

Welcome Letter:

Dear AP Chemistry Students,

Welcome to one of the most challenging and rewarding science courses at Morris Catholic! AP Chemistry moves at a fast pace and focuses on critical thinking, creative problem-solving, and scientific reasoning!

To help us dive straight into the college-level content, you must complete the mandatory **Summer Assignment**. It is mostly a review of foundational chemistry, and it is due during the first week of school as your first grade.

Here is what you need to know to prepare:

- **Helpful Videos:** Most sections include video links to refresh your memory on tough/new concepts.
- **Get Support:** If you have questions over the summer, please email me at **pnarayanan@morriscatholic.org**.
- **First Week Schedule:** We will cover the syllabus and start new lessons on Days 1 and 2. On Day 3, you will be taking a quiz based on the content of this summer packet.
- **Study Books (Optional):** You do not need to buy anything, as we will use free resources like AP Classroom and Khan Academy. However, if you want a supplemental study guide, I recommend *Barron's* or *The Princeton Review*.

You are not expected to know *everything* before the first day of class. But you should come in **prepared** with the Summer Work completed. You should come in with a solid chemistry foundation. You are expected to arrive curious, prepared, and ready to grow as a scientist!

I look forward to working with you this year! Have a wonderful summer! See you in August!

Sincerely,

– **Ms. Priyanka** (AP Chemistry Teacher, Director (Advanced Science Academy))

Summer Assignment (Mandatory)

- **Purpose:** Reviews foundational chemistry concepts to save classroom time.
- **Due Date:** First week of class (counts as your first grade).
- **Resources:** Most sections include instructional videos to help you review/re-learn concepts. Purchasing a prep book is suggested but not required.
- **Help:** Email questions to **pnarayanan@morriscatholic.org**

What to Memorize:

Charges of Ions based on the Periodic Table

AP CHEMISTRY IONIC CHARGE CHEAT SHEET

[GROUP 1] Alkali Metals (+1)	--> Li ⁺ , Na ⁺ , K ⁺ , Rb ⁺ , Cs ⁺
[GROUP 2] Alkaline Earth (+2)	--> Mg ²⁺ , Ca ²⁺ , Sr ²⁺ , Ba ²⁺
[GROUP 13] Aluminum Group (+3)	--> Al ³⁺
[GROUP 15] Pnictogens (-3) (Nitrogen family)	--> N ³⁻ (Nitride), P ³⁻ (Phosphide)
[GROUP 16] Chalcogens (-2) (Oxygen family)	--> O ²⁻ (Oxide), S ²⁻ (Sulfide)
[GROUP 17] Halogens (-1)	--> F ⁻ , Cl ⁻ , Br ⁻ , I ⁻

FIXED-CHARGE TRANSITION METAL EXCEPTIONS

- Silver: Ag⁺ (Always +1)
- Zinc: Zn²⁺ (Always +2)
- Cadmium: Cd²⁺ (Always +2)

The following are variable charges / transition metals

- Fe: Iron +2 or +3
 - Cu: Copper +1 or +2
 - Sn: Tin +2 or +4
 - Pb: Lead +2 or +4
-
-

Diatomic Molecules:

- There are 7 of them
 - **Hydrogen** (H₂), **Nitrogen** (N₂), **Oxygen** (O₂), **Fluorine** (F₂), **Chlorine** (Cl₂), **Bromine** (Br₂) and **Iodine** (I₂).
 - Acronym: **B**eautiful **I**slands **N**aturally **C**reate **L**akes, **H**ills, **O**ceans, & **F**orests
-
-

Acids & Bases

- List of Strong Acids (names and formulas, there are six of them)
- List of Strong Bases (names and formulas, typical ionic compounds, there's 8 of them)

AP CHEMISTRY STRONG ACIDS & BASES

[THE 6 STRONG ACIDS]

- HCl - Hydrochloric Acid
- HBr - Hydrobromic Acid
- HI - Hydroiodic Acid
- HNO₃ - Nitric Acid
- HClO₄ - Perchloric Acid
- H₂SO₄ - Sulfuric Acid (Diprotic; only first H⁺ is strong)

Memory Mnemonic: "Imagine a Hippo, Bear, and Ion wearing a NO₃-hat, a ClO₄-cape, and riding a SO₄-scooter."

