Teacher's Tools® Chemistry
Kinetics: Rate of Reaction

1. The rate of a chemical reaction between substances A and B is found to follow the rate equation rate = k $[A]^2[B]$ where k is a constant. If the concentration of A is halved, what should be done to the concentration of B to make the reaction go at the same rate as before?
(A) The concentration of B should be kept constant.
(B) The concentration of B should be doubled.
(C) The concentration of B should be halved.
(D) The concentration of B should be quadrupled.

2. Which of the following represents a second-order reaction?
(A) rate = k[A] (B) rate = $k[A]^2[B]$ (C) rate = k[A][B] (D) rate = $k[A]^2[B]^2$

3. The half-life of ^{14}C is 5570 years. How many years will it take for 90% of a sample to decompose?
(A) 5,570 years (B) 17,740 years (C) 18,570 years (D) 50,150 years

4. For a first-order reaction of half-life, 150 min, what is the rate constant in min^{-1}?
(A) 0.00104 (B) 0.00462 (C) 69.3 (D) 216

5. The rate of the reaction of $2NO + Cl_2 \rightarrow 2NOCl$ is given by the rate equation rate = $k[NO]^2[Cl_2]$. The value of the rate constant can be increased by
(A) increasing the concentration of NO.
(B) increasing the concentration of Cl_2.
(C) increasing the temperature.
(D) doing all of these.

6. For a certain reaction the rate law is, rate = $k[C]^2$. If the rate of the reaction is 0.020 $M \cdot s^{-1}$ when [C] = 1.0 M, what is the rate when [C] = 0.60 M?
(A) 0.0093 $M \cdot s^{-1}$ (B) 0.020 $M \cdot s^{-1}$ (C) 0.0072 $M \cdot s^{-1}$ (D) 0.012 $M \cdot s^{-1}$

7. The dissociation of HI molecules, $2HI_{(g)} \rightarrow H_{2(g)} + I_{(g)}$, occurs at a temperature of 629 K. The rate constant, k = 3.02 x 10^{-5} $M^{-1} \cdot s^{-1}$. What is the reaction order?
(A) 0 (B) 1 (C) 2 (D) 3

8. The rate constant of a reaction is generally expected to
(A) be independent of temperature.
(A) decrease with increasing temperature.
(C) increase with increasing temperature.
(D) increase with increasing temperature, only if the reaction is endothermic.

9. The rate law of the reaction $2H_2 + 2NO \rightarrow N_2 + 2H_2O$ is second order in [NO] and first order in $[H_2]$. If [NO] is doubled and $[H_2]$ is halved, the rate of the reaction will
(A) increase by a factor of 4.
(B) remain the same.

(C) increase by a factor of 6.
(D) increase by a factor of 2.

10. The rate of a second order decomposition of a substance, A, is 2.7 $M^{-1} \cdot s^{-1}$ when the initial concentration of the reactant A is 0.60 M. What is the initial rate of the reaction when the initial concentration of the reactant is 0.20 M?

(A) 0.30 $M \cdot s^{-1}$ (B) 0.60 $M \cdot s^{-1}$ (C) 0.90 $M \cdot s^{-1}$ (D) 2.7 $M \cdot s^{-1}$

11. The decomposition of $NaClO_3$ is a first-order reaction. In an experiment, a sample of $NaClO_3$ was 90% decomposed in 48.0 minutes. How long would it take for a sample to be 50% decomposed?

(A) 14.4 min (B) 21.6 min (C) 24.0 min (D) 43.2 min (E) 48.0 min

Questions 12-14 refer to these data for the reaction:

$2NO_{(g)} + 2H_{2(g)} \rightarrow N_{2(g)} + 2H_2O_{(g)}$

Run	Pressure(NO) atm	Pressure(H_2) atm	Rate atm/s
1	0.375	0.500	6.43×10^{-4}
2	0.375	0.250	3.22×10^{-4}
3	0.188	0.500	1.56×10^{-4}
4	l.000	1.000	9.00×10^{-3}

12. What is the rate law equation for this reaction?

(A) Rate = k $[P_{NO}]$
(B) Rate = k $[P_{NO}]^2[P_{H_2}]$
(C) Rate = k $[P_{NO}][P_{H_2}]^2$
(D) Rate = k $[P_{NO}][P_{H_2}]$
(E) Rate = k $[P_{NO}]^2$

