REFERENCE SHEET FOR CHEM 1 MIDTERM EXAMINATION
(Not all data on this sheet will be necessary for any given exam)

THIS EXAM HAS 9 PAGES (INCLUDING THE COVER)
MAKE SURE YOU HAVE THEM ALL

PHYSICAL CONSTANTS

\[ c = 2.998 \times 10^8 \text{ m/s} \] (speed of light)

\[ e = 1.602 \times 10^{-19} \text{ C} \] (charge of one electron)

\[ R = 8.3145 \text{ J/(mol K)} = 0.08206 \text{ L atm/(mol K)} \]

For \( T = 298 \text{K} \):

\[ 2.303RT/F = 0.0592 \text{ V} \]

\[ \ln(2) = 0.693 \]

\[ 1 \text{ atomic mass unit} = 1.66 \times 10^{-24} \text{ kg} \]

YOU MAY TEAR THIS SHEET OFF AND USE IT FOR REFERENCE

PUT YOUR NAME ON THE THIRD PAGE, AND ALL FOLLOWING PAGES
1. (10 points) Indicate whether each of the following statements is true or false:

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2. (15 points) Answer all of the following.

   A. (4 points) Identify each of the following as a strong electrolyte, a weak electrolyte or a nonelectrolyte.
      - ethanol
      - hydrochloric acid
      - sodium hydroxide
      - silver nitrate

   B. (4 points) Write the chemical formula of the following ions:
      - Ammonium ion: \( \text{NH}_4^+ \)
      - Iodide ion: \( \text{I}^- \)
      - Sulfate ion: \( \text{SO}_4^{2-} \)
      - Hydrogen carbonate ion: \( \text{HCO}_3^- \)

   C. (4 points) Identify each of the following as an element, a compound, a homogeneous mixture or a heterogeneous mixture (no credit for “mixture” as whole answer):
      - Iodine crystals:
      - An iron bar:
      - Salsa:
      - Pure sodium chloride:

   D. (3 points) Give the number of protons, neutrons and electrons in a \( ^{37}_{17} \text{Cl}^- \) ion.
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<th>Protons:</th>
<th>Neutrons:</th>
<th>Electrons:</th>
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3. (8 points) Answer each of the following:
   A. (4 points) Name the following compounds:
      FeCl$_3$: SiBr$_4$: 
      HClO$_2$: KHCO$_3$: 
   B. (4 points) Write chemical formulas for the following compounds:
      Dinitrogen tetroxide: 
      Hydroiodic acid: 
      Lithium hydroxide: 
      Ammonium sulfate: 
4. (2 points) What did Rutherford’s gold foil experiment prove about the 
   structure of the atom? Answer in no more than 2 sentences.
5. (8 points) Balance the following equations. Do not leave spaces blank. Write “1” to 
   indicate a single unit of a species.
   A. __Mg(s) + __Cl$_2$(g) ? __MgCl$_2$(s) 
   B. __C$_4$H$_8$(g) + __O$_2$(g) ? __H$_2$O(g) + __CO$_2$(g) 
   C. __K(s) + __N$_2$(g) ? __K$_3$N(s) 
   D. __C$_7$H$_8$O$_2$ + __O$_2$ ? __CO$_2$ + __H$_2$O
6. (4 points) Write net ionic equations for the following reactions:
   A. \( \text{Hg}_2(\text{C}_2\text{H}_3\text{O}_2)_2(\text{aq}) + 2 \text{KCl(aq)} \to \text{Hg}_2\text{Cl}_2(s) + 2 \text{K}_2\text{C}_2\text{H}_3\text{O}_2(\text{aq}) \)

