Welcome to AP Chemistry! In order to effectively cover all the material in this course, we will have to move quickly through the topics that you are already familiar with from Honors Chemistry. Therefore, you are expected to review the topics listed below on your own over the summer. These topics are covered in the first three chapters of your AP textbook (Chemistry, The Molecular Nature of Matter and Change, Silberberg 7e). Alternatively, if you do not have a textbook, the same material can be found by clicking here or searching online for “Chemistry Libretexts Map:Silberberg.”

Problems (with answers) have been included below to help you. Although these practice problems will not be collected, you can expect a graded primary assessment with similar problems on the third class meeting of the school year. Therefore, you should complete this assignment thoroughly, preferably in August so that the material is fresh when we begin in September. If you would like more practice, additional practice problems with answers can be found at the end of each chapter, or in the last section of the Libretext.

If you run into trouble, or have any questions about the course, please email me at lfelix@eccrsd.us. (I will be checking my email periodically, but not daily.) Good luck and enjoy your summer - I look forward to meeting you in the fall!

Objective Checklist (with relevant chapters):

___ Use the unit Factor Method (Dimensional Analysis) to convert from one quantity to another (1.4)
___ Report answers with correct units (1.4)
___ Report answers to the correct number of significant figures (1.5)
___ Distinguish between accuracy and precision (1.5)
___ Describe and explain early atomic experiments (2.1 - 2.4)
___ Describe the structure of the atom (2.5)
___ Know charges, formulas, and names of common monatomic and polyatomic ions (THESE MUST BE MEMORIZED! Refer to tables 2.3, 2.4, and 2.5 on pages 66-68).
___ Quickly name and write formulas (2.8) for...
   ○ Binary ionic compounds
   ○ Ionic compounds containing polyatomic ions
   ○ Hydrated ionic compounds
   ○ Acids
   ○ Binary covalent compounds
___ Convert between moles, mass, and number of particles (3.1)
___ Determine the formula of an unknown compound (3.2)
___ Write and balance chemical equations (3.3)
___ Use stoichiometry to calculate quantities of reactant and product (3.4)
Part I: Read “Ch 1: Keys to the Study of Chemistry” (textbook or online libretext). Then, solve the following problems.

Solve the following using the factor label method. Show all work: You must write out all conversion factors and show how units cancel. Report all answers with units and to the correct number of significant figures.

Example: If you ate 2.0 pounds of jelly beans, how many jelly beans did you eat? (Note: 1 jelly bean = 1.18 g; 454 g = 1 lb.)

\[
2.0 \text{ lb} \times \frac{454 \text{ g}}{1 \text{ lb}} \times \frac{1 \text{ jelly bean}}{1.18 \text{ g}} = 770 \text{ jelly beans}
\]

1. What is the length, in inches, of a 100. m soccer field, given that 1 in = 2.54 cm?

2. The average radius of a molecule of lysozyme, an enzyme in tears, is 1430 pm. What is its radius in nanometers (nm)?

3. The radius of a barium atom is \(2.22 \times 10^{-10}\) m. What is its radius in angstroms (Å)? (Note: \(10^{-12}\) m = 1 pm; 100 pm = 1 Å)

4. The center on your school’s basketball team is 6 ft 10 in tall. How tall is the player in millimeters (mm)? (Note: 1 cm = 10 mm; 1 in = 2.54 cm; 12 in = 1 ft)

5. The speed of light in a vacuum is \(2.9983 \times 10^8\) m/s. What is its speed in...
   a. km/h?
   b. mi/min? (Note: 1 km = 0.62 mi)

6. A small hole in the wing of a space shuttle requires a 20.7 cm\(^2\) patch.
   a. What is the patch’s area in square kilometers (km\(^2\))? 
   b. If the patching material costs NASA $3.25/in\(^2\), what is the cost of the patch?

7. The area of a telescope lens is 7903 mm\(^2\). (Note: 2.54 cm = 1 in and 12 in = 1 ft).
   a. What is the area is square feet (ft\(^2\))? 
   b. If it takes a technician 45 s to polish 135 mm\(^2\), how long does it take her to polish the entire lens?
8. The volume of a certain bacterial cell is \(2.56 \text{ um}^3\). (Note: 1 mL = 1 cm\(^3\))
   a. What is its volume in cubic millimeters (mm\(^3\))? 
   b. What is the volume of \(10^5\) cells in L?

