14.1 Multiple-Choice and Bimodal Questions

1) Consider the following reaction:

$$3A \rightarrow 2B$$

The average rate of appearance of B is given by $\Delta[B]/\Delta t$. Comparing the rate of appearance of B and the rate of disappearance of A, we get $\Delta[B]/\Delta t = \_\_\_\_\_ \times (-\Delta[A]/\Delta t)$

A) -2/3
B) +2/3
C) -3/2
D) +1
E) +3/2

2) Nitrogen dioxide decomposes to nitric oxide and oxygen via the reaction:

$$2NO_2 \rightarrow 2NO + O_2$$

In a particular experiment at 300 °C, $[NO_2]$ drops from 0.0100 to 0.00650 M in 100s The rate of appearance of O_2 for this period is _____ M/s.

A) 1.8×10^{-5}
B) 3.5×10^{-5}
C) 7.0×10^{-5}
D) 3.5×10^{-3}
E) 7.0×10^{-3}

3) Which substance in the reaction below either appears or disappears the fastest?

$$4NH_3 + 7O_2 \rightarrow 4NO_2 + 6H_2O$$

A) NH_3
B) O_2
C) NO_2
D) H_2O
E) The rates of appearance/disappearance are the same for all of these.

4) Consider the following reaction:

$$A \rightarrow 2C$$

The average rate of appearance of C is given by $\Delta[C]/\Delta t$. Comparing the rate of appearance of C and the rate of disappearance of A, we get $\Delta[C]/\Delta t = \_\_\_\_\_ \times (-\Delta A/\Delta t)$.

A) +2
B) −1
C) +1
D) $+1/2$
E) $-1/2$

A flask is charged with 0.124 mol of A *and allowed to react to form* B *according to the reaction* A(g) →B(g). *The following data are obtained for* [A] *as the reaction proceeds:*

Time (s)	0.00	10.0	20.0	30.0	40.0
Moles of A	0.124	0.110	0.088	0.073	0.054

5) The average rate of disappearance of A between 10 s and 20 s is _____ mol/s.

A) 2.2×10^{-3}
B) 1.1×10^{-3}
C) 4.4×10^{-3}
D) 454
E) 9.90×10^{-3}

6) The average rate of disappearance of A between 20 s and 40 s is _____ mol/s.

A) 8.5×10^{-4}
B) 1.7×10^{-3}
C) 590
D) 7.1×10^{-3}
E) 1.4×10^{-3}

7) The average rate of appearance of B between 20 s and 30 s is _____ mol/s.

A) $+1.5 \times 10^{-3}$
B) $+5.0 \times 10^{-4}$
C) -1.5×10^{-3}

D) $+7.3\times10^{-3}$
E) -7.3×10^{-3}

8) The average rate disappearance of A between 20 s and 30 s is _____ mol/s.

A) 5.0×10^{-4}
B) 1.6×10^{-2}
C) 1.5×10^{-3}.
D) 670
E) 0.15

9) How many moles of B are present at 10 s?

A) 0.011
B) 0.220
C) 0.110
D) 0.014
E) 1.4×10^{-3}

10) How many moles of B are present at 30 s?

A) 2.4×10^{-3}
B) 0.15
C) 0.073
D) 1.7×10^{-3}
E) 0.051

The peroxydisulfate ion $(S_2O_8^{2-})$ *reacts with the iodide ion in aqueous solution via the reaction:*

$$S_2O_8^{2-}(aq) + 3I^- \rightarrow 2SO_4(aq) + I_3^-(aq)$$

An aqueous solution containing 0.050 M *of* $S_2O_8^{2-}$ i*on and* 0.072 M *of* I^- *is prepared, and the progress of the reaction followed by measuring* $[I^-]$. *The data obtained is given in the table below.*

Time (s)	0.000	400.0	800.0	1200.0	1600.0
$[I^-]$ (M)	0.072	0.057	0.046	0.037	0.029

11) The average rate of disappearance of I^- between 400.0 s and 800.0 s is _____ M/s.

A) 2.8×10^{-5}
B) 1.4×10^{-5}
C) 5.8×10^{-5}
D) 3.6×10^{4}
E) 2.6×10^{-4}

12) The average rate of disappearance of I^- in the initial 400.0 s is _____ M/s.

A) 6.00
B) 3.8×10^{-5}
C) 1.4×10^{-4}
D) 2.7×10^{4}
E) 3.2×10^{-4}

13) The average rate of disappearance of I^- between 1200.0 s and 1600.0 s is _____ M/s.

A) 1.8×10^{-5}
B) 1.2×10^{-5}
C) 2.0×10^{-5}
D) 5.0×10^{4}
E) 1.6×10^{-4}

14) The concentration of $S_2O_8^{2-}$ remaining at 400 s is _____ M.

A) +0.015
B) +0.035
C) –0.007
D) +0.045
E) +0.057

15) The concentration of $S_2O_8^{2-}$ remaining at 800 s is _____ M.

