Chem. 1A Final

Name__________________________________________

Student Number _________________________________

All work must be shown on the exam for partial credit. Points will be taken off for incorrect or no units. Calculators are allowed. Cell phones may not be used for calculators. On short answer problems you must show your work in order to receive credit for the problem. If your cell phone goes off during the exam you will have your exam removed from you.

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Fundamental Questions
Each of these fundamental chemistry questions is worth 6 points. You must show work to get credit. Little to no partial credit will be rewarded. Make sure your answer includes the proper units.

1) 6 pts What is the conjugate acid or base of the following:
   a) NaOH
   b) C₅H₅N

2) 6 pts Calculate the pH of a solution that contains 0.15 M NH₃ and 0.35 M NH₄Cl.

3) 6 pts When the equilibrium is disturbed, in which direction will the reaction proceed? Circle the correct answer.
   \[ \text{2CO(g) + O}_2(g) \rightleftharpoons 2\text{CO}_2(g) \] exothermic
   - Remove CO₂
   - Reduce the volume
   - Increase the temperature
   - Add Ne
   - Add O₂

4) 6 pts A 2.5 mL bubble is released at a depth of 178 feet in a lake where the total pressure is 6.4 atm and the temperature is 4°C. What is the volume (mL) of the bubble at the surface when the pressure is 758 torr and 20.0°C?
5) 6 pts  What is the pH of the following:
   a) 0.25 M Ba(OH)$_2$
   b) 1×10$^{-12}$ M HCl

6) 6 pts  Circle all of the following that are buffer solutions:
   - 0.100 M NaCl and 0.100 M NH$_4$Cl
   - 0.100 M CH$_3$NH$_2$ and 0.150 M CH$_3$NH$_3$Cl
   - 0.100 M HCl and 0.050 M NaNO$_2$
   - 0.100 M HCl and 0.200 M NaC$_2$H$_3$O$_2$
   - 0.100 M HC$_2$H$_3$O$_2$ and 0.125 M NaC$_3$H$_5$O$_2$

7) 6 pts  A solution is prepared by dissolving 25.0 g of ammonium sulfate in enough water to make a 100.0 mL sample of stock solution. A 10.0 mL sample of this stock solution is added to 50.0 mL of water. Calculate the concentration of ammonium ions in the final solution.

8) 6 pts  a) How many protons, electrons, and neutrons does $^{127}$I$^-$ have
   b) Give an example of two species that are isotopes of each other.
9) 6 pts  What is the $K_b$ of the following equation:

$$C_2O_4^{2-}(aq) + H_2O(l) \rightleftharpoons HC_2O_4^-(aq) + OH^-(aq)$$

10) 6 pts  Draw a titration curve of a weak acid titrated with a strong base. Make sure to clearly label (1) the equivalence points, (2) the region with the maximum buffering, (3) where $pH=pK_a$, (4) the buffer region, (5) where the pH only depends on $[HA]$, and (6) where the pH only depends on $[A^-]$.

11) 6 pts  Calculate the value of the equilibrium constant, $K$, for the reaction.

$$O_2(g) + O(g) \rightleftharpoons O_3(g)$$

Given

$$NO_2(g) \rightleftharpoons NO(g) + O(g) \quad K=6.8 \times 10^{-49}$$

$$O_3(g) + NO(g) \rightleftharpoons NO_2(g) + O_2(g) \quad K=5.8 \times 10^{-34}$$

12) 6 pts  Write the net ionic equation that occurs when the following are mixed. If no reaction occurs write no reaction:

a) silver nitrate and potassium chloride

b) barium chloride and ammonium sulfate
Short Answer Questions

Each of the following short answer questions are worth the noted points. Partial credit will be given. Make sure to show your work and include the proper units on your answer.

1a) 6 pts Are solutions of the following salts acidic, basic, or neutral? For those that are not neutral, explain why the solution is acidic or basic.

