Name: _____ Date: _____

AP Chemistry Summer Assignment: CB Unit 1

The College Board revised the AP Chemistry curriculum in late 2019 and arranged the course into nine themed units. I have readjusted my traditional AP Chem Summer Assignment to fully cover Unit 1 of this newly revised curriculum. The eight topics in Unit 1 should be a review of material that we covered in Honors Chemistry. The material does go into more depth and your knowledge of these content areas will increase.

The AP Chemistry Summer Assignment will consist of some work in this packet, 2 POGIL packets, Mastering Chemistry, and College Board APChem Progress Checks.

Google Classroom Join Code: **2bxi7bf**

Due Date for AP Chem Summer Assignment: All assignments will be posted in Google Classroom. The AP Chemistry Summer Assignment must be submitted in **paper format** by the first day of class (tentatively September _____, 2022[1]). There will be a full exam on this material on the 2rd class day. We will have 1 hour of review before the exam.

Work Due 09/_____/2022[1]:

1. This completed packet (1 electronic .pdf) (100pt homework grade)
2. The 2 POGIL packets on mass spectrometry and PES spectroscopy (1 electronic .pdf) (100pt homework grade)
3. Mastering Chemistry (100 pt homework grade)
4. College Board APChem Progress Check (formative grade)

How To Contact Mrs. Voicu: Email is the best way to contact me. Over the summer I do not check my email as regularly as during the school year. If I am unavailable due to my vacation, I will change my email notice to reflect this.

How to Succeed in AP Chemistry: It sounds cliché, but your progress and success in this course will reflect the amount of effort that you put into the course. AP Chemistry has a very large syllabus and requires you to have advanced skills in applied problem solving. The course will continually cover new material and it is *your responsibility* to ensure that you understand and practice what we cover in class. For the majority of students this means considerable practice beyond assigned classwork. You should be committed to *understanding* the material in multiple contexts. This is a college level course! Expect to put in at least 2 hours of homework/reading time per class.

[1] This due date may change when the 2022-2023 school calendar is published.

Pre-Unit 1- Sig Figs, Dimensional Analysis, and Nomenclature: You are expected to be fluent in the use of significant figures (sig figs), dimensional analysis (including squared and cubed units), and ionic/molecular nomenclature. This is not part of the College Board's AP Chemistry Curriculum, but is an anticipated skill.

Sig Figs: All measured numbers have a degree of precision that is related to the number of reported digits. Scientists report all *known values plus an estimated value.* For a digital device the manufacturer has worked this into the digital reading and the value is reported as displayed on the device. When we use measured numerical values in calculations, we want to make sure that our result does not over or underestimate precision.

Reflect: What do you already know about sig figs? _____

_____

_____

_____

Sig Fig Review:

1) All digits with a value of 1-9 are significant.

2) Zeros, Which are significant?

Some zeros have a place value and some are merely placeholders. *Placeholder zeros are not significant and are not counted as sig figs!* How can one tell which zero is which?

a) "Sandwich zeros," or zeros that appear between two digits, are always significant

b) Numbers without a decimal: All trailing zeros are *placeholders and NOT significant*

c) Numbers with a decimal: All leading zeros are *placeholders and NOT significant*

Here is a good mnemonic to help you remember which zeros are significant: The Atlantic-Pacific Rule (Figure 1.1).

