HW08 - Kinetics

Question 1 — 0.5 pts

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 $[O_3]$?

a. 2 and 2

b. -1 and 3

c. 3 and 2

d. 1 and 2

Question 2 — 0.5 pts

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 _____.

a. 0.030 M/s; -0.005 M/s

b. 0.015 M/s; -0.045 M/s

c. 0.015 M/s; -0.005 M/s

d. 0.015 M/s; 0.045 M/s

Question 3 — 1.0 pts

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}

a. rate = 4.48×10^{-3} $[A][B]^2[C]$

b. rate = 5.37×10^{-3} $[A][B]^3$

c. rate = 1.49×10^{-3} $[B]^3[C]$

d. rate = 1.79×10^{-3} $[B]^2[C]$

e. rate = 3.36×10^{-3} $[A][B]^3$

Question 4 — 1.0 pts

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.

a. rate = $k[A][B]^2$

b. rate = $k[B]^2$

c. rate = $k[A][B]$

d. rate = $k[A]^2[B]$

Question 5 — 0.5 pts

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

a. 0.00736

b. 0.327

c. 0.000166

d. 0.00110

Question 6 — 0.5 pts

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?

a. 0.0314 M/min

b. 0.00974 M/min

c. -0.00974 M/min

d. 0.101 M/min

Question 7 — 1.0 pts

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?

a. 1

b. 2

c. 4

d. 8

Question 8 — 1.0 pts

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].

a. 0.20 M; 0.80 M

b. 0.80 M; 0.20 M

c. 0.80 M; 0.10 M

d. 0.40 M; 0.10 M

e. 0.40 M; 0.20 M

Question 9 — 0.5 pts

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

a. the rate constant is zero.

b. the activation energy is zero.

c. the reactant concentration does not change with time.

d. the rate does not change during the reaction.

Question 10 — 0.5 pts

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...

a. decreasing exponentially.

b. slowly increasing.

c. increasing exponentially.

d. constant.

Question 11 — 1.0 pts

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?

a. 6.4 sec

b. Not enough information is given.

c. 2.9 sec

d. 3.2 sec

Question 12 — 1.0 pts

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?

a. There is not enough information to answer.

b. 10.22 sec

c. 2.83 sec

d. 37.94 sec

Question 13 — 0.5 pts

The reaction below:

$A \longrightarrow$ products

is observed to obey first-order kinetics. Which of the following plots should give a straight line?

a. ln[A] vs t^{-1}

b. [A] vs t

c. [A] vs t^{-1}

d. ln[A] vs k^{-1}

e. [A] vs k

f. ln[A] vs t

g. ln[A] vs k

Question 14 — 1.0 pts

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.

a. 1.3 sec

b. 0.63 sec

c. 1.6 sec

d. 1.7 sec

Question 15 — 1.0 pts

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?

a. not enough information

b. $0.02 s^{-1}$

c. $0.01 s^{-1}$

d. $0.2 s^{-1}$

Question 16 — 1.0 pts

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?

a. when the rate also depends on the concentration of another reactant as well

b. All of the other answers could be correct.

c. if the reaction comes to equilibrium

d. if the reaction has any significant backward rate

Question 17 — 0.5 pts

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.

a. all three elementary reactions are bimolecular

b. tetramolecular, termolecular, pentamolecular

c. it is impossible to know without knowing the overall reaction for each

d. bimolecular, unimolecular, termolecular

Question 18 — 1.0 pts

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?

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

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

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

d. $\frac{\Delta[B]}{\Delta t} = -k[A][B]^2; \ \frac{1}{M^2}$

Question 19 — 1.0 pts

Consider the mechanism below:

$NO_2 + F_2 \longrightarrow NO_2F + F$ k_1, slow

$F + NO_2 \longrightarrow NO_2F$ k_2, fast

What is the rate law?

a. rate = $k_1[NO_2F][F_2]$

b. rate = $k_1k_2[NO_2]^2$

c. rate = $k_2[NO_2]^2$

d. rate = $k_1[NO_2][F_2]$

e. rate = $k_2[NO_2][F]$

Question 20 — 1.0 pts

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: $E_3 + A \longrightarrow B_2 + C_2$ fast

and write an acceptable rate law.