A) 0.046
B) 0.076
C) 4.00×10^{-3}
D) 0.015
E) 0.041

16) The concentration of $S_2O_8^{2-}$ remaining at 1600 s

is _____ M.

A) 0.036
B) 0.014
C) 0.043
D) 0.064
E) 0.029

17) At elevated temperatures, dinitrogen pentoxide decomposes to nitrogen dioxide and oxygen:

$$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$$

When the rate of formation of NO_2 is 5.5×10^{-4} M/s, the rate of decomposition of N_2O_5 is _____ M/s.

A) 2.2×10^{-3}
B) 1.4×10^{-4}
C) 10.1×10^{-4}
D) 2.8×10^{-4}
E) 5.5×10^{-4}

18) At elevated temperatures, methylisonitrile (CH_3NC) isomerizes to acetonitrile (CH_3CN):

$$CH_3NC(g) \rightarrow CH_3CN(g)$$

At the start of an experiment, there are 0.200 mol of reactant and 0 mol of product in the reaction vessel. After 25 min, 0.108 mol of reactant (CH_3NC) remain. There are _____ mol of product (CH_3CN) in the reaction vessel.

A) 0.022
B) 0.540
C) 0.200
D) 0.308
E) 0.092

19) At elevated temperatures, methylisonitrile (CH_3NC) isomerizes to acetonitrile (CH_3CN):

$$CH_3NC(g) \rightarrow CH_3CN(g)$$

At the start of the experiment, there are 0.200 mol of reactant (CH_3NC) and 0 mol of product (CH_3CN) in the reaction vessel. After 25 min of reaction, 0.108 mol of reactant (CH_3NC) remain. The average rate of decomposition of methyl isonitrile, CH_3NC, in this 25 min period is _____ mol/min.

A) 3.7×10^{-3}
B) 0.092
C) 2.3
D) 4.3×10^{-3}
E) 0.54

20) A reaction was found to be second order in carbon monoxide concentration. The rate of the reaction _____ if the $[CO]$ is doubled, with everything else kept the same.

A) doubles
B) remains unchanged
C) triples
D) increases by a factor of 4
E) is reduced by a factor of 2

21) If the rate law for the reaction

$$2A + 3B \rightarrow \text{products}$$

is first order in A and second order in B, then the rate law is rate = _____.

A) $k[A][B]$
B) $k[A]^2[B]^3$
C) $k[A][B]^2$
D) $k[A]^2[B]$
E) $k[A]^2[B]^2$

22) The overall order of a reaction is 2. The units of the rate constant for the reaction are _____.

A) M/s
B) $M^{-1}s^{-1}$
C) $1/s$
D) $1/M$
E) s/M^2

23) The kinetics of the reaction below were studied and it was determined that the reaction rate increased

by a factor of 9 when the concentration of B was tripled. The reaction is _____ order in B.

$$A + B \rightarrow P$$

A) zero
B) first
C) second
D) third
E) one-half

24) The kinetics of the reaction below were studied and it was determined that the reaction rate did not change when the concentration of B was tripled. The reaction is _____ order in B.

$$A + B \rightarrow P$$

A) zero
B) first
C) second
D) third
E) one-half

25) A reaction was found to be third order in A. Increasing the concentration of A by a factor of 3 will cause the reaction rate to _____.

A) remain constant
B) increase by a factor of 27
C) increase by a factor of 9
D) triple
E) decrease by a factor of the cube root of 3

26) A reaction was found to be zero order in A. Increasing the concentration of A by a factor of 3 will cause the reaction rate to _____.

A) remain constant
B) increase by a factor of 27
C) increase by a factor of 9
D) triple
E) decrease by a factor of the cube root of 3

The data in the table below were obtained for the reaction:

$$A + B \rightarrow P$$

Experiment Number	[A] (M)	[B] (M)	Initial Rate (M/s)
1	0.273	0.763	2.83
2	0.273	1.526	2.83
3	0.819	0.763	25.47

27) The order of the reaction in A is _____.

A) 1
B) 2
C) 3
D) 4
E) 0

28) The order of the reaction in B is _____.

A) 1
B) 2
C) 3
D) 4
E) 0

29) The overall order of the reaction is _____.

A) 1
B) 2
C) 3
D) 4
E) 0

30) For a first-order reaction, a plot of _____ versus _____ is linear.

A) $\ln [A]_t, \frac{1}{t}$
B) $\ln \left[A \right]_t, t$
C) $\frac{1}{[A]_t}, t$
D) $\left[A \right]_t, t$
E) $t, \frac{1}{[A]_t}$

31) The following reaction occurs in aqueous solution:

$$NH_4^+(aq) + NO_2^-(aq) \rightarrow N_2(g) + 2H_2O(l)$$

The data below is obtained at 25 °C.

