Welcome to AP Chemistry! You will quickly notice that things will be different than they were in Honors/Regular Chemistry. For one, there will be a lot more memorize. This assignment will help us with some of the memorization, math skills, and basic topics that you will need so that we can hit the ground running when the school year begins.

As you progress through this assignment use the following sources for help:

- [https://www.khanacademy.org/science/chemistry](https://www.khanacademy.org/science/chemistry)
- [http://www.chemteam.info/](http://www.chemteam.info/)
- [http://www.chemguide.com](http://www.chemguide.com)
- [https://www.youtube.com/user/tdewitt451](https://www.youtube.com/user/tdewitt451)

Important Dates

- **Due Date:** The packet pages 4-19 are due on the first day of school. It is graded.
- **For the first day of school, you will have a quiz.** Here are the topics:
  - Nomenclature - Elements, polyatomic Ions, and compounds (pages 2-3 and 12-13)
  - Quantitative Skills - scientific notation, significant figures*, metric conversions, dimensional analysis* (pages 4-7)
  - Atomic Structure - Proton/neutron/electron counts of isotopes, full electron configurations, and Lewis structure diagrams (pages 14-15)
- For the remaining topics covered here, you will quiz on each before the start of each unit. These will encompass a set of “starter skills” that are fundamental to your success in AP. Whether you learned these in Honors/Regular or not, you will need to develop these skills and be comfortable enough with them to do them in a limited time frame. The relevant content is:
  - Chemical Reactions and Stoichiometry - Classification of reaction types, balancing equations, Mole conversions from mass, gas at STP, solutions; empirical formula*, full stoichiometry problems (all 3 states), mass percent of compounds* (pages 8-11)
  - Kinetics/Thermochemistry Basics - Collision Theory, Rate Graphs, Reaction Profiles*, Exo/Endothermic Reactions, Maxwell-Boltzmann Distributions* (pages 16-19)

(*) = not covered in Regular Chemistry, * = not covered in Honors Chemistry)
Task 1: Complete Attached Packet

Task 2: Memorize the names of the elements and their corresponding symbols
- You need to know elements 1-56, plus Pt, Au, Hg, Pb, Rn, Fr, Ra, U, Pu
- Many of these elements you will already know
- Making flashcards is helpful!
- It’s important to know these elements because the periodic table you are provided has only the symbols and not the names of the elements.
- You do not need the data of these elements (atomic number, relative atomic mass, etc) but you should be familiar with oxidation states (charges) of these including transition metals.

Task 3: Memorize the ionic charges of the basic ions
- Think about the valence electrons!
- Think about the common elements/ions in that group
  o Group 1 ions = +1
  o Group 2 ions = +2
  o Group 15 (5A) ions (N and P) = -3
  o Group 16 (6A) ions (O and S) = -2
  o Group 17 (7A)/ halogens = -1
  o Zn = +2
  o Ag = +1
  o Cu = +1 or +2
  o Fe = +2 or +3
  o Pb = +2 or +4
  o Sn = +2 or +4

