A.P. Chemistry 2023 – 2024 Summer Work

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WELCOME to A.P. Chemistry!

We will try our best to cover all the topics and the required labs for the AP Exam that is in early May. All of you will find A.P. Chemistry to be challenging and some of you will find it to be down-right hard. There is a lot to cover and while we can do it, we will all need to work very hard. You should expect this class to be more difficult than your first chemistry class but also more relaxed and with lots of lab time. Since there is so much material to learn (2 semesters of college chemistry), we must stay on schedule to get through everything before the test. This means that we cannot slow down if you don't understand a topic. Many students who take A.P. classes are also involved in other activities that will take them away from class. You need to make sure that you are staying current with all assignments and come in for help if you are falling behind. Please communicate with me so that I can best support your efforts. I understand that you will have other things going on next year too.

We need to use our class time effectively during the upcoming year, and the goal of the summer work is to review/preview material. This summer assignment is designed to help you prepare to take A.P. Chemistry by helping you review important
chemistry and math topics that are prerequisites. Rushing though this summer assignment the day before school starts is an ineffective method for reviewing this material. Your focus should be on the learning. Students are encouraged to work together to complete the summer assignment. Think study group, not copying. You should spread out the assignment over a few weeks in June. You will have an opportunity to ask questions on anything in the summer assignment by email. This assignment must be completed and ready to turn in when school starts on August 1st.

We will discuss lab safety first thing in the fall. We will do a lab the first week of class, and you **MUST** get 100% on the lab safety quiz before you can participate in chemistry lab work. You will also need a notebook and binder. This is a lab-intensive course, and we will be doing lots of labs The College Board requires lab work to make
up a minimum of 25% of our class time.

You will need to join A.P. Classroom.

AP Chemistry will be taught with the assumption that all students are taking the AP exam in the spring.

If you have any questions about any of the topics covered in this assignment, please do not hesitate to email me **kara.harris@cobbk12.org**. I will be happy to answer any questions, and I will be checking my email all summer long. I want to help you be as successful as possible in this course! I look forward to seeing all of you in the fall, and I am so excited to have you in A.P. Chemistry!

WHY DO WE HAVE TO DO SUMMER WORK?

- It is a review of some basic content you need from the beginning.
- It provides the necessary fundamentals you will need to be successful in A.P. Chemistry.
- There will not be enough time before the A.P. exam in May to reteach Chemistry 1 and cover all the material tested on the A.P. exam.
- I encourage you to take a break this summer - so, take one! I would say do this in the middle to end of July so it's fresh.
- When we start in the fall, we will hit the ground running!

SUMMER WORK ASSIGNMENT

All work should be done neatly and clearly. All work for every problem (**including units)** needs to be shown. This is an expectation on the A.P. exam in the spring and we want to make this a habit early. On the A.P. exam you must show all work including units or you will lose points. ***(Accordingly in this class and this packet, credit will NOT be given for answer only responses!***) SO, you need to show all work for every problem including

- equations you will be using (if applicable)
- knowns/unknowns (if applicable)
- plugged in equations and any algebraic work

Complete the summer work on a separate sheet paper – your choice, just make it clear to me which problem is which.

Summer Work Assignments Checklist

Part 1 – Why are you taking this course? Due by August 1st but you can turn it in early.

Email me at kara.harris@cobbk12.org with a paragraph about yourself.

Subject Line: AP Chemistry 2021-22, Your Name
Body:

- Your full name, nickname that you go by if you have one, and stuff about you!
- What other A.P. classes are you taking this year?
- What science classes have you taken? What other science classes are you taking?
- What are you looking forward to the most in A.P. Chemistry?
- What are you most anxious about in A.P. Chemistry?
- Why are you taking A.P. Chemistry? What do you hope to accomplish/gain?
    - Include any other relevant details that can help me develop a sense of who you are and
- How you learn. Describe your plan for succeeding in this class and overcoming any challenges that you will face. Also include how I can help to make this year a success for you! While you may be tempted to make this message informal, especially if I have taught you before, please keep in mind that you are representing yourself in writing in an academic setting. Therefore, you should use appropriate formatting, grammar, and language.
- Don't type this email on your phone. Hopefully, this will be the only time I'll need to remind you of this during the year. You must hold yourself to the highest academic standards in this class.

