AP Chemistry Summer Assignment

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 several topics (listed below) on your own prior to September. These topics are covered in the first three chapters of your AP textbook (Chemistry, The Molecular Nature of Matter and Change, Silberberg 7e).

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. If you would like more practice, additional problems with answers can be found at the end of each chapter.

If you run into trouble, or have any questions about the course, please email me. 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!

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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 the structure of the atom (2.5)

___ **MEMORIZE** charges, formulas, and names of common monatomic and polyatomic ions found on the last page of this assignment

___ Quickly name and write formulas for ionic and covalent compounds (2.8)

___ 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: Review "Ch 1: Keys to the Study of Chemistry" (textbook). 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? (Given: 1 jelly bean = 1.18 g; 454 g = 1 lb.)

$$2.0 \cancel{\text{ lb}} \times \frac{454 \cancel{\text{ g}}}{1 \cancel{\text{ lb}}} \times \frac{1 \text{ jelly bean}}{1.18 \cancel{\text{ g}}} = \textbf{770 jelly beans}$$

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 2.22×10^{-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 2.9983×10^{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 in 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 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. 20.°C (a pleasant spring day) to K

    b. –164°C (the boiling point of methane, the main component of natural gas) to K

    c. 0 K (absolute zero, theoretically the coldest possible temperature) to °C

    d. 6.1 x 10^3 K (the surface temperature of the Sun) to °C

11. Round off each measurement to the indicated number of significant figures.

    a. 0.0003554 m (to 2 sf)
    b. 35.8348 g (to 4 sf)
    c. 22.4555 s (to 3 sf)
    d. 231.554 kg(to 4 sf)
    e. 144,000 mL (to 2 sf)
    f. 1.030 x 10^3 L (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. $\frac{2.420\ g + 15.6\ g}{4.8\ g}$

    c. $\frac{7.87\ mL}{16.1\ mL - 8.44\ mL}$

    d. V = π 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.

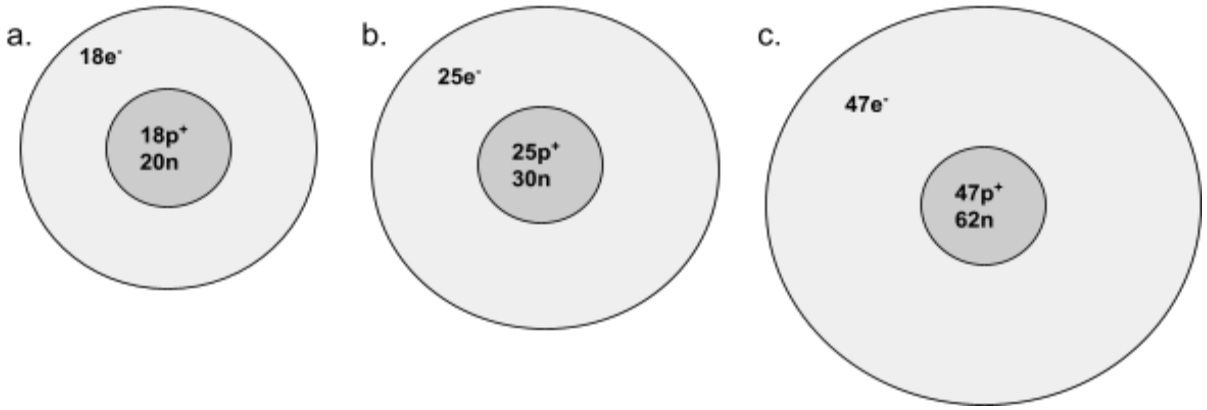
Answers: 1) 3.94 x 10^3 in 2) 1.43 nm 3) 2.22 Å 4) 2.1 X 10^3 mm 5a) 1.0794 x 10^9 km/h 5b) 1.1 x 10^7 mi/min 6a) 2.07 x 10^{-9} km^2 6b) $10.43 7a) 8.507 x 10^{-2} ft^2 7b) 2.6 x 10^3 s 8a) 2.56 x 10^{-9} mm^3 8b) 10^{-10}L 9a) 9.464 x 10^{-4} m^3 9b) 3.16 x 10^3 L 10a) 293 K 10b) 109 K 10c) –273°C 10d) 5.8 x 10^3 °C 11a) 0.00036 m 11b) 35.83 g 11c) 22.5 s 11d) 231.6 kg 11e) 140,000 mL 11f) 1.0 x 10^3L 12a) 443 cm 12b) 3.8 12c) 1.0 12d) 565 cm^3 13) b,d

Part II: Review “Chapter 2: The Components of Matter.” Then, answer the following questions.

