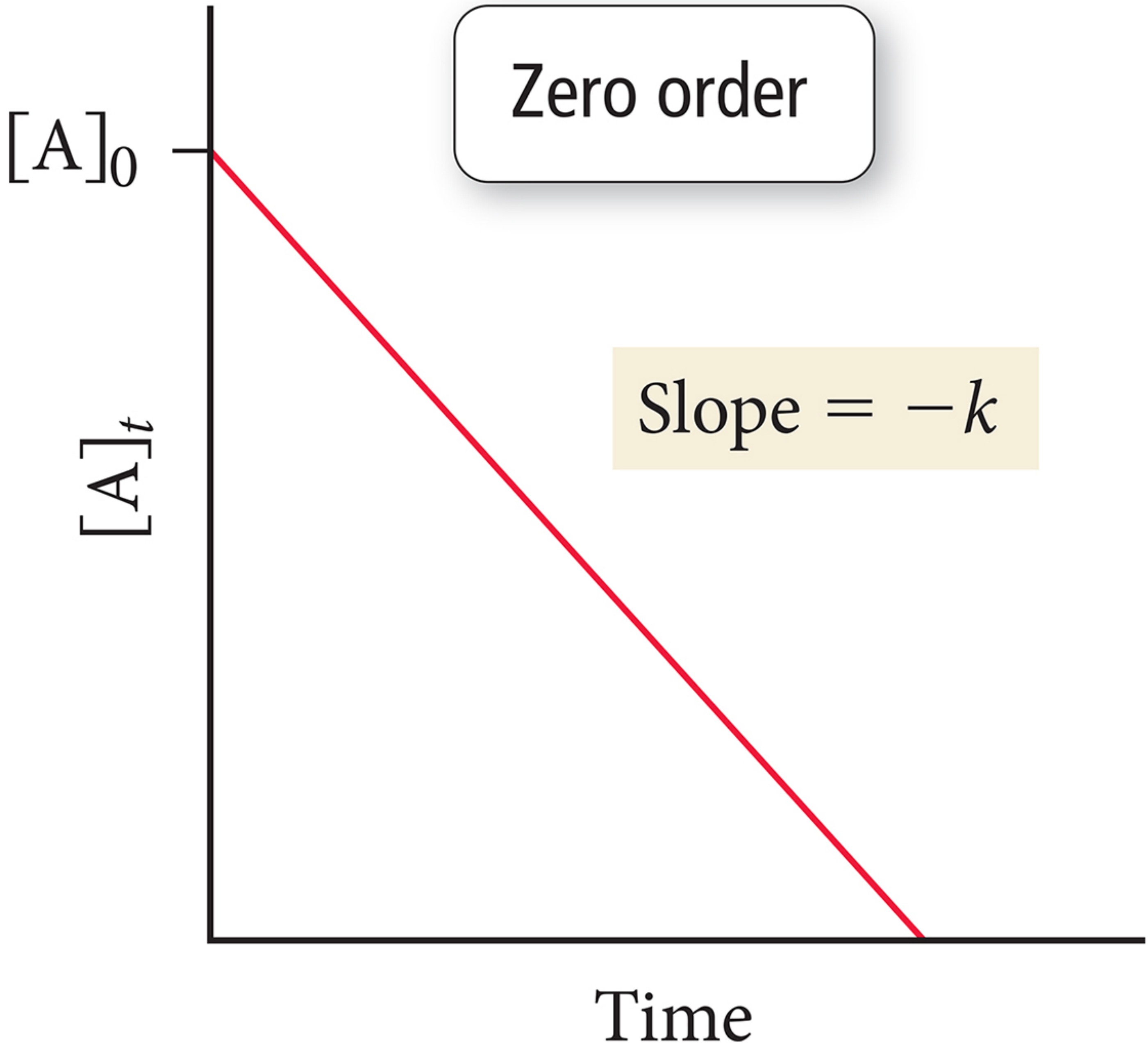
$$\Rightarrow \ln\left(\frac{\frac{1}{2}[A]_0}{[A]_0}\right) = -Kt_{1/2}$$

