SHOW YOUR WORK. NO WORK, NO CREDIT
INCLUDE LABELS AND PROPER NUMBER OF SIG FIGS
Up to 75% of the credit for a problem will be given for correctly setting it up, including labels on all numbers.

CONSTANTS AND EQUATIONS YOU MAY NEED

<table>
<thead>
<tr>
<th>Particle</th>
<th>4.022 x 10²³</th>
<th>1 mL</th>
<th>1 cm³</th>
<th>1 atm</th>
<th>760 torr</th>
<th>14.7 lb</th>
<th>101.325 kPa</th>
<th>1 torr</th>
<th>1 mm Hg</th>
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<td>P₁ %P₂ %P₃ %...</td>
<td>D =</td>
<td>m / V</td>
<td>λν</td>
<td>E = hν</td>
<td>c = 2.998 x 10⁸ m/s</td>
<td>h = 6.626 x 10⁻³⁴ J/γ photon</td>
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<td>4.184 J/g ℃</td>
<td>q lost</td>
<td>q gained</td>
<td>q = m C_p ΔH</td>
<td>△H = q / mole limit reagent</td>
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IONS

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<th>Exceptions</th>
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<tr>
<td>Fluoride</td>
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<tr>
<td>Chlorides, Bromides, and Iodides</td>
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<tr>
<td>Sulfates</td>
<td>soluble</td>
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<tr>
<td>Other anions</td>
<td>insoluble</td>
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I PLEDGE ON MY HONOR THAT DURING THE EXAM I HAVE NEITHER GIVEN NOR RECEIVED ASSISTANCE NOR HAVE I SEEN ANY DISHONEST WORK.

Signed __________________________________________________________________________

If you feel you can’t sign this, contact the instructor (e-mail or in person)

Exam 1

1. (2 pts) If SeO₄²⁻ is called selenate, what is the formula for hyposelenite? ___________________________
2. (2 pts) What is the oxidation number (charge) on Mn in Ca(MnO₄)₂? _______________________________
3. (6 pts) How many micrometers are there in 10 cm? ___________________________
4. (1 pt each) Give an example for each of the following:
   - alkali metal ____________________________________________________________________________
   - diatomic gas __________________________________________________________________________
   - liquid element (at room temperature) __________________________________________________________________________
   - halogen __________________________________________________________________________
   - solid nonmetal __________________________________________________________________________
   - transition metal __________________________________________________________________________
5. (2 pts) What is the volume of solution shown in the graduated cylinder to the right?

6. (3 pts each) Name the following compounds.
   a. Na₂SO₄ ________________________________
   b. FeBr₃ ________________________________
   c. NO₂ ________________________________

7. (3 pts each) Write the formula for each of the following compounds.
   a. zinc chlorite ________________________________
   b. manganese (IV) oxide ________________________________
   c. dichlorine monoxide ________________________________

8. (7 pts) What is the mass percent of oxygen in Ca(MnO₄)₂?

9. (1 pt each) How many protons, electrons, and neutrons are there in the rhodium ion shown below?

   \[
   \begin{array}{c}
   \text{101} \\
   \text{46} \\
   \text{Rh}^{+3}
   \end{array}
   \]

10. (7 pts) How many amu’s (atomic mass units) are there in exactly 1 gram? Explain your reasoning.

11. (7 pts) Methanol, CH₃OH, has a density of 0.7915 g/mL. How many atoms of hydrogen are there in 50.000 mL of methanol?

12. Calcite reacts with hydrochloric acid according to the reaction:

   \[
   \text{CaCO}_3 (s) + \text{HCl (aq)} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2
   \]

   a. (5 pts) Balance the reaction.
   b. (1 pts each) Identify the physical states of the products (write s, l, aq, or g under each product).
   c. (8 pts) If 143.6 mL of 0.186 M HCl solution is added to an excess of CaCO₃, what is the theoretical yield of CO₂?
   d. (6 pts) If 0.0046 mole of CO₂ is actually collected from the reaction in c., what is the percent yield for the reaction?