[THE 8 STRONG BASES]

Group 1 (Alkali Metals):

- LiOH - Lithium Hydroxide
- NaOH - Sodium Hydroxide
- KOH - Potassium Hydroxide
- RbOH - Rubidium Hydroxide
- CsOH - Cesium Hydroxide

Group 2 (Alkaline Earth Metals - Yields 2 moles of OH⁻):

- Ca(OH)₂ - Calcium Hydroxide
- Sr(OH)₂ - Strontium Hydroxide
- Ba(OH)₂ - Barium Hydroxide

* Memory Mnemonic*: Look at their layout on the periodic table. They form a perfect capital letter "L" down Group 1 and over to Group 2!

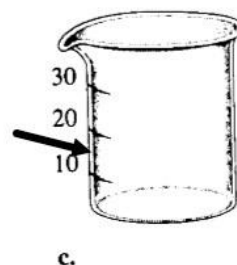
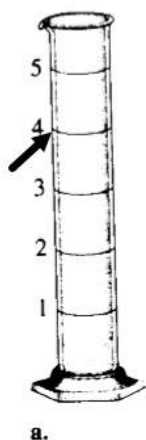
Practice Problems

→ In addition to acquiring the correct answers, be sure you understand.

→ Use significant figures throughout, unless you are solving for an integer.

CHAPTER 1

- For each of the following pieces of glassware, provide a sample measurement at arrow and discuss the number of significant figures and uncertainty.



Video Link: Percent Error-
<https://www.youtube.com/watch?v=7LyLjdBdy0c>

- Calculate the percent error for the following measurements.
 - The density of an aluminum block determined in an experiment was 2.64 g/ml. (Accepted value = 2.70 g/ml)
 - The experimental determination of iron in ore was 16.48%. (Theoretical value was 16.12%)

- How many significant figures are in each of the following?

- 12
- 1098
- 2001
- 2.001×10^3
- 100
- 0.0000101
- 1000.
- 22.04030
- 1.00×10^3

Video Link: Sig Figs-
<https://www.youtube.com/watch?v=a-YOjZOODVv>

- Round of each of the following numbers to two significant figures, and write the answers in scientific notation.

- 0.00031254
- 31,254,000
- 35,900
- 0.00000399

Video Link: Scientific Notation-
<https://www.youtube.com/watch?v=6y35Jlz332M>

5. Use scientific notation to express the number 480 to
 - a. One significant figure
 - b. Two significant figures
 - c. Three significant figures
6. 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. $\frac{0.102 \times 0.0821 \times 273.5}{1.2}$
 - d. $(9.04 - 8.23 + 21.954 + 81.0) / 3.1416$

Video Link: Operations/Sig Figs-
<https://www.youtube.com/watch?v=djmXkaWmys>

8. You have a 1.0 cm^3 sample of lead and a 1.0 cm^3 sample of glass. You drop each in separate beakers of water. How do the volumes of water displaced by each sample compare? Explain.
 Density of lead = 11.35 g/cm^3
 Density of glass = 3.00 g/cm^3

Video Link: Density Calculations-
<https://www.youtube.com/watch?v=B4oWNI39T8k>

9. Convert the following Celsius temperatures to Kelvin.
 - a. The boiling-point temperature of ethyl alcohol, 78.1°C
 - b. A cold winter day, -25°C
 - c. The lowest possible temperature, -273°C
 - d. The melting-point temperature of sodium chloride, 801°C

Video Link: Temperature Conversions-
<https://www.youtube.com/watch?v=WQ5j0nwBmcM>

10. Taking the solubility of sugar to be $487 \text{ g} / 100 \text{ g water}$ at 100°C and $204 \text{ g} / 100 \text{ g water}$ at 20°C .
 - a. Calculate the mass of water required to dissolve one hundred grams of sugar at 100°C .
 - b. Calculate the g of sugar that remains in solution when the mixture in (a) is cooled to 20°C .