$$\Rightarrow \ln(1/2) = -Kt_{\frac{1}{2}}$$

$$\Rightarrow t_{\frac{1}{2}} = \frac{\ln(1/2)}{-K} = \frac{-0.693}{-K}$$

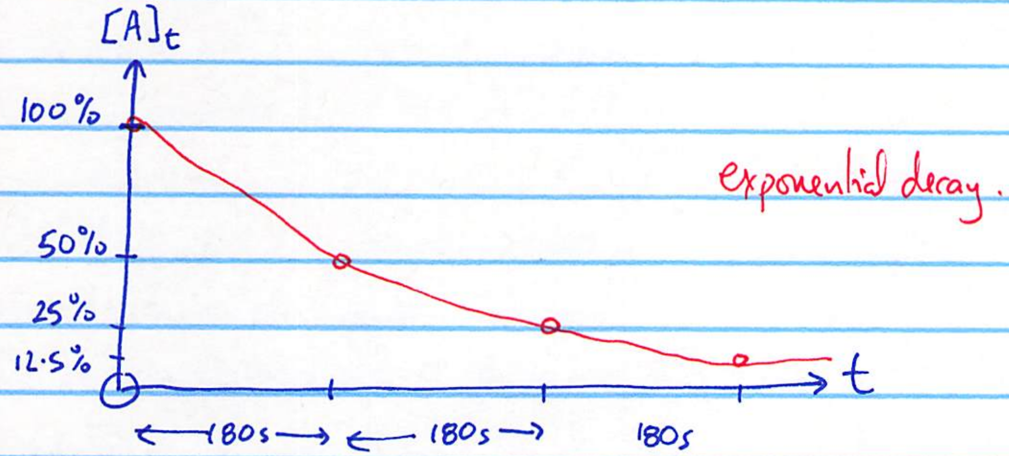
$$\Rightarrow \boxed{t_{\frac{1}{2}} = \frac{0.693}{K}}$$

* 1st order * ~doesn't depend on orig conc of A!


Zero order
$[A]_0$
$[A]_t$
Slope = $-k$
Time

ex: if $k = 3.8 \times 10^{-3} s^{-1}$ (1st order kinetics), $t_{\frac{1}{2}} = \dfrac{0.693}{3.8 \times 10^{-3} s^{-1}}$

$= 180 s$ (3.0 min)



6min.

<u>2nd order</u>

$\left.\begin{array}{l} @\ t=0,\ [A]=[A]_0 \\ @\ t=t_{1/2},\ [A]=\frac{1}{2}[A]_0 \end{array}\right\} \dfrac{1}{[A]_t} = kt + \dfrac{1}{[A]_0}$

