2022-2023 AP Chemistry

Summer Packet

The following items must be completed by the first day of class. Take the time throughout the summer to complete these review assignments. You need to know how to do this before AP Chemistry starts. We will do a quick review of this material during the first week and will take a test over it on the **second day of classes**.

BY THE END OF SUMMER, YOU MUST DO THE FOLLOWING:

- Memorize "AP Chemical Naming Rules" and "POLYATOMIC IONS AND METRIC PREFIXES handouts
- Complete the "Naming Compounds" Worksheet.
- Do the homework problems for chapters 1-3 (Answers are on the last two pages).

TO HELP YOU WITH THIS TASK:

- You can look over your Chemistry I material or find out how to do these problems online if you forgot. Google these concepts - there is a lot of information online! You can also try to create a study group of students that are taking AP Chemistry and study together over the summer. A help video will be uploaded to Canvas in early July.

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AP CHEMICAL NAMING RULES:

IONIC Compounds (metal + nonmetal):

1) Name the first element. Use roman numerals for *d*-block *metals* with *more than 1 charge*.
2) Name the second elements with the *–ide* ending

Ex: **NaCl – sodium chloride**
$CuCl_2$ – copper (II) chloride

POLYATOMIC ION compounds (metal or nonmetal + polyatomic ion):

1) Use the rules for naming ionic compounds
2) Never modify the special name of the polyatomic ion (see polyatomic ions list)

Ex: **$NaHCO_3$ – sodium bicarbonate**
NH_4Cl – ammonium chloride
$Fe(NO_3)_3$ – iron (III) nitrate

Short-cuts:
sulfate (SO_4^{2-}) – *ate* ending for polyatomic ions with more oxygen atoms
sulfite (SO_3^{2-}) – *ite* ending for ions with less oxygen atoms
Ex: **nitrate (NO_3^-)** **nitrite (NO_2^-)**

COVALENT Compounds (nonmetal + nonmetal):

1) Name the first element using the proper prefix (never use *mono*-)
2) Name the second element using the proper prefix with the *–ide* ending

Ex: **NO – nitrogen monoxide**
N_2O_5 – dinitrogen pentoxide

Prefixes:

1	2	3	4	5	6	7	8	9	10
mono	*di*	*tri*	*tetra*	*penta*	*hexa*	*hepta*	*octa*	*nano*	*deca*

ACIDS (compounds beginning with hydrogen)

1) *hydrogen + halogen*
   a) name *hydro-* for H atom
   b) replace the *–ine* ending of the halogen with *–ic* ending
   c) add the word *acid*

Ex: **HCl – hydrochloric acid**

2) *hydrogen + polyatomic ion*
   a) polyatomic ion has ending:
      replace *–ate* with *–ic*
      replace *–ite* with *–ous*
   b) add the word acid

Ex: **H_2SO_4 – sulfuric acid** **H_2SO_3 – sulfurous acid**

POLYATOMIC IONS AND METRIC PREFIXES:

Cations

Ammonium NH_4^+	Hydronium H_3O^+	

Anions

-1		
Hydroxide OH^-	Cyanide CN^-	Acetate $C_2H_3O_2^-$
nitrite NO_2^-	Permanganate MnO_4^-	Bisulfide HS^-
Nitrate NO_3^-	Thiocyanate SCN^-	Dihydrogen phosphate $H_2PO_4^-$
Hydrogen sulfate (bisulfate) HSO_4^-	Hydrogen sulfite (bisulfite) HSO_3^-	Hydrogen carbonate (bicarbonate) HCO_3^-
Hypochlorite ClO^-	Hypobromite BrO^-	Hypoiodite IO^-
Chlorite ClO_2^-	Bromite BrO_2^-	Iodite IO_2^-
Chlorate ClO_3^-	Bromate BrO_3^-	Iodate IO_3^-
Perchlorate ClO_4^-	Perbromate BrO_4^-	Periodate IO_4^-
-2		
Carbonate CO_3^{-2}	Hydrogen Phosphate (biphosphate) HPO_4^{-2}	Sulfite SO_3^{-2}
Chromate CrO_4^{-2}	Oxalate $C_2O_4^{-2}$	Sulfate SO_4^{-2}
Dichromate $Cr_2O_7^{-2}$	Peroxide O_2^{-2}	Thiosulfate $S_2O_3^{-2}$
-3		
Phosphite PO_3^{-3}	Phosphate PO_4^{-3}	Arsenate AsO_4^{3-}