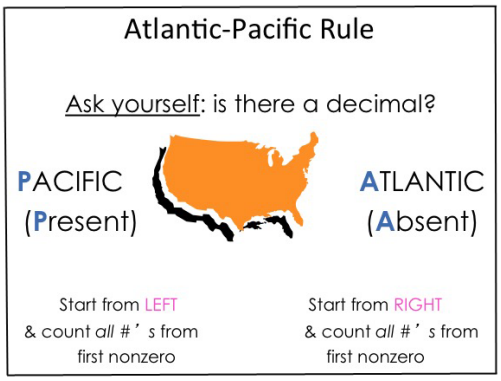
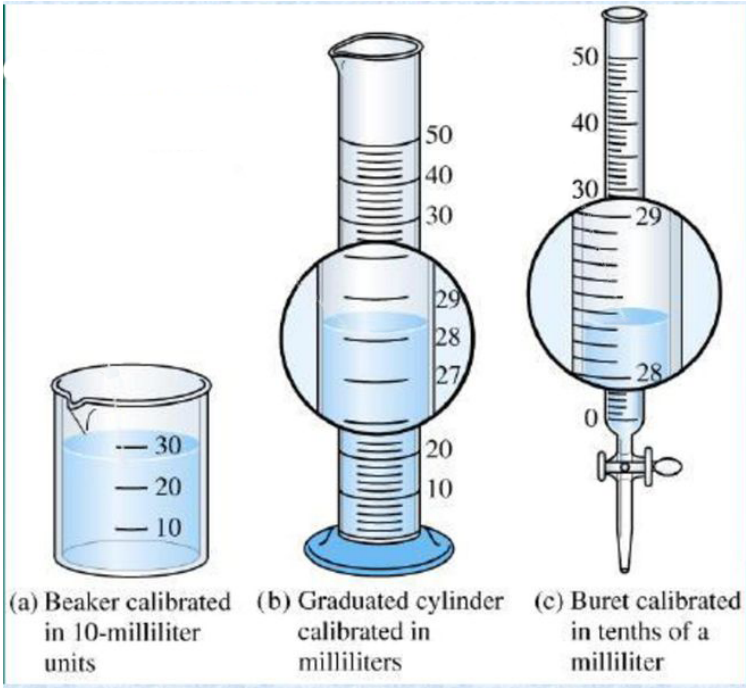


Figure 1.1

Screencast "Atlantic-Pacific Rule of Significance" https://youtu.be/RnDj7ohzcss

3) Reading sig figs on an analog device (ruler, buret, graduated cylinder, etc.)



(a) Beaker calibrated in 10-milliliter units (b) Graduated cylinder calibrated in milliliters (c) Buret calibrated in tenths of a milliliter

The reported values on analog devices are all of the marked values, plus a guess of the next value place.

Reminder: Read at the **bottom** on the meniscus!

Report the correct reading of the listed devices and list the number of sig figs[2] (include units):

a) beaker

= _____ and _____ sig figs

b) graduated cylinder

= _____ and _____ sig figs

c) buret

= _____ and _____ sig figs

4) Mathematical operations with sig figs:

You must account for sig figs in mathematical operations involving *measured numbers*. Conversion factors and counted numbers are considered to have an "infinite" number of sig figs and will not limit the sig figs in your answer. This is to ensure that you don't over or under report the precision of your calculated value.

a) Addition and Subtraction: Round your result to the same number of decimal places as the measurement with the fewest decimal places.

b) Multiplication and Division: Round your result to the smallest number of sig figs in the measured numbers.

c) Combined Operations: Use the rules of PEMDAS to determine the order of operations. Do not round your answers in intermediate steps and round to the final number of sig figs in the final step (using addition/subtraction rules, assuming this is the final step).

See this review of combined sig fig rules in an open source textbook (chem.libretexts.org)(https://qrgo.page.link/xMLJK). Video links in the eTextbook offer additional information and support.

[2] a) 28 mL of liquid (20 is the known value, 8 is the estimated value). 2 sig figs. b) 28.1 mL (28 is the known value, 0.1 is the estimated value). 3 sig figs. c) 28.32 mL (28.3 is the known value, 0.02 is the estimated value). 4 sig figs. c) 28.32 mL (28.3 is the known value, 0.02 is the estimated value). 4 sig figs.

