# AP Chemistry Summer Assignment – 2021

*fig. 1* **Democritus' atom**

*fig. 2* **Rutherford's atom**

*fig. 3* **modern atom**

The purpose of the AP Chemistry summer assignment is to get or keep you "up to speed" with basic chemistry concepts so that we can hit the ground running in August. You will be tested on the material on this assignment at the end of the first week of school, so you need to be prepared. I would recommend that you look over your first year (Honors or Onlevel Chemistry) notes – if you don't have them, get with somebody who does. A "study buddy" is always a good idea. Seniors, it is especially vital that you pay attention to the material in this assignment as it has been some time since you've even "thought" about chemistry and these skills are going to need to be ready the very first week.
There is also some basic information that you will need to memorize – it is important that you commit this information to memory (or become VERY familiar with it), since we will be using it all year. There are problem sets that you will need to work as well. The answers will be posted in my classroom (102) the week before school starts (teachers' pre-planning). Since the test is not the first day, you will be able to check your work and make corrections and, hopefully, remember the basics. The test will soon after the first week of school, so be prepared!
**Since this past academic year has been so very challenging, the pacing and sequencing of this class will be a bit changed from previous years. This does not mean, however, that the scope and rigor of the class will be changing. There are just a few realities that need to be addressed: y'all haven't been in the building for quite a while, and even though you've all got a 'first year' class under your belt, that doesn't mean that you've mastered lab techniques – in fact, if you're like the typical Honors Chemistry student from 2020-2021, you haven't set foot in a chemistry classroom, let alone had any experience with chemistry labs or lab requirements. This means that the first few chapters will be paced in such as way as to include training in basic lab techniques, procedures, and expectations. Reinforcement work will be "hands on" (paper/pencil, physical turn ins, physical homework quizzes to evaluate understanding) and lab-based questions will be on content assessments.**
I look forward to getting to know each of you better in the coming school year. Enjoy your summer, but don't forget the chemistry!
In addition to the assignment, if you have the time, here are some interesting and readable books about the history of chemistry, how chemistry drove human history and the development of our understanding about the world around us: **Atom** by Isaac Asimov, **Napoleon's Buttons** by Penny Le Couteur & Jay Burreson and **A Short History of Nearly Everything** by Bill Bryson – they are worth the time to read.

*Mrs. Bingham* ☺

p.s. – if you need to reach me during the summer, please email me at binghamr@fultonschools.org. I may not get back to you immediately (I'm on vacation, too, remember?), but I do check my email periodically during the summer.
Following this page, there are several pages for the assignment, beginning with stuff that you will need to be very familiar with, as well as problem sets to work.

**AP Chemistry Summer Assignment – Stuff You Need to KNOW (actually, REMEMBER 😊)!**

1. Rules for Naming Acids
    a. When the name of the anion ends in –ide, the acid name begins with the prefix hydro-, the stem of the anion has the suffix –ic and it is followed by the word "acid".
    For example: HCl: Cl- is chlor**ide**, so HCl = hydrochloric acid
    b. When the anion name ends in –ite, the acid name is the stem of the anion with the suffix –ous, followed by the word "acid".
    For example: $ClO_2^-$ is the chlor**ite** ion, so $HClO_2$ = chlorous acid
    c. When the anion name ends in –ate, te acid name is the stem of the anion with the suffix –ic, followed by the word "acid"
    For example: $ClO_3^-$ is the chlor**ate** ion, so $HClO_3$ = chloric acid
    d. When the anion name begins with per-, the acid name begins with per- and the stem of the anion has the suffix –ic and it is followed by the word "acid"
    For example: $ClO_4^-$ is the **per**chlor**ate** ion, so $HClO_4$ = perchloric acid

2. Rules for Naming Ionic Compounds
    a. Balance charges – charges should always = 0
    b. Cation is always written first (in name and in formula)
    c. Change the ending of the anion (if an element) to –ide. If a polyatomic ion, the ion name does not change.
    d. Review the naming for covalent compounds as well!

3. Solubility Rules
    a. All compounds containing alkali metal cations or the ammonium ion are soluble.
    b. All compounds containing $NO_3^-$, $ClO_4^-$, $ClO_3^-$, and $C_2H_3O_2^-$ anions are soluble.
    c. All chlorides, bromides, and iodides are soluble except those containing $Ag^+$, $Pb^{2+}$, or $Hg^{2+}$.
    d. All sulfates are soluble except those containing $Hg^{2+}$, $Pb^{2+}$, $Sr^{2+}$, $Ca^{2+}$, or $Ba^{2+}$.
    e. All hydroxides are insoluble, except compounds of the alkali metals, ammonium, $Ca^{2+}$, $Sr^{2+}$, or $Ba^{2+}$.
    f. All compounds containing $PO_4^{3-}$, $S^{2-}$, $CO_3^{2-}$, and $SO_3^{2-}$ are insoluble, except compounds of the alkali metals or ammonium.