11. A sample containing 33.42 g of metal pellets is poured into a graduated cylinder initially containing 12.7 mL of water, causing the water level in the cylinder to rise to 21.6 mL . Calculate the density of the metal.

CHAPTER 2

Video Link: Atomic Structure-
<https://www.youtube.com/watch?v=poy39PW2NSA>

1. What is the distinction between atomic number and mass number?
2. What is an isotope?
3. How many protons and neutrons are contained in the nucleus of each of the following atoms?

a. ${}^{42}_{22}\text{Ti}$	d. ${}^{86}_{36}\text{Kr}$
b. ${}^{64}_{30}\text{Zn}$	e. ${}^{75}_{33}\text{As}$
c. ${}^{76}_{62}\text{Ge}$	f. ${}^{41}_{19}\text{K}$
4. Write the nuclear symbol for each of the isotopes below.
 - a. Atomic number = 8, number of neutrons = 9
 - b. Atomic number = 27, mass # = 60
 - c. Number of protons = 26, number of neutrons = 31
 - d. The isotope of Iodine with a mass number of 131
5. An element consists of 1.40% of an isotope with mass 203.973 amu, 24.10% of an isotope with mass 205.9745 amu, 22.10% of an isotope with mass 206.9759 amu, and 52.40% of an isotope with mass 207.9766 amu. Calculate the average atomic mass and identify the element.

Video Link: Average Atomic Mass-
<https://www.youtube.com/watch?v=67jAVf-l--s>

Video Link: Periodic Table Families-
https://www.youtube.com/watch?v=gFfug4V_-sw

6. In the periodic table, what is the name of the following groups
 - a. Group (1)
 - b. Group (2)
 - c. Group (17)
 - d. Group (18)
7. An ion contains 50 protons, 68 neutrons, and 48 electrons. What is its symbol and charge?
8. Identify each of the following elements:
 - a. A member of the same family as oxygen whose most stable ion contains 54 electrons
 - b. A member of the alkali metal family whose most stable ion contains 36 electrons
 - c. A noble gas with 18 protons in the nucleus
 - d. A halogen with 85 protons and 85 electrons
9. Would you expect each of the following atoms to gain or lose electrons when forming ions? What ion is the most likely in each case?

a. Na	d. Ba	g. Al
b. Sr	e. I	h. S
c. P	f. O	
10. For each of the following ions, indicate the total number of protons and electrons in the ion. For the positive ions, predict the formula of the simplest compound formed between itself and oxide. For the negative ions predict the simplest compound formed between itself and aluminum.

a. Fe^{+2}	d. Cs^{+1}	g. Br^{-1}
b. Fe^{+3}	e. S^{-2}	h. N^{-3}
c. Ba^{+2}	f. P^{-3}	
11. An element's most stable ion forms an ionic compound with bromine, having the formula XBr_2 . If the ion of element X has a mass number of 230 and 86 electrons, what is the identity of the element, and how many neutrons does it have?

Writing Formulas and Naming Compounds – You may use a generic periodic table but Do WITHOUT an ion chart!

1. Name each of the following compounds:

a. NaCl	h. AlI_3	o. BaSO_3
b. Rb_2O	i. Al_2O_3	p. KMnO_4
c. FeBr_3	j. ZnCl_2	q. Sr_3P_2
d. Cr_2O_3	k. Li_3N	r. $\text{Ca}_3(\text{PO}_4)_2$
e. CaBr_2	l. Ag_2S	s. $\text{Pb}(\text{NO}_3)_2$
f. CsF	m. KClO_3	
g. CaS	n. $\text{Al}_2(\text{SO}_4)_3$	
2. Name each of the following compounds:

a. NI_3	d. ICl_3
b. PCl_3	e. SF_2
c. SO_2	f. N_2F_4
3. Name each of the following compounds:

a. HCl	c. HNO_3
b. HI	d. H_3PO_4
	e. H_2SO_4
4. Name each of the following compounds:

Video Link: Naming Compounds-
<https://www.youtube.com/watch?v=nijb6UMvZuE>

- | | |
|--------------------------------------|---------------------------------|
| a. HgO | j. ICl |
| b. CuI | k. $\text{Pb}_3(\text{PO}_4)_2$ |
| c. CuI_2 | l. KIO_3 |
| d. CoI_2 | m. $\text{Ca}(\text{OH})_2$ |
| e. Na_2CO_3 | n. CoS |
| f. NaHCO_3 | o. S_3N_4 |
| g. $\text{HC}_2\text{H}_3\text{O}_2$ | p. SF_6 |
| h. NH_4NO_3 | q. NaSCN |
| i. Co_2S_3 | r. BaCrO_4 |

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

- Cesium bromide
- Barium sulfate
- Chlorine trifluoride
- Ammonium chloride
- Beryllium oxide
- Chlorine monoxide
- Magnesium fluoride
- Sulfur difluoride
- Sulfur hexafluoride
- Sodium dihydrogen phosphate
- Silicon tetrachloride
- Lithium nitride
- Chromium (III) carbonate
- Tin (II) fluoride
- Ammonium acetate
- Ammonium hydrogen sulfate
- Cobalt (III) nitrate
- Copper (I) sulfide
- Potassium chlorate

Video Link: Writing Formulas-

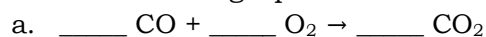
<https://www.youtube.com/watch?v=l7GsWcTlq74>

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

- Sodium oxide
- Sodium peroxide
- Potassium cyanide
- Copper (II) nitrate
- Silicon tetrafluoride
- Lead (II) sulfide
- Lead (IV) sulfide
- Lead (IV) sulfate
- Copper (I) chloride
- Zinc (II) sulfide
- Ammonium hydrogen phosphate
- Hydrobromic acid
- Perchloric acid
- Silicon dioxide
- Sodium sulfate

CHAPTER 3 – Stoichiometry

1. Balance the following equations:



Video Link: Balancing Equations-
<https://www.youtube.com/watch?v=zmdxMlb88Fs>

- b. $\text{N}_2\text{O}_5 + \text{H}_2\text{O} \rightarrow \text{HNO}_3$
- c. $\text{PCl}_5 + \text{H}_2\text{O} \rightarrow \text{H}_3\text{PO}_4 + \text{HCl}$
- d. $\text{CH}_4 + \text{Br}_2 \rightarrow \text{CBr}_4 + \text{HBr}$
- e. $\text{C}_5\text{H}_{10}\text{O}_2 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
- f. $\text{Cr}(\text{OH})_3 + \text{HClO}_4 \rightarrow \text{Cr}(\text{ClO}_4)_3 + \text{H}_2\text{O}$
- g. $\text{KNO}_3 \rightarrow \text{KNO}_2 + \text{O}_2$
- h. $\text{La}_2\text{O}_3 + \text{H}_2\text{O} \rightarrow \text{La}(\text{OH})_3$
- i. $\text{NCl}_3 + \text{H}_2\text{O} \rightarrow \text{NH}_3 + \text{HOCl}$
- j. $\text{Mg}_3\text{N}_2 + \text{HCl} \rightarrow \text{MgCl}_2 + \text{NH}_4\text{Cl}$
- k. $\text{AgNO}_3 + \text{K}_2\text{SO}_4 \rightarrow \text{Ag}_2\text{SO}_4 + \text{KNO}_3$
- l. $\text{Al}(\text{OH})_3 + \text{H}_2\text{SO}_4 \rightarrow \text{Al}_2(\text{SO}_4)_3 + \text{H}_2\text{O}$
- m. $\text{CH}_3\text{NH}_2 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{N}_2$
- n. $(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \rightarrow \text{Cr}_2\text{O}_3 + \text{N}_2 + \text{H}_2\text{O}$

2. Write balanced chemical equations to correspond to each of the following descriptions. (include states) ***Also, pay attention to what is happening in each. These are great to have in your toolbox of known reactions.**
- a. When solid ammonium carbonate is heated it decomposes to form gaseous ammonia, carbon dioxide, water.
 - b. Zinc metal reacts with hydrochloric acid to form hydrogen gas and an aqueous solution of zinc(II) chloride.
 - c. Nitrogen gas and hydrogen gas react to form ammonia gas.
 - d. Aqueous hydrogen peroxide with a catalyst decomposes into liquid water and oxygen gas.
 - e. Aqueous sodium chloride reacts with aqueous silver(I) nitrate to form solid silver(I) chloride and aqueous sodium nitrate.
 - f. Methane gas reacts in air to form gaseous carbon dioxide and water vapor.
 - g. Hydrochloric acid reacts with aqueous sodium hydroxide to form water and aqueous sodium chloride.
 - h. Glucose and Oxygen react to form carbon dioxide and water.