Sig Fig Practice[3]:

1.37) List the number of sig figs in the following numbers:

a) 601 kg = _____ sig figs

b) 0.054 s = _____ sig figs

c) 6.3050 cm = _____ sig figs

d) 0.0105 L = _____ sig figs

e) 7.0500×10^{-3} m = _____ sig figs

f) 400 g = _____ sig figs

1.41) Carry out the following operations and report your answer to the correct number of sig figs.

a) 14.3505 + 2.65 = _____

b) 952.7 – 140.7389 = _____

c) $(3.29 \times 10^{4})(2.501)$ = _____

d) 0.0588/0.677 = _____

1.42) Carry out the following operations and report your answer to the correct number of sig figs.

a) 320.5 – (6104.5/2.3) = _____

b) $[(285.3 \times 10^{5}) - (1.200 \times 10^{3})] \times 2.8954$ = _____

c) (0.0045 x 20,000.0) + (2813 x 12) = _____

d) 863 x [1255 – (3.45 x 108)] = _____

Rate Your Understanding of Sig Figs:

❒ High, no errors

❒ Confident but I had errors

❒ I need help. I will remediate my learning by doing the following:

1) _____

2) _____

3) _____

[3] 1.37 a) 3; b) 2; c) 5; d) 3; e) 5; f) 1; 1.41 a) 17.00; b) 812.0; c) 8.23×10^{3}; d) 8.69×10^{-2}; 1.42 a) -2.3×10^{3}; b) 8.260×10^{7}; c) 3.4×10^{4}; d) 7.62×10^{5}

Dimensional Analysis or Unit Conversion: An algebraic process termed dimensional analysis is used to convert given units into desired units. This was introduced in both regular and honors chemistry. You are expected to be fluent with this technique. You should label units of all intermediate steps to make sure the initial unit(s) cancel(s) and provide the desired unit(s). Answers on assessments that lack units will be graded as zero points. This is consistent with the AP Chem College Board scoring guidelines.

Reminder! You must be using *the same unit* to add and subtract. Units multiply and divide.

Reflect: What do you already know about dimensional analysis? _____

_____

_____

_____

Dimensional Analysis Practice[4]:

1.51) Perform the following conversions; report your answer with the correct number of sig figs:

a) 5.00 days to s = _____

b) 0.0550 mi to m = _____ (1.6093 km = 1 mi)

c) $1.89/gal to dollars/L = _____ (1 L = 1.057 qt); you are expected to know 4 qt = 1 gal)

d) 0.510 in./ms to km/hr = _____ (1 in = 2.54 cm)

e) 22.50 gal/min to L/s = _____ (see problem c) for conversion factor)

Rate your Understanding of Dimensional Analysis:

❒ High, no errors

❒ Confident but I had errors

❒ I need help. I will remediate my learning by doing the following:

1) _____

2) _____

3) _____

Need Assistance? Tyler Dewitt's unit conversion videos on YouTube give clear examples of how to perform dimensional analysis. Follow this link or the QR code to the full playlist: https://qrgo.page.link/ihKFB

[4] 1.51 a)

Nomenclature: You are expected to know how to name ionic, molecular, and molecular acid compounds

Common Polyatomic Ions You Need to Know

Name	Formula	Name	Formula
Acetate	$C_2H_3O_2^-$ or $CH_3CO_2^-$	Superoxide	O_2^-
Chlorate	ClO_3^-	Carbonate	CO_3^{2-}
Bromate	BrO_3^-	Cyanide	CN^-
Iodate	IO_3^-	Azide	N_3^-
Sulfate	SO_4^{-2}	Phosphate	PO_4^{-3}
Permanganate	MnO_4^-	Hydrogen Phosphate	HPO_4^{-2}
Chromate	CrO_4^{-2}	Dihydrogen Phosphate	$H_2PO_4^-$
Dichromate	$Cr_2O_7^{-2}$	Hydroxide	OH^-
Nitrate	NO_3^-	Ammonium	NH_4^+
Peroxide	O_2^{2-}	Hydronium	H_3O^+

For the other polyatomic ions that are variations on those above:

- If there is one more oxygen atom, change the name to per-_____-ate.
- If there is one less oxygen atom, change the name to _____-ite.
- If there are two less oxygen atoms, change the name to hypo-_____-ite.
- If there is a hydrogen ion as part of the polyatomic ion, it reduces the charge on the polyatomic ion by 1.