4. Decomposition Rules
    a. Most binary compounds (composed of 2 elements) will decompose into the separate elements.
    b. Metal oxides → metal + oxygen gas
    c. Metal chlorates and perchlorates → metal halogen salt + oxygen gas
    d. Metal Carbonates → metal oxide + carbon dioxide
    e. Metal Bicarbonates ($HCO_3^-$) → metal oxide + carbon dioxide + water
    f. Metal Hydroxides → metal oxide + water
    g. Oxyacids → water + nonmetal oxide
    h. Hydrates → anhydrous salt

5. Variable Valences (charges) for Transition Metals (when they have > 1 charge option). Not necessary for memorization, but you need to be VERY familiar with these common ions (polyatomic ions, too) as the periodic table you will have for a reference in this class does not have the table of polyatomic ions from your first-year class.

| Element Name | Symbol | Charge | Stock Name | Classical Name |
|---|---|---|---|---|
| Chromium | Cr | +2<br>+3 | Chromium (II)<br>Chromium (III) | Chromous<br>Chromic |
| Manganese | Mn | +2<br>+3 | Manganese (II)<br>Manganese (III) | Manganous<br>Manganic |
| Iron | Fe | +2<br>+3 | Iron (II)<br>Iron (III) | Ferrous<br>Ferric |
| Cobalt | Co | +2<br>+3 | Cobalt (II)<br>Cobalt (III) | |
| Copper | Cu | +1<br>+2 | Copper (I)<br>Copper (II) | Cuprous<br>Cupric |
| Lead | Pb | +2<br>+4 | Lead (II)<br>Lead (IV) | Plumbous<br>Plumbic |
| Mercury | Hg | +1<br>+2 | Mercury (I)<br>Mercury (II) | Mercurous<br>Mercuric |
| Tin | Sn | +2<br>+4 | Tin (II)<br>Tin (IV) | Stannous<br>Stannic |
| Gold | Au | +1<br>+3 | Gold (I)<br>Gold (III) | Aurous<br>Auric |
| Silver | Ag | +1<br>+2 (rarely) | Silver<br>Silver (II) | |
| Bismuth | Bi | +3<br>+5 | Bismuth (III)<br>Bismuth (V) | |
| Antimony | Sb | +3<br>+5 | Antimony (III)<br>Antimony (V) | |
| Cadmium | Cd | +s | Cadmium | |
| Zinc | Zn | +2 | Zinc | |

6. Polyatomic Ions (common)

| Name | Symbol | Charge |
|---|---|---|
| Ammonium | $NH_4^+$ | +1 |
| Acetate | $C_2H_3O_2^-$ | -1 |
| Bromate | $BrO_3^-$ | -1 |
| Chlorate | $ClO_3^-$ | -1 |
| Chlorite | $ClO_2^-$ | -1 |
| Cyanide | $CN^-$ | -1 |
| Dihydrogen phosphate | $H_2PO_4^-$ | -1 |
| Hypochlorite | $ClO^-$ | -1 |
| Hydrogen carbonate (bicarbonate) | $HCO_3^-$ | -1 |
| Hydrogen sulfate (bisulfate) | $HSO_4^-$ | -1 |
| Hydrogen sulfite (bisulfite) | $HSO_3^-$ | -1 |
| Hydroxide | $OH^-$ | -1 |
| Iodate | $IO_3^-$ | -1 |
| Nitrate | $NO_3^-$ | -1 |
| Nitrite | $NO_2^-$ | -1 |
| Perchlorate | $ClO_4^-$ | -1 |
| Permanganate | $MnO_4^-$ | -1 |
| Thiocyanate | $SCN^-$ | -1 |
| Carbonate | $CO_3^{2-}$ | -2 |
| Chromate | $CrO_4^{2-}$ | -2 |
| Dichromate | $Cr_2O_7^{2-}$ | -2 |
| Oxalate | $C_2O_4^{2-}$ | -2 |
| Selenate | $SeO_4^{2-}$ | -2 |
| Sulfate | $SO_4^{2-}$ | -2 |
| Sulfite | $SO_3^{2-}$ | -2 |
| Phosphate | $PO_4^{3-}$ | -3 |
| Phosphite | $PO_3^{3-}$ | -3 |
| Silicate | $SiO_4^{4-}$ | -4 |

**Chapter 1 Problem Set – The Math Basics**

1. How many significant figures are in each of the following?
   a. 12
   b. 1098
   c. 2001
   d. $2.001 \times 10^3$
   e. 0.0000101
   f. $1.01 \times 10^{-5}$
   g. 1000.
   h. 22.04030

2. Use scientific notation to express the number 480 to
   a. one significant figure
   b. two significant figures
   c. three significant figures
   d. four significant figures

3. Perform the following mathematical operations and express each result to the correct number of significant figures.
   a. 97.381 ÷ 4.2502 + 0.99195
   b. 171.5 + 72.915 – 8.23
   c. 1.00914 ÷ 0.87104 + 1.2012
   d. 21.901 – 13.21 – 4.0215

4. Perform the following mathematical operations and express each result to the correct number of significant figures.
   a. $\dfrac{0.102 \times 0.0821 \times 273}{1.01}$
   b. $0.14 \times (6.022 \times 10^{23})$
   c. $(4.0 \times 10^4) \times (5.021 \times 10^{-3}) \times (7.34993 \times 10^2)$
   d. $\dfrac{2.00 \times 10^6}{3.00 \times 10^{-7}}$
   e. $4.184 \times 100.62 \times (25.27 - 24.16)$
   f. $\dfrac{8.925 - 8.904}{8.925} \times 100$
   g. $(9.04 - 8.23 + 21.954 + 81.0) \div 3.1416$
   h. $\dfrac{9.2 \times 100.65}{8.321 + 4.026}$
   i. $0.6154 + 2.07 - 2.114$
   j. $8.27(4.987 - 4.962)$
   k. $\dfrac{9.5 + 4.1 + 2.8 + 3.175}{4}$ (assume that this operation is taking the average of four numbers, therefore the 4 in the denominator is an exact number.)
   l. $\dfrac{9.025 - 9.024}{9.025} \times 100$ (100 is exact)

5. The density of aluminum is 2.70 g/cm$^3$. Express this value in units of kilograms per cubic meter and pounds per cubic foot.

6. A material will float on the surface of a liquid if the material has a density less than that of the liquid. Given that the density of water is approximately 1.0 g/mL, will a block of material having a volume of $1.2 \times 10^4$ in$^3$ and weighing 350 lb float or sink when placed in a reservoir of water?

7. A star is estimated to have a mass of $2 \times 10^{36}$ kg. Assuming it to be a sphere of average radius $7.0 \times 10^5$ km, calculate the average density of the star in units of grams per cubic centimeter.

8. A rectangular block has dimensions 2.9 cm x 3.5 cm x 10.0 cm. The mass of the block is 615.0 g. What are the volume and density of the block?

9. Calculate the percentage error for each case:
   a. The density of an aluminum block determined in an experiment was 2.64 g/cm$^3$. The true value is 2.70 g/cm$^3$.
   b. The experimental determination of iron in a sample of iron ore was 16.48 %. The true value was 16.12 %.

**Chapter 2 Summer Assignment – Atoms, Ions, and Compounds**

1. You have a chemical in a sealed glass container filled with air. The system has a mass of 250.0 g. The chemical is ignited by means of a magnifying glass focusing sunlight on the reactant. After the chemical is completely burned, what is the mass of the setup? Explain your answer.
2. In the periodic table, how many elements are found in
   a. the second period?
   b. the third period?
   c. Group 2A?
   d. the oxygen family?
   e. the fourth period?
   f. Group 5A?
   g. the nickel group?
   h. Group 8A?

5. Give the number of protons and neutrons in the nucleus of each of the following atoms:
   a. $^{238}_{94}Pu$
   b. $^{65}_{29}Cu$
   c. $^{52}_{24}Cr$
   d. $^{4}_{2}He$
   e. $^{60}_{27}Co$
   f. $^{54}_{24}Cr$

6. Complete the following table:

| Symbol | Number of protons in the nucleus | Number of neutrons in the nucleus | Number of electrons | Net charge |
|---|---|---|---|---|
| | 33 | 42 | | 3+ |
| $^{128}_{52}Te^{2-}$ | | | 54 | |
| | 16 | 16 | 16 | |
| | 81 | 123 | | 1+ |
| $^{195}_{78}Pt$ | | | | |

7. Would you expect each of the following atoms to gain or lose electrons when forming ions? What ion is the most likely to form in each case?
   a. Ra b. In c. P d. Te e. Br f. Rb

