

CHEM 2

FINAL EXAMINATION

FALL 02

NAME _____

DATE:

INSTRUCTOR (circle): Voloshchuk Zhang

SHOW ALL WORK

TOTAL POINTS ON EXAM: 150

USE CORRECT UNITS AND SIGNIFICANT DIGITS YOU MAY SHOW YOUR
WORK ON THE BACK OF THE SHEET, BUT INDICATE YOUR ANSWER ON THE
FRONT

REFERENCE DATA ON LAST PAGES MAY BE TORN OFF OF EXAM

ALL PORTIONS OF A MULTIPART QUESTION ARE WORTH THE SAME
NUMBER OF POINTS UNLESS OTHERWISE INDICATED.

<insert per tab and reference data from exam 2>

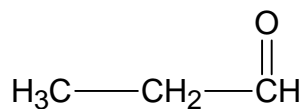
1. (16 points) Indicate whether each of the following statements is true or false:

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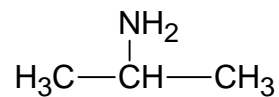
- A catalyst changes the equilibrium constant for a reaction.
- A catalyst changes the rate constant for a reaction.
- Water acts as a Lewis acid when it forms complex ions with transition metals.
- The rate-determining step is the slowest step in a reaction mechanism.
- If a process is reversible, there is no change in the entropy of the universe.
- Samples of the same polymer may have different average molecular weights.
- Polymers formed from two different types of monomers are called copolymers.
- Nuclear fusion occurs when an atomic nucleus splits into two lighter nuclei.
- The half-life of a reagent is the amount of time required for the concentration of that reagent to drop to $\frac{1}{2}$ its original value.
- For a system at equilibrium, the reaction quotient equals the equilibrium constant.
- A system is at equilibrium when the rate of the forward reaction and the rate of the reverse reaction are equal.
- A Lewis acid acts as an electron pair donor.
- An Arrhenius base generates an excess of OH^- ions in solution.
- All carboxylic acids are weak acids.
- A buffer solution is formed by adding a large excess of acid to a solution containing its conjugate base.
- When a weak acid is titrated against a strong base, the equivalence point occurs at a pH greater than 7.

2. (6 points) Identify the class of compound (alcohol, ester, *etc.*) to which each molecule belongs.

A.

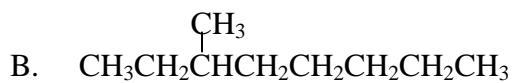
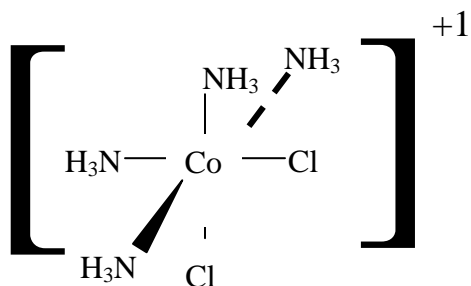


B.

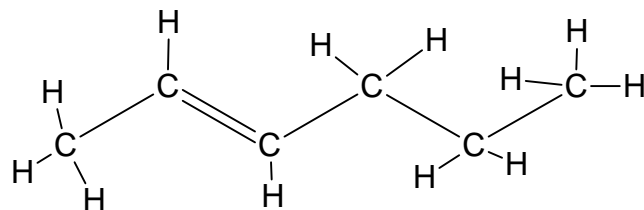


3. (12 points) Name each of the following compounds. Make certain your answer identifies the correct structural and geometric isomer (do not worry about optical isomerism for this question):

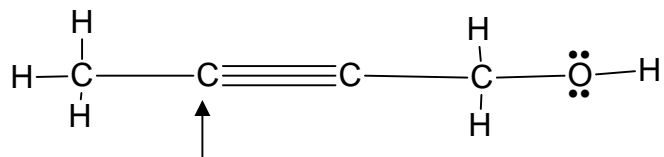
A.



C.



