$\ln k = \frac{-E_a}{R}\left(\frac{1}{T}\right) + \ln A$

slope

Arrhenius and rate constant

Butterworths pg. 301

$2NO_2 \rightarrow 2NO + O_2$ 2nd order

$\Delta H_{rxn} \approx 115\ kJ\ mol^{-1}$ Molecularity: bimolecular

endothermic

$k = A e^{-\frac{E_a}{RT}}$ @ 25°C

$= (2 \times 10^9)\, e^{\frac{-(112.55\ kJ\ mol^{-1})}{(8.314\ J\ mol^{-1}\ K^{-1})(298\ K)}}$

$= 3.84 \times 10^{-11}\ M^{-1}\ s^{-1}$ slow!

Reported @ 603K

$3.8 \times 10^2 \frac{mL}{mol\ s}\left(\frac{L}{10^3\ mL}\right) = 0.38 \frac{L}{mol\ s}$

$= 0.38\ M^{-1} s^{-1}$ ⟷ close!

@ 326.86 °C

600 K

$k = 0.3387\ M^{-1} s^{-1}$ faster!

Int. Rate Law

$[NO_2]_0 = 5.0\ M$

$[NO_2]_t = 4.0\ M$ consume 1/5

$\frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$

@ 25°C

$kt = \frac{\frac{1}{[A]_t} - \frac{1}{[A]_0}}{k}$

$= \frac{\frac{1}{4.0\ M} - \frac{1}{5.0\ M}}{3.84 \times 10^{-11}\ M^{-1} s^{-1}}$

$= 1.3 \times 10^9\ s$

$\approx 41\ yrs$

@ 600K

$\rightarrow = \frac{\frac{1}{4.0\ M} - \frac{1}{5.0\ M}}{0.3387\ M^{-1} s^{-1}}$

$= 0.148\ s$

Half-life

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

@ 25°C

$t_{1/2} = \frac{1}{(3.84 \times 10^{-11}\ M^{-1} s^{-1})(5.0\ M)}$

$= 5.2 \times 10^9\ s$

$\approx 165\ yrs$

@ 600k

$\rightarrow \frac{1}{(0.3387\ M^{-1} s^{-1})(5\ M)}$

$= 0.59\ s$