13. The value of the rate constant, k, is

(A) 9.02×10^{-3} $atm \cdot s^{-1}$
(B) 9.02×10^{-3} $atm^{-1} \cdot s^{-1}$
(C) 9.02×10^{-3} $atm^{-2} \cdot s^{-1}$
(D) 9.02×10^{-4} $atm^{3} \cdot s$
(E) 9.02×10^{-4} $atm^{4} \cdot s^{-1}$

14. If the partial pressures of both NO and the H_2 were initially at 2.000 atm., the initial rate of the reaction would be

(A) 9.00×10^{-3} atm/s
(B) 1.80×10^{-2} atm/s
(C) 2.70×10^{-2} atm/s
(D) 3.60×10^{-2} atm/s
(E) 7.21×10^{-2} atm/s

PROBLEMS

1. The following initial rate data were obtained for the reaction

$$2ClO_{2(aq)} + 2OH^-_{(aq)} \leftrightarrow ClO_3^-{}_{(aq)} + ClO_2^-{}_{(aq)} + H_2O$$

Expt.	$[ClO_2]$	$[OH^-]$	Initial Rate $M \cdot s^{-1}$
1	0.024 M	0.011 M	7.27×10^{-4}
2	0.018 M	0.011 M	4.09×10^{-4}
3	0.024 M	0.014 M	9.25×10^{-4}

(A) (i) Determine the order of reaction with respect to ClO_2 and OH^-.

(ii) Write the rate law for this reaction.

(B) Calculate the specific rate constant k and specify its units.

(C) Calculate the rate when the $[ClO_2] = 0.75$ M and $[OH^-] = 0.0250$ M.

2. Given the following data:

Expt	Rate (mole/L•s)	[A]	[B]
1	1,350	0.20 M	0.30 M
2	13,500	0.50 M	0.60 M
3	54,000	0.50 M	1.2 M

(A) (i) Determine the order of reaction with respect to ClO_2 and OH^-.

(ii) Write the rate law for this reaction.

(B) Calculate the specific rate constant k and specify its units.

(C) What would happen to the rate if both the concentrations of A and B were doubled?

3. The reaction $2I^-_{(aq)} + S_2O_8^{2-}{}_{(aq)} \leftrightarrow I_{2(aq)} + 2SO_4^{2-}{}_{(aq)}$

is performed and the following experimental results are obtained.

Expt.	$[I^-]$	$[S_2O_8^{2-}]$	Rate $M \cdot s^{-1}$
1	0.10	0.080	3.12×10^{-5}
2	0.050	0.080	1.56×10^{-5}
3	0.10	0.040	1.56×10^{-5}
4	0.030	0.030	3.51×10^{-6}
5	0.050	0.040	7.80×10^{-6}

(A) Determine the rate law.

(B) Calculate the rate constant and specify its units.

(C) Determine the rate when $[I^-] = [S_2O_8^{2-}] = 1.5$ M

4. Take for instance a reaction of the form $2A + B \leftrightarrow C$. Let's pretend to perform an experiment and obtain data. The data that has been made-up for your enjoyment is given below:

Initial rate of formation of C M/sec	Initial [A]	Initial [B]
4.0×10^{-2}	0.30 M	0.100 M
2.0×10^{-2}	0.50 M	0.050 M
6.0×10^{-2}	0.50 M	0.150 M
1.0×10^{-2}	0.40 M	0.025 M

(A) What rate law is consistent with these data.
(B) Calculate k and specify its units.
(C) What are the initial rates of disappearance of A and B in experiment #4?

5. The decomposition of N_2O_5 to NO_2 and O_2 is a first-order reaction with the rate constant,
$k = 1.2 \times 10^{-3}\ s^{-1}$ at 374 K.

(A) Determine the half-life of this reaction.
(B) A 0.05 mole sample of N_2O_5 is added to a 1.0 liter flask at 374 K. How much N_2O_5 remains in a 1.0 L after 5.0 minutes?
(C) How long would it take for 60% of a sample of N_2O_5 to disappear?

$$X_{(g)} \leftrightarrow Y_{(g)} + Z_{(g)}$$

6. The concentration of X was monitored at 100°C and these data were compiled:

[X]	0.30	0.297	0.293	0.29	0 .287
t (s)	0	60	120	180	240

What different plots would you construct to determine the order of the rate law? Use your graphing calculator or other means to make the various graphs needed an determine the order of reaction. From the graph, what additional information about the rate law could be obtained?