13. Acetylene, a fuel used for welding, burns according to the reaction:

   \[
   \text{C}_2\text{H}_2 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}
   \]

   a. (5 pts) Balance the reaction.
   b. (8 pts) 260 g of C₂H₂ is mixed with 320 g of O₂ and ignited. Using your balanced reaction, predict which reactant will be the limiting reagent? Explain your reasoning.

14. (5 pts) In lab the class is running a series of reactions that use several potentially hazardous chemicals. Groups are working on the lab benches and are scattered throughout the lab (typical situation for our lab). Your group has finished the experiment earlier than those groups around you. Is it OK for your group to remove your safety goggles to work on calculations at your lab desk while the others finish the lab? Explain your reasoning.
1. (2 pts each) Name the following compounds.
   a. HNO₂ ________________________________
   b. SnSO₄ ________________________________
   c. KOH ________________________________

2. (2 pts each) Write the formula for each of the following compounds.
   a. hydroiodic acid ________________________________
   b. phosphorus (III) oxide ________________________________
   c. barium chloride dihydrate ________________________________

3. (5 pts) Circle the one that are insoluble in water:
   CaF₂        H₂SO₄        NaOH        FeCO₃        none

4. (5 pts) Circle the compounds and ions that will be weak acids in water:
   NH₃        Na₂CO₃        C₂H₃O₂⁻¹        Ba(OH)₂        none

5. (5 pts) Circle the compounds and ions that will be strong bases in water:
   NH₃        Na₂CO₃        C₂H₃O₂⁻¹        Ba(OH)₂        none

6. All of the reactions below take place in aqueous solution. Some reactions may fit more than one category, and some may not fit any category. Which of the reactions:
   a. (2 pts) redox reactions? ____________________
   b. (2 pts) acid-base reactions? ____________________
   c. (2 pts) precipitation reactions? ____________________
   a) H₂CO₃ ! CO₂ + H₂O   c) H₂SO₃ + Ba(OH)₂ ! BaSO₃ + H₂O
   b) H₃PO₄ + 3 KOH ! K₃PO₄ + H₂O   d) CH₄ + O₂ ! CO₂ + H₂O

7. (6 pts) Write and balance the net ionic reaction which occurs in water.
   Pb(ClO₂)₂ + HNO₃ ! Pb(NO₃)₂ + HClO₂

8. (5 pts) Balance the following oxidation-reduction reaction that takes place in acid solution.
   IO₄⁻¹ (aq) + H₂O₂ (aq) ! O₂ (g) + I⁻¹ (aq)

9. KLQL, Laverne, MN, broadcasts at a frequency of 101.1 MHz.
   a. (5 pts) What is the wavelength of this carrier wave?
   b. (5 pts) How much energy will 1.000 mole of these photons have?

10. (5 pts) Is it possible for an atom to have an electron configuration of [Ar] 4s² 3d⁷ 4p²? Explain your reasoning.

11. (6 pts) What is the electron configuration of 78Pt? (You may start with an inert gas core if you wish).

12. (2 pts each) Predict the products of the following reactions. You do NOT have to balance the reactions.
   a. Na   +   O₂ !
   b. HCl   +   NaOH !

13. (3 pts) Which is the largest: Cl⁻¹, Cl⁰, or Cl⁺¹? Explain your reasoning.

14. (3 pts) Which has a larger ionization energy: 32Ge or 82Pb?

15. In lab you ran the following reaction:
   Cu(NO₃)₂ + NaOH ! Cu(OH)₂ + NaNO₃
   a. (2 pts) Under each compound write the physical state (s, l, g, aq).
   b. (2 pts) Under each compound also write the color of each compound.
c. (5 pts) If 2.849 g of Cu(NO₃)₂ is dissolved in enough water to make 50.00 mL of solution, what is the molarity of that solution?

d. (5 pts) How many grams of NaOH are required to precipitate all the Cu²⁺ in the Cu(NO₃)₂ solution of part c. as Cu(OH)₂?