KCl

1b) 6 pts C₅H₅NHF

1c) 6 pts NaHSO₃
2) 13 pts  A 0.100 g sample of a compound containing C, H, and O is burned in oxygen, producing 0.1783 g of CO₂ and 0.0734 g of H₂O. Determine the empirical formula of the compound.
3a) 7 pts Consider the titration of 100.0 mL of 0.200 M acetic acid ($K_a = 1.8 \times 10^{-5}$) with 0.100 M KOH. Calculate the pH of the resulting solution after each of the following volumes of KOH have been added.

50.0 mL

3b) 7 pts 200.0 mL

3c) 7 pts 250.0 mL
The reaction below can be used as a laboratory method of preparing small quantities of Cl\(_2\) (g). If a 62.6 g sample that is 98.5\% K\(_2\)Cr\(_2\)O\(_7\) by mass is allowed to react with 325 mL of HCl(aq) with a density of 1.15 \(\frac{g}{mL}\) and 30.1\% HCl by mass, how many grams of Cl\(_2\) (g) are produced?

\[
\text{Cr}_2\text{O}_7^{2-}(aq) + \text{Cl}^- (aq) \rightarrow \text{Cr}^{3+}(aq) + \text{Cl}_2(g) \text{ (unbalanced)}
\]
Multiple Choice Questions

Each of the following multiple choice questions are worth 5 points. Your answers need to be filled in on the Scantron provided. Note: Your Scantrons will not be returned to you, therefore, for your records, you may want to mark your answers on this sheet. On the Scantron you need to fill in your perm number, test version, and name. Failure to do any of these things will result in the loss of 1 point. Your perm number is placed and bubbled in under the “ID number”. Do not skip boxes or put in a hyphen. In addition, leave bubbles blank under any unused boxes. The version number (A) is bubbled in under the “test form.”

1. True or False? The equation $2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O}$ is an oxidation-reduction reaction.
A) True; the carbon is reduced and the oxygen is oxidized.
B) True; the carbon is oxidized and the hydrogen is reduced.
C) True; the oxygen is reduced and the hydrogen is oxidized.
D) False
E) True; the carbon is oxidized and oxygen is reduced.

2. When aqueous solutions of silver nitrate and potassium chromate are mixed, the blood-red precipitate silver chromate is formed. If 10.0 mL of 0.25 $M$ aqueous silver nitrate is mixed with 15.0 mL of 0.14 $M$ aqueous potassium chromate, what is the total concentration of ions in the solution after the precipitate is formed?
A) 0.25 $M$
B) 0.39 $M$
C) 0.14 $M$
D) 0.30 $M$
E) none of these

3. Consider the following reaction:

$$2\text{HF(g)} \rightleftharpoons \text{H}_2\text{(g)} + \text{F}_2\text{(g)} \quad (K = 1.00 \times 10^{-2})$$

Given 1.14 mol of HF(g), 0.870 mol of H$_2$(g), and 1.08 mol of F$_2$(g) are mixed in a 5.00-L flask, determine the reaction quotient, $Q$, and the net direction to achieve equilibrium.
A) $Q = 0.824$; the equilibrium shifts to the left.
B) $Q = 1.24$; the system is at equilibrium.
C) $Q = 0.723$; the equilibrium shifts to the left.
D) $Q = 0.824$; the equilibrium shifts to the right.
E) $Q = 0.723$; the equilibrium shifts to the right.
4. Which of the following statements concerning equilibrium is not true?
   A) The equilibrium constant is independent of temperature.
   B) A system moves spontaneously toward a state of equilibrium.
   C) A system that is disturbed from an equilibrium condition responds in such a way as to restore equilibrium.
   D) The value of the equilibrium constant for a given reaction mixture is the same regardless of the direction from which equilibrium is attained.
   E) Equilibrium in molecular systems is dynamic, with two opposing processes balancing one another.