9. Answer the following, given that 1 quart = 946.4 mL, 1 gallon = 4 quarts, and 1 mL = 1 cm\(^3\).
   a. How many cubic meters of milk are in 1 qt?
   b. How many liters of milk are in 835 gal?

10. Perform the following conversions:
   a. 68°F (a pleasant spring day) to °C and K
   b. -164°C (the boiling point of methane, the main component of natural gas) to K and °F
   c. 0 K (absolute zero, theoretically the coldest possible temperature) to °C and °F
   d. 6.1 \(\times\) \(10^3\) K (the surface temperature of the Sun) to °F and °C

11. Round off each number to the indicated number of significant figures.
   a. 0.0003554 (to 2 sf)
   b. 35.8348 (to 4 sf)
   c. 22.4555 (to 3 sf)
   d. 231.554 (to 4 sf)
   e. 144,000 (to 2 sf)

12. Carry out the following calculations, and record your answer with the correct number of significant figures.
   a. 1.110 cm + 17.3 cm + 108.2 cm + 316 cm
   b. \(\frac{2.420 \text{ g} + 15.6 \text{ g}}{4.8 \text{ g}}\)
   c. \(\frac{7.87 \text{ mL}}{16.1 \text{ mL} - 8.44 \text{ mL}}\)
   d. \(V = \pi r^2 h\), where \(r = 6.23\) cm and \(h = 4.630\) cm

13. Which statements include exact numbers?
   a. Angel Falls is 3212 ft high.
   b. There are 8 known planets in the Solar System.
   c. There are 453.59 g in 1 lb.
   d. There are 1000 mm in 1 m.

Answers: 1) 3.94 \(\times\) \(10^3\) in 2) 1.43 nm 3) 2.22 Å 4) 2.1 \(\times\) \(10^3\) mm 5a) 1.0794 \(\times\) \(10^9\) km/h 5b) 1.1 \(\times\) \(10^7\) mi/min 6a) 2.07 \(\times\) \(10^9\) km\(^2\) 6b) \$10.43 7a) 8.507 \(\times\) \(10^{-2}\) ft\(^2\) 7b) 2.6 \(\times\) \(10^3\) s 8a) 2.56 \(\times\) \(10^8\) mm\(^3\) 8b) 10\(^{-10}\)L 9a) 9.464 \(\times\) \(10^4\) m\(^3\) 9b) 3.16 \(\times\) \(10^3\) L 10a) 20°C, 293 K 10b) 109 K; -263 °F 10c) -273°C; -460°F 10d) 5.8 \(\times\) \(10^3\) °C; 1.1 \(\times\) \(10^4\) °F 11a) 0.00036 11b) 35.83 11c) 22.5 11d) 231.6 11e) 140,000 12a) 443 cm 12b) 3.8 12c) 1.0 12d) 565 cm\(^3\) 13) b,d
Part II: Read “Chapter 2: The Components of Matter.” Then, answer the following questions.

1. Which component of Dalton’s atomic theory reflects his understanding of the law of conservation of mass for chemical processes? Why?

2. Describe the “plum pudding” model of the atom. On which experiment/reasoning was it based?

3. Describe Rutherford’s “Gold Foil Experiment”? What conclusions were made from the results? How did this experiment change the atomic model?

4. Complete the table below for the following neutral atoms.

<table>
<thead>
<tr>
<th>Name</th>
<th># of Protons</th>
<th># of Neutrons</th>
<th># of Electrons</th>
<th>Atomic number (Z)</th>
<th>Mass number (A)</th>
<th>Nuclide Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>26</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>17</td>
<td></td>
<td>37</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iodine-127</td>
<td></td>
<td></td>
<td>16</td>
<td>17</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Write the nuclide symbol (\( ^A_Z X \) notation) for each of the following.

