HW05 - Kinetics

1 0.75 points

Consider the reaction:

$2O_3(g) \longrightarrow 3O_2(g)$ rate = $k[O_3]^2[O_2]^{-1}$

What is the overall order of the reaction and the order with respect to $[O_3]$?

- 3 and 2
- 2 and 2
- 1 and 2
- -1 and 3

2 0.75 points

When the reaction below:

$3NO(g) \longrightarrow N_2O(g) + NO_2(g)$

is proceeding under conditions such that 0.015 mol/L of N_2O is being formed each second, the rate of the overall reaction is ________ and the rate of change for NO is ________.

- 0.015 M/s; 0.045 M/s
- 0.015 M/s; -0.045 M/s
- 0.030 M/s; -0.005 M/s
- 0.015 M/s; -0.005 M/s

3 0.75 points

What is the rate law for the reaction below:

$A + B + C \longrightarrow D$

if the following data were collected?

Exp	$[A]_0$	$[B]_0$	$[C]_0$	Initial Rate
1	0.4	1.2	0.7	2.32×10^{-3}
2	1.3	1.2	0.9	7.54×10^{-3}
3	0.4	4.1	0.8	9.25×10^{-2}
4	1.3	1.2	0.2	7.54×10^{-3}

- rate = 4.48×10^{-3} [A] $[B]^2$ [C]
- rate = 1.79×10^{-3} $[B]^2$ [C]
- rate = 3.36×10^{-3} [A] $[B]^3$
- rate = 5.37×10^{-3} [A] $[B]^3$
- rate = 1.49×10^{-3} $[B]^3$ [C]

4 0.75 points

A chemical reaction is expressed by the balanced chemical equation:

$A + 2B \longrightarrow C$

Consider the data below:

exp	$[A]_0$	$[B]_0$	initial rate (M/min)
1	0.15	0.15	0.00110363
2	0.15	0.3	0.0044145
3	0.3	0.3	0.008829

Find the rate law for the reaction.

- rate = k $[B]^2$
- rate = k $[A]^2$ [B]
- rate = k [A] [B]
- rate = k [A] $[B]^2$

5 0.75 points

Calculate the value of the rate constant (k) for the reaction in question 4.

- 0.00110
- 0.000166
- 0.327
- 0.00736

6 0.75 points

If the initial concentrations of both A and B are 0.31 M for the reaction in questions 4 and 5, at what initial rate is C formed?

- 0.101 M/min
- -0.00974 M/min
- 0.0314 M/min
- 0.00974 M/min

7 0.75 points

We know that the rate expression for the reaction below:

$2NO + O_2 \longrightarrow 2NO_2$

at a certain temperature is rate = $[NO]^2[O_2]$. We carry out two experiments involving this reaction at the same temperature, but in the second experiment the initial concentration of NO is doubled while the initial concentration of $O_2$is halved. The initial rate in the second experiment will be how many times that of the first?

- 4
- 1
- 2
- 8

8 0.75 points

Consider the data collected for a chemical reaction between compounds A and B that is first order in A and first order in B:

rxn	$[A]_0$	$[B]_0$	rate (M/s)
1	0.2	0.05	0.1
2	?	0.05	0.4
3	0.4	?	0.8

From the information above for 3 experiments, determine the missing concentrations of A and B. Answers should be in the order [A] then [B].

- 0.20 M; 0.80 M
- 0.40 M; 0.20 M
- 0.80 M; 0.10 M
- 0.80 M; 0.20 M
- 0.40 M; 0.10 M

9 0.75 points

For a reaction that is zero-order overall...

- the rate constant is zero.
- the reactant concentration does not change with time.
- the activation energy is zero.
- the rate does not change during the reaction.

10 0.75 points

Consider the reaction below:

$A + B \longrightarrow C$

If it is 1st order in A and 0th order in B, a plot of ln[A] vs time will have a slope that is...

- slowly increasing.
- decreasing exponentially.
- increasing exponentially.
- constant.

11 0.75 points

At a certain fixed temperature, the reaction below:
$A(g) + 2B(g) \longrightarrow AB_2(g)$
is found to be first order in the concentration of A and zeroth order in the concentration of B. The reaction rate constant is $0.05 s^{-1}$. If 2.00 moles of A and 4.00 moles of B are placed in a 1.00 liter container, how many seconds will elapse before the concentration of A has fallen to 0.30 moles/liter?

- There is not enough information to answer.
- 37.94 sec
- 2.83 sec
- 10.22 sec

12 0.75 points

The reaction below:
$A \longrightarrow$ products
is observed to obey first-order kinetics. Which of the following plots should give a straight line?

- [A] vs t^{-1}
- ln[A] vs k
- ln[A] vs k^{-1}
- [A] vs k
- [A] vs t
- ln[A] vs t^{-1}
- ln[A] vs t

13 0.75 points

A reaction is found to be first order with respect to one of the reactant species, A. When might a plot of ln[A] vs time NOT yield a straight line?

