

CHEM 1212K Reading Day Problems

Ch. 14: Chemical Kinetics

1. Which statements regarding chemical kinetics are true and which are false?
 - a. T/F: The activated complex (transition state) of a chemical reaction is an observable species.
 - b. T/F: Catalysts speed up reactions by increasing the frequency of collisions.
 - c. T/F: The rate law for the slow step is the rate law for the overall reaction, assuming the slow step does not include an intermediate.
 - d. T/F: In some cases, the orders of reaction in the rate law for a reaction can be predicted from the coefficients of the balanced equation.
 - e. T/F: Catalysts can appear either as a product first and then a reactant or as a reactant first and then a product in a reaction mechanism.
 - f. T/F: Intermediates may appear in an overall rate law.
 - g. T/F: Catalysts may appear in an overall rate law.
 - h. T/F: The forward and reverse rate constants are equal when a system is at equilibrium.
 - i. T/F: There is only one combination of reactant and product concentrations that indicate a given reaction is at equilibrium at a given temperature.
 - j. T/F: A reaction stops when equilibrium is reached.
2. For a given reaction at 398 K, $k = 0.0054 \text{ M}^{-1}\text{s}^{-1}$. What is the order of reaction for this reaction?
3. Consider the reaction $\text{CH}_3\text{Br}(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{CH}_3\text{OH}(\text{aq}) + \text{Br}^-(\text{aq})$
 When the OH^- concentration alone is doubled, the rate quadruples
 When the CH_3Br concentration alone is increased by a factor of 1.2, the rate increases by a factor of 1.2
 Write the rate law for the reaction.
4. The following data were collected for the reaction
 $2\text{A}(\text{g}) + 2\text{B}(\text{g}) + \text{C}(\text{g}) \rightarrow 3\text{G}(\text{g}) + 4\text{F}(\text{g})$

Experiment	[A] _o (mM)	[B] _o (mM)	[C] _o (mM)	Initial Rate (mM/s)
1	10.0	100.	700.	2.00
2	20.0	200.	300.	4.00
3	20.0	200.	200.	16.0
4	10.0	100.	400.	2.0
5	4.62	1.77	12.4	?

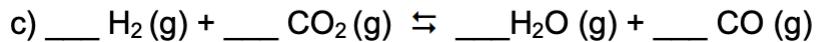
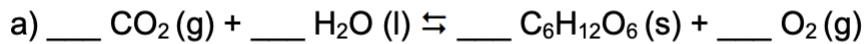
- a. What is the order for each reactant and the overall order of the reaction?
- b. Write the rate law for the reaction.
- c. Determine the reaction rate constant.
- d. Predict the initial rate for Experiment 5.

5. The biological half-life of a medication is the time required for the drug to lose half of its pharmacologic activity. The biological half-life of a new medication is 6.0 hours and its decay follows first-order kinetics. How long does it take for medication to lose 75% of its pharmacologic activity?
- A) 0.0479 hours
B) 0.0834 hours
C) 2.31 hours
D) 2.49 hours
E) 12.0 hours
6. Consider the reaction mechanism below and predict the overall rate law assuming that step 1 is fast and at equilibrium (reversible) and step 2 is slow.
- 1) $\text{NO}_2 + \text{NO}_2 \rightleftharpoons \text{N}_2\text{O}_4$
 - 2) $\text{N}_2\text{O}_4 + \text{CO} \rightleftharpoons \text{NO} + \text{NO}_2 + \text{CO}_2$
7. Which statement or statements explain why collision rate is greater than reaction rate for a given chemical reaction?
- I. Most collisions occur with an energy that is less than energy required to begin breaking bonds in reactants.
 - II. Collisions don't occur that frequently because there are no attractions between molecules of a gas.
 - III. Some collisions occur with orientations that are not conducive to product formation.
- A) I only
B) II only
C) Both II and III
D) Both I and III
E) All of I, II, and III
8. A 2.0 L vessel contains 0.75 moles of N_2O_5 at a given temperature. The rate constant at the temperature of reaction is 0.00052 s^{-1} . How many moles of NO_2 does the vessel contain after 5.0 minutes?