6. Draw atomic representations similar to those in the previous problem for
   a. \(^{40}\text{Ti}\)  
   b. \(^{79}\text{Se}\)  
   c. \(^{11}\text{B}\)
7. Atom “A” has 11 neutrons and Atom “B” also has 11 neutrons. Are these atoms isotopes? Explain.

8. The atomic masses of elements are generally not whole numbers. Explain why.

9. Naturally occurring chlorine is 75.78% Cl - 35 (34.9689 amu) and 24.22% Cl - 37 (36.9659 amu). Calculate the average atomic mass.

10. An element is found to gain three electrons when it forms an ion.
   a. What group number would this element be found in?
   b. Is there enough information provided to determine what period it is in? Explain.

11. Look at the average atomic mass of Ar and K.
   a. Explain why early scientists might have been tempted to have K follow Cl on the periodic table.
   b. Propose two reasons as to why they placed Ar after Cl instead of K

12. Identify the following elements:
   a. An alkali metal in the 5th period.
   b. A transition metal in period 4
   c. An atom in the 3rd period that forms a stable ion with a -1 charge.

13. Explain why atoms tend to gain or lose electrons relative to the number of valence electrons. How can you predict the number of electrons lost or gained?

14. Classify each element as metal, nonmetal, or metalloid. What ions would each element be likely to form?
   a. Nitrogen
   b. Calcium
   c. Sulfur
   d. Carbon

15. How many total ions (cations and anions) are present in the following ionic compounds?
   a. sodium acetate
   b. aluminum nitrate.
   c. Copper(II) chloride

16. Aluminum reacts with a certain nonmetallic element to form a compound with the general formula Al₂X₃. Element X must be from which group on the periodic table?

17. Complete the table on the next page. (No answer key - these can be easily checked online.)
<table>
<thead>
<tr>
<th>Chemical Formula</th>
<th>Chemical Name</th>
<th>Type of compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>NaI</td>
<td>Sodium iodide</td>
<td>Binary Ionic</td>
</tr>
<tr>
<td>KNO₃</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(NH₄)₂SO₃</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CuSO₄•5H₂O</td>
<td></td>
<td>Hydrated ionic</td>
</tr>
<tr>
<td>AuNO₂</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Al₂(CrO₄)₃</td>
<td></td>
<td>Ionic containing polyatomic ions</td>
</tr>
<tr>
<td>IF₇</td>
<td></td>
<td>Binary covalent</td>
</tr>
<tr>
<td>Cu(OH)₂</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H₂SO₄</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CuI₂</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HIO₂</td>
<td></td>
<td>Acid</td>
</tr>
<tr>
<td>Manganese II sulfide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potassium peroxide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lithium permanganate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mercury (I) chloride</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum cyanide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manganese (II) nitride</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ammonium sulfide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diphosphorus pentoxide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barium hydroxide octahydrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium acetate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum nitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper (II) chloride</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron (III) Carbonate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Answers: 1) postulate 1 - see p.47  2) see p.50  3) see p.51  4) iron-56, 26e, Z=26, A=56; chlorine-35, 17p, 18n, 17e, Z=17, A=35; chlorine-37, 20n, 17e, Z=17, A=37; 53p, 74n, 53e, Z=53, A=74  5a) Z=18 and A=38, Ar  5b) Z=25 and A=55, Mn  5c) Z=47 and A=109, Ag  6a) 22p, 26n, 22d, 6b) 34p, 45n, 34e, 6c) 5p, 6n, 5e  7) No, isotopes have same Z (# of protons), but different A (# of protons+neutrons)  8) Weighted average of all isotopes  9) 35.45 amu  10a) group 15  10b) No  11a) K has a greater average atomic mass than Ar  11b) Ar behaves like other group 18 elements  12a) Rb  12b) Any element Z= 21 to 30  12c) Cl  13) metals gain nonmetals lose to get the same # of e's as the nearest noble gas  14a) nonmetal, -3  14b) metal, 2+  14c) nonmetal 2-  14d) nonmetal 4+ or 4-  15a) 2  15b) 4  15c) 3  16) group 16
Part III: Read “Chapter 3: Stoichiometry of Formulas and Equations.” Then, solve the following problems.

