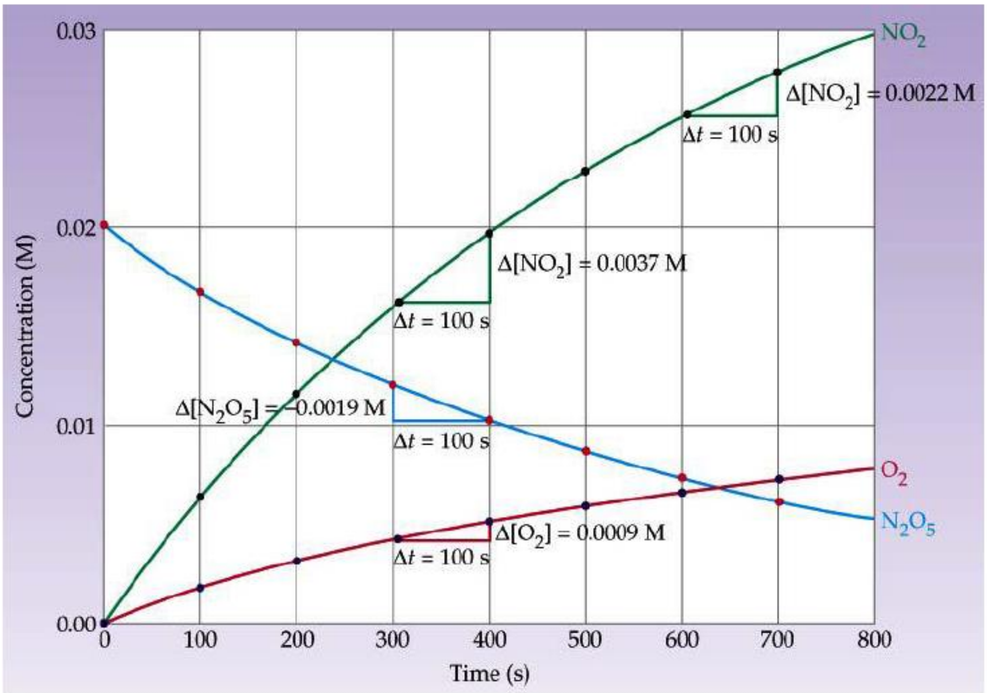
Sheet 1

Example: Consider the decomposition of N_2O_5 to give NO_2 and O_2:

$$2N_2O_5(g) \longrightarrow 4NO_2(g) + O_2(g)$$

Time (s)	Concentration (M)		
	N_2O_5	NO_2	O_2
0	0.0200	0	0
100	0.0169	0.0063	0.0016
200	0.0142	0.0115	0.0029
300	0.0120	0.0160	0.0040
400	0.0101	0.0197	0.0049
500	0.0086	0.0229	0.0057
600	0.0072	0.0256	0.0064
700	0.0061	0.0278	0.0070

Answer



from the graph looking at t = 300 to 400 s

$$Rate\ O_2 = \frac{(0.0049 - 0.0040)M}{(400 - 300)s} = 9 \times 10^{-6} Ms^{-1}$$

$$Rate\ NO_2 = \frac{0.0037M}{100s} = 3.7 \times 10^{-5} Ms^{-1}$$

$$Rate\ N_2O_5 = \frac{0.0019M}{100s} = 1.9 \times 10^{-5}\ Ms^{-1}$$

To compare the rate one must account for the stoichiometry

$$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$$

$$Rate\ O_2 = \frac{1}{1} \times 9 \times 10^{-6} Ms^{-1} = 9 \times 10^{-6}\ Ms^{-1}$$

$$Rate\ NO_2 = \frac{1}{4} \times 3.7 \times 10^{-5} Ms^{-1} = 9.2 \times 10^{-6}\ Ms^{-1}$$

$$Rate\ N_2O_5 = \frac{1}{2} \times 1.9 \times 10^{-5} Ms^{-1} = 9.5 \times 10^{-6} Ms^{-1}$$

EXAMPLE: The reaction 2 NOBr (*g*) → 2 NO (*g*) + Br2 (*g*) is second order reaction with respect to NOBr. $k = 0.810\ M^{-1} \cdot s^{-1}$ at 10º C. If $[NOBr]_o = 7.5 \times 10^{-3}$ M, how much NOBr will be left after a reaction time of 10 minutes?

SOLUTION: One can solve for the amount of NOBr after 10 minutes by substituting the given data into the integrated rate law for a second-order reaction.

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

$$\frac{1}{[NOBr]_t} = (0.810\ M^{-1}s^{-1}) \times (600\ s) + \frac{1}{7.5 \times 10^{-3} M}$$

$$\frac{1}{[NOBr]_t} = 6.19 \times 10^2 M^{-1}$$

$$[NOBr]_t = 1.6 \times 10^{-3}\ M$$

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Determine the half-life of this reaction.

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$$[NOBr]_t = 1.6 \times 10^{-3}\ M$$

To determine the half-life for this reaction, we substitute the initial concentration of NOBr and the rate constant for the reaction into the equation for the half-life of a second-order reaction.

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

$$t_{1/2} = \frac{1}{0.810\ M^{-1} \cdot s^{-1}(7.5 \times 10^{-3}\ M)} = 160\ s$$