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

Name	# of Protons	# of Neutrons	# of Electrons	Atomic Number (Z)	Mass Number (A)	Nuclide Symbol
	26	30				
						$^{35}_{17}Cl$
	17				37	
Iodine-127						
	16	17				

2. Write the nuclide symbol ($^{A}_{Z}X$ notation) for each of the following.



3. Draw atomic representations for the atoms below (similar to those shown in the previous problem).

   a. ^{48}Ti b. ^{79}Se c. ^{11}B

4. Atom “A” has 11 neutrons and Atom “B” also has 11 neutrons. Are these atoms isotopes? Explain.

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

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

7. 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.

8. 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

9. 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 –1 ion
    d. Period 3 element that has two valence electrons
    e. Group 17 element with fewer than 15 protons
    f. Noble gas in period 5

10. 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?

11. Classify each element as metal, nonmetal, or metalloid. What ion(s) would each element be likely to form?
    a. nitrogen
    b. calcium
    c. sulfur
    d. carbon
    e. hydrogen
    f. oxygen
    g. bromine
    h. aluminum

12. How many total ions (cations and anions) are present in the following compounds?
    a. sodium acetate
    b. Aluminum nitrate
    c. copper(II) chloride
    d. copper (I) chloride
    e. carbon dioxide
    f. calcium phosphate

13. Aluminum reacts with a certain nonmetallic element to form a compound with the general formula Al_2X_3. Element X must be from which group on the periodic table?

14. Complete the table on the next page. (No answer key - these can be easily checked online.)

	Chemical Formula	Chemical Name	Type of compound
1	NaI	Sodium iodide	Ionic
2	KNO_2		
3	$(NH_4)_2SO_3$		
4	$CuSO_4 \bullet 5H_2O$		Ionic
5	$AuNO_2$		
6	$Al_2(CrO_4)_3$		Ionic
7	IF_7		Covalent
8	$Cu(OH)_2$		
9	NO		
10	CO_2		Covalent
11	CuI_2		
12	P_4O_{10}		
13		Manganese II sulfide	
14		Potassium peroxide	
15		Lithium permanganate	
16		Mercury (I) chloride	
17		Aluminum cyanide	
18		Manganese (II) nitride	
19		Ammonium sulfide	
20		Diphosphorus pentoxide	
21		Barium hydroxide octahydrate	
22		Sodium acetate	
23		Aluminum nitrate	
24		Copper (II) chloride	
25		Iron (III) Carbonate	

Answers: 1) 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 2a) Z=18 and A=38, Ar 2b) Z=25 and A=55, Mn 2c) Z=47 and A=109, Ag 3a) $22p^+$, 26n, $22e^-$ 3b) $34p^+$, 45n, $34e^-$ 3c) $5p^+$, 6n, $5e^-$ 4) No, isotopes have same Z (# of protons), but different A (# of protons+neutrons) 5) Weighted average of all isotopes 6) 35.45 amu 7a) group 15 7b) No 8a) K has a greater average atomic mass than Ar 8b) Ar behaves like other group 18 elements 9a) Rb 9b) Any element Z= 21 to 30 9c) Cl 9d) Mg 9e) F 9f) Xe 10) metals gain nonmetals lose to get same # of e^-s as the nearest noble gas 11a) NM 3– 11b) M 2+ 11c) NM 2– 11d) NMl 4+ or 4– 11e) NM +1 11f) NM 2– 11g) NM 1– 11h) M +3 12a) 2 15b) 4 12c) 3 12d) 2 12e) 0, it's covalent 12f) 5 13) group 16

Part III: Review “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 6.4×10^{-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 5.23×10^{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. Percent by mass of Mn in potassium permanganate

9. Find the molecular formula for each compound.

    a. Empirical formula CH_2 (molar mass = 42.08 g/mol)

    b. Empirical formula NO_2 (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 (B_2H_6) reacts with excess water.

$$B_2H_6(g) + H_2O(l) \rightarrow H_3BO_3(s) + H_2 \quad \text{[unbalanced]}$$

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

$$Ag_2S(s) + HCl(aq) \rightarrow AgCl(S) + H_2S(g) \quad \text{[unbalanced]}$$

13. Consider the following reaction: **$4HCl(aq) + MnO_2(s) \rightarrow MnCl_2(aq) + 2H_2O(g) + Cl_2(g)$**

    a. How many moles of hydrochloric acid are needed to make 500. g of water?

    b. What mass, in g, of hydrochloric acid is required to produce 0.88 moles of $MnCl_2$?

    c. If 25.0 g of hydrochloric acid reacts completely, how many molecules of chlorine gas are formed?