Prefix	Symbol	Multiplier	Exponential
peta	P	1,000,000,000,000,000	10^{15}
tera	T	1,000,000,000,000	10^{12}
giga	G	1,000,000,000	10^{9}
mega	M	1,000,000	10^{6}
kilo	k	1,000	10^{3}
hecto	h	100	10^{2}
deca	da	10	10^{1}
		1	10^{0}
deci	d	0.1	10^{-1}
centi	c	0.01	10^{-2}
milli	m	0.001	10^{-3}
micro	μ	0.000001	10^{-6}
nano	n	0.000000001	10^{-9}
pico	p	0.000000000001	10^{-12}
femto	f	0.000000000000001	10^{-15}

NAMING COMPOUNDS WORKSHEET

IONIC COMPOUNDS

Chemical Name	Chemical Formula
iron(III) phosphide	
	NiSe
lithium oxide	
nickel(I) bromide	
aluminum sulfide	
	K_2O
	Pb_3N_4
lithium arsenide	
	$CaBr_2$
copper(II) oxide	
	Zn_3N_2
	Co_2S_3
	FeO
	AgCl
	$BaCl_2$
vanadium(III) selenide	
beryllium oxide	
	Mn_2O_7
	Cu_2S
strontium sulfide	

COVALENT COMPOUNDS

Chemical Name	Chemical Formula
	$SbBr_3$
chlorine dioxide	
dinitrogen trisulfide	
	IF_5
	N_2O_3
	NH_3
phosphorus triiodide	
	P_4S_5
	XeF_6
selenium hexafluoride	
	Si_2Br_6
sulfur tetrachloride	
	B_2Si
nitrogen trifluoride	
dinitrogen monoxide	
	S_2Cl_2
dinitrogen tetroxide	
	OF_2
	Cl_2O_8
	SO_3

POLYATOMIC COMPOUNDS

Chemical Name	Chemical Formula
	$Cu(C_2H_3O_2)_2$
sodium hydroxide	
	$SnCr_2O_7$
ammonium sulfate	
	$KMnO_4$
cobalt(III) nitrate	
	K_2SO_3
zinc phosphate	
	$Sn(OH)_2$
copper(II) cyanide	
	H_2O_2
	$Cr(NO_2)_3$
	$CoCO_3$
magnesium chlorate	
	$CuHCO_3$
aluminum carbonate	
nickel(II) hydroxide	
	$Mn(NO_3)_7$
	$Ga(SO_4)_3$
	$AgNO_3$

ACIDS

Chemical Name	Chemical Formula
	HBr
	$HC_2H_3O_2$
Nitric acid	
	HNO_2
	HCN
Hypochlorous acid	
Phosphoric acid	
Hydrofluoric acid	
	H_2CO_3
Hydrochloric acid	
	$HClO_3$
Perchloric acid	
	H_2SO_4
	$H_2C_2O_4$
Sulfurous acid	
	HF
Bromic acid	
	H_2CrO4
Chlorous acid	
Hydroiodic acid	

CUMULATIVE

Chemical Name	Chemical Formula
	NH_4NO_3
dinitrogen tetroxide	
phosphoric acid	
	Mg_3P_2
barium fluoride	
	MnO
	IO_9
	$PbCrO_4$
aluminum bicarbonate	
	ZnO
	CaH_2
aluminum iodide	
iron(III) oxalate	
	SnO_2
sulfuric acid	
nitrogen dioxide	
	XeF_4
	N_2H_4
	$HClO_4$
barium phosphate	
	Fe_2O_3
boron trichloride	
	CdF_2
dinitrogen monoxide	
copper(I) acetate	
	$HgBr_2$
	PI_3
	$Fe(BrO)_2$
	HCl
silver chloride	
	CuCl
	KNO_3
carbon monoxide	
	$Pb(SO_3)_2$
	H_2SO_3
diphosphorus pentoxide	
	NH_4Cl
nitrous acid	
	K_3PO_4
magnesium hydroxide	