Task 4: Memorize the names, symbols, and charges of Polyatomic ions below:
- Oxyanions - polyatomics containing oxygen, names end in -ate or -ite
- -ate is used for the most common form
- -ite is used for the form with the same charge, but one less oxygen
  o Example:
    - NO$^-$ = nitrate
    - NO$_2^-$ = nitrite
  o Prefixes are also used
    o Per- indicates one more oxygen than the -ate form
    o Hypo- indicates one fewer oxygen than the -ite form
    o Example:
      - ClO$_4^-$ = perchlorate (b/c it has one more O than the -ate form)
      - ClO$_3^-$ = chlorate (b/c it is the most common)
      - ClO$_2^-$ = chlorite (b/c it has one less oxygen than - ate form)
      - ClO$^-$ = hypochlorite (b/c it has one less oxygen than -ite form)
    - F, Cl, Br, I all behave the same
      - Therefore, if chlorate is ClO$_3^-$, the bromate ion is...
      - BrO$_3^-$ !!!!
      - Simply substitute one halogen for the other
      - If you learn the chlorate series, you also automatically know the bromate, iodate, and fluorate series
    - Hydrogen can be added to -2 or -3 ions to make a “new ion”
      - HPO$_4^{2-}$ is hydrogen phosphate, H$_2$PO$_4^{-}$ is dihydrogen phosphate (note the - charge went up 1 for each H$^+$ added)
      - HCO$_3^-$ is hydrogen carbonate (bicarbonate)
      - HSO$_4^{1-}$ is hydrogen sulfate
<table>
<thead>
<tr>
<th>Charge</th>
<th>Polyatomic Ion</th>
</tr>
</thead>
<tbody>
<tr>
<td>+1</td>
<td>ammonium, NH$_4^+$</td>
</tr>
<tr>
<td>-1</td>
<td>acetate, C$_2$H$_3$O$_2^-$ or CH$_3$COO$^-$</td>
</tr>
<tr>
<td></td>
<td>bromate, BrO$_3^-$</td>
</tr>
<tr>
<td></td>
<td>perchlorate, ClO$_4^-$</td>
</tr>
<tr>
<td></td>
<td>chlorate, ClO$_3^-$</td>
</tr>
<tr>
<td></td>
<td>chlorite, ClO$_2^-$</td>
</tr>
<tr>
<td></td>
<td>hypochlorite, ClO$^-$</td>
</tr>
<tr>
<td></td>
<td>cyanide, CN$^-$</td>
</tr>
<tr>
<td></td>
<td>hydrogen carbonate/bicarbonate, HCO$_3^-$</td>
</tr>
<tr>
<td></td>
<td>hydroxide, OH$^-$</td>
</tr>
<tr>
<td></td>
<td>iodate, IO$_3^-$</td>
</tr>
<tr>
<td></td>
<td>nitrate, NO$_3^-$</td>
</tr>
<tr>
<td></td>
<td>nitrite, NO$_2^-$</td>
</tr>
<tr>
<td></td>
<td>permanganate, MnO$_4^-$</td>
</tr>
<tr>
<td></td>
<td>thiocyanate, SCN$^-$</td>
</tr>
<tr>
<td>-2</td>
<td>carbonate, CO$_3^{2-}$</td>
</tr>
<tr>
<td></td>
<td>chromate, CrO$_4^{2-}$</td>
</tr>
<tr>
<td></td>
<td>dichromate, Cr$_2$O$_7^{2-}$</td>
</tr>
<tr>
<td></td>
<td>oxalate, C$_2$O$_4^{2-}$</td>
</tr>
<tr>
<td></td>
<td>peroxide, O$_2^{2-}$</td>
</tr>
<tr>
<td></td>
<td>sulfate, SO$_4^{2-}$</td>
</tr>
<tr>
<td></td>
<td>sulfite, SO$_3^{2-}$</td>
</tr>
<tr>
<td>-3</td>
<td>phosphate, PO$_4^{3-}$</td>
</tr>
<tr>
<td></td>
<td>phosphite, PO$_3^{3-}$</td>
</tr>
<tr>
<td></td>
<td>arsenate, AsO$_4^{3-}$</td>
</tr>
</tbody>
</table>

**Be able to name polyatomic ions using the rules above such as these below:**

<table>
<thead>
<tr>
<th>HPO$_4^{2-}$</th>
<th>HSO$_3^{-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>FO$_3^{-1}$</td>
<td>HCO$_3^{-1}$</td>
</tr>
</tbody>
</table>

**Be able to write formulae for polyatomic ions using the rules above such as these below:**

<table>
<thead>
<tr>
<th>Bromite</th>
<th>periodate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dihydrogen phosphite</td>
<td>hydrogen chromate</td>
</tr>
</tbody>
</table>
Quantitative Skills

Significant Figures (Sig Figs)*

1. How many sig figs are in the following numbers?
   
   a. 790 __________
   
   b. 0.0450 __________
   
   c. 32.10 __________
   
   d. 1001 __________
   
   e. 0.0006 __________
   
   f. 300. __________

2. Solve the following problems. Round your answer to the correct number of sig figs (and use the correct unit on your answer).

   a) 825 cm x 32 cm x 0.248 cm ______________

   b) $15.68 \text{ g}$
      $2.885 \text{ mL}$ ______________

   c) $1.20 \text{ g} + 13.0 \text{ g} + 10.0 \text{ g}$ ______________

   d) $(1.01 \text{ g} + 1.01 \text{ g} + 16.00 \text{ g})$
      $1.0 \text{ mL}$ ______________

Density* (round your answers to correct number of sig figs and show all work with units)

3. A cube of ruthenium metal 1.5 cm on a side has a mass of $42.0 \text{ g}$. What is the density in $\text{g/cm}^3$? Will ruthenium metal float on water?
4. The density of bismuth metal is 9.8 g/cm$^3$. What is the mass of a sample of bismuth that displaces 65.8 mL of water?
**Metric Conversions** (round answers correctly and show work with units). You are responsible for the following prefixes: nano- \((10^{-9}, \text{n}-)\), micro- \((10^{-6}, \mu-)\), milli- \((10^{-3}, \text{m}-)\), kilo- \((10^{3}, \text{k}-)\), Mega- \((10^{6}, \text{M}-)\). Use scientific notation for any answers \(\geq1000\) or \(\leq0.01\).

5. Make the following conversions:

   a) 16.2 m to km

   b) 12 ks to ms

   c) 5.44 nL to mL

   d) 2.0 L to mL

   e) 43.8 kg to g

   f) 20.1 \(\mu\)m to km

**Dimensional Analysis**

Dimensional analysis is a problem-solving strategy that allows you to treat units as if they were variables, and cancel them out by using known “conversion factors.” Consider the following:

6. Make the following conversions:

   a) Convert 45.7 mL/s to kL/hr

   Solution:

   

   \[
   \frac{45.7 \text{ mL}}{1 \text{ s}} \cdot \frac{1 \text{ L}}{1000 \text{ mL}} \cdot \frac{1 \text{ kL}}{1000 \text{ L}} \cdot \frac{60 \text{ s}}{1 \text{ minute}} \cdot \frac{60 \text{ minutes}}{1 \text{ hour}} = \text{kL/hr}
   \]

   The units cancel out via division:

   \[
   \frac{45.7 \text{ mL}}{1 \text{ s}} \cdot \frac{1 \text{ L}}{1000 \text{ mL}} \cdot \frac{1 \text{ kL}}{1000 \text{ L}} \cdot \frac{60 \text{ s}}{1 \text{ minute}} \cdot \frac{60 \text{ minutes}}{1 \text{ hour}} = \text{kL/hr}
   \]

   Giving you the answer, with correct units:

   \[
   \frac{45.7}{1} \cdot \frac{1 \text{ kL}}{1000} \cdot \frac{60}{1 \text{ hour}} = 0.169 \text{ kL/hr}
   \]

   If you need additional support in the form of video tutorials, check out the following:

   https://www.youtube.com/watch?v=7N0IRJLwpPI

   https://www.youtube.com/watch?v=LdZ00OFAfaQ

   https://www.youtube.com/watch?v=BKsPi-VXp5U
b) Convert 1.000 yr to seconds

c) Convert 5 km to miles (1 km = 0.621 mi)

d) Convert 80.0 km/hr to mm/s

e) Convert 300. Atoms/s to moles/yr ($N_A = 6.022 \times 10^{23}$ atoms/mole)
Moles, Reactions, and Stoichiometry

Percent Composition*

8. Calculate the percent composition of \( \text{C}_{12}\text{H}_{22}\text{O}_{11} \) (sugar). (Give Percent of each element.) Show all work.

Mole Conversions

9. Calculate the number of moles of the following: (SHOW WORK)
   a) 42.8 g of \( \text{KNO}_3 \)
   
   b) 4.1 g \( \text{NH}_4\text{OH} \)
   
   c) 155.7 L of \( \text{CO}_2 \) at STP
   
   d) 89.1 L of \( \text{Ne} \) at STP
   
   e) 0.018 L of a 3.0 \( \text{M} \) (\( \text{M} = \text{mol/L} \) or \( \text{mol/dm}^3 \)) solution of \( \text{HCl} \)
   
   f) 25 L of a 0.08 \( \text{M} \) solution of \( \text{NaOH} \)
   
   g) \( 1.21 \times 10^{25} \) molecules of \( \text{CH}_4 \)
   
   h) \( 9.25 \times 10^{26} \) formula units of \( \text{CaCl}_2 \)
Empirical Formula

10. A compound contains, by mass, 40% C, 6.7% H, 53.3% O. Determine the empirical formula of the compound.

11. A compound contains, by mass, 42.9% C, 2.4% H, 16.7% N, and 38.1% O. Determine the empirical formula of the compound.