<u>Examples:</u>

SO_3^{2-} = sulfite

HSO_4^- = hydrogen sulfate

SO_2^{2-} = hyposulfite

CO_3^{2-} = carbonate

carbonate

carbonite

HCO_3^- = hydrogen

HCO_2^- = hydrogen

<u>Acids</u>

- Acids always begin with an “H” atom. If the “H” atom is not first, it is not an acid!
- Acids that do not contain “O” atoms, are called “hydro-_____-ic acid”.
- Acids that contain “O” atoms NEVER include the prefix “hydro”.
    - If the acid comes from the____ –ate anion, it becomes “____-ic acid”
    - If the acid comes from the ____-ite anion, it becomes “____-ous acid”

Examples:

HCl = hydrochloric acid

$HClO_3$ = chloric acid

HClO = hypochlorous acid

H_3PO_4 = phosphoric acid

KH_2PO_4 = potassium dihydrogen phosphate

H_2SO_4 = sulfuric acid

$NaHSO_4$ = sodium hydrogen sulfate

H_2S = hydrosulfuric acid

HI = hydroiodic acid

HIO_3 (from iodate) = iodic acid

AP Chem CED[5] Unit 1 Atomic Structure and Properties- Topics:

1.1 Moles and Molar Mass

1.2 Mass Spectroscopy of Elements

1.3 Elemental Composition of Pure Substances

1.4 Composition of Mixtures

1.5 Atomic Structure and Electron Configuration

1.6 Photoelectron Spectroscopy

1.7 Periodic Trends

1.8 Valence Electrons and Ionic Compounds

1.1 Moles and Molar Mass

SPQ 1.A Calculate quantities of a substance or its relative number of particles using dimensional analysis and the mole concept

1.A.1 One cannot count particles directly while performing laboratory work. Thus, there must be a connection between the masses of substances reacting and the actual number of particles undergoing chemical changes.

1.A.2 Avogadro's number ($N_A = 6.022 \times 10^{23}$ mol^{-1}) provides the connection between the number of moles in a pure sample of a substance and the number of constituent particles (or formula units) of that substance.

1.A.3 Expressing the mass of an individual atom or molecule in atomic mass units (amu) is helpful because the average atomic mass in amu of one particle (atom or molecule) or formula unit of a substance will always be numerically equal to the molar mass of that substance in grams. Thus, there is a quantitative connection between the mass of a substance and the number of particles that the substance contains.

Correlation to Chemistry the Central Science, 13e (Brown, LeMay, et. al.): Chapters 2.4, 3.3, 3.4

1.2 Mass Spectroscopy of Elements

SPQ 1.B Explore the quantitative relationship between the mass spectrum of an element and the masses of the element's isotopes

1.B.1 The mass spectrum of a sample containing a single element can be used to determine the identity of the isotopes of that element and the relative abundance of each isotope in nature

1.B.2 The average atomic mass of an element can be estimated from the weighted average of the isotopic masses using the mass of each isotope and its relative abundance

** Interpreting mass spectra of samples containing multiple elements or peaks arising from species other than singly charged monatomic ions will not be assessed on the AP exam. **

Problem 1: "A Closer Look: The Mass Spectrometer." Understand that scientists can obtain the atomic weight of a substance using a mass spectrometer (mass spec). The element chlorine has two isotopes (^{35}Cl and ^{37}Cl in relative abundances of 75.78% and 24.22% (a 3:1 ratio)). When we analyze a chlorine containing compound with a mass spec we can readily see the two different chlorine isotopes.

Problem 2: Chloroethane ($ClCH_2CH_3$) has a molecular mass of 64, when we use the data from the periodic table to perform this calculation. However, when this compound it analyzed by mass spec we see peaks at 64 and 66 in a ratio of 3:1. This is because chlorine has two isotopes and the mass spec is precise enough to be able to detect the difference. The x-axis of the mass spectrum shows m/e (or m/z) which is the charge to mass ratio while the y-axis shows relative abundance. The mass spec ionizes the chloroethane to form both $^{35}ClCH_2CH_3^+$ and $^{37}ClCH_2CH_3^+$ which can be analyzed by the detector. As expected, chloroethane with a ^{35}Cl-isotope is in higher abundance than that with the ^{37}Cl-isotope.

