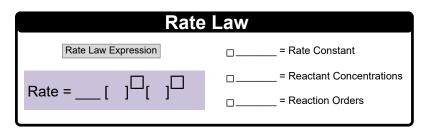
CONCEPT: RATE LAW

• An expression that relates the rate of a reaction to its Δ [], rate constant and reaction order(s).
□ Rate Constant: a proportionality constant that links the	to [].
□ Reaction Orders: the component for the giv	en concentrations.
- Determined mathematically with a or from a	a series of steps called a reaction mechanism.
□ Rate Law ignores	



EXAMPLE: The chemical reaction: 2 A + 3 B + C \longrightarrow D has a Rate Law of k[A]³[B][C]⁰. By what factor would the rate increase if the concentration of A were tripled, the concentration of B was cut by half, the concentration of C increased by half, and the rate constant k was kept constant?

a) 2.5

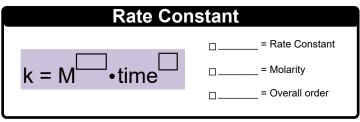
b) 9.0

c) 13.5

d) 3.0

Rate Constant Units

- The units of the rate constant k can be determined by first calculating the *overall order*.
 - □ Overall order (___): The numerical value calculated from the _____ of all reaction orders.



EXAMPLE: What is the overall order and the units for the rate constant k for the following chemical reaction shown below that has Rate = $k [NO_2]^2 [Cl_2]$?

$$NO_2(g) + Cl_2(g) \longrightarrow NOCl(g) + ClO(g)$$

CONCEPT: RATE LAW

Rate Law Determination

- Rate constant and reaction orders of the Rate Law are determined mathematically when given [_____] and initial rates.

EXAMPLE: The initial rates of reaction for 2 NO (g) + Cl ₂ (g) 2 NOCl (g) are:					
Experiment	[NO], M	[Cl ₂], M	Initial Rate, M/s		
1	0.0250	0.0510	18.2		
2	0.0250	0.0255	9.08		
3	0.0500	0.0255	18.2		
Determine the new rate if given new initial concentrations of [NO] = 0.0730 M and [Cl ₂] = 0.0510 M.					

- **STEP 1:** Choose a reactant and look at _____ experiments where its concentration changes, but the other(s) stay the same.
 - _____ the reactant(s) whose concentrations remain the same.
- STEP 2: Create a pair of ______ for the reactant that sets rate/rate = [reactant]/[reactant].
 - □ Place the _____ rate value on top of the ____ rate value to get whole numbers when solving.
 - □ Raise the [reactant]/[reactant] to an unknown _____ for the reaction order and solve.

STEP 3: Repeat the process for any remaining reactant(s) until all reaction orders are determined.

$$\frac{\mathsf{Rate} \, \underline{\hspace{1cm}}}{\mathsf{Rate} \, \underline{\hspace{1cm}}} = \left(\begin{array}{c} [&] \\ \hline [&] \end{array} \right) \longrightarrow \cdots \longrightarrow = \left[\begin{array}{c} [&] \\ \hline [&] \end{array} \right]$$

STEP 4: If necessary, to solve for the rate constant k plug in the [reactant] and reaction orders into the Rate Law.

STEP 5: If necessary, to solve for the _____ initial rate plug in the k, reaction orders, and additional [reactants] given.

CONCEPT: RATE LAW

PRACTICE: Given the following chemical reaction, A

B. If the concentration of A is doubled the rate increases by a factor of 2.83, what is the order of the reaction with respect to A.

a) 1

- b) 0.5
- c) 1.5
- d) 0

e) 2

PRACTICE: In the experiments on the reaction 2 ICI (g) + H_2 (g) \longrightarrow I_2 (g) + 2 HCI (g), the following initial rate data were obtained. What is the overall order of the reaction?

Experiment	[ICI], M	[H ₂], M	Initial Rate, M/s
1	1.5	1.5	3.7 x 10 ⁻⁷
2	3.0	1.5	1.5 x 10 ⁻⁶
3	3.0	4.5	1.34 x 10 ⁻⁵

- a) Third
- b) Second
- c) Zeroth
- d) Fourth
- e) First

PRACTICE: The data below were collected for the following reaction: CH₃Cl (g) + 3 Cl₂ (g) → CCl₄ (g) + 3 HCl (g)

Experiment	[CH ₃ CI], M	[Cl ₂], M	Initial Rate, M/s
1	0.050	0.050	0.014
2	0.100	0.050	0.029
3	0.100	0.100	0.041
4	0.200	0.200	0.115

Calculate the value and units for the rate constant k.