16. The expected electron configuration for Cr is [Ar] 4s² 3d⁴.
   a. (3 pts) Is +4 expected to be a stable charge for Cr? Explain your reasoning.
   b. (3 pts) Is the Cr atom (zero charge) diamagnetic or paramagnetic? Explain your reasoning.

17. (5 pts) During a particular lab you are heating a solution with a bunsen burner. Someone working across the desk from you pushes their book bag out of their road. In a few moments you notice that it has gotten too close to your burner and is burning brightly. If you are in our lab (GSC 243), where would you find a fire extinguisher?

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**Exam 3**

1. (3 pts each) Name the following compounds.
   a. HClO ________________________________
   b. HgI₂ ________________________________
   c. (NH₄)₃PO₄ ________________________________

2. (3 pts each) Write the formula for each of the following compounds.
   a. Hydrosulfuric acid ________________________________
   b. dinitrogen pentoxide ________________________________
   c. chromium (VI) sulfate ________________________________

3. (1 pt each) Label the compounds below as ionic, polar covalent, or purely covalent.
   Br-Br ________________________ Ba-O ________________________ N-O ________________________

4. (7 pts each) Draw Lewis structures including and resonance structures for the following.
   a. SeO₃
   b. IF₄⁺

5. (7 pts) In the ozone layer, the partial pressure of O₃ is 1.2 x 10⁻⁶ torr. If the density of O₃ in the ozone layer is 4.105 x 10⁻⁹ g/L, what is the temperature of the ozone layer?

6. (6 pts) Following the simple rules for Lewis structures we have used in class, we would predict the Lewis structure for sulfate to be that shown in Fig. A. If we include the concept of formal charges in our considerations, we would predict the structure shown in Fig. B. What effect does consideration of formal charges have on the shape we would predict for sulfate? Explain your reasoning.

   ![Lewis Structure A](image1)
   ![Lewis Structure B](image2)

7. (8 pts) Fill in the blanks for each structure

   ![Structure 1](image3)
   ![Structure 2](image4)

   Shape ________________________
   Polar (yes/no)? ________________________
   Shape ________________________
   Polar (yes/no)? ________________________
8. (7 pts) What is the specific heat of titanium if it takes 89.7 J to raise the temperature of a 33.0 g block of Ti 5.20 degrees?

9. A reaction often used to illustrate an endothermic reaction is:

$$\text{Ba(OH)}_2 (aq) + \text{NH}_4\text{Cl} (aq) \rightarrow \text{BaCl}_2 (aq) \ + \ \text{NH}_3 (aq) \ + \ \text{H}_2\text{O} (l)$$

a. (5 pts) Balance the reaction.

b. (7 pts) If 9.15 kJ are absorbed from the surroundings when 0.50 mole barium hydroxide is mixed with 0.50 mole ammonium chloride, what is the $\Delta H$ for the reaction?

10. On a nice, sunny day when the air pressure was 700.0 torr and the temperature was 27°C, an industrious student decided to do an experiment using a bicycle tire pump. She first raised the plunger on a pump to its highest position and then screwed a pressure gauge into the end of the hose forming a closed system (no air leaks). She adjusted the gauge so it read atmospheric pressure (700.0 torr).

a. (7 pts) She then pushed the plunger half way in and allowed the pump temperature to return to 27°C. What pressure did she read on the pressure gauge? (Remember, there are no air leaks).

b. (7 pts) Just after she read that pressure, the phone rang. She dropped the pump and ran to the phone. When she dropped the pump, the plunger returned to its fully raised position. During the next 30 minutes while she was visiting with a friend, the pump sat in the hot sun. When she returned, the temperature of the pump was 54°C. What pressure did the gauge read when she returned?