8. Name each of the following compounds:

a. NaCl
   b. $Rb_2O$
   c. CaS
   d. $AlI_3$
   e. $Hg_2O$
   f. $FeBr_3$
   g. CoS
   h. $TiCl_4$
   i. $CrO_2$
   j. $Cr_2O_3$
   k. $Al_2O_3$
   l. NaH
   m. $ZnCl_2$
   n. CsF
   o. $Li_3N$
   p. $Ag_2S$
   q. $MnO_2$
   r. $TiO_2$
   s. $Sr_3P_2$
   t. $CaBr_2$

9. Write the formula for each of the following compounds:

a. cesium bromide
b. barium sulfate
c. ammonium chloride
d. chlorine monoxide
e. silicon tetrachloride
f. chlorine trifluoride
g. beryllium oxide
h. magnesium fluoride
i. sulfur difluoride
j. sulfur hexafluoride
k. sodium dihyrdogen phosphate
l. lithium nitride
m. chromium (III) carbonate
n. tin (II) fluoride
o. ammonium acetate
p. ammonium hydrogen sulfate
q. cobalt (III) nitrate
r. mercury (I) chloride
s. sodium hydride
t. sodium oxide
u. sodium peroxide
v. potassium cyanide
w. copper (II) nitrate
x. silicon tetrachloride
y. lead (II) sulfide
z. lead (IV) sulfide

**Chapter 3 Summer Assignment – Stoichiometry Review**

1. Naturally occurring sulfur consists of four isotopes, $^{32}S$ (95.0 %), $^{33}S$ (0.76 %), $^{34}S$ (4.22 %), and $^{36}S$ (0.014 %). Using these data, calculate the atomic weight of naturally occurring sulfur. The masses of the isotopes are given in the table below.

| Isotope | Atomic Mass (amu) |
|---|---|
| $^{32}S$ | 31.91 |
| $^{33}S$ | 32.97 |
| $^{34}S$ | 33.97 |
| $^{35}S$ | 35.97 |

2. A noble gas consists of three isotopes of masses 19.99 amu, 20.99 amu, and 21.99 amu. The relative abundance of these isotopes is 90.92 %, 0.257 %, and 8.82 % respectively. What is the average atomic mass of this noble gas? What element might this be?
3. An element "X" has 5 major isotopes, listed below along with their relative abundances. What is this element? Does the atomic mass you calculate based on these data agree with that listed in your periodic table?

| Isotope | % Natural Abundance | Atomic Mass |
|---|---|---|
| $^{46}X$ | 8.0 % | 45.95269 |
| $^{47}X$ | 7.3 % | 46.951764 |
| $^{48}X$ | 73.8 % | 47.947947 |
| $^{49}X$ | 5.5 % | 48.947841 |
| $^{50}X$ | 5.4 % | 49.944792 |

4. How many moles are in a sample of 300 atoms of nitrogen? How many grams?
5. If you buy 38.9 moles of M & M's, how many M & M's do you have?
6. A sample of sulfur has a mass of 5.37 g. How many moles are in the sample? How many atoms?
7. Give the number of moles of each elements present in 1.0 mole of each of the following substances:
   a. $Hg_2I_2$
   b. LiH
   c. $PbCO_3$
   d. $Ba_3(AsO_4)_2$
   e. $RbOH{\cdot}2H_2O$
   f. $H_2SiF_6$
8. How many grams of zinc are in $1.16 \times 10^{22}$ atoms of zinc?
9. Calculate the molar masses of each of the following:
   a. $Cu_2SO_4$
   b. $NH_4OH$
   c. $C_{10}H_{16}O$
   d. $Zr(SeO_3)_2$
   e. $Ca_2Fe(CN)_6{\cdot}12H_2O$
   f. $Cr_4(P_2O_7)_3$
10. What is the mass of $4.28 \times 10^{22}$ molecules of water?