Ch. 15: Chemical Equilibrium

1. Predict what will happen when the reaction **volume** is **decreased** in each of the following, after balancing the reactions.



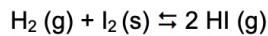
2. Balance, the exothermic reaction below.



Predict the effect of each of the following changes on this system at equilibrium (drive forward reaction, drive reverse reaction, no effect).

- a) add N_2O_4
 - b) remove NO_2
 - c) increase the volume
 - d) decrease the temperature
 - e) Add N_2

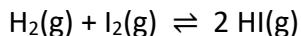
- ### 3. The equilibrium constant, K_P , for the reaction



is 0.35 at 25° C. Decide if each of the following mixtures is at equilibrium, at 25° C. If it is not at equilibrium, decide which way the reaction will proceed to reach equilibrium.

- a) $P_{H_2} = 0.10$ atm, $P_{HI} = 0.90$ atm and there is solid I_2 present
 - b) $P_{H_2} = 0.55$ atm, $P_{HI} = 0.44$ atm, and there is solid I_2 present
 - c) $P_{H_2} = 0.25$ atm, $P_{HI} = 0.15$ atm and there is solid I_2 present

4. At a given temperature, K_c for the following reaction is 50.0. What is the equilibrium concentration of HI at the same temperature if the equilibrium concentrations of H₂ and I₂ are 0.46 M and 0.39 M, respectively?

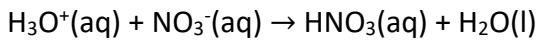
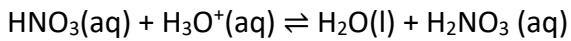
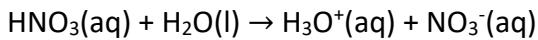
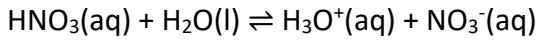


5. A mixture of 0.384 M H₂O, 0.384 M Cl₂O, and 0.652 M HClO are placed in a vessel at 25 °C. Calculate the equilibrium concentration of HClO at the same temperature.



Ch. 16: Acids and Bases

1. Determine the [OH⁻], [H₃O⁺], pOH and pH of a 0.045 mol/L HCl solution.
2. What is the Ba(OH)₂ concentration of an aqueous solution of Ba(OH)₂ with pH = 11.25 at 25 °C?
3. Identify a correct ionization reaction for nitric acid.



4. What is the pH of a neutral solution at 50 °C at which temperature $K_w = 5.48 \times 10^{-14}$?
5. What concentration of an aqueous solution of NH₄⁺ at 25 °C has the same pH as that of 6.8 × 10⁻⁵ M HCl. The pK_b for NH₃ is 4.74 at 25 °C.

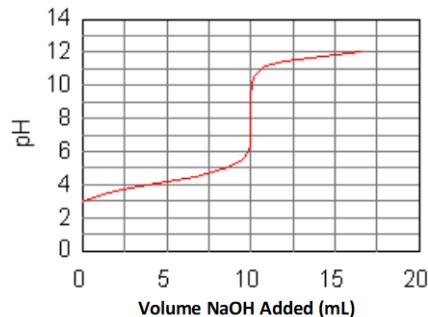
Ch. 17: Aqueous Equilibrium (Titrations, buffers, K_{sp})

3. Which compound has the greatest molar solubility in pure water?
 - A) Al(OH)₃, $K_{sp} = 3 \times 10^{-34}$
 - B) PbS, $K_{sp} = 9.04 \times 10^{-29}$
 - C) ZnS, $K_{sp} = 1.6 \times 10^{-24}$
 - D) Ag₂S, $K_{sp} = 8 \times 10^{-48}$
 - E) CuS, $K_{sp} = 1.27 \times 10^{-36}$
4. Which solution is a buffer?
 - A) A solution that is 0.100 M in HNO₃ and 0.100 M in KNO₃
 - B) A solution that is 0.100 M NaCl and 0.100 M in NaNO₃
 - C) A solution that is 0.100 M in NH₃ and 0.100 M in KOH
 - D) A solution that is 0.100 M in NaOH and 0.100 M in CH₃COOH
 - E) A solution that is 0.100 M in NaNO₂ and 0.100 M in HNO₂

5. Which statement is true at the equivalence point of *any* acid/base titration?

- A) The pH is 7.00
- B) Moles of OH^- = moles of H_3O^+
- C) Moles of HA = moles of A^-
- D) Moles of analyte = moles of titrant
- E) More than one of these statements is true

6. The curve for the titration of 50.0 mL of 0.0200 M $\text{C}_6\text{H}_5\text{COOH}$ (aq) with 0.100 M NaOH (aq) is given below. What are the main species in the solution after 7.5 mL of base have been added?

