# Kinetics AP Practice Problems

1. Graphical methods are frequently used to analyze data and obtain desired quantities.

(a) 2 HI(g) -----> $H_2(g) + I_2(g)$

The following data give the value of the rate constant at various temperatures for the gas phase reaction above.

| T(k) | 647 | 666 | 683 | 700 | 716 |
|---|---|---|---|---|---|
| k (liter/mole sec) | $8.58 \times 10^{-5}$ | $2.19 \times 10^{-4}$ | $5.11 \times 10^{-4}$ | $1.17 \times 10^{-3}$ | $2.50 \times 10^{-3}$ |

Describe, without doing calculations, how a graphical method can be used to obtain the activation energy for this reaction.

(b) A(g) -----> B(g) + C(g)

The following data give the partial pressure of A as a function of time and were obtained at 100 °C for the reaction above.

| $P_A$(mm Hg) | 348 | 247 | 185 | 105 | 58 |
|---|---|---|---|---|---|
| t(sec) | 0 | 600 | 1200 | 2400 | 3600 |

Describe, without doing calculations, how graphs can be used to determine whether this reaction is first or second order in A and how these graphs are used to determine the rate constant.

2.

$$PCl_3(g) + Cl_2(g) \Longleftrightarrow PCl_5(g)$$

In the equation above, the forward reaction is first order in both $PCl_3$ and $Cl_2$ and the reverse reaction is first order in $PCl_5$

(b) Give the initial rate law for the forward reaction.

(c) Provide a molecular explanation for the dependence of the rate of the forward reaction on the concentrations of the reactants.

(d) Provide a molecular explanation for the dependence of the rate of the forward reaction on temperature.

3. The overall order of a reaction may not be predictable from the stoichiometry of the reaction.

(a) Explain how this statement can be true.

(b) 2 XY ---> $X_2 + Y_2$

1. For the hypothetical reaction above, give a rate law that shows that the reaction is first order in the reactant XY.
2. Give the units for the specific rate constant for this rate law.
3. Propose a mechanism that is consistent with both the rate law and the stoichiometry.

4. Consider the following general equation for a chemical reaction.

$$A(g) + B(g) \rightarrow C(g) + D(g)$$

(a) Describe the two factors that determine whether a collision between molecules of A and B results in a reaction.

(b) How would a decrease in temperature affect the rate of the reaction shown above? Explain your answer.

(c) Write the rate law expression that would result if the reaction proceeded by the mechanism shown below.

$A + B \leftrightarrows [AB]$ (fast)
$[AB] + B \rightarrow C + D$ (slow)

(d) Explain why a catalyst increases the rate of a reaction but does not change the value of the equilibrium constant for that reaction.

5.

$$2\ ClO_2(g) + F_2(g) \rightarrow 2\ ClO_2F(g)$$

The following results were obtained when the reaction represented above was studied at 25 °C.

| Experiment | Initial $[ClO_2]$, (mol $L^{-1}$) | Initial $[F_2]$, (mol $L^{-1}$) | Initial Rate of Increase of $[ClO_2F]$, (mol $L^{-1}$ $sec^{-1}$) |
|---|---|---|---|
| 1 | 0.010 | 0.10 | $2.4 \times 10^{-3}$ |
| 2 | 0.010 | 0.40 | $9.6 \times 10^{-3}$ |
| 3 | 0.020 | 0.20 | $9.6 \times 10^{-3}$ |

(a) Write the rate law expression for the reaction above.

(b) Calculate the numerical value of the rate constant and specify the units.

(c) In experiment 2, what is the initial rate of decrease of $[F_2]$?

(d) Which of the following reaction mechanisms is consistent with the rate law developed in (a)? Justify your choice.

I.

$ClO_2 + F_2 \leftrightarrows ClO_2F_2$ (fast)
$ClO_2F_2 \rightarrow ClO_2F + F$ (slow)
$ClO_2 + F \rightarrow ClO_2F$ (fast)

II.

$F_2 \rightarrow 2\ F$ (slow)
$2\ (ClO_2 + F \rightarrow ClO_2F)$ (fast)