11. How many milligrams of $Br_2$ are in $4.8 \times 10^{20}$ molecules of $Br_2$?
12. How many sodium ions are present in each of the following:
    a. 2 moles of sodium phosphate
    b. 5.8 g of sodium chloride
    c. A mixture containing 14.2 grams of sodium sulfate and 2.9 grams of sodium chloride?
13. Determine the molar mass of $KAl(SO_4)_2 \cdot 12H_2O$.
14. How many moles of cadmium bromide, $CdBr_2$, are in a 39.25 gram sample?
15. Bauxite, the principle ore used in the production of aluminum cans, has a molecular formula of $Al_2O_3 \cdot 2H_2O$.
    a. Determine the molar mass of bauxite.
    b. How many grams of Al are in 0.58 moles of bauxite?
    c. How many atoms of Al are in 0.58 moles of bauxite?
    d. What is the mass in grams of $2.1 \times 10^{24}$ formula units of bauxite?
16. Calculate the mass percent of Cl in each of the following compounds:
    a. ClF
    b. $HClO_2$
    c. $CuCl_2$
    d. PuOCl
17. Calculate the mass percent of each element in potassium ferricyanide, $K_3Fe(CN)_6$.
18. Calculate the mass percent of silver in each of the following compounds:
    a. AgCl
    b. AgCN
    c. $AgNO_3$
19. Fill in the blanks to balance the following chemical equations:
    a. ___ AgI + ___ $Na_2S$ → ___$Ag_2S$ + ___NaI
    b. ___ $(NH_4)_2Cr_2O_7$ → ___ $Cr_2O_3$ + ___ $N_2$ + ___ $H_2O$
    c. ___ $Na_3PO_4$ + ___ HCl → ___ NaCl + ___ $H_3PO_4$
    d. ___ $TiCl_4$ + ___ $H_2O$ → ___ $TiO_2$ + ___ HCl
    e. ___ $Ba_3N_2$ + ___ $H_2O$ → ___ $Ba(OH)_2$ + ___ $NH_3$
    f. ___ $HNO_2$ → ___ $HNO_3$ + ___ NO + $H_2O$
20. Balance the following equation:
    ___$NH_4OH(l)$ + ___ $KAl(SO_4)_2 \cdot 12H_2O$ → ___ $Al(OH)_3(s)$ + ___ $(NH_4)_2(SO_4)(aq)$ + ___ KOH $(aq)$ + ___ $H_2O$ $(l)$
21. Balance the following equation:
    ___ $Fe(s)$ + ___ $HC_2H_3O_2(aq)$ → ___ $Fe(C_2H_3O_2)_3(aq)$ + ___ $H_2(g)$
22. How many grams of sodium hydroxide are required to form 51.63 g of lead hydroxide?
    $Pb(NO_3)_2$ (aq) + NaOH (aq) → $Pb(OH)_2$ (aq)+ $NaNO_3$ (aq) (**unbalanced**)
23. How many grams of water vapor can be generated from the combustion of 18.74 g of ethanol?
    $C_2H_6O(g) + O_2(g) \rightarrow CO_2 + H_2O$ (**unbalanced**)
24. How many grams of potassium iodide are necessary to completely react with 20.61 g of mercury (II) chloride?
    $HgCl_2$ (aq) + KI (aq) → $HgI_2$ (s) + KCl (aq) (**unbalanced**)
25. How many grams of oxygen are necessary to completely react with 22.8 g or methane, $CH_4$? (Please write the entire reaction.
26. If, in the previous problem, only 25.9 g of water vapor were formed, how much methane actually reacted with oxygen?
27. What mass of calcium carbonate, $CaCO_3$, would be formed if 248.6 g of carbon dioxide, $CO_2$, were exhaled into limewater, $Ca(OH)_2$? How many grams of calcium would be needed to form that amount of calcium carbonate? Assume 100% yield in each reaction.
28. The following reaction is used to form lead iodide crystals. What mass of crystal ($PbI_2$) could be formed from $1.0 \times 10^3$ g of lead (II) acetate [$Pb(C_2H_3O_2)_2$]?
    $Pb(C_2H_3O_2)_2$ (aq) + 2 KI (aq) → $PbI_2$ (s) + 2 K $C_2H_3O_2$ (aq)
29. How many grams of precipitate ($Hg_2Cl_2$) would be formed from a solution containing 102.9 g of mercury ions that are reacted with chloride ions as follows?
    $2\ Hg^+$ (aq) + $2\ Cl^-$ (aq)→ $Hg_2Cl_2$ (s)
30. You were hired by a laboratory to recycle 6 moles of silver ions. You were given 150. g of copper. How many grams of silver can you recover using the following reaction? Is this enough copper to recycle 6 moles of silver ions?

$2\ Ag^{+} + Cu \rightarrow 2\ Ag + Cu^{2+}$

31. Fermentation converts sugar into ethanol and carbon dioxide. If you were to ferment a bushel of apples containing 235 g of sugar, what is the maximum amount of ethanol in grams that would be produced?

    $C_6H_{12}O_6 \rightarrow 2\ C_2H_6O + 2\ CO_2$

32. The reaction between potassium chlorate and red phosphorus is highly exothermic and takes place when you strike a match on a matchbox. If you were to react 52.9 g of potassium chlorate ($KClO_3$) with red phosphorus, how many grams of tetraphosphorus decaoxide ($P_4O_{10}$) would be produced?

    $KClO_3\ (s) + P_4\ (s) \rightarrow P_4O_{10}\ (s) + KCl\ (s)$ (**unbalanced**)