

**GENERAL CHEMISTRY 2
FINAL EXAM
June 14, 2019**

Name _____

Panthersoft ID _____

Signature _____

Part 1 _____ (50 points)

Part 2 _____ (59 points)

Part 3 _____ (91 points)

TOTAL _____ (200 points)

Do all of the following problems. Show your work.

Part 1. Multiple choice. Circle the letter corresponding to the correct answer. There is one and only one correct answer per problem. [5 points each]

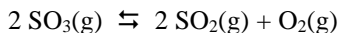
1) Which of the following mixtures of liquids is likely to form a solution?

- a) A mixture of two polar liquids
- b) A mixture of two nonpolar liquids
- c) A mixture of a polar liquid and a nonpolar liquid
- d) Both a and b
- e) Both a and c

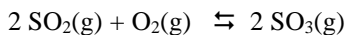
2) For a process to be spontaneous, which of the following must be true?

- a) $\Delta S_{\text{univ}} > 0$
- b) $\Delta S_{\text{syst}} > 0$
- c) $\Delta S_{\text{surr}} > 0$
- d) Both b and c
- e) Both a and b and c

3) The numerical value for the equilibrium constant for the reaction



is $K_C = 3.6 \times 10^{-7}$ at $T = 350. \text{ }^\circ\text{C}$. The numerical value for the equilibrium constant for the reaction

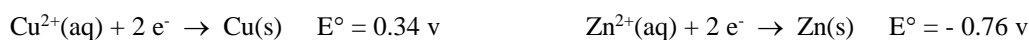


measured at the same temperature, is

- a) $K_C = 3.6 \times 10^{-7}$
 - b) $K_C = 1.8 \times 10^{-5}$
 - c) $K_C = 6.0 \times 10^{-4}$
 - d) $K_C = 1.7 \times 10^3$
 - e) $K_C = 2.8 \times 10^6$
- 4) For an acidic aqueous solution at $T = 25. \text{ }^\circ\text{C}$
- a) $[\text{H}_3\text{O}^+] > 1.0 \times 10^{-7}$
 - b) $[\text{H}_3\text{O}^+] > [\text{OH}^-]$
 - c) $\text{pH} > 7.0$
 - d) Both a and b
 - e) Both a and b and c
- 5) Which of the following is a strong acid?
- a) HClO_4
 - b) HI
 - c) HF
 - d) Both a and b
 - e) Both a and c
- 6) Consider the three substances H_2SO_4 , H_2SeO_4 , and H_2SeO_3 . Of these three substances
- a) H_2SeO_3 is the strongest acid and H_2SeO_4 is the weakest acid
 - b) H_2SeO_4 is the strongest acid and H_2SeO_3 is the weakest acid
 - c) H_2SeO_4 is the strongest acid and H_2SO_4 is the weakest acid
 - d) H_2SO_4 is the strongest acid and H_2SeO_3 is the weakest acid
 - e) H_2SO_4 is the strongest acid and H_2SeO_4 is the weakest acid

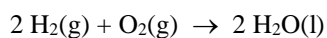
- 7) The indicator methyl red has $pK_a = 5.1$. Methyl red would be a good choice for an indicator for
- the titration of a strong acid with a strong base
 - the titration of a strong base with a strong acid
 - the titration of a weak base with a strong acid
 - the titration of a weak acid with a strong base
 - Methyl red would be a good choice of indicator for all of the above titrations
- 8) In which of the following substances does phosphorus have the largest value for oxidation number?
- $PF_3(g)$
 - $P_4(s)$
 - $P_2O_5(s)$
 - $P_4O_6(s)$
 - $H_3PO_3(aq)$

9) Consider the following two half cell reduction potentials



Based on this information, which reaction is most likely to occur for standard conditions

- $Zn(s) \rightarrow Zn^{2+}(aq) + 2 e^-$
 - $Zn^{2+}(aq) + 2 e^- \rightarrow Zn(s)$
 - $Cu(s) \rightarrow Cu^{2+}(aq) + 2 e^-$
 - $Cu^{2+}(aq) + 2 e^- \rightarrow Cu(s)$
 - All of these reactions are equally likely to occur for standard conditions
- 10) The stoichiometric equation for the reaction of hydrogen with oxygen to form water may be written as



This reaction is

- 2nd order with respect to $H_2(g)$
- 2nd order with respect to $O_2(g)$
- 2nd order with respect to $H_2O(l)$
- Both a and c
- Cannot tell from the information given

Part 2. Short answer questions.