Video Link: Writing Balanced Equations from Words-
<https://www.youtube.com/watch?v=yEdaso8vDYc>

Video Link: Grams to Moles- <https://www.youtube.com/watch?v=TFbGLEZ4qt0>

Video Link: Moles to molecules-
<https://www.youtube.com/watch?v=wRI3YyoSkto>

3. The molecular formula of aspartame, the artificial sweetener marketed as Nutrasweet, is $\text{C}_{14}\text{H}_{18}\text{N}_2\text{O}_5$.
- a. What is the molar mass of aspartame?
 - b. How many moles of aspartame are present in 3769.4 grams of aspartame?
 - c. How many molecules of aspartame are present in 345.9 grams of aspartame?
 - d. How many oxygen atoms are present in 23.6 grams of aspartame?
4. How many moles of ammonium ions are in 0.557 g of ammonium carbonate?
5. What is the mass, in grams, of 0.0438 moles of iron (III) phosphate?
6. What is the mass, in grams, of 2.69×10^{23} molecules of aspirin, $\text{C}_9\text{H}_8\text{O}_4$?
7. What is the molar mass of diazepam (Valium) if 0.05570 mol has a mass of 15.86 g?

8. Determine the empirical formulas of the following compounds.
- 10.4 % C, 27.8 % S, and 61.7% Cl
 - Monosodium glutamate (MSG), a flavor enhancer in certain foods, 35.51 g C, 4.77 g H, 37.85 g O, 8.29 g N, 13.60 g Na

9. Find the molecular formulas of the following compound.
 80.0% carbon, 20.0% hydrogen, molar mass = 30.0 g/mol

10. Calculate the % oxygen (by mass) in SO₂.

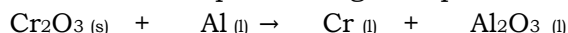
Video Link: Percent Composition-
<https://www.youtube.com/watch?v=Snnt0CpkWSM>

11. $4 \text{ FeCr}_2\text{O}_7 + 8 \text{ K}_2\text{CO}_3 + \text{O}_2 \rightarrow 2 \text{ Fe}_2\text{O}_3 + 8 \text{ K}_2\text{CrO}_4 + 8 \text{ CO}_2$
- How many grams of FeCr₂O₇ are required to produce 44.0 g of CO₂?
 - How many grams of O₂ are required to produce 100.0 g of Fe₂O₃?
 - If 300.0 g of FeCr₂O₇ react, how many grams of O₂ will be consumed?
 - How many grams of Fe₂O₃ will be produced from 300.0 g of FeCr₂O₇?
 - An experiment is run and actually produces 79.10 g of Fe₂O₃ from 300.0 g FeCr₂O₇. Calculate the % yield?

Video Link: Full Stoichiometry Practice-
<https://www.youtube.com/watch?v=IcnliC8JZg0>

12. $6 \text{ NaOH} + 2 \text{ Al} \rightarrow 2 \text{ Na}_3\text{AlO}_3 + 3 \text{ H}_2$
- How much aluminum is required to produce 17.5 g of hydrogen?
 - How much Na₃AlO₃ can be formed from 165.0 g of sodium hydroxide?
 - How many moles of NaOH are required to produce 3 g of hydrogen?
 - How many moles of hydrogen can be prepared from 1 gram of aluminum?

13. The following *unbalanced* reaction takes place at high temperatures.



If 42.7 g Cr₂O₃ and 9.8 g Al are mixed and reacted until one of the reactants is used up.