$[NH_4^+]$ (M)	$[NO_2^-]$ (M)	Initial rate (M/s)
0.0100	0.200	3.2×10^{-3}
0.0200	0.200	6.4×10^{-3}

The order of the reaction in NH_4^+ is _____.

A) −2
B) −1
C) +2
D) +1
E) 0

32) The rate constant for a particular second-order reaction is $0.47\ M^{-1}s^{-1}$. If the initial concentration of reactant is 0.25 mol/L it takes _____ s for the concentration to decrease to 0.13 mol/L

A) 7.9
B) 1.4
C) 3.7
D) 1.7
E) 0.13

33) A first-order reaction has a rate constant of $0.33\ min^{-1}$. It takes _____ min for the reactant concentration to decrease from 0.13 M to 0.088 M.

A) 1.2
B) 1.4
C) 0.51
D) 0.13
E) 0.85

34) The initial concentration of reactant in a first-order reaction is 0.27 M. The rate constant for the reaction is $0.75\ s^{-1}$. What is the concentration (mol/L) of reactant after 1.5 s?

A) 3.8
B) 1.7
C) 8.8×10^{-2}
D) 2.0×10^{-2}
E) 0.135

35) The rate constant for a second-order reaction is $0.13\ M^{-1}s^{-1}$. If the initial concentration of reactant is 0.26mol / L it takes _____ s for the concentration to decrease to 0.13mol / L

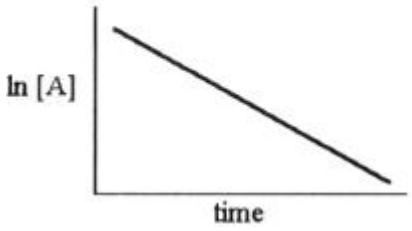
A) 0.017
B) 0.50
C) 1.0
D) 30
E) 4.4×10^{-3}

36) The half-life of a first-order reaction is 13 min. If the initial concentration of reactant is 0.085 M it takes _____ min for it to decrease to 0.055 M.

A) 8.2
B) 11
C) 3.6
D) 0.048
E) 8.4

37) The graph shown below depicts the relationship between concentration and time for the following chemical reaction.

$$2A \longrightarrow C$$



The slope of this line is equal to _____.

A) k
B) −1 / k
C) $\ln[A]_o$
D) −k
E) 1 / k

38) The reaction below is first order in $[H_2O_2]$:

$$2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$$

A solution originally at 0.600 M H_2O_2 is found to be 0.075 M after 54 min. The half-life for this reaction is _____ min.

A) 6.8
B) 18
C) 14
D) 28
E) 54

39) A second-order reaction has a half-life of 18 s when the initial concentration of reactant is 0.71 M. The rate constant for this reaction is _____ $M^{-1}s^{-1}$.

A) 7.8×10^{-2}
B) 3.8×10^{-2}
C) 2.0×10^{-2}
D) 1.3
E) 18

14.2 Multiple-Choice Questions

1) A burning splint will burn more vigorously in pure oxygen than in air because

A) oxygen is a reactant in combustion and concentration of oxygen is higher in pure oxygen than is in air.
B) oxygen is a catalyst for combustion.
C) oxygen is a product of combustion.
D) nitrogen is a product of combustion and the system reaches equilibrium at a lower temperature.
E) nitrogen is a reactant in combustion and its low concentration in pure oxygen catalyzes the combustion.

2) Of the following, all are valid units for a reaction rate except _____.

A) mol / L
B) M / s
C) mol / hr
D) g / s
E) mol / L – hr

3) Nitrogen dioxide decomposes to nitric oxide and oxygen via the reaction:

$$2NO_2 \rightarrow 2NO + O_2$$

In a particular experiment at 300 °C, $[NO_2]$ drops from 0.0100 to 0.00650 M in 100 s. The rate of disappearance of NO_2 for this period is _____ M/s.

A) 0.35
B) 3.5×10^{-3}
C) 3.5×10^{-5}
D) 7.0×10^{-3}
E) 1.8×10^{-3}

4) At elevated temperatures, dinitrogen pentoxide decomposes to nitrogen dioxide and oxygen:

$$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$$

When the rate of formation of O_2 is 2.2×10^{-4} M / s, the rate of decomposition of N_2O_5 is _____ M/s.

A) 1.1×10^{-4}
B) 2.2×10^{-4}
C) 2.8×10^{-4}
D) 4.4×10^{-4}
E) 5.5×10^{-4}

5) Which one of the following is <u>not</u> a valid expression for the rate of the reaction below?

$$4NH_3 + 7O_2 \rightarrow 4NO_2 + 6H_2O$$

A) $-\frac{1}{7}\frac{\Delta[O_2]}{\Delta t}$
B) $\frac{1}{4}\frac{\Delta[NO_2]}{\Delta t}$
C) $\frac{1}{6}\frac{\Delta[H_2O]}{\Delta t}$
D) $-\frac{1}{4}\frac{\Delta[NH_3]}{\Delta t}$
E) All of the above are valid expressions of the reaction rate.

