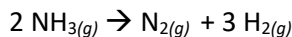


Review Problems

_____ 1. The rate of decomposition of ammonia to hydrogen gas and nitrogen gas is expressed as $-\Delta[\text{NH}_3]/\Delta t$. Express the rate of reaction in terms of $\Delta[\text{H}_2]/\Delta t$.



- a. Rate = $2/3 \Delta[\text{H}_2]/\Delta t$ c. Rate = $3 \Delta[\text{H}_2]/\Delta t$
 b. Rate = $\Delta[\text{H}_2]/\Delta t$ d. Rate = $2 \Delta[\text{H}_2]/\Delta t$

_____ 2. Given the following information, calculate the average rate, $\Delta[\text{SO}_2]/\Delta t$, between 10 and 40 minutes for the production of SO_2 . $2 \text{SO}_{3(g)} \rightarrow 2 \text{SO}_{2(g)} + \text{O}_{2(g)}$

t (min)	$[\text{SO}_3]$	$[\text{SO}_2]$	$[\text{O}_2]$
0.0	0.124	0.0	0.0
10.0	0.092	0.032	0.01
20.0	0.068	0.056	0.028
30.0	0.050	0.074	0.037
40.0	0.037	0.087	0.044
50.0	0.028	0.096	0.048

- a. $1.8 \times 10^{-3} \text{ M/min}$ c. $3.0 \times 10^{-3} \text{ M/min}$
 b. $1.5 \times 10^{-3} \text{ M/min}$ d. $3.2 \times 10^{-3} \text{ M/min}$

_____ 3. Given the following information, calculate the average rate, $\Delta[\text{O}_2]/\Delta t$, between 20 and 40 minutes for the production of O_2 . $2 \text{SO}_{3(g)} \rightarrow 2 \text{SO}_{2(g)} + \text{O}_{2(g)}$

t (min)	$[\text{SO}_3]$	$[\text{SO}_2]$	$[\text{O}_2]$
0.0	0.124	0.0	0.0
10.0	0.092	0.032	0.01
20.0	0.068	0.056	0.028
30.0	0.050	0.074	0.037
40.0	0.037	0.087	0.044
50.0	0.028	0.096	0.048

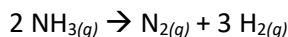
- a. $8.0 \times 10^{-3} \text{ M/min}$ c. $6.7 \times 10^{-4} \text{ M/min}$
 b. $1.6 \times 10^{-3} \text{ M/min}$ d. $8.0 \times 10^{-4} \text{ M/min}$

_____ 4. Given the following information, calculate the average rate, $-\Delta[\text{NH}_3]/\Delta t$, between 10 and 30 minutes for the production of NH_3 . $2 \text{NH}_{3(g)} \rightarrow \text{N}_{2(g)} + 3 \text{H}_{2(g)}$

t (min)	$[\text{NH}_3]$	$[\text{N}_2]$	$[\text{H}_2]$
0.0	1.00	0.0	0.0
10.0	0.083	0.034	0.11
20.0	0.063	0.044	0.024
30.0	0.045	0.053	0.036
40.0	0.033	0.059	0.044
50.0	0.025	0.063	0.049

- a. $8.0 \times 10^{-3} \text{ M/min}$ c. $1.5 \times 10^{-2} \text{ M/min}$
 b. $1.9 \times 10^{-3} \text{ M/min}$ d. $2.3 \times 10^{-3} \text{ M/min}$

_____ 5. Based on the following equation, which one of the following compounds would you expect to undergo the most change in concentration in a certain amount of time?