- Which reactant will be left over?
 - How much will be left?
 - How many grams of chromium will be formed?
14. Calculate the mass of water produced when 42.0 g of propane, C₃H₈, is burned with 115 g of oxygen.
15. Marathon Problem: A pleasant smelling liquid organic compound with a mass of 12.00 grams that was known to contain the elements carbon, hydrogen, and oxygen was burned producing 21.4 grams of carbon dioxide gas and 8.76 grams of water vapor. The energy from this reaction caused the temperature of 1.00 kg of water to rise from 20.8°C to 77.0°C.
- Give the molar mass of water and carbon dioxide.
 - How many molecules of carbon dioxide were formed?
 - How many atoms of hydrogen were in the original liquid?
 - Give the Lewis structure of water and carbon dioxide.
 - How many grams of oxygen were in the original liquid?
 - Determine the empirical (simplest) formula of the original compound.
 - If the 12.00 grams of liquid was vaporized at a temperature of 70°C and a pressure of 1.05 atm it would occupy 4.34 liters. Determine the molar mass of this unknown.
 - What is the molecular formula of the unknown?
 - Determine the amount of heat (in kJ) released by the 12.00 grams of unknown when it burned.
 - Determine the heat of combustion, ΔH, for the unknown in kJ/mol.
 - There are two possible structural formulas for this unknown. Give each along with their correct organic class.
 - Based on the properties of this unknown. Which of the two molecules is it?

What is Dimensional Analysis?

Background:

Dimensional analysis is a critical technique used throughout chemistry. It is a mathematical approach used to convert one unit into another unit using conversion factors. This is not the only approach used to solve this type of problem, but it is the recommended approach in terms of time and efficiency.

Instructions:

Video Link: Dimensional Analysis-

1. Watch the linked video : <https://www.youtube.com/watch?v=DsTg1CeWchc>
2. Complete below questions. Be sure to show your work. Make sure you always include the units in your answers.

Example Problem:

The density of mercury is 13.6 g/mL. What is the mass in kilograms of a 2 L commercial flask of mercury?

$$2 \text{ L} \times \frac{1000 \text{ mL}}{1 \text{ L}} \times \frac{13.6 \text{ g}}{1 \text{ mL}} \times \frac{1 \text{ kg}}{1000 \text{ g}} = 27.2 \text{ kg}$$

Conversion factors are equivalent values expressed in different units. For example, one of the of the conversion factors used above is 1000 mL = 1 L. Sometimes they will be given in the prompt (such as density of mercury) and other times they are known values and can be looked up online or in the textbook.

Conversion Factors		
1 yd = 3 ft 1 in = 2.54 cm 1 L = 1.06 qt	1 mi = 5280 ft 2 pt = 1 qt 3.785 L = 1 gal	1 ft = 12 in 1 mL = 1 cm ³ 1 kg = 2.2 lbs

Complete the problems below using the same format as the example:

1. Convert 3.55 yd to its equivalent in cm.

$$\times \text{ ————— } \times \text{ ————— } \times \text{ ————— } =$$

2. Convert 143.55 mL to its equivalent in pints.

3. Lake Michigan holds 1.3×10^{15} gallons of water. How many liters is this?

4. The average American student is in class for 330 minutes/day. How many hours/day is this?

5. Chicago uses 1.2×10^9 gallons of water /day. How many gallons per second must be pumped from the lake every second to supply the city?

6. What is the cost to drive to Los Angeles from San Francisco (a distance of 405 miles) if the cost of gasoline is \$2.90 a gallon and the car gets 25 miles per gallon of gas?

$\times \text{————} \times \text{————} \times \text{————} =$

7. The speed of light is 3.0×10^{10} cm/s. Express this in mi/hr.

$\times \text{————} \times \text{————} \times \text{————} =$

8. An ounce of coffee contains 12 mg of caffeine, while a dark chocolate Hershey's kiss contains 2.2 mg of caffeine. How many Hershey's kisses contain as much caffeine as a cup (8.0 oz) of coffee?

9. Convert a density of 13.6 g/mL to its equivalent in lb/ft³.

10. A sample of sea water contains 0.075 g of sodium chloride per mL of solution. How many moles of sodium chloride are there one liter of this solution? (1 mole of sodium chloride = 58.5 g of sodium chloride)