5. Which of the following solutions will be the best buffer at a pH of 4.74? (\(K_a\) for \(\text{HC}_2\text{H}_3\text{O}_2\) is \(1.8 \times 10^{-5}\); \(K_b\) for \(\text{NH}_3\) is \(1.8 \times 10^{-5}\).)
   A) 0.10 \(M\) \(\text{NH}_3\) and 0.10 \(M\) \(\text{NH}_4\text{Cl}\)
   B) 3.0 \(M\) \(\text{HC}_2\text{H}_3\text{O}_2\) and 3.0 \(M\) \(\text{NaC}_2\text{H}_3\text{O}_2\)
   C) 3.0 \(M\) \(\text{HC}_2\text{H}_3\text{O}_2\) and 3.0 \(M\) \(\text{NH}_3\)
   D) 0.10 \(M\) \(\text{HC}_2\text{H}_3\text{O}_2\) and 0.10 \(M\) \(\text{NaC}_2\text{H}_3\text{O}_2\)
   E) 3.0 \(M\) \(\text{HC}_2\text{H}_3\text{O}_2\) and 3.0 \(M\) \(\text{NH}_4\text{Cl}\)

6. You have two salts, \(\text{AgX}\) and \(\text{AgY}\), with very similar \(K_{sp}\) values. You know that \(K_a\) for \(\text{HX}\) is much greater than \(K_a\) for \(\text{HY}\). Which salt is more soluble in acidic solution?
   A) They are equally soluble in acidic solution.
   B) This cannot be determined from the information given.
   C) \(\text{AgY}\)
   D) \(\text{AgX}\)

7. Consider the following gas samples:

<table>
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<tr>
<th>Sample A</th>
<th>Sample B</th>
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<tr>
<td>(\text{S}_2(g))</td>
<td>(\text{O}_2(g))</td>
</tr>
<tr>
<td>(n = 1) mol</td>
<td>(n = 2) mol</td>
</tr>
<tr>
<td>(T = 800) K</td>
<td>(T = 400) K</td>
</tr>
<tr>
<td>(P = 0.20) atm</td>
<td>(P = 0.40) atm</td>
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Which one of the following statements is false?
   A) Assuming identical intermolecular forces in the two samples, sample A should be more nearly ideal than sample B.
   B) The root-mean-square velocity of molecules in sample A is twice as large as the root-mean-square velocity of molecules in sample B.
   C) The average kinetic energy of the molecules in sample A is twice the average kinetic energy of the molecules in sample B.
   D) The volume of sample A is twice the volume of sample B.
   E) The fraction of molecules in sample A having a kinetic energies greater than some high fixed value is larger than the fraction of molecules in sample B having kinetic energies greater than that same high fixed value.
8. Calculate the pH of a solution prepared by mixing 50 mL of a 0.10 \( M \) solution of HF with 25 mL of a 0.20 \( M \) solution of NaF. \( pK_a \) of HF is 3.14.
   A) 2.84
   B) 3.14
   C) 5.83
   D) 3.44
   E) none of these

9. Calculate the pH of a solution made by mixing equal volumes of a solution of NaOH with a pH of 11.40 and a solution of KOH with a pH of 10.30. (Assume the volumes are additive.)
   A) 10.85
   B) 21.70
   C) 1.10
   D) 11.13
   E) none of these

10. Indium has atomic number 49 and atomic mass 114.8 g. Naturally occurring indium contains a mixture of indium-112 and indium-115 in an atomic ratio of approximately
    A) 94/6.
    B) 6/94.
    C) 75/25.
    D) 25/75.
    E) none of these

11. The salt BX, when dissolved in water, produces an acidic solution. Which of the following could be true?
    A) The cation \( B^+ \) is a weak acid.
    B) HX is a weak acid.
    C) HX is a strong acid.
    D) All of these could be true.
    E) Both HX and the cation \( B^+ \) are weak acids.

12. Consider a solution of 2.0 \( M \) HCN and 1.0 \( M \) NaCN (\( K_a \) for HCN = \( 6.2 \times 10^{-10} \)). Which of the following statements is true?
    A) The buffer will be more resistant to pH changes from addition of strong acid than to pH changes from addition of strong base.
    B) \([\text{OH}^-] > [\text{H}^+]\)
    C) The solution is not a buffer because [HCN] is not equal to [CN\(^-\)].
    D) The pH will be below 7.00 because the concentration of the acid is greater than that of the base.
    E) All of these statements are false.