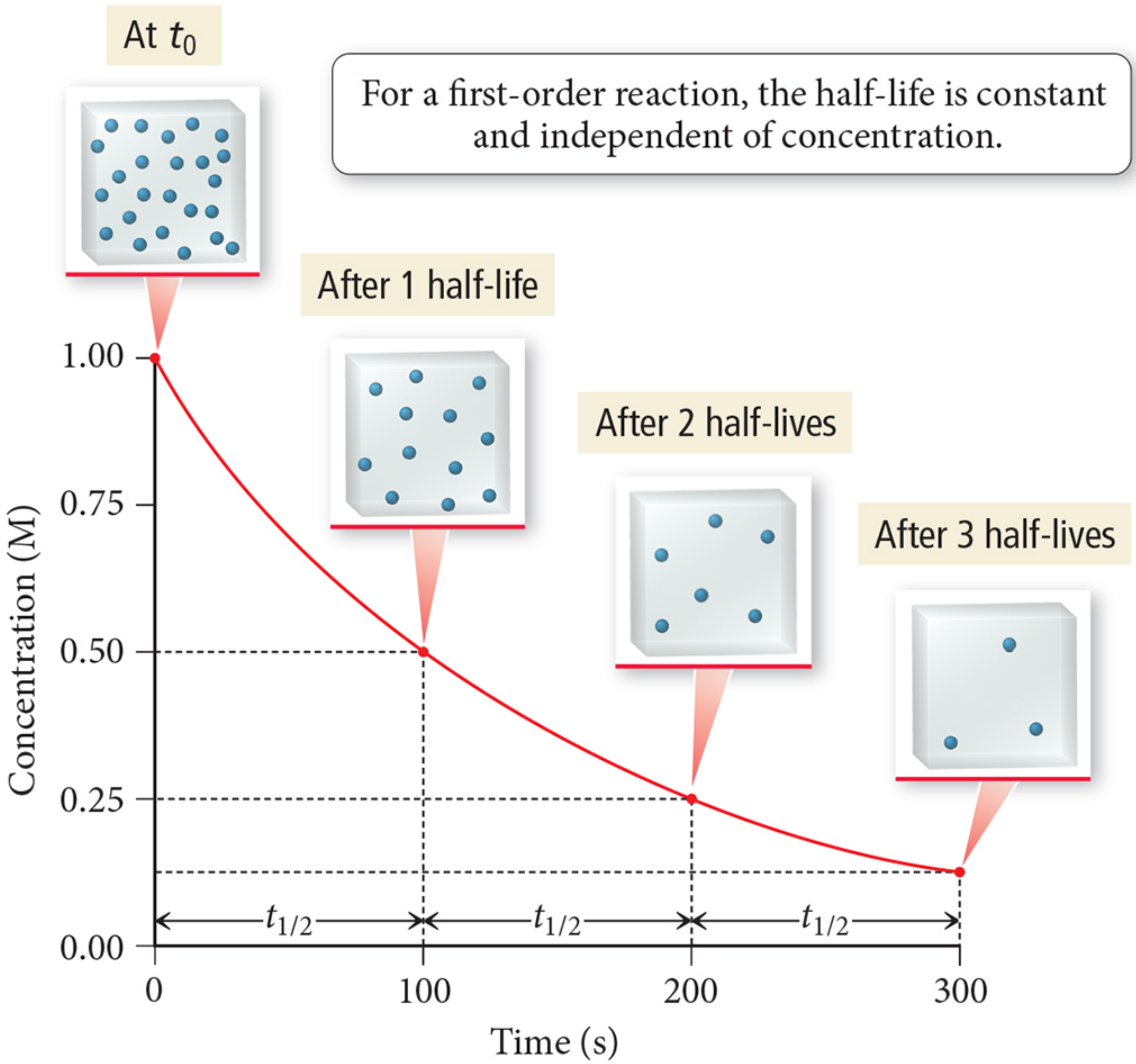
$\Rightarrow \dfrac{1}{\frac{1}{2}[A]_0} = kt_{1/2} + \dfrac{1}{[A]_0}$

$\Rightarrow \dfrac{2}{[A]_0} = kt_{\frac{1}{2}} + \dfrac{1}{[A]_0} \quad \Rightarrow \dfrac{\frac{2}{[A]_0} - \frac{1}{[A]_0}}{k} = \dfrac{kt_{\frac{1}{2}}}{k}$

$\Rightarrow \boxed{\dfrac{1}{k[A]_0} = t_{\frac{1}{2}}}$

- not a constant (like 1st order)
- keeps increasing as $[A]_0 \downarrow$

Half-Life for a First-Order Reaction



2nd order

ex: $\underset{[A]}{1.0\,M} \xrightarrow{10s} 0.50M \xrightarrow{20s} 0.25M \xrightarrow{40s} 0.125M$

$t_{\frac{1}{2}} = \frac{1}{K[A]_0}$

Zero-order

can show: $t_{\frac{1}{2}} = \frac{[A]_0}{2K}$ (depends on $[A]_0$!)