1) A 1.358 mol/L solution of glycerol ($C_3H_8O_3$, MW = 92.09 g/mol) in water (H_2O , MW = 18.02 g/mol) has a density $D = 1.029$ g/mL. What is the percent by mass glycerol in the solution? [10 points]

2) A solution is prepared by dissolving 0.0681 g of potassium bromide (KBr, MW = 119.0 g/mol), a soluble ionic compound, in water, at $T = 30.0\text{ }^{\circ}\text{C}$. The final volume of the solution formed is $V = 200.0\text{ mL}$. What is the osmotic pressure of the solution (relative to pure water)? Give your final answer in units of torr. [12 points]

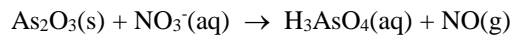
3) Define the following terms [5 points each]

a) amphoteric

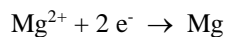
b) buffer

c) electrode

4) Balance the following oxidation-reduction reaction for acid conditions [12 points]



5) Pure magnesium metal (Mg, MW = 24.31 g/mol) does not occur in nature, but can be produced by electrolysis of molten magnesium chloride (MgCl₂, MW = 95.22 g/mol). The half-cell reaction corresponding to the production of magnesium metal is

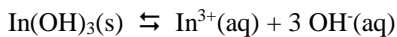


In a particular experiment, molten magnesium chloride undergoes electrolysis for a period $t = 6.00$ hours, at a current $i = 35.0$ amp = 35.0 Coulomb/s. How many grams of magnesium metal are produced? [10 points]

Part 3. Problems

1) Thermochemistry is often useful in determining properties for substances that cannot be measured directly.

Consider the following reaction



Thermochemical data for the substances involved in the above reaction are given below.

Substance	ΔH°_f (kJ/mol)	ΔG°_f (kJ/mol)	S° (J/mol·K)
$\text{In}^{3+}(\text{aq})$	- 14.2	- 133.9	259.4
$\text{In(OH)}_3(\text{s})$	- 895.4	- 761.5	104.6
$\text{OH}^-(\text{aq})$	- 230.0	- 157.3	- 10.7

a) What are the values for $\Delta S^\circ_{\text{rxn}}$ and $\Delta G^\circ_{\text{rxn}}$ for the above reaction? [10 points]

b) Give the expression for K (the equilibrium constant) for the above reaction, in terms of reactant and product concentrations. [5 points]

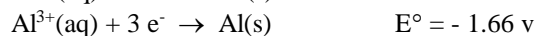
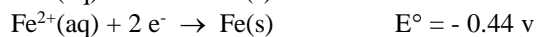
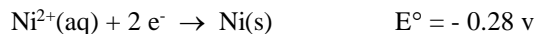
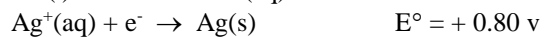
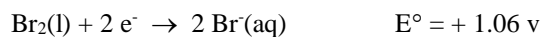
c) What is the numerical value for K, the equilibrium constant for the above reaction. [8 points]

2) Find the values for pH for the following two solutions.

a) A 0.0409 M solution of pivalic acid ($C_5H_{10}O_2$, MW = 102.1 g/mol), a weak monoprotic acid with $K_a = 9.3 \times 10^{-6}$. [10 points]

b) A solution that contains 0.0521 M of acetic acid (CH_3COOH , MW = 60.1 g/mol), a weak monoprotic acid with $K_a = 1.8 \times 10^{-5}$, and 0.0338 M sodium hydroxide ($NaOH$, MW = 40.0 g/mol), a strong soluble base. [15 points]

3) Several reduction reactions and their half-cell potentials for standard conditions are given below



a) Which of the following metals is easiest to oxidize (circle the correct answer)? [5 points]

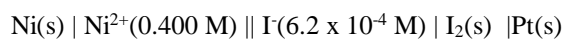
Ag(s)

Al(s)

Fe(s)

Ni(s)

b) Consider the following galvanic cell



For the above galvanic cell, give the half-cell oxidation reaction, the half-cell reduction reaction, and the net cell reaction. Also find the values for E°_{cell} and E_{cell} for the galvanic cell. [15 points]

4) In the gas phase, dinitrogen pentoxide (N_2O_5 , MW = 108.0 g/mol) decomposes to form nitrogen dioxide (NO_2 , MW = 46.0 g/mol) and nitrogen trioxide (NO_3 , MW = 62.0 g/mol). The balanced chemical equation for the reaction is



The reaction follows first order kinetics, with

$$\text{rate} = k [\text{N}_2\text{O}_5]$$

Experimentally, it is found that $k = 3.4 \times 10^{-5} \text{ s}^{-1}$ at $T = 30.0 \text{ }^\circ\text{C}$, and $k = 7.5 \times 10^{-4} \text{ s}^{-1}$ at $T = 75.0 \text{ }^\circ\text{C}$.

a) A system at $T = 30.0 \text{ }^\circ\text{C}$ initially contains $4.55 \times 10^{-2} \text{ mol/L}$ of N_2O_5 . After 100.0 minutes, what will be the concentration of N_2O_5 in the system? [8 points]

b) Assuming the rate constant for this reaction obeys the Arrhenius equation, find the values for A and E_a (including correct units). [15 points]