14. Consider the formation of copper (I) sulfide from its elements: **$16Cu(s) + S_8(s) \rightarrow 8Cu_2S(s)$**

    a. How many moles of sulfur are needed to react with 32.0 moles of copper?

    b. How many moles of copper (I) sulfide are formed if 32.0 moles of copper react completely?

    c. How many molecules of S_8 are consumed during the production of 14.55 g of copper (I) sulfide?

15. Consider the following reaction: **$2C_6H_6(l) + 7O_2(g) \rightarrow 2C_4H_2O_3(l) + 4H_2O(l) + 4CO_2(g)$**

    a. How many grams of oxygen gas are needed to make 250 grams of maleic anhydride, $C_4H_2O_3$?

    b. Continuing from the previous question, what mass of carbon dioxide will be released as a byproduct?

Answers: 1a) $Al_2(SO_4)_3$: 342.145 g/mol 1b) 510 g 1c) 1.1×10^{25} O atoms 2a) 71.1 g 2b) 2.61×10^{23} formula units 2c) 5.21×10^{23} nitrate ions 3a) $AlCl_3$:133.33 g/mol 3b) 87 g 3c) 3.9×10^{23} formula units 3d) 1.6×20^{24} ions 3e) 2.5×10^{25} protons 4a) 53.1 g 4b) 32.3 g 5a) 1.71×10^{24} atoms C 5b) 1.71×10^{22} atoms C-13 6a) 9.7 g $MnSO_4$ 6b) 44.6 mol $Fe(ClO_4)_3$ 6c) 1.74×10^{21} N atoms 7) 1.31×10^{24} atoms Ni 8a) 6.375 % H 8b) 34.58 % O 9a) C_3H_6 9b) N_2O_4 9c) $C_5H_5N_5$ 10) $C_{21}H_{30}O_5$ 11) 195.8 g H_3BO_3 and 19.16 g H_2 12) 201 g AgCl and 23.9 g H_2S 13a) 55.5 mol HCl 13b) 130 g HCl 13c) 1.03×10^{23} molecules Cl_2 14a) 2.00 mol S_8 14b) 16.0 mol Cu_2S 14c) 6.87×10^{21} molecules S_8 15a) 280 g O_2 15b) 220 g CO_2

Monatomic Ions

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Li^{+1}	Be^{2+}												C^{-4}	N^{-3}	O^{-2}	F^{-1}	
Na^{+1}	Mg^{+2}											Al^{+3}		P^{-3}	S^{-2}	Cl^{-1}	
K^{+1}	Ca^{+2}				Cr^{+2} Cr^{+3}	Mn^{+2} Mn^{+3}	Fe^{+2} Fe^{+3}	Co^{+2} Co^{+3}	Ni^{+2} Ni^{+3}	Cu^{+1} Cu^{+2}	Zn^{+2}				Se^{-2}	Br^{-1}	
Rb^{+1}	Sr^{+2}									Ag^{+1}	Cd^{+2}		Sn^{+2} Sn^{+4}		Te^{-2}	I^{-1}	
Cs^{+1}	Ba^{+2}										Hg_2^{+2} Hg^{+2}		Pb^{+2} Pb^{+4}				

Polyatomic Ions

Charge	Formula	Name
+1	NH_4^+	ammonium
	H_3O^+	hydronium
–1	CH_3COO^-	acetate
	CN^-	cyanide
	OH^-	hydroxide
	ClO_3^-	chlorate
	NO_3^-	nitrate
	MnO_4^-	permanganate
–2	CO_3^{2-}	carbonate
	CrO_4^{2-}	chromate
	$Cr_2O_7^{2-}$	dichromate
	O_2^{2-}	peroxide
	$C_2O_4^{2-}$	oxalate
	SeO_4^{2-}	selenate
	SO_4^{2-}	sulfate
	SiO_3^{2-}	silicate
	$C_4H_4O_6^{2-}$	tartrate
–3	AsO_4^{3-}	arsenate
	BO_3^{3-}	borate
	PO_4^{3-}	phosphate

Polyatomic ions can be altered as follows:

- **hypo__ite**
  - two less oxygen atoms
  - ex) **hypo**sulf**ite**, SO_2^{2-}
- **__ite**
  - one less oxygen atom
  - ex) sulf**ite**, SO_3^{2-}
- **__ate**
  - unaltered form
  - ex) sulf**ate**, SO_4^{2-}
- **per__ate**
  - one more oxygen atom
  - ex) **per**sulf**ate**, SO_5^{2-}
- **hydrogen __**
  - add a hydrogen atom, increase the charge by 1
  - ex) **hydrogen** sulfate, HSO_4^{1-}