6) Of the units below, _____ are appropriate for a first-order reaction rate constant.

A) Ms^{-1}
B) s^{-1}
C) mol / L
D) $M^{-1}s^{-1}$
E) $L\ mol^{-1}s^{-1}$

7) The rate law of a reaction is rate = k[D][X]. The units of the rate constant are _____.

A) $mol\ L^{-1}s^{-1}$
B) $L\ mol^{-1}s^{-1}$
C) $mol^2L^{-2}s^{-1}$
D) $mol\ L^{-1}s^{-2}$
E) $L^2mol^{-2}s^{-1}$

The data in the table below were obtained for the reaction:

$$A + B \rightarrow P$$

Experiment Number	[A] (M)	[B] (M)	Initial Rate (M/s)
1	0.273	0.763	2.83
2	0.273	1.526	2.83
3	0.819	0.763	25.47

8) The rate law for this reaction is rate = _____.

A) k[A][B]
B) k[P]
C) $k[A]^2[B]$
D) $k[A]^2[B]^2$
E) $k[A]^2$

9) The magnitude of the rate constant is _____.

A) 38.0
B) 0.278
C) 13.2
D) 42.0
E) 2.21

The data in the table below were obtained for the reaction:

$$2ClO_2(aq) + 2OH^-(aq) \rightarrow ClO_3^-(aq) + ClO_2^-(aq) + H_2O(l)$$

Experiment Number	$[ClO_2]$ (M)	$[OH^-]$ (M)	Initial Rate (M/s)
1	0.060	0.030	0.0248
2	0.020	0.030	0.00276
3	0.020	0.090	0.00828

10) What is the order of the reaction with respect to ClO_2 ?

A) 1
B) 0
C) 2
D) 3
E) 4

11) What is the order of the reaction with respect to OH^- ?

A) 0
B) 1
C) 2
D) 3
E) 4

12) What is the overall order of the reaction?

A) 4
B) 0
C) 1
D) 2
E) 3

13) What is the magnitude of the rate constant for the reaction?

A) 1.15×10^4
B) 4.6
C) 230
D) 115
E) 713

14) The rate law for a reaction is

$$\text{rate} = k[A][B]^2$$

Which one of the following statements is false?
A) The reaction is first order in A.
B) The reaction is second order in B.
C) The reaction is second order overall.
D) *k* is the reaction rate constant
E) If [B] is doubled, the reaction rate will increase by a factor of 4.

15) Under constant conditions, the half-life of a first-order reaction _____.

A) is the time necessary for the reactant concentration to drop to half its original value
B) is constant
C) can be calculated from the reaction rate constant
D) does not depend on the initial reactant concentration
E) All of the above are correct.

16) The reaction

$$2NO_2 \rightarrow 2NO + O_2$$

follows second-order kinetics. At 300 °C, $[NO_2]$ drops from 0.0100 M to 0.00650 M in 100.0 s. The rate constant for the reaction is _____ $M^{-1}s^{-1}$.

A) 0.096
B) 0.65
C) 0.81
D) 1.2
E) 0.54

17) The reaction

$$CH_3 - N \equiv C \rightarrow CH_3 - C \equiv N$$

is a first-order reaction. At 230.3 °C, $k = 6.29 \times 10^{-4} s^{-1}$ If $[CH_3 - N \equiv C]$ is 1.00×10^{-3} initially, $[CH_3 - N \equiv C]$ is _____ after 1.000×10^3 s

A) 5.33×10^{-4}
B) 2.34×10^{-4}
C) 1.88×10^{-3}
D) 4.27×10^{-3}
E) 1.00×10^{-6}

18) The reaction

$$2NOBr\,(g) \rightarrow 2NO(g) + Br_2(g)$$

is a second-order reaction with a rate constant of $0.80\ M^{-1}s^{-1}$ at 11 °C. If the initial concentration of NOBr is 0.0440 M, the concentration of NOBr after 10.0 seconds is _____.

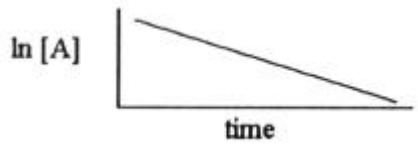
A) 0.0400 M
B) 0.0350 M
C) 0.0325 M
D) 0.0300 M
E) 0.0275 M

19) A compound decomposes by a first-order process. If 25.0 % of the compound decomposes in 60.0 minutes, the half-life of the compound is _____.

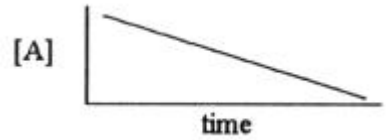
A) 65 minutes
B) 120 minutes
C) 145 minutes
D) 180 minutes
E) 198 minutes

20) Which one of the following graphs shows the correct relationship between concentration and time for a reaction that is second order in [A]?

