$$p = \frac{nRT}{V-nb} - \frac{n^2 a}{V^2} = \frac{388 \cdot 0,082 \cdot 294}{49 - 388 \cdot 0,0427} = 147 \text{ atm}$$

$$p = 100 \cdot \frac{191-147}{191} = 23\%$$

R — $0,08206\ L \cdot atm\ mol^{-1} K^{-1}$; $8,314\ J \cdot mol^{-1} K^{-1}$; $62,37\ \frac{L \cdot Torr}{mol \cdot K}$

Gas density

$$C_M = \frac{n}{V} = \frac{p \cdot V}{R \cdot T V} = \frac{p}{R \cdot T}$$

$$\rho = \frac{m}{V} = \frac{n \cdot M}{V} = \left(\frac{p \cdot V}{R \cdot T} M\right) / V = \frac{p \cdot M}{R \cdot T}$$

ex: ~~General~~ Geramiol

$T = 260^\circ C = 530\ K$

$p = 103$ Torr

$\rho = 0,480$ g/L

$C_{10}H_{18}O$

the molar mass of Geramiol = ?

$$\rho = \frac{p \cdot M}{R \cdot T} \Rightarrow M = \frac{\rho \cdot R \cdot T}{p}$$

$$M = \frac{0,480 \cdot 62,37 \cdot 533,15}{103} = 154,96 = 155\ g/mol$$

Course 12

Chemical kinetics - the study of reaction and how quickly a reaction takes place.

→ the reactant concentration will decrease

→ reaction rate of a chemical reaction ?

$R \rightarrow p$ molar concentr. MS

$t_1 \rightarrow [R]_{init}$ FTIR

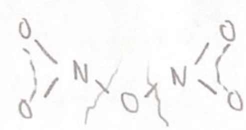
$t_2 \rightarrow [R]_{final}$ flue catalysts

$\Delta[R] = [R]_{final} - [R]_{initial}$

$$\ominus \frac{\Delta[R]}{\Delta t} = -\frac{[R]_{final} - [R]_{init}}{t_2 - t_1}$$

$$\frac{\Delta[P]}{\Delta t}$$

$N_2O_5 \xrightarrow{65^\circ C} 2NO_2 + \frac{1}{2} O_2$



$2N_2O_5 \rightarrow 4NO_2 + O_2$

First Order Reaction

$2NO_2 \rightarrow 2NO + O_2$

$$-\frac{d[A]}{dt} = k[A]$$

$$-\int_{[A]_0}^{[A]} \frac{d[A]}{[A]} = k \cdot \int_0^t dt$$

$$-(\ln[A] - \ln[A]_0) = k \cdot t$$

$$\ln[A]_0 - \ln[A] = k \cdot t$$

$$\ln[A] = \ln[A]_0 - k \cdot t$$

$$[A] = [A]_0 / 2$$

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

$$\ln[A]_0 - \ln 2 = \ln[A]_0 - k \cdot t_{1/2}$$

$$t_{1/2} = \frac{\ln 2}{k} = \frac{0.693}{k}$$

Zero Order Reaction ($2NH_3(g) \rightarrow N_2(g) + 3 \cdot H_2(0)$)

$$-\frac{d[A]}{dt} = k \qquad -\int_{[A]_0}^{[A]} d[A] = k \int_0^t dt$$

$[A] - [A]_0 = -k \cdot t \Rightarrow [A] = [A]_0 - k \cdot t$; we take $\frac{[A]_0}{2} = [A]$

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

Ea

Collision theory

→ the min. energy of collision required for 2 molecules to react is called the activation energy

$\boxed{k = A \cdot e^{-Ea/RT}}$ - Arrhenius equation

$T_1 : k_1 = A \cdot e^{-Ea/R \cdot T_1}$ $\qquad \ln k_1 = \ln A - \frac{Ea}{RT_1}$

$T_2 : k_2 = A \cdot e^{-Ea/R \cdot T_2}$ $\qquad \ln k_2 = \ln A - \frac{Ea}{RT_2}$

$\ln \frac{k_1}{k_2} = -\frac{Ea}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

slope

$aA + b \cdot B \rightarrow c \cdot C + d \cdot D$

$$-\frac{1}{a} \cdot \frac{d[A]}{dt} = -\frac{1}{b} \cdot \frac{d[B]}{dt} = \frac{1}{c} \cdot \frac{d[C]}{dt} = \frac{1}{d} \cdot \frac{d[D]}{dt}$$

Rate forw = k forw [R]
Rate rev = k rev [P]

k for [R] = k rev [P]

$$\frac{k_{rev}}{k_{for}} = \frac{[R]}{[P]} = k$$

Applications:

$k = 33$

$T = 250^\circ C$

PCl_3 0.05 M

Cl_2 0.015 M

$Cl_2(g) + PCl_3(g) \rightleftharpoons PCl_5(g)$

$\frac{x}{(0{,}05 - x)(0{,}015 - x)} = 33 \Rightarrow x_1 = 0{,}08$ $\quad \boxed{x_2 = 0{,}008}$

$33x^2 - 3{,}14x + 0{,}024 = 0$

$[Cl_2] = 0{,}015 - 0{,}008 = 0{,}007$ M/L

$[PCl_3] = 0{,}05 - 0{,}008 = 0{,}042$ M/L