- if the reaction has any significant backward rate
- All of the other answers could be correct.
- when the rate also depends on the concentration of another reactant as well
- if the reaction comes to equilibrium

14 0.75 points

The reaction rate constant is determined to be $0.012\ M^{-1}s^{-1}$. If after 27 minutes the amount of A left is 0.048 M. What was the initial concentration of A?

- 19.49
- 0.049
- 2.53e16
- 0.72

15 0.75 points

For the reaction below:
cyclobutane(g) $\longrightarrow$ 2ethylene(g)
at 800K, a plot of ln[cyclobutane] vs t gives a straight line with a slope of $-1.6\ s^{-1}$. Calculate the time needed for the concentration of cyclobutane to fall to 1/16 of its initial value.

- 1.7 sec
- 0.63 sec
- 1.6 sec
- 1.3 sec

16 0.75 points

The initial concentration of the reactant A in a first-order reaction is 1.2 M. After 69.3 sec, the concentration has fallen to 0.3 M. What is the rate constant k?

- 0.01 s^{-1}
- not enough information
- 0.2 s^{-1}
- 0.02 s^{-1}

17 0.75 points

Consider the reaction below:
$H_2CO_3(aq) \longrightarrow CO_2(aq) + H_2O(l)$
If it has a half-life of 1.6 sec, how long will it take a system with $[H_2CO_3]_0$ of 2M to reach $[H_2CO_3]$ of 125mM?

- 2.9 sec
- Not enough information is given.
- 6.4 sec
- 3.2 sec

18 0.75 points

Consider the following elementary reactions:
a) $NO + O_3 \longrightarrow NO_2 + O_2$
b) $CS_2 \longrightarrow CS + S$
c) $O + O_2 + N_2 \longrightarrow O_3 + N_2$
Identify the molecularity of each reaction respectively.

- it is impossible to know without knowing the overall reaction for each
- all three elementary reactions are bimolecular
- tetramolecular, termolecular, pentamolecular
- bimolecular, unimolecular, termolecular

19 0.75 points

A and B react to form C according to the single step reaction below:
$A + 2B \longrightarrow C$
Which of the following is the correct rate equation for [B] and the correct units for the rate constant of this reaction?

- $\frac{\Delta[B]}{\Delta t} = -k[A][B]^2;\ \frac{1}{M^2}$
- $\frac{\Delta[B]}{\Delta t} = -2k[A][B];\ \frac{1}{M \cdot s}$
- $\frac{\Delta[B]}{\Delta t} = -2k[A][B]^2;\ \frac{1}{M^2 \cdot s}$
- $\frac{\Delta[B]}{\Delta t} = -\frac{2k[A][B]}{[C]};\ \frac{1}{M \cdot s}$

20 0.75 points

Consider the mechanism below:
$NO_2 + F_2 \longrightarrow NO_2F + F$ $\quad k_1$, slow
$F + NO_2 \longrightarrow NO_2F$ $\quad k_2$, fast
What is the rate law?

- rate = $k_1[NO_2][F_2]$
- rate = $k_2[NO_2][F]$
- rate = $k_1k_2[NO_2]^2$
- rate = $k_1[NO_2F][F_2]$
- rate = $k_2[NO_2]^2$

21 1 point

Determine the overall balanced equation for a reaction having the following proposed mechanism:

Step 1: $B_2 + B_2 \longrightarrow E_3 + D$ slow

Step 2: $E_3 + A \longrightarrow C_2$ fast

and write an acceptable rate law.

- ○ $A + B_2 \longrightarrow C_2 + D$; rate = k[A][$B_2$]
- ○ $E_3 + A \longrightarrow B_2 + C_2$; rate = k[$E_3$][A]
- ○ $A + 2B_2 \longrightarrow C_2 + D$; rate = k[$B_2$]^2
- ○ $2B_2 \longrightarrow E_3 + D$; rate = k[$B_2$]^2

22 1 point

Consider the reaction below:

$H_2(g) + I_2(g) \longrightarrow 2HI(g)$

The proposed mechanism of this reaction is:

$I_2 \rightleftharpoons 2I$ k_1, k_{-1} (reverse rxn), fast

$2I + H_2 \longrightarrow 2HI$ k_2 , slow

What is the rate of the overall reaction?

- ○ $rate = \frac{k_{-1}k_2}{k_1}[I_2][H_2]$
- ○ $rate = \frac{k_1 k_2}{k_{-1}}[I_2][H_2]$
- ○ $rate = \frac{k_1 k_2}{k_{-1}}[I]^2[H_2]$
- ○ $rate = k_1 k_2 [I_2][H_2]$
- ○ $rate = k_2 [I]^2 [H_2]$

23 1 point

A reaction rate increases by a factor of 655 in the presence of a catalyst at 37°C. The activation energy of the original pathway is 106 kJ/mol. What is the activation energy of the new pathway, all other factors being equal?