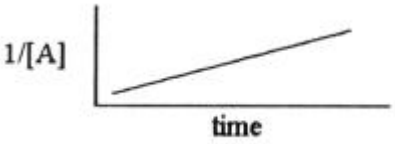
A)



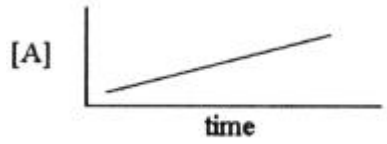
B)



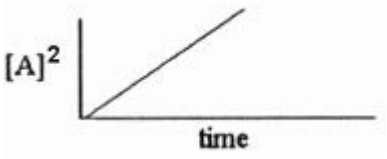
C)



D)



E)



21) The following reaction is second order in [A] and the rate constant is $0.039\ M^{-1}s^{-1}$

$$A \rightarrow B$$

The concentration of A was 0.30 M at 23 s. The initial concentration of A was _____ M.

A) 2.4
B) 0.27
C) 0.41
D) 3.7
E) 1.2×10^{-2}

The reaction A → B *is first order in* [A]. *Consider the following data.*

time (s)	[A] (M)
0.0	1.60
10.0	0.40
20.0	0.10

22) The rate constant for this reaction is _____s^{-1}.

A) 0.013
B) 0.030
C) 0.14
D) 3.0
E) 3.1×10^{-3}

23) The half-life of this reaction is _____ s.

A) 0.97
B) 7.1
C) 5.0
D) 3.0
E) 0.14

The reaction A → B *is first order in* [A]. *Consider the following data.*

Time (s)	0.0	5.0	10.0	15.0	20.0
[A] (M)	0.20	0.14	0.10	0.071	0.050

24) The rate constant for this reaction is _____s^{-1}.

A) 6.9×10^{-2}
B) 3.0×10^{-2}
C) 14
D) 0.46
E) 4.0×10^{2}

25) The concentration of A is _____ M after 40.0 s.

A) 1.3×10^{-2}
B) 1.2
C) 0.17
D) 3.5×10^{-4}
E) 0.025

26) The rate constant of a first-order process that has a half-life of 225 s is _____s^{-1}.

A) 0.693
B) 3.08×10^{-3}
C) 1.25
D) 12.5
E) 4.44×10^{-3}

27) The reaction A(aq) → B(aq) is first order in [A]. A solution is prepared with [A] = 1.22 M. The following data are obtained as the reaction proceeds:

Time (s)	0.0	6.0	12.0	18.0
[A] (M)	1.22	0.61	0.31	0.15

The rate constant for this reaction is _____s^{-1}.

A) 0.23
B) 1.0
C) 0.17
D) 0.12

E) −0.12

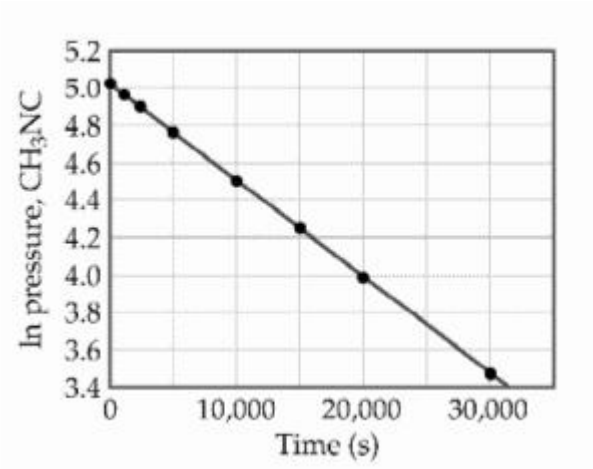
28) One difference between first- and second-order reactions is that _____.

A) the half-life of a first-order reaction does not depend on $[A]_0$; the half-life of a second-order reaction does depend on $[A]_0$
B) the rate of both first-order and second-order reactions do not depend on reactant concentrations
C) the rate of a first-order reaction depends on reactant concentrations; the rate of a second-order reaction does not depend on reactant concentrations
D) a first-order reaction can be catalyzed; a second-order reaction cannot be catalyzed
E) None of the above are true.

29) At elevated temperatures, methylisonitrile (CH_3NC) isomerizes to acetonitrile (CH_3CN):

$$CH_3NC\,(g) \rightarrow CH_3CN\,(g)$$

The reaction is first order in methylisonitrile. The attached graph shows data for the reaction obtained at 198.9 °C.



The rate constant for the reaction is _____ s^{-1}.

A) -1.9×10^{4}
B) $+1.9\times10^{4}$
C) -5.2×10^{-5}
D) $+5.2\times10^{-5}$
E) +6.2

30) At elevated temperatures, nitrogen dioxide decomposes to nitrogen oxide and oxygen:

$$NO_2(g) \rightarrow NO(g) + \frac{1}{2}O_2(g)$$

The reaction is second order in NO_2 with a rate constant of $0.543\ M^{-1}s^{-1}$ at 300 °C. If the initial $[NO_2]$ is 0.260 M, it will take _____ s for the concentration to drop to 0.100 M.

