Unit 13 – Chapter 12: Kinetics **Name _____**

Review Problems **Period _____**

_____1. The rate of decomposition of ammonia to hydrogen gas and nitrogen gas is expressed as $-\Delta[NH_3]/\Delta t$. Express the rate of reaction in terms of $\Delta[H_2]/\Delta t$.

$$2\ NH_{3(g)} \rightarrow N_{2(g)} + 3\ H_{2(g)}$$

a. Rate = $2/3\ \Delta[H_2]/\Delta t$
b. Rate = $\Delta[H_2]/\Delta t$
c. Rate = $3\ \Delta[H_2]/\Delta t$
d. Rate = $2\ \Delta[H_2]/\Delta t$

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

t (min)	$[SO_3]$	$[SO_2]$	$[O_2]$
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. 1.8×10^{-3} *M*/min
b. 1.5×10^{-3} *M*/min
c. 3.0×10^{-3} *M*/min
d. 3.2×10^{-3} *M*/min

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

t (min)	$[SO_3]$	$[SO_2]$	$[O_2]$
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. 8.0×10^{-3} *M*/min
b. 1.6×10^{-3} *M*/min
c. 6.7×10^{-4} *M*/min
d. 8.0×10^{-4} *M*/min

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

t (min)	$[NH_3]$	$[N_2]$	$[H_2]$
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. 8.0×10^{-3} *M*/min
b. 1.9×10^{-3} *M*/min
c. 1.5×10^{-2} *M*/min
d. 2.3×10^{-3} *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?

$$2\ NH_{3(g)} \rightarrow N_{2(g)} + 3\ H_{2(g)}$$

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? $AlCl_{3(g)} + PH_{3(g)} \rightarrow Cl_3AlPH_{3(g)}$

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:

$$SO_{2(g)} + Cl_{2(g)} \rightarrow SOCl_2 + Cl_2O_{(g)}$$

Experiment	$[SO_2]$ (*M*)	$[Cl_2]$ (*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. $R = k[SO_2]$
b. $R = k[SO_2][Cl_2]$
c. $R = k[Cl_2]$
d. $R = k[SO_2][Cl_2]^2$

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

$$SO_{2(g)} + Cl_{2(g)} \rightarrow SOCl_2 + Cl_2O_{(g)}$$

Experiment	$[SO_2]$ (*M*)	$[Cl_2]$ (*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:

$2\ PO_{(g)} + Cl_{2(g)} \rightarrow 2\ POCl_{(g)}$

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 $k = 2.46 \times 10^{-3}\ s^{-1}$, what concentration of this substance remains after 2 minutes, knowing that $[Substance]_0 = 0.550\ M$?

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 $k = 1.25 \times 10^{-2}$/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 *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 N_2O gas obeys zero-order kinetics. Given a rate constant = 2.46×10^{-3} *M*/s and $[N_2O]_{120} = 0.155\ M$, calculate $[N_2O]_0$.

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 X 10^{-3} *M*/s and $[N_2O]_{120}$ = 0.450 *M*, calculate $[N_2O]$ 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. [X] vs. l/t
b. [X] vs. t
c. l/[X] vs. t
d. $[X]^3$ vs. l/t

_____ 19. A specific reaction is known to have a first-order rate expression. If k = 1.52 X 10^{-2}/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: $H_{2(g)} + Br_{2(g)} \rightarrow 2\ HBr_{(g)}$

a. Br_2 + light → 2 Br
b. 2 Br + 2 H_2 → 2 HBr + 2 H
c. H + Br_2 → HBr + Br
d. H + HBr → H_2 + Br
e. Br + Br → 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: $H_{2(g)} + Br_{2(g)} \rightarrow 2\ HBr_{(g)}$

a. Br_2 + light → 2 Br
b. 2 Br + 2 H_2 → 2 HBr + 2 H
c. H + Br_2 → HBr + Br
d. H + HBr → H_2 + Br
e. Br + Br → 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 K and T_2 = 371 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
c. 158 K
b. 253 K
d. 2.53 K

_____ 26. In a "reaction progress" graph, reacting molecules are most unstable at:

a. their initial position.
c. right after they collide.
b. when they are about to 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
c. decomposition of ozone
b. oxidation of sulfur dioxide
d. catalytic converters of car exhaust systems.