Part 2 – Review AP Chemistry Course Online

- Get a feel for what the course covers. Go to college board website https://apstudent.collegeboard.org/apcourse/apchemistry and review the course by clicking on the "AP Course Overview (PDF)" link and the "AP Chemistry Course and Exam Description (PDF)" link.

Part 3 – Complete Review Work

- This is due on August 1st. *Students are encouraged to work together to complete the work but THAT DOES NOT MEAN COPY!*

AP Chemistry Class Perception and Reality

Students need to be realistic about the expectations for this course. Many students THINK they are ready for college level work, but really don't know what that means. In order to get a more realistic view of this course, I have included some
perceptions entering students have, and the reality of the situation.

1. **PERCEPTION**: I can miss class (sports, activities, family vacations, jobs, field trips, etc.) and catch up on my own. I always have before.

REALITY: You can't!!! In A.P. Chemistry, missing class is the number one reason why students fall behind, get lost, give up, and either drop the class or get a low grade. You cannot be gone for three days and expect to get caught up with a 10-minute session after school. I cannot teach in 10 minutes what it took 4.5 hours to teach earlier. You will need to come in for tutoring and/or make arrangements for assignments to catch up which will be put onto CTLS. I'm happy to help you catch up, but **you have to** put in the time and effort to do so.

2. **PERCEPTION**: Mrs. Harris is making this class a lot tougher than it really needs to be.
   REALITY: Never forget-this is a college level course NOT an advanced high school course. If I am doing my job, students in this course should learn as much as they would if they were taking freshman chemistry at any college or university in the United States. A second goal is to properly prepare students for the A.P. Exam in May. I cannot make the course easier and still accomplish the above goals.

3. **PERCEPTION**: If the majority of the class falls behind, Mrs. Harris will just have to slow down so that we can catch up.
   REALITY: I can't!!! You will find that time is of the essence in this course. As much as I may like to, our schedule cannot be adjusted. You will need to come in for tutoring if you fall behind. Students will be expected to study the text on their own, and class time will be used more for practice problems, labs, and activities than for reviewing old material. There really is no other way to cover the vast amount of material required by the A.P. exam. If we slow down to make the course easier, we will not cover the required subject matter, and students will have to face exam questions on material not covered in class. As a result, I will make up a schedule that will allow us to complete all required material prior to the exam, and students MUST keep to this schedule. Chemistry topics build upon each other, and students who fall behind have to be responsible and take action to catch back up.

4. **PERCEPTION**: All this work Mrs. Harris is talking about must be necessary only if I don't pay attention in class. I've never had to study before!
   REALITY: All students who expect to be successful in this course will have to spend time after school—either by getting help with an assignment, completing lab work/homework, or reviewing for tests. If you are not willing or able to work/study after school to complete chemistry work, you should not take this course! I WILL be available Tuesday and Thursday. Students are encouraged to come in for help and to form study groups with peers. Students should expect to spend time outside of class in the study of chemistry most nights. Students who have after school jobs or who are heavily involved in after-school activities will have to budget their time accordingly.

5. **PERCEPTION**: Mrs. Harris doesn't really expect us to do a summer assignment, and she isn't really going to test us the first week of classes.
   REALITY: I am serious about this—the summer assignment is mainly a review. You will have a quiz on naming and formulas during week 1. This early work will allow us to spend additional time later in the year on more difficult topics.

Congratulations on choosing A.P. Chemistry!!! It is a fun and interesting course, but both of those outcomes depend upon WORK. You should be aware that you are challenging yourself to the limit of your academic ability, and know that if you apply yourself you will reap the rewards. I'm excited to work with you next year!