A) 3.34
B) 8.8×10^{-2}
C) −0.611
D) 0.299
E) 11.3

31) The decomposition of N_2O_5 in solution in carbon tetrachloride proceeds via the reaction

$$2N_2O_5(soln) \rightarrow 4NO_2(soln) + O_2(soln)$$

The reaction is first order and has a rate constant of $4.82\times10^{-3}s^{-1}$ at 64 °C. The rate law for the reaction is rate = _____.

A) $k[N_2O_5]^2$
B) $k\dfrac{[NO_2]^4\,[O_2]}{[N_2O_5]^2}$
C) $k[N_2O_5]$
D) $k\dfrac{[N_2O_5]^2}{[NO_2]^4\,[O_2]}$
E) $2k[N_2O_5]$

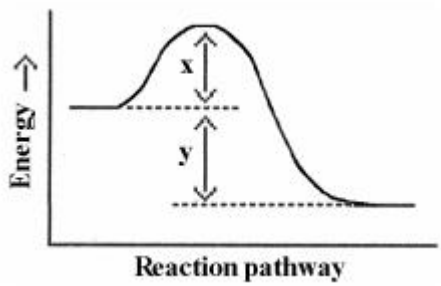
32) As the temperature of a reaction is increased, the rate of the reaction increases because the _____.

A) reactant molecules collide less frequently
B) reactant molecules collide more frequently and with greater energy per collision
C) activation energy is lowered
D) reactant molecules collide less frequently and with greater energy per collision
E) reactant molecules collide more frequently with less energy per collision

33) The rate of a reaction depends on _____.

A) collision frequency
B) collision energy
C) collision orientation
D) all of the above
E) none of the above

34) Which energy difference in the energy profile below corresponds to the activation energy for the forward reaction?



A) x
B) y
C) x + y
D) x – y
E) y – x

35) In the energy profile of a reaction, the species that exists at the maximum on the curve is called the _____.

A) product
B) activated complex
C) activation energy
D) enthalpy of reaction
E) atomic state

36) In the Arrhenius equation,

$$k = Ae^{-Ea/RT}$$

_____ is the frequency factor.

A) k
B) A
C) e
D) E_a
E) R

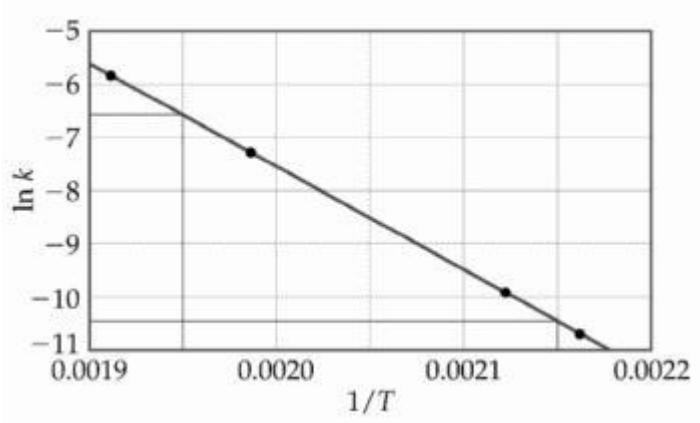
37) In general, as temperature goes up, reaction rate _____.

A) goes up if the reaction is exothermic
B) goes up if the reaction is endothermic
C) goes up regardless of whether the reaction is exothermic or endothermic
D) stays the same regardless of whether the reaction is exothermic or endothermic
E) stays the same if the reaction is first order

38) At elevated temperatures, methylisonitrile (CH_3NC) isomerizes to acetonitrile (CH_3CN):

$$CH_3NC(g) \rightarrow CH_3CN\ (g)$$

The dependence of the rate constant on temperature is studied and the graph below is prepared from the results.



The energy of activation of this reaction is _____ kJ/mol.

A) 160
B) 1.6×10^5
C) 4.4×10^{-7}
D) 4.4×10^{-4}
E) 1.9×10^4

39) The mechanism for formation of the product X is:

$$A + B \rightarrow C + D \quad \text{(slow)}$$
$$B + D \rightarrow X \quad \text{(fast)}$$

The intermediate reactant in the reaction is _____.

A) A
B) B

C) C
D) D
E) X

40) For the elementary reaction

$$NO_3 + CO \rightarrow NO_2 + CO_2$$

the molecularity of the reaction is _____, and the rate law is rate = _____.