   B. \( \text{Fe(s)} + 3 \text{CuNO}_3(\text{aq}) \to 3 \text{Cu(s)} + \text{Fe(NO}_3)_3(\text{aq}) \)

7. (4 points) Write the products of the following reactions. If no reaction takes place, indicate “N.R.” You must write all the products, but you do not need to balance the reaction.
   A. \( \text{AgNO}_3(\text{aq}) + \text{NaCl(aq)} \to \)
   B. \( \text{Cu(s)} + \text{AgNO}_3(\text{aq}) \to \)
   C. \( \text{Au(s)} + \text{Zn(NO}_3)_2(\text{aq}) \to \)
   D. \( \text{CH}_4(\text{g}) + \text{O}_2(\text{g}) \to \)

8. (6 points) How many nitrogen atoms are there in 30.0g of \( \text{N}_2\text{O}_4 \). Give your answer in individual atoms, not moles.
9. (6 points) The density of metallic lead is 11.35 g/cm³. Calculate the volume of metallic lead required to react with 50.0 mol of chlorine gas according to the equation:

\[ \text{Pb(s)} + \text{Cl}_2(g) \rightarrow \text{PbCl}_2(s) \]

10. (6 points) What mass of NaCl is needed to precipitate all the silver ions from 7.5L of 0.0150M AgNO₃ solution?
NAME_____________________

11. (4 points) A compound is 74.4% gallium and 25.6% oxygen by weight. What is its empirical formula?

12. (4 points) 1.07g of solid Ca(NO\textsubscript{3})\textsubscript{2} are dissolved in enough water to make 452.1mL.
   A. (3 points) Calculate the molar concentration of Ca(NO\textsubscript{3})\textsubscript{2} in solution.

   B. (1 point) Calculate the molar concentration of the nitrate ion, NO\textsubscript{3}\textsuperscript{-} in solution.

13. (4 points) A molecule has an empirical formula C\textsubscript{5}H\textsubscript{4}. Its molecular weight is 128.16 atomic mass units. Give the molecular formula.
14. (6 points) Consider the reaction:

\[ 4 \text{NH}_3(g) + 5 \text{O}_2(g) \rightarrow 4 \text{NO}(g) + 6 \text{H}_2\text{O}(g) \]

If 7.5x10^2 g of NH\(_3\) are mixed with 7.5x10^2 g of O\(_2\), identify the limiting reagent and calculate the number of grams of NO produced and calculate the number of grams of excess reagent remaining.
15. (7 points) A solid powder is known to be a mixture of NaCl and Na$_2$CO$_3$, but the relative amounts of each compound in the sample are unknown. Sodium carbonate reacts with hydrochloric acid according to the equation:

$$\text{Na}_2\text{CO}_3(aq) + 2\text{HCl}(aq) \rightarrow 2\text{NaCl}(aq) + \text{H}_2\text{O}(l) + \text{CO}_2(g)$$

A solution of the mixture is prepared by adding 10.0g of the mixture to enough water to make 1.0L of solution. It is observed that the above reaction goes to completion (i.e. the solution is neutralized) after the addition of 83.15mL of 0.1174M hydrochloric acid to the 1.0L sample of the solution.

A. (4 points) What is the concentration of sodium carbonate in the solution before the addition of HCl?

B. (3 points) What is the mass of NaCl in the initial 10.0g sample?
16. (6 points) Hydrogen cyanide, HCN, is a poisonous gas. The lethal dose is approximately 3.0x10^2 mg of HCN per kilogram of air. The density of air at room temperature is approximately 0.00118 g/cm^3.

If HCN gas is formed by the reaction

\[2 \text{NaCN(s)} + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + 2 \text{HCN(g)}\]

what mass of NaCN is required to produce a lethal dose of HCN in a sealed room that measures 4.0m x 3.0m x 2.0m. Neglect the volume of any objects in the room.

EXTRA CREDIT:

(1 point): Give the name of the cavity formed in a rock by the formation and subsequent dissolution of a crystal of a soluble material (Hint: Their presence was cited by NASA as evidence of water on Mars):

(1 point): Give the approximate distance from the North Pole to the equator in meters: