AP Chemistry
Summer Review
Santa Fe High School 2016-2017

Welcome to the wonderful world of AP Chemistry! I'm looking forward to the school year and the work we're going to do together. This packet is meant to refresh you on several things you already learned so that you have them firmly in mind for the start of school. Information is also included on the lab notebook you need to purchase and have with you the first week of school. I recommend that you take home your Pre-AP Chemistry notes, and start looking at this material several weeks before school starts in the fall.

1. **lab notebook**: this is a required purchase. I recommend that you buy this now or at the *beginning* of the summer, so that you are not competing with college students trying to get their notebooks in August.
2. **AP Exam Review book (ie, Princeton Review, Fast Track to a 5, Crash Course, etc)**: this is an optional purchase. I would NOT get a book during the summer, because publishers usually revise their books. Wait until the spring semester to purchase a review book.
3. **Polyatomic ions**: the polyatomic ions on page 2 should be memorized. Rather than trying to memorize them by brute force, look at the patterns related to the periodic table and the numbers of oxygen atoms. You already know most of these!
4. **Solubility rules**: the solubility rules on page 3 should be memorized. This is the same information you got in Pre-AP Chemistry.
5. **Nomenclature**: the practice sheet on page 4 is a review over basic name and formula writing. You should be able to do these with one hand tied behind your back!
6. **Chemical equations**: the sheet on page 5 has various reactions for which you have to predict the products and balance the equations. Review your notes on reaction types and products of decomposition reactions for this section.
7. **Short answer problems**: The practice problems starting on page 6 are a sampling of different problems taken directly from previous AP exams. You already know how to do all of them, but you might not have seen them put together in this way before.

This work is meant to get your brain back into Chemistry mode before school starts. We will not spend any time reviewing these things in school—I'll just assume you know it all! ☺

Polyatomic Ions Containing Non-metals and Oxygen

Group IIIB or 13	Group IVB or 14	Group VB or 15	Group VIB or 16	Group VIIIB or 17
Charge -3	Charge -2	Charge -1		
BO_3^{-3} borate	CO_3^{-2} carbonate	NO_3^{-1} nitrate NO_2^{-1} nitrite	O	F
	SiO_3^{-2} silicate	PO_4^{-3} phosphate PO_3^{-3} phosphite	SO_4^{-2} sulfate SO_3^{-2} sulfite	ClO_4^{-1} perchlorate ClO_3^{-1} chlorate ClO_2^{-1} chlorite ClO^{-1} hypochlorite
		AsO_4^{-3} arsenate AsO_3^{-3} arsenite	SeO_4^{-2} selenate SeO_3^{-2} selenite	BrO_4^{-1} perbromate BrO_3^{-1} bromate BrO_2^{-1} bromite BrO^{-1} hypobromite
		Charge -3	TeO_4^{-2} telurate TeO_3^{-2} telurite	IO_4^{-1} periodate IO_3^{-1} iodate IO_2^{-1} iodite IO^{-1} hypoiodite
			Charge -2	Charge -1

one member in the ion family

two members in the ion family

four members in the ion family

Remember:
- ions with the greater # of oxygens: ATE
- ions with the fewer # of oxygens: ITE
- adding hydrogen in front makes BI and reduces charge by 1

Other important polyatomic ions to remember:

acetate	$C_2H_3O_2^{-1}$	chromate	CrO_4^{-2}	Bisulfite	HSO_3^{-1}
hydroxide	OH^{-1}	dichromate	$Cr_2O_7^{-2}$	Bisulfate	HSO_4^{-1}
permanganate	MnO_4^{-1}	peroxide	O_2^{-2}	Bicarbonate	HCO_3^{-1}
cyanide	CN^{-1}	oxalate	$C_2O_4^{-2}$	Biphosphite	HPO_3^{-2}
hydronium	H_3O^{+1}	thiosulfate	$S_2O_3^{-2}$	Biphosphate	HPO_4^{-2}
ammonium	NH_4^{+1}	tartrate	$C_2H_4O_6^{-2}$	hydrogen biphosphite	$H_2PO_3^{-1}$