A) 2, $k[NO_3][CO]$

B) 4, $k[NO_3][CO][NO_2][CO_2]$

C) 2, $k[NO_2][CO_2]$

D) 2, $k[NO_3][CO]/[NO_2][CO_2]$

E) 4, $k[NO_2][CO_2]/[NO_3][CO]$

41) A possible mechanism for the overall reaction

$$Br_2(g) + 2NO(g) \rightarrow 2NOBr(g)$$

is

$$NO(g) + Br_2(g) \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} NOBr_2(g) \quad \text{(fast)}$$

$$NOBr_2(g) + NO(g) \xrightarrow{k_2} 2NOBr \quad \text{(slow)}$$

The rate law for formation of NOBr based on this mechanism is rate = _____.

A) $k_1[NO]^{1/2}$

B) $k_1[Br_2]^{1/2}$

C) $(k_2k_1/k^{-1})[NO]^2[Br_2]$

D) $(k_1/k^{-1})^2[NO]^2$

E) $(k_2k_1/k^{-1})[NO][Br_2]^2$

42) Which of the following is true?

A) If we know that a reaction is an elementary reaction, then we know its rate law.
B) The rate-determining step of a reaction is the rate of the fastest elementary step of its mechanism.
C) Since intermediate compounds can be formed, the chemical equations for the elementary reactions in a multistep mechanism do not always have to add to give the chemical equation of the overall process.
D) In a reaction mechanism, an intermediate is identical to an activated complex.
E) All of the above statements are true.

43) Of the following, _____ will lower the activation energy for a reaction.

A) increasing the concentrations of reactants
B) raising the temperature of the reaction
C) adding a catalyst for the reaction
D) removing products as the reaction proceeds
E) increasing the pressure

44) The rate law of the overall reaction

$$A + B \rightarrow C$$

is rate = $k[A]^2$. Which of the following will <u>not</u> increase the rate of the reaction?

A) increasing the concentration of reactant A
B) increasing the concentration of reactant B
C) increasing the temperature of the reaction
D) adding a catalyst for the reaction
E) All of these will increase the rate.

45) A catalyst can increase the rate of a reaction _____.

A) by changing the value of the frequency factor (A)
B) by increasing the overall activation energy (E_a) of the reaction
C) by lowering the activation energy of the reverse reaction
D) by providing an alternative pathway with a lower activation energy
E) All of these are ways that a catalyst might act to increase the rate of reaction.

46) The primary source of the specificity of enzymes is _____.

A) their polarity, which matches that of their specific substrate
B) their delocalized electron cloud
C) their bonded transition metal, which is specific to the target substrate
D) their locations within the cell

E) their shape, which relates to the lock-and-key model

47) _____ are used in automotive catalytic converters.

A) Heterogeneous catalysts
B) Homogeneous catalysts
C) Enzymes
D) Noble gases
E) Nonmetal oxides

48) The enzyme nitrogenase converts _____ into _____.

A) ammonia, urea
B) CO and unburned hydrocarbons, H_2O and CO_2
C) nitrogen, ammonia
D) nitrogen oxides, N_2 and O_2
E) nitroglycerine, nitric acid, and glycerine

49) The active site of nitrogenase is a cofactor that contains two transition metals. These transition metals are _____.

A) Cr and Mg
B) Mn and V
C) Os and Ir
D) Fe and Zn
E) Fe and Mo

50) Nitrogen fixation is a difficult process because _____.

A) there is so little nitrogen in the atmosphere
B) nitrogen exists in the atmosphere primarily as its oxides which are very unreactive
C) nitrogen is very unreactive, largely due to its triple bond
D) of the extreme toxicity of nitrogen
E) of the high polarity of nitrogen molecules preventing them from dissolving in biological fluids, such as those inside cells

14.3 Short Answer Questions.

1) The relationship of absorbed light to the concentration of the substance absorbing the light is governed by _____.

2) For the reaction $aA + Bb \rightarrow cC + dD$ the rate law is _____.

3) If a rate law is second order (reactant) , doubling the reactant _____ the reaction rate.

4) The earth's ozone layer is located in the _____.

5) Reaction rates are affected by reactant concentrations and temperature. This is accounted for by the _____.

6) The minimum energy to initiate a chemical reaction is the _____.

7) Reaction rate data showing temperature dependence obey an equation devised by _____.

8) The number of molecules that participate as reactants defines the _____ of the reaction.

9) Elementary reactions involving the simultaneous collision of three molecules are _____.

10) A catalyst that is present in the same phase as the reacting molecules is called a _____ catalyst.

11) A catalyst that is present in a different phase from the reacting molecules is called a _____ catalyst.

12) The binding of molecules to the surface of a catalyst is referred to as _____.

13) The uptake of molecules into the interior of another substance is referred to as _____.

14.4 True/False Questions Questions.

1) Rates of reaction can be positive or negative.

2) The instantaneous rate of a reaction can be read directly from the graph of molarity versus time at

any point on the graph.

3) The overall reaction order is the sum of the orders of each reactant in the rate law.

4) Units of the rate constant of a reaction are independent of the overall reaction order.