Mrs. Harris

Summer Packet – Some Chemistry Review

1. **Scientific Notation – Powers of 10:**
   - Video: Math Antics – Scientific Notation, 14 min. https://youtu.be/bXkewQ7WEdI
   - Chemquiz.net: Practice quizzes with answers https://chemquiz.net/sci
   - Practice Problems: Record the following in correct scientific notation:
     1. 350,000,000 cal
     2. 0.0000721 mol
     3. 0.0000000809 Å
     4. 765,400,000,000 atoms

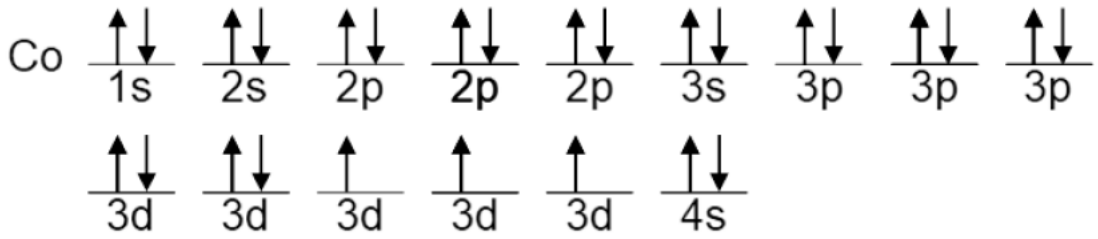
2. **Significant Figures**
   - Video: Ken Richardson, 20 min. https://www.youtube.com/watch?v=gYmQlgiiNeo&t=4s
   - Chemquiz.net: Practice quizzes with answers https://chemquiz.net/sig/
   - Practice Problems:
     1. Write the most common guidelines to determine significant figures (digits) with multiplication/division and addition/subtractions, with an example for each.
     2. How many significant figures are in each of the following?
        a. 1.92 mm
        b. 0.030200 kJ
        c. 6.022×10^{23} atoms
        d. 460.00 L
        e. 0.00036 cm^3
        6. 100
        7. 1001
        8. 0.001
        9. 0.0101
     3. Calculate the following to the correct number of significant figures.
        a. 1.27 g/5.296 cm^3 =
        b. 12.235 g/1.01 L =
        c. 12.2 g + 0.38 g =
        d. 17.3 g + 2.785 g =
        e. 2.1 ×3.21 =
        f. 200.1 ×120 =
        g. 17.6 ÷ 2.838 + 2.3 + 110.77 =

3. **Metric System and Unit Conversions/Dimensional Analysis**
   - Metric Units
     - Video: Math Antics – Intro to the Metric System, 11min. https://youtu.be/ZNX-a-5jGeM
     1. Practice Problems: Classify each of the following as units of mass, volume, length, density, or energy.
     1. mg
     2. mL
     3. cm^3
     4. mm
     5. µL
     6. g/mL
     7. kJ
   - Video: Ken Richardson, 15 min. https://www.youtube.com/watch?v=3xLj2yWX3F0
   - Chemquiz.net: https://chemquiz.net/sic/
   - Practice Problems: Use dimensional analysis (Conversion factor) to convert the following.
     1. 515 m to km
     2. 200 mm to m
     3. 325 days to seconds
     4. 20 L to mL

4. **Element Symbols and Names and Atomic Structure and Isotopes and Average Atomic Mass**
   - Video: Isotopes – Ken Richardson, 13 min. https://www.youtube.com/watch?v=Cks2ersHHIw
   - Video: How to Calculate Average Atomic Mass, 6 min. https://www.youtube.com/watch?v=ULRsJYhQmlo
   - Chemquiz.net: https://chemquiz.net/iso/
   - Practice Problems: Use your Periodic Table
     1. Give the chemical symbols for the following elements.
        a. Carbon
        b. Sulfur
        c. Titanium
        d. Nitrogen
        e. Helium
        f. Krypton
        g. Fluorine
        h. Scandium
        i. Arsenic
     2. Write the name for each of the following element symbols.
        a. Na
        b. Au
        c. Ag
        d. Sn
        e. Fe
        f. Hg
        g. K
     3. Define the words:
        a. Atomic number
        b. Atomic mass
        c. Mass number
        d. Isotopes
        e. Metalloid
     4. Determine the number of protons and neutrons in each of the following isotopes.
        a. $^{39}_{19}K$ b. $^{23}_{11}Na$ c. $^{208}_{82}Pb$ d. $^{33}_{15}P$
     5. Strontium consists of four isotopes with masses and their percent abundances: 83.9134 amu (0.5%), 83.9094 amu (9.9%), 86.9089 (7.0%), and 87.9056 amu (82.6%. Calculate the atomic mass of strontium.