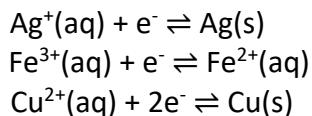


- A) $\text{C}_6\text{H}_5\text{COOH}$ (aq) and $\text{C}_6\text{H}_5\text{COO}^-$ (aq)
- B) $\text{C}_6\text{H}_5\text{COOH}$ (aq) and NaOH (aq)
- C) NaOH and $\text{C}_6\text{H}_5\text{COO}^-$ (aq)
- D) $\text{C}_6\text{H}_5\text{COOH}$ (aq) only
- E) NaOH (aq) only

7. A buffer solution contains 0.0200 M acetic acid and 0.0200 M sodium acetate. What is the pH after 0.0020 mol of HCl are added to 1.00 L of this buffer? $pK_a = 4.75$ for acetic acid. Assume no change in volume.
- A) 4.75
B) 4.70
C) 4.80
D) 4.84
E) 4.66
8. A 10.00 mL sample of HCl was titrated with 0.150 M KOH. If 15.00 mL of KOH was required to reach the equivalence point (stoichiometric point), then what was the concentration of the HCl?
- A) 0.100 M
B) 0.150 M
C) 0.200 M
D) 0.225 M
E) 0.250 M
9. A buffer solution of 100mL volume is 0.1 M $\text{CH}_3\text{CO}_2\text{H}$ (aq) and 0.1 M NaCH_3CO_2 (aq).
- What is the initial pH of the buffer?
 - What is the pH after the addition of 10 ml of 0.95 M NaOH (aq)
10. Suppose that 4.25 g of an unknown weak monoprotic acid is dissolved in water. Titration of the solution with 0.35 M NaOH (aq) required 52ml to reach the stoichiometric point. After the addition of 26ml, the pH of the solution was found to be 3.82.
- What is the pK_a for the acid?
 - What is the molar mass of the acid?
11. The molarity of CrO_4^{2-} in a saturated Ti_2CrO_4 solution is 6.3×10^{-5} mol/L. What is the K_{sp} of Ti_2CrO_4 ?

Ch. 19: Electrochemistry

1. Which is the strongest oxidizing agent?

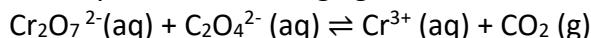


- A) Ag
- B) Cu²⁺
- C) Cu
- D) Ag⁺
- E) Fe²⁺

2. Consider the reaction $2\text{Ag}^+(\text{aq}) + \text{Cu(s)} \rightleftharpoons \text{Cu}^{2+}(\text{aq}) + 2\text{Ag(s)}$ Calculate the value of E°_{cell} for the given reaction above given:



3. Identify the the reducing agent in the reaction (balanced in acidic solution):



4. What is the coefficient for CO₂ when the following reaction is balanced in acidic solution? $\text{Cr}_2\text{O}_7^{2-}(\text{aq}) + \text{C}_2\text{O}_4^{2-}(\text{aq}) \rightarrow \text{Cr}^{3+}(\text{aq}) + \text{CO}_2(\text{g})$

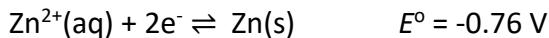
5. If the reaction $\text{CH}_3\text{OH}(\text{aq}) + \text{Cr}_2\text{O}_7^{2-}(\text{aq}) \rightarrow \text{CH}_2\text{O(l)} + \text{Cr}^{3+}(\text{aq})$ is balanced *in base* then what is the coefficient for water, and on which side does it appear?