AP CHEMISTRY SUMMER HOMEWORK **Name_____**

CHAPTER 1

1. Express the following numbers in scientific notation: a) 0.000000027 b) 356 c) 47,764 d) 0.096
2. Express the following numbers as decimals: a) 1.52×10^{-2} b) 7.78×10^{-6} c) 8.352×10^{6}
3. What is the number of significant figures in each of the following measurements? a) 4867 mi b) 0.0056 L
   c) 60,104 ton d) 2900 g e) 40.2 g/cm3 f) 0.0000003 cm g) 0.7 min h) 4.60×10^{19} atoms
4. Carry out the following operations as if they were calculations of experimental results, and express each answer in the correct units with the correct number of significant figures:
   a) 7,310 km / 5.70 km b) $(3.26 \times 10^{-3}$mg) – $(7.88 \times 10^{-5}$ mg) c) $(4.02 \times 10^{6}$ dm) + $(7.74 \times 10^{7}$ dm)
5. Which of the following statements describe physical properties and which describe chemical properties?
   a) Iron has a tendency to rust. b) Rainwater in industrialized regions tends to be acidic.
   c) Hemoglobin molecules have a red color.
   d) When a glass of water is left out in the sun, the water gradually disappears
   e) Carbon dioxide in air is converted to more complex molecules by plants during photosynthesis.
6. Which one of the following is <u>not</u> an intensive property?
   a) density b) temperature c) melting point d) mass e) boiling point
7. Which one of the following is an intensive property?
   a) mass b) temperature c) heat content d) volume e) amount
8. Comment on whether each of the following is a homogeneous mixture or a heterogeneous mixture:
   a) Air in a closed bottle b) Air over New York City
9. Carry out the following conversions:
   a) 22.6 m to kilometers b) 25.4 mg to kilograms c) 37 nanometers to centimeters
   d) 65 km/hr to meters/s e) 1.87 g/cm^3 to lbs/m^3
10. The distance from Earth to the Moon is approximately 240,000 mi. a) What is this distance in meters? b) The Concorde SST has an air speed of about 2400 km/hr. If the Concorde could fly to the Moon, how many seconds would it take?
11. Mercury is the only metal that is a liquid at room temperature. Its density if 13.6 g/mL. How many grams of mercury will occupy a volume of 95.8 mL?
12. A piece of silver metal weighing 194.3 g is placed in a graduated cylinder containing 242.0 mL of water. The volume of water now reads 260.5 mL. From these data calculate the density of silver.
13. The following procedure was used to determine the volume of a flask. The flask was weighed dry and then filled with water. If the masses of the empty flask and filled flask were 56.12 g and 87.39 g, respectively, and the density of water is 0.9976 g/cm^3, calculate the volume of the flask in cm^3
14. Convert the following temperatures to Kelvin: a) 113 ^{o}C, the melting point of sulfur, b) 37 ^{o}C, the normal body temperature, c) 357 ^{o}C, the boiling point of mercury.
15. Chalcopyrite, the principal ore of copper (Cu), contains 34.63% Cu by mass. How many grams of Cu can be obtained from 5.11×10^{3} kg of the ore?
16. Calculate the percent error for the following measurements:
   a) The density of alcohol (ethanol) is found to be 0.802 g/mL. (True value: 0.798 g/mL)
   b) The mass of gold in an earring is analyzed to be 0.837 g. (True value: 0.864 g.)

CHAPTER 2:

1. What do we call atoms of the same elements with different mass numbers?
2. Indicate the number of protons, neutrons, and electrons in each of the following neutral species:
   a) ^{15}N b) ^{33}S c) ^{63}Cu d)^{202}Hg

3. Each of the following nuclides is used in medicine. Indicate the number of protons and neutrons in each nuclide:
   a) Phosphorus-32 b) chromium-51 c) cobalt-60 d) iodine-131
4. Write the appropriate nuclear symbol for each of the following isotopes:
   a) An isotope with 6 neutrons and 6 protons b) A Uranium isotope with 146 neutrons
   c) An isotope of lead that has a mass number of 206
5. Define, with two examples, the following terms: a) alkali metals b) alkaline earth metals, c) halogens, d) noble gases
6. Group the following elements in pairs that you would expect to show similar chemical properties: K, F, P, Na, Cl, N
7. Identify the following as elements or compounds: a) NH_3 b) N_2 c) S_8 d) NO e) CO f) CO_2 g) H_2
8. Give the number of protons and electrons in each of the following common ions:
   a) Na^+ b) Al^{3+} c) Fe^{2+} d) I^- e) N^{3-}
9. Define molecular formula and empirical formula. What are the similarities and differences between the empirical formula and molecular formula of a compound?
10. What are the empirical formulas of the following compounds? a) C_2N_2, b) C_6H_6 c) C_9H_20, d) P_4O_{10} e) B_2H_6
11. Which of the following are likely to be ionic? Which are likely to be molecular (covalent bonds)?
   a) C_2H_4 b) LiF c) $BaCl_2$ d) B_2H_6 e) KCl f) $SiCl_4$
12. One isotope of a metallic element has mass number 65 and 35 neutrons in the nucleus. The cation derived from the isotope has 28 electrons. Write the symbol for this cation.
13. Which of the following are elements, which are molecules but not compounds, which are compounds but not molecules, and which are both compounds and molecules?
   a) SO_2 b) S_8 c) Cs d) N_2O_5 e) O f) O_2 g) O_3 h) CH_4 i) KBr j) S k) P_4 l) LiF
14. What ion is each of the following most likely to form in ionic compounds:
   a) Li b) S c) I d) N e) Al f) Cs g) Mg
15. Predict the formula and name of a binary compound formed from the following elements:
   a) Na and H b) K and S c) Al and F d) Sr and Cl

CHAPTER 3

1. How many atoms are there in 5.10 moles of sulfur (S)?
2. How many moles of calcium (Ca) are in 77.4 g of Ca?
3. How many atoms are present in 3.14 g of copper (Cu)?
4. Only two isotopes of copper occur naturally, ^{63}Cu (mass = 62.9298 amu; abundance 69.09 percent) and ^{65}Cu (mass = 64.9278 amu; abundance 30.91 percent). Calculate the average atomic mass (atomic weight) of copper.
5. Calculate the molar mass of the following substances: a) Li_2CO_3 b) CS_2 c)$CHCl_3$ d)$C_6H_8O_6$
6. Calculate the molar mass of a compound if 0.372 mole of it has a mass of 152 g.
7. Calculate the percent carbon in capsaicin, $C_{18}H_{27}NO_3$, the compound that gives the hot taste to chili peppers.
8. What are the empirical formulas of the compounds with the following compositions?
   a) 2.1 percent H, 65.3 percent O, 32.6 percent S b) 20.2 percent Al, 79.8 percent Cl
9. What is the molecular formula of each of the following compounds?
   a) empirical formula CH_2, molar mass = 84 g/mol b) empirical formula NH_2Cl, molar mass = 51.5 g/mol
10. Allicin is the compound responsible for the characteristic smell of garlic. An analysis of the compound gives the following percent composition by mass: C: 44.4%, H: 6.21%, S: 39.5 %, O: 9.86%. Calculate its empirical formula. What is its molecular formula given that its molar mass is about 162 g?
11. Why must a chemical equation be balanced? What law is obeyed by a balanced chemical equation?

12. Balance the following equations:

a) $KClO_3 \rightarrow KCl + O_2$ b) $KNO_3 \rightarrow KNO_2 + O_2$ c) $NH_4NO_3 \rightarrow N_2O + H_2O$ d) $NH_4NO_2 \rightarrow N_2 + H_2O$

e) $NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$ f) $P_4O_{10} + H_2O \rightarrow H_3PO_4$ g) $HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$

h) $Al + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2$ i) $CO_2 + KOH \rightarrow K_2CO_3 + H_2O$ j) $CH_4 + O_2 \rightarrow CO_2 + H_2O$

k) $Be_2C + H_2O \rightarrow Be(OH)_2 + CH_4$ l) $Cu + HNO_3 \rightarrow Cu(NO_3)_2 + NO + H_2O$

m) $S + HNO_3 \rightarrow H_2SO_4 + NO_2 + H_2O$ n) $NH_3 + CuO \rightarrow Cu + N_2 + H_2O$

13. Write the balanced chemical equation for a) the complete combustion of butyric acid, $C_4H_8O_2$, a compound produced when butter becomes rancid. b) the decomposition of solid copper(II) hydroxide into solid copper(II) oxide and water vapor. c) the combination reaction between zinc metal and chlorine gas.

14. Write balanced chemical equations to correspond to each of the following descriptions: a) solid calcium carbide, CaC_2, reacts with water to form an aqueous solution of calcium hydroxide and acetylene gas, C_2H_2. b) When solid potassium chlorate is heated, it decomposes to form solid potassium chloride and oxygen gas. c) solid zinc metal reacts with sulfuric acid to form hydrogen gas and an aqueous solution of zinc sulfate.

15. Silicon tetrachloride ($SiCl_4$) can be prepared by heating Si in chlorine gas:

$Si(s) + 2Cl_2(g) \rightarrow SiCl_4(l)$

In one reaction, 0.507 mole of $SiCl_4$ is produced. How many moles of molecular chlorine were used in the reaction?

16. Nitrous oxide (N_2O) is also called "laughing gas." It can be prepared by the thermal decomposition of ammonium nitrate (NH_4NO_3). The other product is H_2O. a) Write a balanced equation for this reaction. b) How many grams of N_2O are formed if 0.46 mole of NH_4NO_3 is used in the reaction?

17. Calculate the mass in grams of iodine (I_2) that will react completely with 20.4 g of aluminum (Al) to form aluminum iodide (AlI_3). Hint: first write out and balance the equation.

18. Nitric oxide (NO) reacts instantly with oxygen gas to form nitrogen dioxide (NO_2), a dark-brown gas:

$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$

In one experiment 0.886 mole of NO is mixed with 0.503 mole of O_2. Calculate which of the two reactants is the limiting reagent. Calculate also the number of moles of NO_2 produced.

19. The depletion of ozone (O_3) in the stratosphere has been a matter of great concern among scientists in recent years. It is believed that ozone can react with nitric oxide (NO) that is discharged from the high-altitude jet plane, the SST. The reaction is: **$O_3 + NO \rightarrow O_2 + NO_2$**

If 0.740 g of O_3 reacts with 0.670 g of NO, how many grams of NO_2 will be produced? Which compound is the limiting reagent? Calculate the number of moles of the excess reagent remaining at the end of the reaction.

20. Consider the reaction: **$MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$**

If 0.86 mole of MnO_2 and 48.2 g of HCl react, which reagent will be used up first? How many grams of Cl_2 will be produced?

21. Nitroglycerin ($C_3H_5N_3O_9$) is a powerful explosive. Its decomposition may be represented by

$4C_3H_5N_3O_9 \rightarrow 6N_2 + 12CO_2 + 10H_2O + O_2$

This reaction generates a large amount of heat and many gaseous products. It is the sudden formation of these gases, together with their rapid expansion, that produces the explosion. a) What is the maximum amount of O_2 in grams that can be obtained from 2.00×10^2 g of nitroglycerin? b) Calculate the percent yield in this reaction if the amount of O_2 generated is found to be 6.55g.

22. A sample of a compound of Cl and O reacts with an excess of H_2 to give 0.233 g of HCl and 0.403 g of H_2O. Determine the empirical formula of the compound.

23. When 0.273 g of Mg is heated strongly in a nitrogen (N_2) atmosphere, a chemical reaction occurs. The product of the reaction weighs 0.378 g. Calculate the empirical formula of the compound containing Mg and N.