5. **Matter and Physical/Chemical Changes**
   - Video: Matter and Change, part 1 Ken Richardson, 12 min. https://www.youtube.com/watch?v=GkXo1XlmwEQ
   - Video: Matter and Change, part 2 Ken Richardson, 12 min. https://www.youtube.com/watch?v=4E_5P04bAxo&t=584s
   - Practice Problems:
     1. Label each of the following as either a physical process (PP) or a chemical process (CP).
        a. Corrosion of aluminum metal
        b. Melting of ice
        c. Pulverizing an aspirin
        d. Digesting a candy bar
        e. Explosion of nitroglycerin
        f. Milk turning sour
        g. Burning of paper
        h. Forming frost on a cold night
        i. Bleaching of hair with hydrogen peroxide
        j. A copper wire is hammered flat
     2. What is the difference in the number of subatomic particles between the two elements in each set? (protons, neutrons, electrons, and overall charge)
        a. Chlorine atom and chloride ion
        b. Sodium atom and sodium ion
     3. Explain how you distinguish:
        a. An element from a compound
        b. An element from a mixture
        c. A homogeneous mixture from a heterogeneous mixture

6. **Electron Configuration and Periodic Trends**
   - Video: Electron Configurations, part 1 15.5 min. https://www.youtube.com/watch?v=31PzVQ7zNf8&t=7s
   - Video: Electron Configurations, part 2, 12 min. https://www.youtube.com/watch?v=fMZVYhpwJOc&t=192s
   - Video: Periodic Trends, part 1, 9:23 min. https://www.youtube.com/watch?v=k2bYEZi7mxw
   - Video: Periodic Trends, part 2, 8:45 min. https://www.youtube.com/watch?v=85jkiDoe11Q
   - Chemquiz.net: https://chemquiz.net/ele/
   - Practice Problems:
     1. $Co : 27\ e^-\quad 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^7$



        a. Lithium
        b. Gallium
        c. Iron
        d. Argon
        e. Nitrogen

     2. There are four types of electron orbital shapes, designated s, p, d, and f.
        a. There are different number of orbitals for each shape on a particular energy level.
           i. s = _____ orbitals per energy level
           ii. p = _____ orbitals per energy level
           iii. d = _____ orbitals per energy level
           iv. f = _____ orbitals per energy level
        b. Orbital types are only on certain energy levels.
           i. s orbitals are on levels _____
           ii. p orbitals are on levels _____
           iii. d orbitals are on levels _____
           iv. f orbitals are on levels _____
        c. Explain the patters (diagonal rule) for the orbitals in the energy levels.
     3. There are three rules regarding how electrons go into the orbitals and make electron configurations. Write the rule for each.
        a. Aufbau principle
        b. Pauli exclusion principle
        c. Hund's rule
     4. Explain what the arrow diagrams show you.
     5. What extra information does the arrow diagram show that the electron configuration does not?

