SOLUBILITY RULES

1. Nitrates
2. Group I and NH\(_4^+\)
3. All acetates (\(C_2H_3O_2^-\)) are soluble
4. All chlorides are soluble except AgCl, Hg\(_2\)Cl\(_2\), and PbCl\(_2\)
5. Most sulfates are soluble - except SrSO\(_4\), BaSO\(_4\), PbSO\(_4\), and Hg\(_2\)SO\(_4\) and …
6. All carbonates are insoluble - except…
7. All hydroxides are insoluble - except…
8. All sulfides are insoluble – except Ca\(^{2+}\), Sr\(^{2+}\), Ba\(^{2+}\), and …
Name:__________________________

Questions 1 - 4 (18 points) are multiple choice questions. There will be no partial credit given for these problems. Problems 5 - 14 (82 points) should be worked out on the exam. Partial credit will be given for work shown. The answer by itself is not satisfactory for full credit.

**Academic Honesty Policy:** Intentionally using or attempting to use unauthorized materials, information or study aids in any academic exercise, OR intentionally or knowingly helping or attempting to help someone else to commit an act of academic dishonesty, such as knowingly allowing another to copy information during an examination or other academic exercise constitutes Academic Dishonesty and is **punishable with a possible grade of F** in this course!!!

There is a blank page at the end of this examination for use as scratch paper.

1. (4) How should water be classified with respect to its electrical conductivity properties?
   a. weak electrolyte
   b. nonconductor
   c. strong electrolyte
   d. good conductor

2. (4) Which of the following properties of water is NOT due to hydrogen bonding?
   a. Waters’ specific heat = 1.00 cal/g °C.
   b. Water is colorless.
   c. The solid form is less dense than the liquid form.
   d. Water boils at 100°C.

3. (5) Which of the following would you expect would NOT dissolve in water?
   a. NaOH
   b. HCl
   c. C8H18
   d. CaCl2
   e. NH3

4. (5) Which has the greatest electronegativity?
   a. Sodium
   b. Aluminum
   c. Phosphorus
   d. Nitrogen
   e. Iodine
Show your work on all problems!

5. (8) Given the following data:

\[ 2 \text{O}_3(g) \rightarrow 3 \text{O}_2(g) \quad \Delta H^\circ = -427 \text{ kJ} \]
\[ \text{O}_2(g) \rightarrow 2 \text{O}(g) \quad \Delta H^\circ = +495 \text{ kJ} \]
\[ \text{NO}(g) + \text{O}_3(g) \rightarrow \text{NO}_2(g) + \text{O}_2(g) \quad \Delta H^\circ = -199 \text{ kJ} \]

Calculate \( \Delta H^\circ \) for the reaction

\[ \text{NO}(g) + \text{O}(g) \rightarrow \text{NO}_2(g) \]

6. (6) When 1.00 mole of methane (\(\text{CH}_4\)) is burned, 890. kJ of energy is released as heat. Calculate \( \Delta H_{\text{rxn}} \) for a process in which a 5.8 g sample of methane is burned.

7. (8) Estimate the \( \Delta H^\circ_{\text{rxn}} \) for the formation of gaseous phosgene (\(\text{Cl}_2\text{C}=\text{O}\)) from \(\text{CO}(g)\) and \(\text{Cl}_2(g)\)
8. (6) Write a molecular and net ionic equation for the reaction of ammonium sulfate and barium nitrate.

9. (6) Place the atoms and/or ions in order of decreasing size and explain your rational for the order:
   Ar, Cl, K⁺, Ca²⁺, and S²⁻

10. (4) Write a balanced chemical equation to describe what occurs when hard water is heated.

11. (12) Aqua regia is an acid solution capable of dissolving gold. A dilute solution of it is made by adding 50.0 mL of 0.050 M HCl to 150.0 mL of 0.10 M HNO₃. Calculate the concentrations of all ionic species in this solution.
12. (10) For most organisms, maintaining a stable pH is crucial to survival. If this pH is changed by 1 pH unit from physiological conditions (average pH of 7.4), most biological systems will no longer function.

   a. What is the concentration of $H^+$ when the pH is 6.4? (2 points)

   b. How does this compare to the $H^+$ concentration in most physiological conditions? (3 points)

   c. Most biological systems can function if the concentration of $H^+$ remains within 150% of the average value of $H^+$ concentration. Find the upper and lower range of pH so that most biological systems can still function. (5 points)

13. (10) Trichloroacetic acid (CCl₃CO₂H) is a corrosive acid that is used to precipitate proteins. The pH of a 0.050 M solution of the trichloroacetic acid is 1.34. Calculate $K_a$.

14. (10) Calculate the pH of a 0.2 M triethylamine [($C_2H_5)_3N$, $K_b = 4.0 \times 10^{-4}$].