- A) 7 on the products side
- B) 8 on the reactants side
- C) 7 on the reactants side
- D) 1 on the reactants side
- E) 14 on the reactants side

6. Consider the electrolysis of molten barium chloride. How many grams of barium metal can be produced by supplying 0.50 amperes for 30.0 minutes?

- A) 0.13 g
- B) 0.64 g
- C) 0.36 g
- D) 1.6 g
- E) 2.8 g

7. A galvanic cell was constructed using the Zn^{2+}/Zn and H_2/H^+ (standard hydrogen electrode) half-cells under the following conditions. What is E_{cell} at 298 K?



$$[\text{Zn}^{2+}] = 0.010 \text{ M}$$

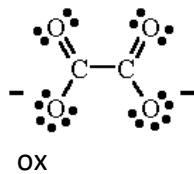
$$[\text{H}^+] = 2.5 \text{ M}$$

$$P_{\text{H}_2} = 0.30 \text{ atm}$$

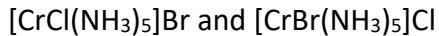
- A) 0.86 V
 - B) 0.76 V
 - C) 0.53 V
 - D) 0.31 V
 - E) 1.21
8. In an electrochemical cell, $Q = 0.0010$ and $K = 2.30$. What can you conclude about E_{cell} and E°_{cell} ?
- A) E_{cell} is positive and E°_{cell} is negative.
 - B) E_{cell} is negative and E°_{cell} is positive.
 - C) Both E_{cell} and E°_{cell} are negative.
 - D) Both E_{cell} and E°_{cell} are positive.

Ch. 22: Coordination Chemistry

1. What is the coordination number for Pd in the complex $\text{Na}_2[\text{Pd}(\text{ox})_2]$?

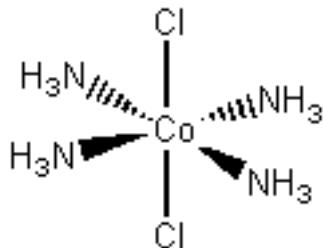


2. The coordination complexes below exhibit what type of isomerism?



- A) coordination
- B) linkage
- C) ionization
- D) enantiomerism
- E) diastereoisomerism

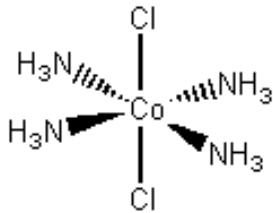
3. Which statement about the coordination complex below is *true*.



- A) It is a *cis* isomer.
 - B) The name of the complex has a +2 charge.
 - C) The complex is chiral.
 - D) The complex has a stereoisomer.
 - E) The complex rotates the plane of polarized light.
4. Which statement regarding $[\text{Fe}(\text{OH}_2)_6]^{2+}$ is *true*?

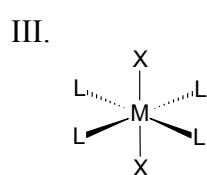
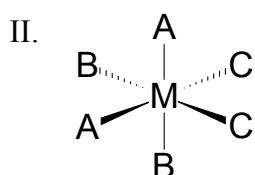
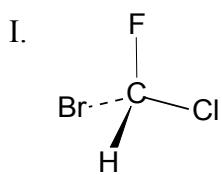
- A) It is diamagnetic.
- B) Its electron configuration is t_{2g}^6 .
- C) It is high-spin.
- D) If the ligands were replaced with NH_3 , the configuration would be $t_{2g}^4e_g^2$.
- E) Both B and D are true.

5. Which statement about the coordination complex below is *true*.



- A) The oxidation state for the Co is 0.
 - B) The coordination number for the complex is six.
 - C) The complex is chiral.
 - D) The complex has no stereoisomers.
 - E) The complex rotates the plane of polarized light.
6. How many *unpaired* electrons would you expect for the central metal to have in the complex $[\text{Fe}(\text{CN})_6]^{4-}$?