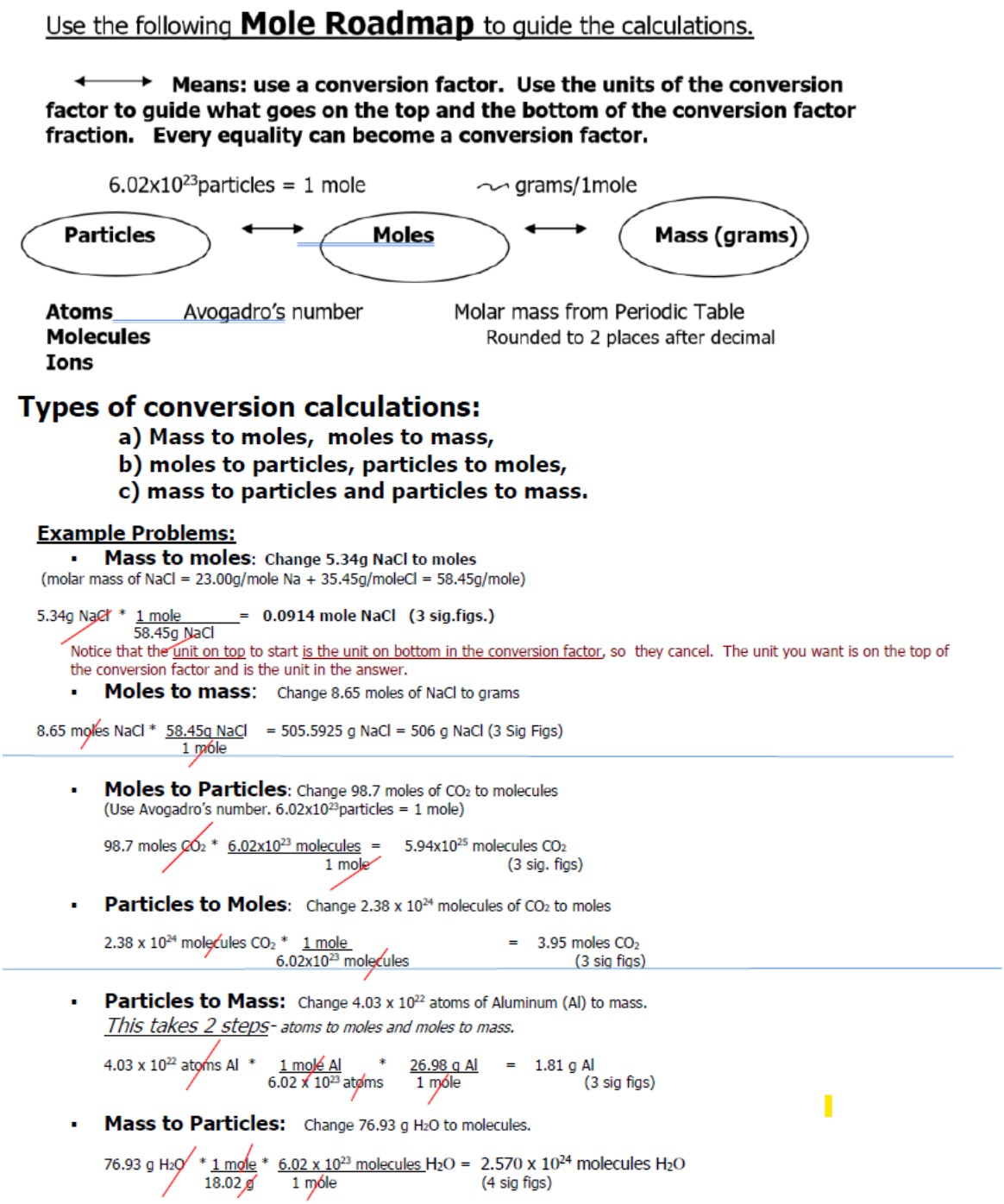
7. **Nomenclature (Names and Formulas)**
   - This is a BIG topic. Expect to put some effort into this.
   - Know the charges of the monatomic cations and anions. Know the formulas, names, and charges of the polyatomic ions. Know how to name and write formulas for ionic compounds, including acids, and binary covalent compounds. (See reference charts at the end of the summer assignment.)
   - Video: Ken Richardson, Polyatomic Ions and Formulas,17 min. https://www.youtube.com/watch?v=vFPR-OXtRrM