11. (6 pts) It is often said that real gases behave most like ideal gases at low pressures and high temperatures. Using the two characteristics of an ideal gas discussed in class, explain why this statement is true.

12. (5 pts) The class has just finished the burner lab. Just outside GSC, you realize that you left your lab manual in the lab. When you get back to the lab to pick it up, you see that everyone is gone and you detect an odor of natural gas in the lab. What should you do?

**Exam 4**

1. (6 pts) In pure compounds there are three kinds of molecular interactions that make the molecules sticky: ion-ion, dipole-dipole, and induced dipole-induced dipole. Which of the three interactions is the most important for ClI? Explain your reasoning.

2. (3 pts each) Name the following compounds:

   a. $\text{NH}_4\text{C}_2\text{H}_3\text{O}_2$
   b. $\text{H}_2\text{CO}_3$
   c. $\text{Hg}_2\text{SO}_3$

3. (3 pts each) Write the formula for the following compounds:

   a. bromic acid
   b. lead (IV) chromate
   c. zinc sulfide
4. Chloroform (CHCl₃) and carbon tetrachloride (CCl₄) are liquids at room temperature.
   a. (6 pts) Which liquid is expected to have the lower surface tension? Explain your reasoning.
   b. (6 pts) Which liquid is expected to be the better solvent for CH₃OH? Explain your reasoning.

5. (3 pts) Which of the following compounds are expected to exhibit hydrogen bonding: H₂O, NH₃, H₂S? Explain your reasoning.

6. (3 pts) Two new, environmentally friendly compounds have been developed recently, sodium meltrate (NaMl) and sodium nofreezate (Na₂Nf). If the cost to produce one mole is the same for both compounds, which would be the more economical choice for melting ice on sidewalks and streets? Explain your reasoning.

7. (6 pts) A manufacturing plant produces wastewater at 83.7 °C containing 180 g/L glucose (C₆H₁₂O₆). What is the minimum pressure that a reverse osmosis system will have to apply to clean up this effluent stream?

8. (7 pts) Write the equilibrium constant expression (Kₑq) for:

   \[ 2 \text{H}_2\text{PO}_4^{-1} (aq) + 3 \text{Ba}^{+2} (aq) + 4 \text{OH}^{-1} (aq) \rightleftharpoons \text{Ba}_3(\text{PO}_4)_2 (s) + 4 \text{H}_2\text{O} (l) \]

9. (3 pts) Which of the following will be strong bases in water?
   - HCl
   - NH₃
   - H₂
   - SO₃
   - Na₂O
   - CH₃OH
   - none

10. (3 pts each) If each of the following were dissolved in water, would the resulting solution be acidic, basic, or neutral? Write detailed, net ionic reactions to justify your prediction.
   a. KClO₂
   b. SO₂

11. (7 pts) Calculate the pH of 4.65 x 10⁻³ M Sr(OH)₂.

12. When hydrofluoric acid is dissolved in water, it sets up the following equilibrium:

   \[ \text{HF (aq)} + \text{H}_2\text{O (l)} \rightleftharpoons \text{F}^{-1} (aq) + \text{H}_3\text{O}^{+1} (aq) \]

   a. (6 pts) If NaF (s) is added to this equilibrium mixture, will the equilibrium adjust by forming more reactants, forming more products, or not be affected by the addition? Explain your reasoning.
   b. (6 pts) If Ca(NO₃)₂ (s) is added to the original mixture, will the equilibrium adjust by forming more reactants, forming more products, or not be affected by the addition? Explain your reasoning.

13. (4 pts) If 1 mole of HCl and 0.75 mole of NaCl were dissolved in 100 mL of water, would the resulting solution be a buffer? Explain your reasoning.

14. (7 pts) The pH of 0.040 M hypobromous acid is 5.05. What is the Kₐ for this acid?

15. While in lab, your lab partner accidentally slops 10 mL of 1 M HCl onto your bare arm.
   a. (3 pts) What action should you take?
   b. (3 pts) What action should your lab partner take?