- a. Nitrogen
b. Ammonia
c. Hydrogen
d. None of the molecules

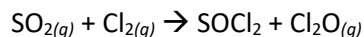
_____ 6. For the following reaction, under circumstances where the reverse reaction can be neglected, the reaction rate will depend on which of the options below? $\text{AlCl}_3(g) + \text{PH}_3(g) \rightarrow \text{Cl}_3\text{AlPH}_3(g)$

- a. AlCl_3
b. AlCl_3 and PH_3
c. PH_3
d. Cl_3AlPH_3

_____ 7. For the following rate law: $R = k[X]^3$, what is the order on X?

- a. 2
b. 4
c. 9
d. 3

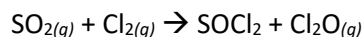
_____ 8. Based on the following data, determine the rate law of this reaction:



Experiment	$[\text{SO}_2]$ (M)	$[\text{Cl}_2]$ (M)	Initial rate (M/sec)
1	0.400	0.400	0.2918
2	0.400	0.200	0.0730
3	0.400	0.800	1.1674
4	0.200	0.800	0.5837

- a. $R = k[\text{SO}_2]$
b. $R = k[\text{SO}_2][\text{Cl}_2]$
c. $R = k[\text{Cl}_2]$
d. $R = k[\text{SO}_2][\text{Cl}_2]^2$

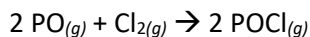
_____ 9. Based on the following data, determine the rate constant of this reaction:



Experiment	$[\text{SO}_2]$ (M)	$[\text{Cl}_2]$ (M)	Initial rate (M/sec)
1	0.400	0.400	0.2918
2	0.400	0.200	0.0730
3	0.400	0.800	1.1674
4	0.200	0.800	0.5837

- a. 1.82
b. 9.12
c. 4.56
d. 0.0351

_____ 10. Based on the following data, determine the rate law of this reaction:



Experiment	[PO] (M)	[Cl ₂] (M)	Initial rate (M/sec)
1	0.20	0.20	0.40
2	0.20	0.40	0.80
3	0.60	0.20	3.2
4	0.60	0.60	9.6

- a. 3
b. 2
c. 5/2
d. 4

_____ 11. Fill in the missing data item in this table:

Experiment	[AB] (M)	[CV](M)	Initial rate (M/hr)
1	1.00	0.500	Z
2	1.00	0.750	?
3	2.00	0.750	3.00 Z
4	1.00	0.250	0.500 Z

- a. 1.00 Z
b. 1.50 Z
c. 2.00 Z
d. 1.75 Z

_____ 12. In a zero-order rate expression, what units must the specific rate constant possess?

- a. t/M
b. l/t
c. M/t
d. l/M · t

_____ 13. The rate of decomposition of a substance is first order. If $k = 2.46 \times 10^{-3} \text{ s}^{-1}$, what concentration of this substance remains after 2 minutes, knowing that $[\text{Substance}]_0 = 0.550 \text{ M}$?

- a. 0.409 M
b. 0.547 M
c. 0.553 M
d. 0.739 M

_____ 14. A particular drug can be sold until 20% of the original drug has undergone change. Knowing that $k = 1.25 \times 10^{-2} / \text{day}$ and the change is first order, how long – in days – will it take before the drug can no longer be sold?

- a. 17 days
b. 18 days
c. 18 hours
d. 35 hours

_____ 15. A gas phase reaction in which substance A reacts with substance B to produce AB, is found to be second order on A. Knowing that $k = 0.0368 \text{ M}$, what percent of A remains after 177 hours of reaction?

- a. 3.31%
b. 85.6%
c. 14.4%
d. 6.39%

_____ 16. The decomposition of N₂O gas obeys zero-order kinetics. Given a rate constant = $2.46 \times 10^{-3} \text{ M/s}$ and $[\text{N}_2\text{O}]_{120} = 0.155 \text{ M}$, calculate $[\text{N}_2\text{O}]_0$.

- a. 0.445 M
b. 0.450 M
c. 0.550 M
d. 0.225 M

_____ 17. The decomposition of N_2O gas obeys zero-order kinetics. Given a rate constant = $2.46 \times 10^{-3} \text{ M/s}$ and $[\text{N}_2\text{O}]_{120} = 0.450 \text{ M}$, calculate $[\text{N}_2\text{O}]$ at the end of 0.0445 hours.