- Video: Ken Richardson, Naming Ionic Compounds, 14 min. https://www.youtube.com/watch?v=koz3M0i3b80
- Video: Writing Ionic Formulas: Ken Richardson, 5 min. https://www.youtube.com/watch?v=CAWx3HhXvY0
- Video: Tyler Dewitt, Naming Covalent Compounds, 14 min. https://www.youtube.com/watch?v=DejkvR4pvRw
- Practice Problems
    1. Classify the following as a diatomic molecule, molecular compound, ionic compound, or element.
        a. F_2
        b. Cl_2
        c. C
        d. NaCl
        e. KF
        f. CO_2
        g. H_2
        i. Rust (Fe_2O_3)
        j. MgO
        k. O_2
        l. I_2
        m. CO
        n. K_2CO_3
        o. Ag
    2. Write the formula for the following compounds.
        a. Calcium sulfate
        b. Ammonium phosphate
        c. Lithium nitrite
        d. Iron (II) perchlorate
        e. Barium oxide
        f. Cobalt (III) sulfide
        g. Sodium bromate
        h. Calcium iodide
        i. Manganese (II) carbonate
    3. Write the chemical formulas for the following compounds.
        a. Calcium carbonate
        b. Copper (II) phosphite
        c. Sodium chloride
        d. Rubidium oxide
        e. Calcium sulfate
        f. Sodium nitrate
        g. Magnesium acetate
        h. Potassium cyanide
        i. Zinc (II) nitrate
        j. Iron (III) oxalate
        k. Nickel (II) fluoride
    4. Name the following molecular compounds.
        a. SF_6
        b. P_4S_{10}
        c. NI_3
        d. PCl_5
        e. CCl_4
    5. Give the formula for the following acids.
        a. Hydrochloric acid
        b. Perchloric acid
        c. Carbonic acid
        d. Nitrous acid
        e. Nitric acid
        f. Chlorous acid
        g. Perchloric acid
        g. Phosphoric acid
        h. Acetic acid
        i. Sulfurous acid
        j. Sulfuric acid
        k. Hypochlorous acid
        l. Chloric acid

8. Moles, Mass, Particle Calculations

- The ability to do these calculations are essential for you success in A.P. Chemistry.
- Video: Ken Richardson, Intro to the Mole, 15 min. https://www.youtube.com/watch?v=6fxUJGw2R-s&t=2s
- Video: Ken Richardson, Molar Mass of Compounds, 11 min. https://www.youtube.com/watch?v=M_X3WVo7TRA
- Video: Ken Richardson, Percent Composition, 10 min. https://www.youtube.com/watch?v=47t6gV5Ff4Y
- Video: Ken Richardson, Empirical Formulas, 12 min. https://www.youtube.com/watch?v=i3ikZm0AoZU&t=12s
- Video: Ken Richardson: Empirical and Molecular Formulas, 7 min. https://www.youtube.com/watch?v=zIHZUe5PkBI

- Chemquiz.net: https://www.youtube.com/watch?v=zIHZUe5PkBI
- Practice Problems: With only a Periodic Table, do the following calculations. Remember to show your work, include units, and correct significant figures in your answer.



Use the following **Mole Roadmap** to guide the calculations.

↔ **Means: use a conversion factor. Use the units of the conversion factor to guide what goes on the top and the bottom of the conversion factor fraction. Every equality can become a conversion factor.**

6.02×10^{23} particles = 1 mole ~ grams/1mole

Particles ↔ **Moles** ↔ **Mass (grams)**

Atoms Avogadro's number
Molecules
Ions

Molar mass from Periodic Table
Rounded to 2 places after decimal

Types of conversion calculations:

a) Mass to moles, moles to mass,
b) moles to particles, particles to moles,
c) mass to particles and particles to mass.

Example Problems:

- **Mass to moles**: **Change 5.34g NaCl to moles**

(molar mass of NaCl = 23.00g/mole Na + 35.45g/moleCl = 58.45g/mole)

$$5.34\text{g NaCl} * \frac{1\text{ mole}}{58.45\text{g NaCl}} = \textbf{0.0914 mole NaCl (3 sig.figs.)}$$

Notice that the unit on top to start is the unit on bottom in the conversion factor, so they cancel. The unit you want is on the top of the conversion factor and is the unit in the answer.

