L1 : KINETICS PROBLEMS

Differential Rate Law: rate of change over time
Integrated Rate Law: concentration as function of time

Order	Diff. Rate Law	Int. Rate Law
0th	$\frac{dA}{dt} = k$	$A(t) = A_0 - kt$
1st	$\frac{dA}{dt} = k[A]$	$A(t) = A_0 e^{-kt}$
2nd	$\frac{dA}{dt} = k[A]^2$	$A(t) = \frac{A_0}{1+kt A_0}$

① Show that:
- $[A] \propto t$ if 0th order.
- $\ln [A] \propto t$ if 1st order.
- $\frac{1}{[A]} \propto t$ if 2nd order.

using the Integrated Rate Laws.

② The half-life of a 1st order reaction is $\frac{\ln 2}{k}$. Prove this using the integrated rate law.

③ If half-life of a reaction increases as initial reactant concentration increases, reaction order is

A. zero
B. first
C. second
D. third

④ Propanone reacts with iodine in an acid solution as shown:

$$CH_3COCH_3 + I_2 \xrightarrow{H^+} CH_3COCH_2I + HI$$

These data were obtained when this reaction was studied:

$[CH_3COCH_3]$ (M)	$[I_2]$(M)	$CH^+]$ M	Relative Rate
0.010	0.010	0.010	1
0.020	0.010	0.010	2
0.020	0.020	0.010	2
0.020	0.010	0.020	4

What is the rate equation (differential) for this reaction?

Bromate Ion
⑤ ~~Propanone~~ reacts with iodine in acid solution:

$$6I^-(aq) + BrO_3^-(aq) + 6H^+(aq) \rightarrow 3I_2(aq) + Br^-(aq) + 3H_2O(l)$$

This data was obtained when this reaction was studied:

$[I^-]$ (M)	$[BrO_3^-]$ (M)	$[H^+]$ (M)	Rate $(mol \cdot L^{-1} \cdot s^{-1})$
0.0010	0.0020	0.010	8.0×10^{-5}
0.0020	0.0020	0.010	1.6×10^{-4}
0.0020	0.0040	0.010	1.6×10^{-4}
0.0010	0.0040	0.020	1.6×10^{-4}

What are the units of the rate constant for this reaction?

A. s^{-1}
B. $mol \cdot L^{-1} \cdot s^{-1}$
C. $L \cdot mol^{-1} \cdot s^{-1}$
D. $L^2 \cdot mol^{-1} \cdot s^{-1}$

⑥ For reaction $A \rightarrow B$, rate law is rate = $k[A]$ (first order). If the reaction is 40.0% complete after 50.0 min, what is the rate constant, k?

A. 8.00×10^{-3} min^{-1}
B. 1.02×10^{-2} min^{-1}
C. 1.39×10^{-2} min^{-1}
D. 1.83×10^{-2} min^{-1}

⑦ CHALLENGE PROBLEM:
Given generic reaction:

$$A + B \rightarrow C + D$$

and experimental data:

$[A]$(M)	$[B]$(M)	Relative Rate
a	b	c
d	e	f

Ⓐ Derive a rate equation $k = [A]^m [B]^n$ for constants m and n written as functions of a, b, c, d, e, and/or f.

Ⓑ Let R_n = reactants and $\sum_{i=1}^{n} P_i$ = all of the products
Let m_n = order of reaction with respect to reactant R_n

Given generic equation,

$$R_1 + R_2 + R_3 + \cdots + R_n \rightarrow \sum_{i=1}^{n} P_i$$

how many unique experimental trials using unique initial reactant concentrations do you need to determine m_n for all R_n in this reaction?