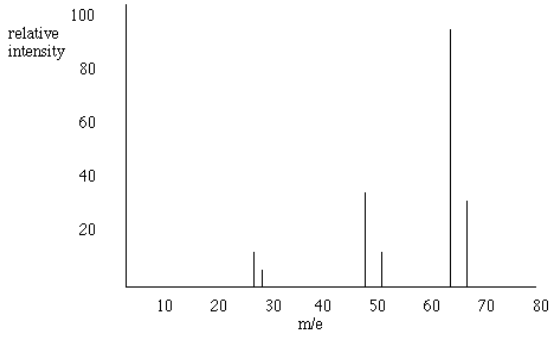


Figure 1. Mass spectrum of chloroethane

See the following Bozeman Science link which has a good explanation of what mass spec is and how it works: https://youtu.be/mBT73Pesiog

After you look at the video, what do you think the peaks at m/e 51 and 49 are in the chloroethane mass spectrum (remember, compounds can fragment in the mass spec)?

m/e @ 49 = _____ and m/e = 51 = _____

Additional Practice:

- Solve each of the following problems. Report your answers with the correct number of significant figures.
  - 16.5 + 8 + 4.73 =
  - 23.27 - 12.058 =
  - 0.0853 + 0.05477 + 0.0002 =
  - 35 / 0.0622 =
  - 3400 x 0.00800 =
  - (43.1 + 27.250) x (22.514 - 18.0) =

0.00155 x 22.1011

- Solve the following problems using dimensional analysis. Report your answers with the correct number of significant figures.
    - Your plumber discovers a small leak that is leaking water at a rate of 1.2 mL per hour. How many Liters of water are leaked in exactly one week?

    - You visit the Willis Tower. You notice that every room in the Willis Tower has 18 lights on the ceiling and get curious about how many lights are in the whole building. There are 110 floors in the Willis Tower, and each floor has 98 rooms in it. Wow! How many total lights are in the Willis Tower?

    - Dr. Ott can run a marathon (26.2 miles) in 2.925 hours. What is his average speed in meters per second? (1 meter = 3.28 feet, 1 mile = 5280 feet)

- Solve the following density problems:
    - The density of a copper cube is 8.92 g/mL. If that cube had its volume computed to be 74 mL, what is the mass of that cube?

    - Using water displacement, a fine young chemist decides to submerge an iron (D = 7.6 g/mL) chunk into a graduated cylinder with 20.0 mL of water. If the cylinder has a mass of 67 grams, what is the <u>final</u> volume in the graduated cylinder?

    - You go fishing and obtain some lead weights for your trip. Since you are the smartest chemistry student in the land, you know that lead's density is 11.34 g/mL. If there are 50 weights in a 250. mL box, what is the mass of each weight?

- A student pipettes 5.00 mL of ethanol into a flask that has a mass of 15.25 grams. She finds the mass of the flask plus ethanol is 19.17 grams. Calculate the density of ethanol.

- Identify the following as a physical property, physical change, chemical property, or chemical change.
  - Ethanol has a density of 0.697 g/mL.
  - The solution turns blue upon mixing two clear aqueous solutions.
  - Wood burns in an oven.
  - Methyl alcohol is highly flammable.
  - Ice melts in a beaker.
  - Methyl ethanoate smells like green apple.
  - A car crashes into a wall.
  - Sugar dissolves in water.

- Complete the following table concerning an atom/ion and its subatomic particles:

Mass #	Atomic #	# of Protons	# of Neutrons	# of Electrons	Symbol
41	19				
			35	32	
		10	13		

- Answer the following questions which deal with the Laws of Definite and Multiple Proportions:
  - Nitrogen (N) and silicon (Si) form two binary compounds with the following compositions:

Compound	**Mass % N**	**Mass % Si**
1	33.22	66.72
2	39.94	60.06

  - Compute the mass of silicon that combines with 1.000 g of nitrogen in each case.
  - Show that these compounds satisfy the Law of Multiple Proportions. If the second compound has the formula Si_3N_4, what is the formula of the first compound?