- **Moles to mass**: Change 8.65 moles of NaCl to grams

$$8.65\text{ moles NaCl} * \frac{58.45\text{g NaCl}}{1\text{ mole}} = 505.5925\text{ g NaCl} = 506\text{ g NaCl (3 Sig Figs)}$$

- **Moles to Particles**: Change 98.7 moles of CO_2 to molecules
(Use Avogadro's number. 6.02×10^{23} particles = 1 mole)

$$98.7\text{ moles } CO_2 * \frac{6.02 \times 10^{23}\text{ molecules}}{1\text{ mole}} = 5.94 \times 10^{25}\text{ molecules } CO_2 \text{ (3 sig. figs)}$$

- **Particles to Moles**: Change 2.38×10^{24} molecules of CO_2 to moles

$$2.38 \times 10^{24}\text{ molecules } CO_2 * \frac{1\text{ mole}}{6.02 \times 10^{23}\text{ molecules}} = 3.95\text{ moles } CO_2 \text{ (3 sig figs)}$$

- **Particles to Mass:** Change 4.03×10^{22} atoms of Aluminum (Al) to mass.
This takes 2 steps- atoms to moles and moles to mass.

$$4.03 \times 10^{22}\text{ atoms Al} * \frac{1\text{ mole Al}}{6.02 \times 10^{23}\text{ atoms}} * \frac{26.98\text{ g Al}}{1\text{ mole}} = 1.81\text{ g Al (3 sig figs)}$$

- **Mass to Particles:** Change 76.93 g H_2O to molecules.

$$76.93\text{ g } H_2O * \frac{1\text{ mole}}{18.02\text{ g}} * \frac{6.02 \times 10^{23}\text{ molecules } H_2O}{1\text{ mole}} = 2.570 \times 10^{24}\text{ molecules } H_2O \text{ (4 sig figs)}$$

1. Calculate the molar masses of the following compounds.
    a. Ammonia (NH_3)
    b. Baking soda ($NaHCO_3$)
    c. Osmium metal (Os)
2. Determine the number of molecules present in 4.56 mol of nitrogen (N_2).
3. How many grams of methane (CH_4) are present in 5.6 mol of the gas.

4. In an experiment, a student gently heated a hydrated copper compound to remove the water of hydration. The following data was recorded. Calculate the experimental percent of water in the original compound.

Mass of test tube before heating	23.4 g
Mass of empty test tube	18.82 g
Mass of test tube after heating to a constant mass	20.94

5. Convert the following to moles.
    a. 3.86 g of carbon dioxide
    b. 6.0×10^5 g of hydrazine (N_2H_2), rocket fuel
6. Calculate the percent composition by mass of each element in the following compounds.
    a. SO_3
    b. CH_3COOCH_3
    c. Ammonium nitrate
7. Determine the empirical formula of the compounds with the following compositions by mass.
    a. 10.4% C, 27.8% S, and 61.7% Cl
    b. 21.7% C, 9.6% O, and 68.7% F
8. Arsenic reacts with chlorine to form a chloride. If 1.587g of arsenic reacts with 3.755 g of chlorine, what is the empirical formula.
9. What is the correct empirical formula for each of the following molecular formulas.
    a. H_2O_2
    b. C_6H_{12}
    c. CH_4
    d. H_2SO_4
    e. $C_4H_6O_2$
10. 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
11. Find the empirical and molecular formula of ibuprofen, which contains 75.6% C, 8.80%H, and 15.5% O by mass and has a molar mass of approximately 206 g/mol.
12. Which of the following statements are always true, never true, or sometimes true?
    a. A compound with a molecular formula of C_6H_6 has the same empirical formula.
    b. The mass percent of copper in CuO is less than than in Cu_2O.
    c. The limiting reactant is the one present in the smallest number of grams.
    d. Since formulas $C_3H_6O_3$ and $C_6H_{12}O_6$ reduce to the same empirical formula, they represent the same compound.