Solubility Rules

1. All salts formed from Group IA elements and ammonium are soluble.
   KClO4 is only slightly soluble.

2. All salts formed from Group VIIA elements are soluble except for those containing silver, mercury(I), lead and copper.
   Lead(II) chloride is soluble in hot water.
   Mercury (II) iodide is insoluble.
   The oxychlorides of bismuth and antimony, BiOCl and SbOCl are insoluble.

3. All acetates, nitrates and chlorates are soluble.
   Silver acetate is only slightly soluble.

4. Sulfates are soluble except for those containing barium, strontium and lead.
   Calcium sulfate, silver sulfate, and mercury (I) sulfate are slightly soluble.

5. Carbonates, phosphates, hydroxides, oxides, sulfites, sulfides, silicates and chromates are insoluble except for those which contain rule 1 cations.
   Lithium phosphate is only slightly soluble.
   Hydroxides of calcium, strontium, and barium are slightly soluble.

Nomenclature: Name and Formula Writing Practice

Formula	Name
1. P_4O_{10}	
2. $ZnAt_2$	
3. SBr_6	
4. CaF_2	
5. P_2S_3	
6.	carbon monoxide
7.	sodium hydride
8.	aluminum selenide
9.	xenon hexafluoride
10.	dinitrogen monoxide
11. $KClO_3$	
12. $Pb(OH)_2$	
13. $Ca(MnO_4)_2$	
14. N_2O_4	
15. $Ti(HPO_4)_2$	
16.	manganese (VII) oxide
17.	francium dichromate
18.	copper (II) dihydrogen phosphate
19.	silver chromate
20.	ammonium oxalate
21. $(NH_4)_2SO_3$	
22. $Ni_3(PO_4)_2$	
23. $Fe(IO_2)_3$	
24. $NaBrO_2$	
25. H_3PO_3	
26.	tartaric acid
27.	hydrotellluric acid
28.	mercury (I) nitrate
29.	vanadium (V) oxide
30.	tetraphosphorous decaoxide

Reaction Completion and Balancing

In each of the equations below, the reactants are written correctly. You must write the correct products and then balance the equation. It might be useful to identify the type of chemical reaction before writing the products.

1. $CaCO_3$ →
2. $Al + O_2$ →
3. $Fe + CuSO_4$ →
4. $C_6H_{12} + O_2$ →
5. $Zn + H_2SO_4$ →
6. $Cl_2 + MgI_2$ →
7. $NaOH$ →
8. $Fe + HCl$ →
9. $NaOH + H_3PO_4$ →
10. $(NH_4)_2SO_4 + Ca(OH)_2$ →
11. $AgNO_3 + K_2SO_4$ →
12. $Mg(OH)_2 + H_3PO_4$ →
13. $Na + H_2O$ →
14. $KClO_3$ →
15. $Al_2(SO_4)_3 + Ca_3(PO_4)_2$ →
16. $SO_2 + H_2O$ →
17. $(NH_4)_3PO_4 + Ba(OH)_2$ →
18. $Ca(OH)_2 + HNO_3$ →
19. $C_3H_8 + O_2$ →
20. $Li + S$ →

Short-Answer Problems (from previous AP Exams)

1. The reaction between silver ion and solid zinc is represented by the following equation:

   $2Ag^{+}$ (aq) + Zn (s) → Zn^{+2} (aq) + 2Ag (s)

   A 1.50 g sample of Zn is combined with 250 mL of 0.110 M $AgNO_3$ at 25°C.
   a. Identify the limiting reagent. Show calculations to support your answer.
   b. On the basis of the limiting reactant that you identified in part (i), determine the value of [Zn^{+2}] after the reaction is complete.