a. $A + B_2 \longrightarrow C_2 + D$; rate = $k[B_2]^2$

b. $A + B_2 \longrightarrow C_2 + D$; rate = $k[A][B_2]$

c. $E_3 + A \longrightarrow B_2 + C_2$; rate = $k[E_3][A]$

d. $2B_2 \longrightarrow E_3 + D$; rate = $k[B_2]^2$

Question 21 — 1.0 pts

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?

a. $rate = k_1k_2[I_2][H_2]$

b. $rate = \frac{k_{-1}k_2}{k_1}[I_2][H_2]$

c. $rate = \frac{k_1k_2}{k_{-1}}[I_2][H_2]$

d. $rate = k_2[I]^2[H_2]$

e. $rate = \frac{k_1k_2}{k_{-1}}[I]^2[H_2]$

Question 22 — 1.0 pts

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?

a. 89.3 J/mol

b. 16,600 J/mol

c. 16,600 kJ/mol

d. 89.3 kJ/mol

Question 23 — 1.0 pts

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?

a. 100°C

b. 150°C

c. 115°C

d. 125°C

Question 24 — 1.0 pts

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 -5.1×10^{3} K. What is the activation energy for this reaction?

a. 12 kJ/mol

b. 42 kJ/mol

c. 5.1 kJ/mol

d. 98 kJ/mol

Question 25 — 1.0 pts

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?

a. $\ln(k_2) = 1$

b. $\ln(k_2) = 0.5$

c. $\ln(k_2) = -0.5$

d. $\ln(k_2) = 1.5$

Question 26 — 1.0 pts

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.

a. 0.45 kJ/mol

b. 23.4 kJ/mol

c. 2.34 kJ/mol

d. 67.2 kJ/mol

Question 27 — 1.0 pts

A catalyst...

a. speeds up the reaction and increases K to favor product formation.

b. increases K to favor product formation.

c. speeds up the reaction but does not change K.

d. changes the reaction mechanism to ensure that K is increased.

Question 28 — 1.0 pts

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

a. be more exothermic.

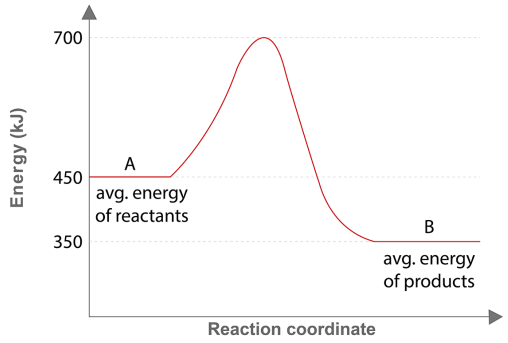
b. be more endothermic.

c. proceed faster.

d. proceed slower.

Question 29 — 1.0 pts

Consider the potential energy diagram below:



What is the change in enthalpy (ΔH) for the reaction A ⟶ B?

a. -100 kJ

b. 350 kJ

c. -350 kJ

d. 100 kJ

Question 30 — 1.0 pts

Consider the potential energy diagram in the previous question where A reacts to form B. What is the activation energy (E_a) for the reaction?

a. 200 kJ

b. 250 kJ

c. 100 kJ

d. 350 kJ

Question 31 — 1.0 pts

Which of the following statements is TRUE?

a. The exponents in the rate-law must match the coefficients in the balanced chemical equation for the reaction.

b. 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.

c. The rate-law for a reaction can be predicted from the balanced chemical equation.

d. 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.

Question 32 — 1.0 pts

"Reaction mechanisms usually involve only unimolecular or bimolecular steps."

Is this statement true or false?

a. True, because collisions of higher molecularity would occur too infrequently to account for an observed rate.

b. False.

c. True, because steps of higher molecularity would not be compatible with observed reaction rate laws.

d. True, because the activation energy for collisions of higher molecularity would be too great.

Question 33 — 1.0 pts

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.

a. II and III

b. II only

c. I only

d. III only

e. All are true.

f. I and III

Question 34 — 1.0 pts

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?

a. Pt, Cl

b. ClCO

c. Pt, Cl, ClCO

d. Cl, ClCO

e. Pt