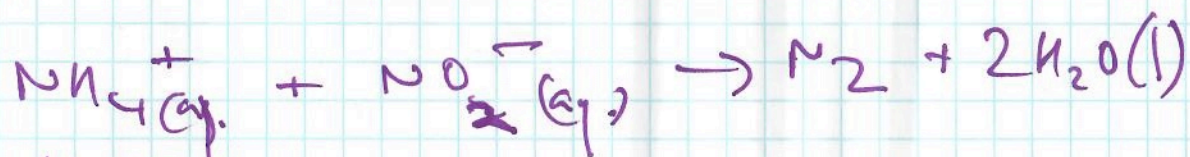


Class 2

(1)

Method of initial rates

→ measure rates when different concentrations of reactants are mixed, immediately after the reaction starts.



Expt	$[\text{NH}_4^+]_0$	$[\text{NO}_2^-]_0$	Rates
1	0.1 M	0.005 M	$1.35 \times 10^{-7} \text{ (mol L}^{-1}\text{s}^{-1}\text{)}$
2	0.1 M	0.01 M	2.70×10^{-7}
3	0.2 M	0.01 M	5.4×10^{-7}

$$\text{rate} = -\frac{d[\text{NH}_4^+]}{dt} = k [\text{NH}_4^+]^n [\text{NO}_2^-]^m$$

$$n = 1 \quad \& \quad m = 1$$

$$\boxed{\text{rate} = k [\text{NH}_4^+] [\text{NO}_2^-]}$$

Integrated rate laws

(2)

$$-\frac{d[A]}{dt} = k[A]^n \text{ is a}$$

differential equation.

we wish to find the value of
[A] at time $t = t$

We need to integrate

0th order

(3)

$$\text{rate } -\frac{d[A]}{dt} = k[A]^0 = k$$

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

Enzyme
kinetics

$$-[A] + [A]_0 = k(t-0) = kt$$

$$[A] = -kt + [A]_0$$

Half life of a reaction:

Time $t = t_{1/2}$ when $[A] = \frac{[A]_0}{2}$

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

1st order

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

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

$$-\ln[A] + \ln[A]_0 = -kt$$

$$\ln[A] = -kt + \ln[A]_0 \quad \text{or} \quad \ln \frac{[A]_0}{[A]} = kt$$

$$\text{at } t = t_{1/2} : [A] = \frac{[A]_0}{2}$$

$$\ln \frac{[A]_0}{[A]_0/2} = kt_{1/2}$$

$$\ln 2 = kt_{1/2}$$

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

Second order

5

$$-\frac{d[A]}{dt} = k[A]^2$$

$$\int_{[A]_0}^{[A]} \frac{d[A]}{[A]^2} = \int_0^t -k dt$$

$[A]_0$

$$+\frac{1}{[A]} - \frac{1}{[A]_0} = -kt \quad \text{or}$$

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

when $t = t_{1/2}$; $[A] = \frac{[A]_0}{2}$

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

Newton's Law of Cooling

(6)

$$-\frac{dT}{dt} = k\Delta T = kT - kT_{env.}$$

The rate of cooling is proportional to the temperature difference

$$-\int \frac{d\Delta T}{\Delta T} = \int k \Delta T dt$$

$$-\int \frac{d\Delta T}{\Delta T} = \int k dt$$

$$\Delta T(t) = \Delta T(0) e^{-kt}$$

diff
at time 0

Compound interest

Q

$$A = P \left(1 + \frac{r}{n} \right)^{nt}$$

↑
accumulated value (including principal P)
 r annual interest rate

n is the compounding frequency
(eg. 4 times per year)

t is time

\$1500 at 4% compounded annually
over 20 years
 $t=20, r=0.04, n=1$

$$A = \$3286.68 \text{ cents}$$

If the compounding is instantaneous
(continuous compounding)

$$P(t) = P_0 e^{rt}$$

$$P_0 = \$1,500$$

$$r = 4\% = 0.04$$

$$t = 20 \text{ years}$$

$$P(20 \text{ years}) = \$3338.31$$

$\$1,800$ in 40 years at
 10% annually is
 $\$100,000$