4. (8 points) Consider the following structure:



- Give the hybridization of the carbon indicated by the arrow.
- Give the hybridization of the oxygen atom.
- How many σ -bonds are there in this molecule?
- When writing the name of this molecule, would you have to specify whether it is *cis*- or *trans*-?

5. (12 points)

A. Draw the structure of *cis*-2-butene.

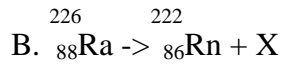
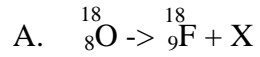
B. Draw the structure of 2,5-dimethylheptane.

C. Draw the structure of *cis*-diamminedichloroplatinum(II).

6. (4 points) Is the complex $\text{Mo}(\text{H}_2\text{O})_6^{+3}$ diamagnetic or paramagnetic?

7. (10 points) In acidic solution, the iodate ion may be reduced to the iodide ion according to the reaction $\text{IO}_3^- (\text{aq}) \rightarrow \text{I}^- (\text{aq})$. Write a balanced net ionic equation for the reduction of sodium iodate by solid silver in an acidic environment (*i.e.* assume a piece of silver is in contact with an acidic solution containing sodium iodate).

8. (6 points) Balance the following equations by replace the letter X with the appropriate particle. Make certain your notation includes mass number and charge.



9. (6 points) Consider the reaction ${}^{60}_{27}\text{Co} \rightarrow {}^{60}_{28}\text{Ni} + {}^0_{-1}\text{e}$. Give the energy of the reaction, and state whether the energy is absorbed or emitted.

Mass cobalt-60 nucleus: 59.919007 g/mol

Mass nickel-60 nucleus: 59.915428 g/mol

Mass of electron: 0.00054858 g/mol

10. (15 points) Consider the following reaction: $\text{NH}_3(\text{g}) + \text{HCl}(\text{g}) \rightarrow \text{NH}_4\text{Cl}(\text{s})$
- A. (3 points) Write the equilibrium constant expression for this equation.
- B. (3 points) Would a decrease in pressure (at constant temperature) drive this system toward reactants or products? Justify your answer in words.
- C. (6 points) Calculate the standard enthalpy and entropy of reaction.

D. (3 points) Indicate whether an increase in temperature (at constant pressure) will shift the equilibrium of this system toward the reactants or the products. Justify your answer based on the results of Part C.

11. (10 points) Methylamine acts as a base according to the following reaction:
 $\text{CH}_3\text{NH}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{CH}_3\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq}) \quad K_b = 4.4 \times 10^{-4}$
0.10 moles of methylamine are dissolved in enough water to make 1.0L of solution. What is the concentration of hydroxide ion in this solution?

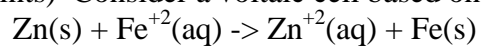
12. (10 points) The following data were collected for the rate of disappearance of NO in the reaction $2 \text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{NO}_2(\text{g})$.

Experiment	[NO](M)	[O ₂](M)	Initial rate (M/s)
1	0.0126	0.0125	1.41×10^{-2}
2	0.0252	0.0250	1.13×10^{-1}
3	0.0252	0.0125	5.64×10^{-2}

Write the rate law for this reaction, and calculate the rate constant.

13. (3 points) Calculate the hydroxide ion concentration of a pH=12 solution.

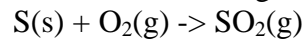
14. (10 points) Consider a voltaic cell based on the following net ionic equation:



A. Calculate the standard cell potential for this system.

B. Calculate the emf for a cell made from a 0.5M solution of $\text{Fe}^{+2}(\text{aq})$ and a 0.01M solution of $\text{Zn}^{+2}(\text{aq})$.

15. (10 points) Consider the following reaction:



A. If $\Delta G^\circ = -300.4 \text{ kJ}$, what is the equilibrium constant for this reaction under standard conditions?

B. What is the free energy of reaction if $[\text{O}_2(\text{g})]=0.0010 \text{ M}$ and $[\text{SO}_2(\text{g})]=0.030\text{M}$, under conditions of standard temperature and pressure?