- A 57.6 gram sample of methane (CH_4) is found to contain 43.2 grams of carbon. How much hydrogen, in grams, would a 37.8 gram sample of methane contain?

- Name or form the following ionic compounds:

	Name / *Formula*
• Lithium oxide	_____
• _____	$Mg(NO_3)_2$
• Calcium nitride	_____
• _____	$(NH_4)_2SO_4$
• Iron (II) carbonate	_____
• _____	Cu_2S

- Write and balance the following chemical equations:
  - ___ $Cu_{(s)}$ + ___ $Al_2O_{3\,(aq)}$ ___ $CuO_{(aq)}$ + ___ $Al_{(s)}$
  - ___ $C_4H_{10\,(l)}$ + ___ $O_{2\,(g)}$ ___ $CO_{2\,(g)}$ + ___ $H_2O_{(g)}$
  - ___ $(NH_4)_2SO_{4\,(aq)}$ + ___ $Fe(NO_3)_{3\,(aq)}$ ___ $Fe_2(SO_4)_{3\,(s)}$ + ___ $NH_4NO_{3\,(aq)}$
  - Hydrogen peroxide decomposes into water and oxygen gas.
  - Sodium metal reacts with aqueous barium fluoride….
  - Aqueous strontium acetate reacts with aqueous potassium hydroxide….
  - Pentanol ($C_5H_{11}OH$) is combusted in air.

- Calculate the following using molar conversions:
  - Find the number of moles in 75.5 grams of aluminum hydroxide.
  - How many molecules are in 35.5 grams of carbon dioxide?
  - How many atoms of nitrogen are in 4.33 moles of calcium nitrate?
  - Find the mass that is equivalent to 0.056 moles of sugar ($C_{12}H_{22}O_{11}$).
  - How many atoms of hydrogen can be found in 100. grams of acetic acid?

- Determine the percentage by mass for the given element/molecule in each problem:
  - % carbon in C_8H_{18}
  - % oxygen in magnesium phosphate
  - % aluminum in aluminum acetate
  - % water in $BaSO_4 \cdot 2\ H_2O$

- Calculate the average atomic mass of an isotope given their masses and relative abundances.
    -

Isotope	% Abundance
Chlorine – 35	75.77%
Chlorine – 37	24.23 %

    -

Isotope	% Abundance
Ak – 141	47.23 %
Ak – 145	21.22 %
Ak – 146	31.55 %

- Solve the following stoichiometry problems:
    - ___ $CaCl_{2\,(aq)}$ + ___ $Al_2O_{3\,(s)}$ __ $CaO_{\,(s)}$ + ___ $AlCl_{3\,(aq)}$
        - How many moles of calcium chloride would react with 5.99 moles of aluminum oxide?
        - If 2.44 moles of calcium oxide are made, how many grams of aluminum chloride are also made?
        - If 14.5 grams of $CaCl_2$ react with excess Al_2O_3, how many grams of CaO are produced?

    - Ammonium chloride reacts with lead (IV) nitrate.
        - If 18.5 grams of each reactant is present:
            - Which reactant limits?
            - How many grams of the excess reactant would remain?
            - How much lead (IV) chloride is made?

        - If 9.50 grams of lead (IV) chloride are experimentally made, what is the percent yield?

    - Hexane (C_6H_{14}) is combusted in air.
        - Write the balanced equation for the combustion reaction.
        - How many moles of carbon dioxide are made if 43.0 grams of oxygen gas react?
        - If 3.22 grams of hexane react with 10.4 grams of oxygen gas, what is the maximum mass of water vapor that can be produced?
- Determine the empirical and molecular formulas given the following information:
    - Methyl butanoate has a percent composition of 58.8% C, 9.8% H, and 31.4% O. Its molecular weight is 102 g/mol. Find its molecular formula.
    - A compound is found to have 9.09 g C, 1.52 g H, and 14.4 g F. What is its empirical formula? If the compound has a molecular mass of 66 g/mol, what is its molecular formula?

Additional Work:

- Assigned on mastering chemistry link will be provided on google classroom Summer Assignment tab
- 2 POGILs