5) The concentration of reactants or products at any time during the reaction can be calculated from the integrated rate law.

6) The rate of a second order reaction can depend on the concentrations of more than one reactant.

7) The half-life for a first order rate law depends on the starting concentration.

8) The rate limiting step in a reaction is the slowest step in the reaction sequence.

9) Heterogeneous catalysts have different phases from reactants.

14.5 Algorithmic Questions.

1) The rate of disappearance of HBr in the gas phase reaction

$$2HBr(g) \rightarrow H_2(g) + Br_2(g)$$

is $0.301\ M\ s^{-1}$ at $150\ °C$. The rate of appearance of Br_2 is _____ $M\ s^{-1}$.

A) 1.66
B) 0.151
C) 0.0906
D) 0.602
E) 0.549

2) The rate of disappearance of HBr in the gas phase reaction

$$2HBr(g) \rightarrow H_2(g) + Br_2(g)$$

is $0.130\ M\ s^{-1}$ at $150\ °C$. The rate of reaction is _____ $M\ s^{-1}$

A) 3.85
B) 0.0650
C) 0.0169
D) 0.260
E) 0.0860

3) The combustion of ethylene proceeds by the reaction

$$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O\ (g)$$

When the rate of disappearance of O_2 is $0.28\ Ms^{-1}$, the rate of appearance of CO_2 is _____ Ms^{-1}.

A) 0.19
B) 0.093
C) 0.84
D) 0.42
E) 0.56

4) The combustion of ethylene proceeds by the reaction

$$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O\ (g)$$

When the rate of disappearance of O_2 is $0.23\ Ms^{-1}$, the rate of disappearance of C_2H_4 is _____ Ms^{-1}.

A) 0.15
B) 0.077
C) 0.69
D) 0.35
E) 0.46

5) The isomerization of methylisonitrile to acetonitrile

$$CH_3NC(g) \rightarrow CH_3CN(g)$$

is first order in CH_3NC. The rate constant for the reaction is $9.45 \times 10^{-5} s^{-1}$ at 478 K. The half-life of the reaction when the initial $[CH_3NC]$ is 0.030 M is _____ s.

A) 1.06×10^4
B) 5.29×10^3
C) $3.53E \times 10^5 Ź$
D) 7.33×10^3
E) 1.36×10^{-4}

6) The elementary reaction

$$2NO_2(g) \rightarrow 2NO(g) + O_2(g)$$

is second order in NO_2 and the rate constant at 501 K is $7.93 \times 10^{-3} M^{-1}s^{-1}$. The reaction half-life at this temperature when $[NO_2]_0 = 0.45$ M is _____ s.

A) 3.6×10^{-3}
B) 0.011
C) 126
D) 87
E) 280

7) The isomerization of methylisonitrile to acetonitrile

$$CH_3NC(g) \rightarrow CH_3CN(g)$$

is first order in CH_3NC. The half life of the reaction is 1.60×10^5 s at 444 K. The rate constant when the initial $[CH_3NC]$ is 0.030 M is _____ s^{-1}.

A) 2.31×10^5
B) 2.08×10^{-4}
C) 4.33×10^{-6}
D) 4.80×10^3
E) 7.10×10^7

8) The decomposition of N_2O_5 in solution in carbon tetrachloride proceeds via the reaction

$$2N_2O_5(soln) \rightarrow 4NO_2(soln) + O_2(soln)$$

The reaction is first order and has a rate constant of 4.82×10^{-3} s^{-1} at 64 °C. If the reaction is initiated with 0.058 mol in a 1.00-L vessel, how many moles remain after 151 s?

A) 0.055
B) 0.060
C) 0.028
D) 12
E) 2.0×10^3

9) SO_2Cl_2 decomposes in the gas phase by the reaction

$$SO_2Cl_2(g) \rightarrow SO_2(g) + Cl_2(g)$$

The reaction is first order in SO_2Cl_2 and the rate constant is 3.0×10^{-6} s^{-1} at 600 K. A vessel is charged with 2.4 atm of SO_2Cl_2 at 600 K. The partial pressure of SO_2Cl_2 at 3.0×10^5 s is _____ atm.

A) 0.76
B) 2.2
C) 0.98
D) 0.29
E) 1.4×10^5

10) A particular first-order reaction has a rate constant of 1.35×10^2 s^{-1} at 25.0 °C. What is the magnitude of k at 95.0 °C if $E_a = 55.5$ kJ/mol?

A) 9.56×10^3
B) 2.85×10^4
C) 576
D) 4.33×10^{87}
E) 1.36×10^2

11) A particular first-order reaction has a rate constant of 1.35×10^2 s^{-1} at 25.0 °C. What is the magnitude of k at 75.0 °C if $E_a = 85.6$ kJ/mol?

A) 3.47×10^4
B) 1.92×10^4
C) 670
D) 3.85×10^6
E) 1.36×10^2