7. Which of these molecules is *chiral*?

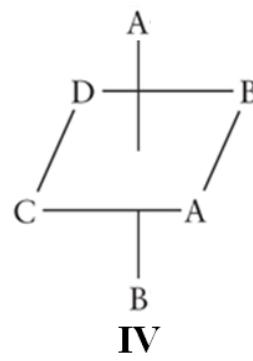
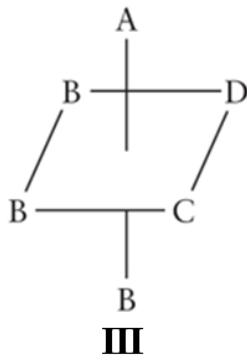
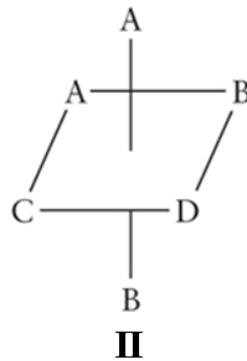
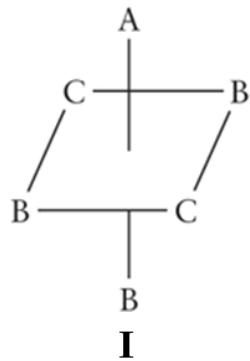


- A) I only
- B) II only
- C) III only
- D) I and II
- E) II and III

8. Which transition metal cation is least likely to exist?

- A) Fe^{2+}
- B) Mn^{7+}
- C) Cu^+
- D) Ru^{8+}
- E) Rh^{9+}

9. Which statement regarding the coordination compounds is true?



- A) Compound I is chiral.
- B) Compound III is NOT chiral.
- C) Compound II is NOT chiral.
- D) Compounds II and IV are enantiomers (optical isomers).
- E) Compounds I and III are enantiomers (optical isomers).

Ch. XX: Main Group Chemistry

1. Which oxides can be basic?

- I. Na_2O
 - II. SO_3
 - III. Al_2O_3
 - IV. P_2O_5
- A) I and III
B) I only
C) II and IV
D) II and III
E) II, III, and IV

2. Which statement regarding diamond and graphite is true?

- A) Carbon and diamond are allotropes, so they have identical structures.
- B) The C atoms in carbon and the C atoms in graphite have the same hybridization.
- C) The C atoms in diamond have no unhybridized p orbitals.
- D) Graphite is a poor electrical conductor because of hybridization.
- E) Diamond is a good electrical conductor due to delocalization of electrons.

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4. Which hydrides below are metallic?

- I. CrH
- II. NaH
- III. CaH_2
- IV. SiH_4

- A) II and IV
B) I, II, and III
C) I only
D) II and III
E) IV only

5. Which oxides are acidic?

- I. Na_2O
 - II. SO_3
 - III. Al_2O_3
 - IV. P_2O_5
- A) I and III
B) I only
C) II and IV
D) II and III
E) IV only
6. Identify the reducing agent: $\text{SiH}_4 + 2\text{O}_2 \rightleftharpoons \text{SiO}_2 + 2\text{H}_2\text{O}$
- A) SiO_2
B) H_2O
C) SiH_4
D) O_2
E) This is not an oxidation – reduction reaction.
7. The reaction $\text{HI}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_3\text{O}^+(\text{aq}) + \text{I}^-(\text{aq})$ is an example of:
- A) heterolytic cleavage by proton transfer
B) homolytic cleavage by hydride transfer
C) heterolytic cleavage by hydride transfer
D) homolytic cleavage by proton transfer
8. Which reaction correctly demonstrates the reaction of a basic oxide with water?
- A) $\text{BaO}(\text{s}) + 3\text{H}_2\text{O}(\text{l}) \rightarrow \text{Ba}^{2+}(\text{aq}) + 2\text{H}_3\text{O}^+(\text{aq})$
B) $\text{Na}_2\text{O}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2\text{Na}^+(\text{aq}) + \text{H}_2\text{O}_2(\text{l})$
C) $\text{CaO}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{Ca}^{2+}(\text{aq}) + \text{O}_2(\text{g}) + \text{H}_2(\text{g})$
D) $\text{MgO}(\text{s}) + 2\text{HNO}_3(\text{aq}) \rightarrow \text{Mg}(\text{NO}_3)_2(\text{aq}) + \text{H}_2\text{O}(\text{l})$
E) $\text{Li}_2\text{O}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2\text{Li}^+(\text{aq}) + 2\text{OH}^-(\text{aq})$