ANSWERS:

CHAPTER 1:

1. a) 2.7×10^{-8} b) 3.56×10^{2} c) 4.7764×10^{4} d) 9.6×10^{-2}
2. a) 0.0152 b) 0.00000778 c) 8,352,000
3. a) 4 b) 2 c) 5 d) 2 e) 3 f) 1 g) 1 h) 3
4. a) 1,280 b) 3.18×10^{-3} mg c) 8.14×10^{-7} dm
5. a) chemical b) chemical c) physical d) physical e) chemical
6. d) mass
7. b) temperature
8. a) homogeneous b) heterogeneous
9. a) 0.0226 km b) 2.54×10^{-5} kg c) 3.7 X 10-6 cm d) 18 m/s e) 4.11×10^{3} lbs/m^3
10. a) 3.8×10^{8} m b) 5.7×10^{5} seconds
11. 1.30×10^{3} grams
12. 10.50 g/mL
13. 31.35 cm^3
14. a) 386 K b) 310 K c) 630 K
15. 1.77×10^{6} g
16. a) 0.501 % b) 3.13 %

CHAPTER 2:

1. Isotopes
2. a) p = 7 n = 8 e = 7 b) p = 16 n = 17 e = 16 c) p = 29 n = 34 e = 29 d) p = 80 n = 122 e = 80
3. a) p = 15 n = 17 b) p = 24 n = 27 c) p = 27 n = 33 d) p = 53 n = 78
4. a) ^{12}C b) ^{238}U c) ^{206}Pb
5. a) group 1A elements: Li, Na b) group 2A elements: Mg, Ca
   c) group 7A elements: Cl, Br d) group 8A elements: He, Ne
6. K and Na P and N F and Cl
7. a) compound b) element c) element d) compound e) compound f) compound g) element
8. a) p = 11 e = 10 b) p = 13 e = 10 c) p = 26 e = 24 d) p = 53 e = 54 e) p = 7 e = 10
9. molecular formula = the actual formula of the compound empirical formula = the most reduced version of the formula. The molecular formula is a whole number multiple of the empirical formula
10. a) CN b) CH c) C_9H_2O d) P_2O_5 e) BH_3
11. a) molecular b) ionic c) ionic d) molecular e) ionic f) in between ionic and molecular
12. Zn^{2+}
13. a) molecule and compound b) molecule but not compound c) element d) molecule and compound
    e) element f) molecule but not compound g) molecule but not compound
    h) molecule and compound i) compound but not molecule j) element k) molecule but not compound
    l) compound but not molecule
14. a) Li^{+} b) S^{2-} c) I^{-} d) N^{-3} e) Al^{3+} f) Cs^{+} g) Mg^{2+}
15. a) NaH, sodium hydride b) K_2S, potassium sulfide c) AlF_3, aluminum fluoride d) $SrCl_2$, strontium chloride

CHAPTER 3

1. 3.07 x 10^{24} atoms
2. 1.93 mol Ca
3. 2.98 X 10^{22} atoms Cu
4. 63.55 amu
5. 73.89 g/mol b) 76.14 g/mol c) 119.37 g/mol d) 176.14 g/mol
6. 408 g/mol
7. 70.8% Carbon
8. a) H_2SO_4 b) $AlCl_3$
9. a) C_6H_{12} b) NH_2Cl
10. $C_6H_{10}S_2O$ (empirical formula); $C_6H_{10}S_2O$ (molecular formula)
11. The law of mass conservation: matter can neither be created nor destroyed
12. On your own
13. On your own
14. On your own
15. 1.01 mol Cl_2
16. A) $NH_4NO_3(s) \rightarrow N_2O(g) + 2H_2O(g)$ b) 20 g N_2O
17. 288 g I_2
18. NO limiting reagent, 0.886 mol NO_2 produced
19. O_3 is the limiting reactant. 0.709 g NO_2 is produced and 6.9 X 10^{-3} mol NO (excess reactant) remains
20. HCl is the limiting reactant and will be used up first. 23.4 g Cl_2 will be formed.
21. a) 7.05 g O2 b) 92.9%
22. Cl_2O_7
23. Mg_3N_2 (Magnesium Nitride)