

SAMPLE PROBLEM B

For more help, go to the *Math Tutor* at the end of this chapter.

Three experiments that have identical conditions were performed to measure the initial rate of the reaction



The results for the three experiments in which only the HI concentration was varied are as follows:

Experiment	[HI] (M)	Rate (M/s)
1	0.015	1.1×10^{-3}
2	0.030	4.4×10^{-3}
3	0.045	9.9×10^{-3}

Write the rate law for the reaction. Find the value and units of the specific rate constant.

SOLUTION

- 1 ANALYZE** The general rate law for this reaction has the form $R = k[\text{HI}]^n$. We need to deduce the value of the power n .
- 2 PLAN** Find the ratio of the reactant concentrations between two experiments, such as 1 and 2, $\frac{[\text{HI}]_2}{[\text{HI}]_1}$. Then, see how the ratio of concentration affects the ratio of rates, $\frac{R_2}{R_1}$.
- 3 COMPUTE** Concentration ratio: $\frac{[\text{HI}]_2}{[\text{HI}]_1} = \frac{0.030 \text{ M}}{0.015 \text{ M}} = 2.0$; rate ratio: $\frac{R_2}{R_1} = \frac{4.4 \times 10^{-3} \text{ M/s}}{1.1 \times 10^{-3} \text{ M/s}} = 4.0$
- Thus, when the concentration changes by a factor of 2, the rate changes by a factor of 4, or 2^2 , so the rate law is $R = k[\text{HI}]^2$.
- To find the value of k , we can rearrange the rate law and substitute known values for any one experiment. Do the following for Experiment 1:
- $$k = \frac{R}{[\text{HI}]^2} = \frac{1.1 \times 10^{-3} \text{ M/s}}{(0.015 \text{ M})^2} = 4.9 \text{ M}^{-1}\text{s}^{-1}$$
- 4 EVALUATE** By comparing items 1 and 3 in the table, we see that when [HI] is tripled, the rate changes by a factor of 9, or 3^2 . This rate change confirms that the order is 2. The same value of k can be calculated from any other experiment. Thus, the rate law and k are correct.

PRACTICE

Answers in Appendix E

- For the reaction $3\text{A} \longrightarrow \text{C}$, the initial concentration of A was 0.2 M and the reaction rate was 1.0 M/s. When [A] was doubled, the reaction rate increased to 4.0 M/s. Determine the rate law for the reaction.
- The rate law for a reaction is found to be $\text{rate} = k[\text{X}]^3$. By what factor does the rate increase if [X] is tripled?

extension

Go to **go.hrw.com** for more practice problems that ask you to determine rate law and rate constant.



Keyword: HC6RXXK