2. Consider the hydrocarbon pentane, C_5H_{12} (molar mass 72.15 g).
   a. Write the balanced equation for the combustion of pentane to yield carbon dioxide and water.
   b. What volume of dry carbon dioxide, measured at 25°C and 785 mmHg, will result from the complete combustion of 2.50 g pentane?
   c. The complete combustion of 5.00 g of pentane releases 243 kJ of heat. On the basis of this information, calculate the value of ΔH for the complete combustion of one mole of pentane.

3. A student is asked to determine the molar enthalpy of neutralization, ΔH_{neut}, for the reaction: H^{+} (aq) + OH^{-} (aq) → H_2O (*l*) The student combines equal volumes of 1.0M HCl and 1.0 M NaOH in an open polystyrene cup calorimeter. The heat released by the reaction is determined by using the equation q = mc ΔT.

   Assume the following:
   - Both solutions are at the same temperature before they are combined.
   - The densities of all the solutions are the same as that of water.
   - Any heat lost to the calorimeter or to the air is negligible.
   - The specific heat capacity of the combined solutions is the same as that of water.

   a. Give appropriate units for each of the terms in the equation q = mc ΔT.
   b. List the measurements that must be made in order to obtain the value of q.
   c. Explain how to calculate each of the following.
      i. The number of moles of water formed during the experiment.
      ii. The value of the molar enthalpy of neutralization, ΔH_{neut}, for the reaction between HCl (aq) and NaOH (aq).
   d. The student repeats the experiment with the same equal volumes as before, but this time uses 2.0 M HCl and 2.0 M NaOH.
      i. Indicate whether the value of q increases, decreases, or stays the same when compared to the first experiment. Justify your prediction.
      ii. Indicate whether the value of the molar enthalpy of neutralization, ΔH_{neut}, increases, decreases, or stays the same when compared to the first experiment. Justify your prediction.
   e. Suppose that a signification amount of heat were lost to the air during the experiment. What effect would this have on the calculated value of the molar enthalpy of neutralization ΔH_{neut}? Justify your answer.

4. Use the principles of atomic structure and/or chemical bonding to explain each of the following. In each part, your answer must include references to <u>both</u> substances.
    a. The atomic radius of Li is larger than that of Be.
    b. The second ionization energy of K is greater than the second ionization energy of Ca.
    c. The carbon-to-carbon bond energy in C_2H_4 is greater than it is in C_2H_6.
    d. The boiling point of Cl_2 is lower than the boiling point of Br_2.

5. A student is given the task of determining the I^- content of tablets that contain KI and an inert, water-soluble sugar as a filler. A tablet is dissolved in 50.0 mL of distilled water and an excess of 0.20 M $Pb(NO_3)_2$ (aq) is added to the solution. A yellow precipitate forms, which is then filtered, washed, and dried. The data from the experiment are shown here:

Mass of KI tablet	0.425 g
Mass of thoroughly dried filter paper	1.462 g
Mass of filter paper + precipitate after first drying	1.775 g
Mass of filter paper + precipitate after second drying	1.699 g
Mass of filter paper + precipitate after third drying	1.698

    a. For the chemical reaction that occurs when the precipitate forms,
        i. write a balanced, net-ionic equation for the reaction, and
        ii. explain why the reaction is best represented by a net-ionic equation.
    b. Explain the purpose of drying and weighing the filter paper with the precipitate three times.
    c. In the filtrate solution, is $[K^+]$ greater than, less than, or equal to $[NO_3^-]$? Justify your answer.
    d. Calculate the number of moles of precipitate that is produced in the experiment.
    e. Calculate the mass percent of I^- in the tablet.
    f. In another trial, the student dissolves a tablet in 55.0 mL of water instead of 50.0 mL of water. Predict whether the experimentally determined mass percent of I^- will be greater than, less than, or equal to the amount calculated in part (e). Justify your answer.