Solve the following using the factor label method. Show all work: You must write out all conversion factors and show how units cancel. Report all answers with units and to the correct number of significant figures.

1. Answer the following questions for the compound aluminum sulfate.
   a. What is the molar mass of this compound?
   b. What is the mass of a 1.5 mole sample?
   c. How many oxygen atoms are present in the 1.5 mol sample?

2. Consider a 0.433 mol sample of calcium nitrate.
   a. Calculate the mass of the sample in grams.
   b. How many formula units of calcium nitrate are present?
   c. How many nitrate ions are present?

3. Answer the following questions for the compound aluminum chloride.
   a. What is the molar mass of this compound?
   b. What is the mass of a 0.65 mole sample?
   c. How many formula units are in the 0.65 mole sample?
   d. How many ions are in the 0.65 mole sample?
   e. How many protons are in the 0.65 mole sample?
4. What mass of rhodium contains the same number of atoms as there are
   a. gallium atoms in 36.0 g gallium

   b. indium atoms in 36.0 g indium

5. Carbon has two isotopes C-12 (99%) and C-13 (1%).
   a. How many atoms of C would be present in a 34 gram sample of pure diamond (pure carbon)?

   b. How many atoms of those are C-13 atoms?

6. Calculate each of the following quantities.
   a. Mass (in g) of $6.4 \times 10^{-2}$ mol of manganese (II) sulfate

   b. Amount (in moles) of formula units in 15.8 kg of Fe(ClO$_4$)$_3$

   c. Number of nitrogen atoms in 92.6 mg of ammonium nitrite

7. A sample of Ni(CO)$_4$, a toxic transition-metal complex, has $5.23 \times 10^{24}$ atoms of carbon. How many atoms of Ni does it contain?

8. Calculate each of the following:
   a. Mass % of H in ammonium bicarbonate

   b. Mass % of Mn in potassium permanganate
9. Find the molecular formula for each compound.
   a. Empirical formula CH₂ (molar mass = 42.08 g/mol)

   b. Empirical formula NO₂ (molar mass = 92.02 g/mol)

   c. Empirical formula CHN (molar mass = 135.14 g/mol)

10. Cortisol (molar mass = 362.47 g/mol) is a steroid hormone involved in protein synthesis. Medically, it is used to reduce inflammation from arthritis. Cortisol is 69.6% C, 8.34% H, and 22.1% O by mass. What is its molecular formula?

11. Calculate the mass (in grams) of each product formed when 43.82 g of diborane (B₂H₆) reacts with excess water.

   \[ \text{B₂H₆(g)} + \text{H₂O(l)} \rightarrow \text{H₃BO₃(s)} + \text{H₂} \]  [unbalanced]

12. Calculate the mass of each product formed when 174 g of silver sulfide reacts with excess hydrochloric acid.

   \[ \text{Ag₂S(s)} + \text{HCl(aq)} \rightarrow \text{AgCl(S)} + \text{H₂S(g)} \]  [unbalanced]

Answers: 1a) Al₂(VO₄)₃: 342.145 g/mol 1b) 510 g 1c) 1.1 x 10²⁵ O atoms 2a) 71.1 g 2b) 2.61 x 10²³ formula units 2c) 5.21 x 10²³ nitrate ions 3a) AlCl₃:133.33 g/mol 3b) 87 g 3c) 3.9 x 10²³ formula units 3d) 1.6 x 10²⁴ ions 3e) 2.5 x 10²⁵ protons 4a) 53.1 g 4b) 32.3 g 5a) 1.71 x 10²⁴ atoms C 5b) 1.71 x 10²² atoms C-13 6a) 9.7 g MnSO₄ 6b) 44.6 mol Fe(CIO₄)₃ 6c) 1.74 x 10²¹ N atoms 7) 1.31 x 10²⁴ atoms Ni 8a) 6.375 % H 8b) 34.58 % O 9a) C₃H₆ 9b) N₂O₄ 9c) C₃H₂N₅ 10) C₂H₃O₅ 11) 195.8 g H₃BO₃ and 19.16 g H₂ 12) 201 g AgCl and 23.9 g H₂S