9. Chemical Reactions – Writing, Balancing, Classifying, and Stoichiometry

- Video: Ken Richardson - Writing Chemical Reactions, 13 min. https://www.youtube.com/watch?v=SiQSWkiG2VI&t=640s
- Video: Ken Richardson – Balancing Chemical Reactions, part 1, 15 min. https://www.youtube.com/watch?v=01umpQ01iZU
- Video: Ken Richardson – Balancing Chemical Reactions, part 2, 13 min. https://www.youtube.com/watch?v=24vm2EQptTI
- Video: Ken Richardson – Types of Chemical Reactions, 8 min. https://www.youtube.com/watch?v=F3zf161Zln0
- Video: Ken Richardson – Stoichiometry, 13 min. https://www.youtube.com/watch?v=cy13PWnpjIc&t=486s
- Chemquiz.net: https://chemquiz.net/bal/
- Chemquiz.net: https://chemquiz.net/sto/
- Chemquiz.net: https://chemquiz.net/per/

- Practice Problems:
    1. Write a balanced chemical equation and classify the type of reaction for the following:
        a. Reaction of boron trifluoride gas with water to produce liquid hydrogen fluoride and solid boric acid (H_3BO_3).
        b. Reaction of magnesium oxide with iron to form iron (III) oxide and magnesium.
        c. The decomposition of dinitrogen monoxide gas to its elements.
        d. The reaction of calcium carbide solid with water to form calcium hydroxide and acetylene (C_2H_2) gas.
        e. The reaction of solid calcium cyanamide ($CaCN_2$) with water for form calcium carbonate and ammonia gas.
        f. Ethane (C_2H_6) burns in air to form carbon dioxide and water.
        g. Hydrogen reacts with oxygen to form water.
        h. Nitrogen gas reacts with hydrogen gas to form ammonia gas.
        i. Hydrogen gas reacts with solid iodine to form hydrogen iodide gas.
        j. Sodium reacts with iodine gas to form sodium iodide.
        k. Solid sodium oxide reacts with water to form sodium hydroxide and hydrogen.
        l. Carbon dioxide reacts with water for form carbonic acid solution.
        m. Solid magnesium and nitrogen gas combine to form solid magnesium nitride.
        n. Concentrated hydrochloric acid reacts with concentrated sodium hydroxide to form aqueous sodium chloride and water.
    2. Define limiting reactant (reagent), theoretical yield, and actual yield.
    3. One way to remove nitrogen monoxide from smokestack emissions is to react it with ammonia,

        $$4\ NH_3\ (g)\ +\ 6\ NO\ (g)\ \rightarrow\ 5\ N_2\ (g)\ +\ 6\ H_2O\ (l)$$

        a. How many moles of ammonia react with 12.3 moles of nitrogen monoxide?
        b. How many moles of nitrogen gas are produced from 5.87 mol of nitrogen monoxide?
    4. What mass of copper is required to replace silver from 4.00 g of silver nitrate in solution?

        $$Cu\ (s)\ +\ AgNO_3\ (aq)\ \rightarrow\ Cu(NO_3)_2\ +\ Ag\ (s)$$

    5. Sodium hydroxide reacts with carbon dioxide as follows:

        $$2NaOH\ (s) + CO_2\ (g)\ \rightarrow\ Na_2CO_3\ (s) + H_2O\ (l)$$

        Which reactant is the limiting reactant when 1.85 moles of sodium hydroxide and 1.00 mol of carbon dioxide react? How many moles of sodium carbonate can be produced? How many moles of excess reactant remain after the completion of the reaction?

    6. When benzene (C_6H_6) reacts with bromine, bromobenzene is obtained:

        $$C_6H_6 + Br_2 \rightarrow C_6H_5Br + HBr$$

        a. What is the theoretical yield of bromobenzene in this reaction when 30.0 g of benzene reacts with 65.0 g of bromine?
        b. If the actual yield of bromobenzene was 56.7 g, what is the % yield?
    7. Chlorine and fluorine react to form gaseous chlorine trifluoride. You start with 1.75 mol of chlorine and 3.68 mol of fluorine.
        a. Write the balanced equation for the reaction.
        b. What is the limiting reactant?

10. Molarity

- Video: Ken Richardson, Molarity and Dilution, 10 min. https://www.youtube.com/watch?v=WhBAvy4ZzrA
- Practice Problems:
    1. What is a solute and solvent? Define molarity.
    2. Calculate the molarity of a solution that contains 0.0345 moles of NH_4CL in exactly 400. mL of solution.
    3. Calculate the molarity of a solution that contains 20.0 g of sodium hydroxide in 200 mL.
    4. How many grams of solute are present in 40.0 mL of 0.360 M sodium chloride?