- ○ 16,600 kJ/mol
- ○ 89.3 kJ/mol
- ○ 89.3 J/mol
- ○ 16,600 J/mol

24 1 point

A given reaction has an activation energy of 24.52 kJ/mol. At 25°C, the half-life is 4 minutes. At what temperature will the half-life be reduced to 20 seconds?

- ○ 100°C
- ○ 125°C
- ○ 150°C
- ○ 115°C

25 1 point

For the reaction below:

$HO(g) + H_2(g) \longrightarrow H_2O(g) + H(g)$

a plot of lnk vs 1/*T* gives a straight line with a slope equal to -5.1x10^3 K

What is the activation energy for this reaction?

- ○ 42 kJ/mol
- ○ 98 kJ/mol
- ○ 5.1 kJ/mol
- ○ 12 kJ/mol

26 1 point

A certain reaction has an activation energy of 0.8314 kJ/mol and a rate constant of 2.718 s^{-1} at -73°C. At -173°C, which expression for the rate constant is correct?

- ○ ln(k_2) = -0.5
- ○ ln(k_2) = 1.5
- ○ ln(k_2) = 1
- ○ ln(k_2) = 0.5

27 1 point

A food substance kept at 0°C becomes rotten (as determined by a good quantitative test) in 8.3 days. The same food rots in 10.6 hours at 30°C. Assuming the kinetics of the microorganisms enzymatic action is responsible for the rate of decay, what is the activation energy for the decomposition process? Hint: Rate varies INVERSELY with time; a faster rate produces a shorter decomposition time.

- ○ 0.45 kJ/mol
- ○ 67.2 kJ/mol
- ○ 2.34 kJ/mol
- ○ 23.4 kJ/mol

28 1 point

A catalyst...

- ○ changes the reaction mechanism to ensure that K is increased.
- ○ increases K to favor product formation.
- ○ speeds up the reaction but does not change K.
- ○ speeds up the reaction and increases K to favor product formation.

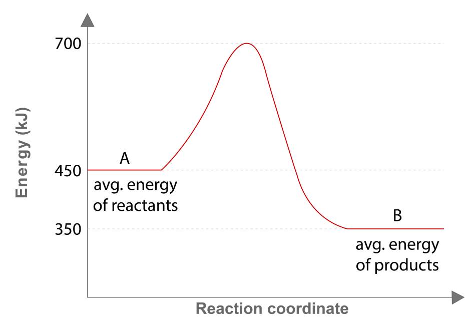
29 1 point

All else being equal, a reaction with a higher activation energy compared to one with a lower activation energy will...

- ○ be more endothermic.
- ○ proceed slower.
- ○ be more exothermic.
- ○ proceed faster.

30 1 point

Consider the potential energy diagram below:



What is the change in enthalpy (ΔH) for the reaction $A \longrightarrow B$?

- ○ 350 kJ
- ○ -100 kJ
- ○ 100 kJ
- ○ -350 kJ

31 1 point

Consider the potential energy diagram in question 13. What is the activation energy (E_a) for the reaction?

- 100 kJ
- 200 kJ
- 250 kJ
- 350 kJ

32 1 point

Which of the following statements is TRUE?

- If the exponents in the rate-law do not match the coefficients in the balanced equation, then we know that the reaction does not take place in one step.
- The rate-law for a reaction can be predicted from the balanced chemical equation.
- The exponents in the rate-law must match the coefficients in the balanced chemical equation for the reaction.
- If the exponents in the rate-law do not match the coefficients in the balanced chemical equation, then we know that the reaction takes place in one step.

33 1 point

"Reaction mechanisms usually involve only unimolecular or bimolecular steps."
Is this statement true or false?

- True, because steps of higher molecularity would not be compatible with observed reaction rate laws.
- False.
- True, because collisions of higher molecularity would occur too infrequently to account for an observed rate.
- True, because the activation energy for collisions of higher molecularity would be too great.

34 1 point

Which of the following is/are ALWAYS true concerning collision and transition state theory?
I) Transition states are short-lived.
II) A balanced reaction shows which species must collide for the reaction to occur.
III) Intermediates are short-lived.

- I only
- All are true.
- II only
- II and III
- I and III
- III only

35 1 point

Consider the following reaction mechanism:
1) $Cl_2 + Pt \longrightarrow 2Cl + Pt$
2) $Cl + CO + Pt \longrightarrow ClCO + Pt$
3) $Cl + ClCO \longrightarrow Cl_2CO$
Overall: $Cl_2 + CO \longrightarrow Cl_2CO$
Which species is/are intermediates?

- Cl, ClCO
- Pt, Cl
- ClCO
- Pt
- Pt, Cl, ClCO