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rate = k

rate = k[A]

rate = k[A]²

[A]_t = -kt + [A]₀

ln[A]_t = -kt + ln[A]₀

R = 8.314 J/(mol•K)

$1/[A]_t = kt + 1/[A]_0$

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

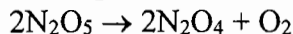
$t_{1/2} = 0.693/k$

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

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

e=mc²

1. (5 Pts) Nitrogen pentoxide decomposes by a first-order process yielding N₂O₄ and oxygen.

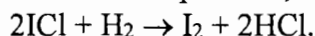


At a given temperature, the half-life of N₂O₅ is 0.90 hr. What is the first-order rate constant for N₂O₅ decomposition?

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

$$k = 0.77 \text{ hr}^{-1}$$

2. (5 Pts) At a certain temperature, the data below were collected for the reaction below.



Determine the rate law and the rate constant along with its units for the reaction.

	Initial concentrations (M)		Initial Rate of Formation of I ₂
	[ICl]	[H ₂]	mol/L•s
①	0.10	0.10	0.0015
②	0.20	0.10	0.0030
③	0.10	0.050	0.00075

a. Rate law: General rate law: rate = k [ICl]^x [H₂]^y

for ICl use ② ÷ ① $\frac{0.0030}{0.0015} = \frac{(0.20)^x (0.10)^y}{(0.10)^x (0.10)^y}$

$$2 = 2^x \text{ so } x = 1$$

for H₂ use ① ÷ ③

$$\frac{0.0015}{0.00075} = \frac{(0.10)^x (0.10)^y}{(0.10)^x (0.050)^y}$$

$$2 = 2^y \text{ so } y = 1$$

$$\text{rate} = k [\text{ICl}] [\text{H}_2]$$

b. Value of k and its units:

$$k = \frac{\text{rate}}{[\text{ICl}] [\text{H}_2]} = \frac{0.0015}{[0.10][0.10]} = 0.15 \text{ M}^{-1} \cdot \text{s}^{-1}$$

$$\frac{\text{M}}{\text{s}} \frac{1}{\text{M}} \frac{1}{\text{M}} = \text{s}^{-1} \cdot \text{M}^{-1}$$

Key

3. (5 Pts) The rate constant for the first-order decomposition of C_4H_8 at $500^\circ C$ is $9.2 \times 10^{-3} s^{-1}$. How long will it take for 10.0% of a 0.100 M sample of C_4H_8 to decompose at $500^\circ C$?

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

$$a \ln \frac{[A]_t}{[A]_0} = -kt \quad \ln \left(\frac{90}{100} \right) = -9.2 \times 10^{-3} s^{-1} (t)$$

$$t = 11.4 \text{ sec}$$

4. (5 Pts) What is the rate law that corresponds to the data shown for the reaction $2A + B \rightarrow C$?

Exp.	Initial [A]	Initial [B]	Initial rate
1	0.015	0.022	0.125
2	0.030	0.044	0.500
3	0.060	0.044	0.500
4	0.060	0.066	1.125

General rate law: $rate = k[A]^x[B]^y$

for A use 2 & 3: no change in rate shows 0 order

for B use 4 & 3: $\frac{1.125}{0.500} = \left(\frac{0.066}{0.044} \right)^y$

$$2.25 = (1.5)^y$$

$$\ln 2.25 = y \ln 1.5 \quad y = 2$$

$$rate = k[B]^2$$

5. (5 Pts) A nuclear stress test utilizes a gamma-emitting radioisotope such as thallium-201 to follow the flow of blood through the heart – first at rest, and then under stress. The first-order rate constant for the decay of thallium-201 is $9.5 \times 10^{-3} hr^{-1}$. Calculate how long it takes for the amount of thallium-201 to fall to 5.0% of its original value.

1st order

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

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

$$\ln \left(\frac{5}{100} \right) = -9.5 \times 10^{-3} hr^{-1} (t)$$

$$t = 315 \text{ hr}$$