12. The mass of a sample of hydrated copper (II) chloride is 0.996 g before being heated, and 0.790 g after all water is driven off by heat. Determine the empirical formula of the hydrate.
   a. Determine the mass of water in the hydrate sample.
   b. Determine the number of moles of CuCl$_2$ and H$_2$O.
   c. Compare the number of moles to estimate the mole ratio and determine the empirical formula.
Chemical Reactions - Balancing and Identification

13. Balance the following and equations and tell what type of reaction it is (synthesis, decomposition, single replacement, double replacement, or combustion)

a. _____ KNO₃ → _____KNO₂ + _____O₂  
Type: __________

b. _____AgNO₃ + ____K₂SO₄ → _____Ag₂SO₄ + _____KNO₃  
Type: __________

c. _____CH₃NH₂ + ___O₂ → _____CO₂ + ___H₂O + ___N₂  
Type: __________

d. _____N₂O₅ + _____H₂O → _____HNO₃  
Type: __________

e. _____Na + ___Zn(NO₃)₂ → _____Zn + _____NaNO₃  
Type: __________

14. What are diatomic molecules? List the 7 diatomic elements.
Stoichiometry

15. Using the following equation:

\[ 2 \text{NaOH} + \text{H}_2\text{SO}_4 \rightarrow 2 \text{H}_2\text{O} + \text{Na}_2\text{SO}_4 \]

How many grams of sodium sulfate will be formed if you start with 200 grams of sodium hydroxide and you have an excess of sulfuric acid?

16. Using the following equation:

\[ \text{Pb(SO}_4)_2 + 4 \text{LiNO}_3 \rightarrow \text{Pb(NO}_3)_4 + 2 \text{Li}_2\text{SO}_4 \]

How many grams of lithium nitrate will be needed to make 250 grams of lithium sulfate, assuming that you have an adequate amount of lead (IV) sulfate to do the reaction?

17. Using the following equation:

\[ \text{Fe}_2\text{O}_3 + 3 \text{H}_2 \rightarrow 2 \text{Fe} + 3 \text{H}_2\text{O} \]

Calculate the volume of \( \text{H}_2 \) gas at STP needed to fully react with 16.5 grams of \( \text{Fe}_2\text{O}_3 \).

18. Using the following equation:

\[ \text{HCl} + \text{NaOH} \rightarrow \text{H}_2\text{O} + \text{NaCl} \]

Determine the volume of 0.100 M \( \text{NaOH} \) needed to neutralize 100 mL 0.300 M \( \text{HCl} \).
Practice Naming Compounds

1. Provide names for the following ionic compounds:
   a. AlF₃
   b. Fe(OH)₂
   c. Cu(NO₃)₂
   d. Ba(ClO₄)₂
   e. Li₃PO₄
   f. Hg₂S
   g. Cr₂(CO₃)₃
   h. (NH₄)₂SO₄

2. Write the chemical formulas for the following compounds:
   a. Copper(I) oxide
   b. Potassium peroxide
   c. Iron(III) carbonate
   d. Zinc nitrate
   e. Sodium hypobromite
   f. Aluminum hydroxide

3. Give the name or chemical formula for each of the following molecular substances:
   a. SF₆
   b. XeO₃
   c. Dinitrogen tetroxide
   d. Hydrogen cyanide
   e. IF₅
   f. Dihydrogen monoxide
   g. Tetraphosphorous hexasulfide

4. Give the name or chemical formula for the following compounds:
   a. Ammonium oxalate
   b. Manganese(III) dichromate
   c. Ti(OH)₄
   d. Ni(ClO₂)₃
   e. Dinitrogen pentoxide
   f. Aluminum oxide
   g. Fe₂S₃
5. Name the following acids
   a. $\text{H}_2\text{C}_2\text{O}_4$
   b. $\text{HBrO}_3$
   c. $\text{HBr}$
   d. $\text{HNO}_2$
   e. $\text{H}_2\text{SO}_4$
   f. $\text{HClO}$