- a. 0.0558 M
- b. 0.221 M
- c. 0.225 M
- d. 0.450 M

_____ 18. To determine whether data from different experiments correspond to a zero-order rate expression, a plot of what variables will yield a straight line?

- a. $[\text{X}]$ vs. $1/t$
- b. $[\text{X}]$ vs. t
- c. $1/[\text{X}]$ vs. t
- d. $[\text{X}]^3$ vs. $1/t$

_____ 19. A specific reaction is known to have a first-order rate expression. If $k = 1.52 \times 10^{-2}/\text{min}$, what is the half-life, in minutes, of this reaction?

- a. 91.2
- b. 66.7
- c. 33.3
- d. 45.6

_____ 20. The following is a proposed mechanism for this reaction: $\text{H}_2(g) + \text{Br}_2(g) \rightarrow 2 \text{HBr}(g)$

- a. $\text{Br}_2 + \text{light} \rightarrow 2 \text{Br}$
- b. $2 \text{Br} + 2 \text{H}_2 \rightarrow 2 \text{HBr} + 2 \text{H}$
- c. $\text{H} + \text{Br}_2 \rightarrow \text{HBr} + \text{Br}$
- d. $\text{H} + \text{HBr} \rightarrow \text{H}_2 + \text{Br}$
- e. $\text{Br} + \text{Br} \rightarrow \text{Br}_2$

In this proposed mechanism, which steps are bimolecular?

- a. a only
- b. b, c, d, e
- c. All
- e. b, c, d

_____ 21. The following is a proposed mechanism for this reaction: $\text{H}_2(g) + \text{Br}_2(g) \rightarrow 2 \text{HBr}(g)$

- a. $\text{Br}_2 + \text{light} \rightarrow 2 \text{Br}$
- b. $2 \text{Br} + 2 \text{H}_2 \rightarrow 2 \text{HBr} + 2 \text{H}$
- c. $\text{H} + \text{Br}_2 \rightarrow \text{HBr} + \text{Br}$
- d. $\text{H} + \text{HBr} \rightarrow \text{H}_2 + \text{Br}$
- e. $\text{Br} + \text{Br} \rightarrow \text{Br}_2$

In this proposed mechanism, which step consists only of intermediates as reactants?

- a. e only
- b. a only
- c. c, d
- d. b only

_____ 22. For a reaction to take place, the molecules that are reacting:

- a. must have more energy than the products.
- b. must have less energy than the products.
- c. must be able to reach the activation energy.
- d. must be in considerable numbers.

_____ 23. Which of the following is not a factor determining the energy of activation according to the Arrhenius equation?

- a. Orientation of molecules
- b. Temperature
- c. Frequency factor
- d. None of these choices

_____ 24. Calculate E_a when $k_1 = 2.00$ and $k_2 = 10.0$, $T_1 = 318 \text{ K}$ and $T_2 = 371 \text{ K}$.

- a. 9.0 J
- b. 30.0 kJ
- c. 85.0 kJ
- d. 3.1 J

- _____ 25. Calculate T_2 when $E_a = 30.0$ kJ, $T_1 = 285$ K, $k_1 = 3.00$, and $k_2 = 15.0$.
- a. 327 K
 - b. 253 K
 - c. 158 K
 - d. 2.53 K
- _____ 26. In a “reaction progress” graph, reacting molecules are most unstable at:
- a. their initial position.
 - b. when they are about to collide.
 - c. right after they collide.
 - d. at the transition state.
- _____ 27. A catalyst:
- a. is consumed during a reaction, while effectively increasing the number of reacting molecules that can reach the energy of activation.
 - b. changes an endothermic reaction into an exothermic reaction.
 - c. increases the energy of the products.
 - d. provides an alternate pathway to the reaction, effectively lowering E_a .
- _____ 28. In which of the following examples is a heterogenous catalyst NOT used?
- a. hydrogenation of fats
 - b. oxidation of sulfur dioxide
 - c. decomposition of ozone
 - d. catalytic converters of car exhaust systems.