6. Write formulas for the following acids.
   a. hydrochloric acid
   b. sulfuric acid
   c. nitric acid
   d. phosphoric acid
   e. carbonic acid
   f. acetic acid
Atomic Structure

1. Where is most of the mass of an atom located? What subatomic particles are located here?

2. Draw the p-orbitals p_x, p_y, p_z on the x-y-z axes below.

   ![p-orbitals diagram]

3. Give the full electron configurations of the following elements:
   a. N
   b. Na
   c. Ca
   d. V
   e. Cu
   f. Sr
   g. Xe

Average Atomic Mass, Isotopes

4. Magnesium consists of 3 naturally occurring isotopes with the masses 23.98504, 24.98584, and 25.98259 amu. The relative abundances of these three isotopes are 78.70%, 10.13 %, and 11.17% respectively. Calculate the average atomic mass.

   Determine the amounts of protons, neutrons, and electrons for the 3 isotopes.
5. Titanium consists of 5 naturally occurring isotopes with the masses 47.947942, 45.952628, 46.951759, 48.947866, and 49.944787 amu, with relative abundances 73.72%, 8.25%, 7.44%, 5.41%, and 5.18% respectively. Calculate the average atomic mass.

Determine the amounts of protons, neutrons, and electrons for the 5 isotopes.
1. List the 5 factors that affect the rate of a chemical reaction. Indicate how rate is affected (i.e. as one factor increases, rate increases/decreases)
   a. 
   b. 
   c. 
   d. 
   e. 

2. Explain **two reasons** using collision theory why the rate of a chemical reaction is increased by raising the temperature. Justify your answer in terms of collision frequency and kinetic energy.
   a. 

   b. 

3. Use the graph below to show the data for two reactions between zinc and hydrochloric acid, where the volume of gas formed is being monitored over time. In one trial, zinc ribbon is being used. In a second trial, zinc powder is being used. Label the data sets and axes with appropriate units.
1. Distinguish the difference between heat and temperature.

2. How is Celsius different from Kelvin? How do you convert between the two systems?

   a. If a system loses energy, where does the energy go?
   b. If a system gains energy, where does the energy come from?
   c. When we are studying the thermochemistry of a reaction, where are we measuring?

4. Draw the reaction coordinate (reaction profile) diagram for an endothermic process. Indicate products, reactants, activation energy, and $\Delta H$. Indicate how the heat is being transferred between system and surroundings. Does the observed temperature decrease or increase?
5. Draw the reaction coordinate (reaction profile) diagram for an exothermic process. Indicate products, reactants, activation energy, and ΔH. Indicate how the heat is being transferred between system and surroundings. Does the observed temperature decrease or increase?

6. Draw a Maxwell-Boltzmann Distribution on the graph below, and label axes. Indicate the activation energy. Draw a second curve for the reaction run at a higher temperature. Indicate a second activation energy point for the reaction run with a catalyst.
Determining ∆H from Bond Enthalpies

7. Calculate ∆H (in kJ/mol) for the combustion of ethane using the table of bond enthalpies.

\[ 2 \text{H}_2\text{C=CH}_2 + 7 \text{O}_2 \rightarrow 4 \text{CO}_2 + 6 \text{H}_2\text{O} \]

<table>
<thead>
<tr>
<th>Bond</th>
<th>Bond Enthalpy (kJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-H</td>
<td>413</td>
</tr>
<tr>
<td>C-C</td>
<td>347</td>
</tr>
<tr>
<td>C=O</td>
<td>498</td>
</tr>
<tr>
<td>O=O</td>
<td>805</td>
</tr>
<tr>
<td>O-H</td>
<td>464</td>
</tr>
</tbody>
</table>

8. Calculate ∆H (in kJ/mol) for the reaction between chlorine and propane.

\[ \text{H}_3\text{C=CH}_2 + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_4 + \text{Cl}_2 \]

<table>
<thead>
<tr>
<th>Bond</th>
<th>Bond Enthalpy (kJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-H</td>
<td>413</td>
</tr>
<tr>
<td>Cl-Cl</td>
<td>243</td>
</tr>
<tr>
<td>C-Cl</td>
<td>346</td>
</tr>
<tr>
<td>H-Cl</td>
<td>432</td>
</tr>
</tbody>
</table>