AP Chemistry Summer Assignment

AP Chemistry Summer Assignment

Firstly, I want to welcome you to my AP Chemistry class! We will be spending a lot of time together the next year; we will feel like family by the end of the year!

In this course you can expect to be challenged academically, it is a college-level chemistry course so the material will be rigorous and the pacing is quick. You should expect to be spending time outside of class every day reinforcing your knowledge and practicing your skills. I will be available to help along the way, but you need to recognize when you need more support and be prepared to seek extra help or explanations. I expect that you will participate in class and labs and that you will be prepared to work in groups and independently. The class dynamics are always better if you are willing to help others and accept help from your peers. I want to see you succeed in this class and I'm looking forward to supporting you along your chemistry journey, your successes are my successes and your failures are my failures.

The summer assignment for AP chemistry is focused on making sure that your science skills are ready for the year ahead. You should have learned all of the material in your first chemistry experience (with the exception of net ionic equations), so it should all be review material. The only part of the summer assignment that you are going to turn in is the Timeline (1). All of the other skills will be assessed in class. Take the practice quizzes at the end to give you an idea of what the in-class quizzes will be like. There is an answer key at the very end so that you can check your work.

1) Timeline Atomic Discoveries *(**Turn in** - Friday of the first week of school)*
2) Learn Your Ions *Ion Quiz*
3) Nomenclature Review *Naming Quiz*
4) Sig Figs and Uncertainty *Sig Fig and Uncertainty Quiz*
5) Dimensional Analysis *Dimensional Analysis and Stoichiometry Quiz*
6) Net Ionic Equations *Net Ionic Quiz*

All quizzes will occur in the first 2 weeks of school. All will be short. (≤15 minutes of class) If you receive less than a 70% you will retake them on your own time (before/after school/lunch/study) up to three times. You will receive the average grade.

If you have any questions, need help or if you find an extremely funny chemistry joke, please feel free to contact me over the summer by email. It might take me some time to respond but I will see it.
Try to pace yourself over the summer so that the material moves from your short-term memory to your long-term memory. Be sure to have plenty of downtime so that you are well-rested and ready to work hard next year.

Periodically yours,

Mrs. Ashley Callahan

acallahan@oconeeschools.org

1) Timeline Atomic Discoveries <- click here to make a copy

There is often very little time devoted to the history of chemistry. Construct a timeline with dates for the following scientists. Briefly indicate their contributions to science. You can find all of these scientists in your textbook, or you can research them on the internet. This is not a comprehensive list, you may add additional scientists/discoveries.

	Year(s)	Contribution
Ancient Greeks		
Bauer Paracelsus		
Boyle		
Stahl		
Priestley		
Lavoisier		
Proust		
Dalton		
Gay-Lussac		
Avogadro		
Berzelius		
Thomson		
Millikan		
Becquerel Curie		
Rutherford		

2) Learn Your Ions

If you know your ions you will save a lot of time this year because you won't have to look them up. Memorize the following ions, you will have an ion quiz during the first two weeks of school. You will have the Periodic Table when you take the quiz, however, it will not have the names of the elements on it. Try to look for patterns based on the periodic table, it is much easier to learn the patterns than it is to memorize each one individually. Color/label the ions by charge on the periodic table to help you to remember the patterns.

Monatomic Ions					
Group 1 Alkali Metal Ions		Group 2 Alkaline Earth Metal Ions		Group 7 Halogen Ions	
Lithium	Li^{+}	Beryllium	Be^{2+}	Fluoride	F^{-}
Sodium	Na^{+}	Magnesium	Mg^{2+}	Chloride	Cl^{-}
Potassium	K^{+}	Calcium	Ca^{2+}	Bromide	Br^{-}
Rubidium	Rb^{+}	Strontium	Sr^{2+}	Iodide	I^{-}
Cesium	Cs^{+}	Barium	Ba^{2+}	Astatide	At^{-}
Francium	Fr^{+}	Radium	Ra^{2+}	Tennesside	Ts^{-}
Transition Metal Ions		Other Metal Ions		Other Nonmetal Ions	
Zinc	Zn^{2+}	Tin (II)	Sn^{2+}	Hydrogen	H^{+}
Copper (II)	Cu^{2+}	Tin (IV)	Sn^{4+}	Oxide	O^{2-}
Copper (I)	Cu^{+}	Lead (II)	Pb^{2+}	Sulfide	S^{2-}
Iron (II)	Fe^{2+}	Lead (IV)	Pb^{4+}	Selenide	Se^{2-}
Iron (III)	Fe^{3+}	Mercury (I)	Hg_2^{2+}	Nitride	N^{3-}
Gold	Au^{3+}	Mercury (II)	Hg^{2+}	Phosphide	P^{3-}
Silver	Ag^{+}	Aluminum	Al^{3+}		
Chromium(II)	Cr^{2+}	Gallium	Ga^{3+}		
Chromium (III)	Cr^{3+}				
Titanium	Ti^{2+}				

Polyatomic Ions					
Cations		Anions -ate endings *		Other Polyatomic Ions	
Hydronium	H_3O^{+}	Phosphate	PO_4^{3-}	Hydroxide	OH^{-}
Ammonium	NH_4^{+}	Nitrate	NO_3^{-}	Acetate	CH_3COO^{-}
		Sulfate	SO_4^{2-}	Dichromate	$Cr_2O_7^{2-}$
		Chlorate	ClO_3^{-}	Oxalate	$C_2O_4^{2-}$
		Iodate	IO_3^{-}	Permanganate	MnO_4^{-}
		Chromate	CrO_4^{2-}	Cyanate	OCN^{-}

Anion Rule 1		
-ate	Learn these (base ion)	
-ite	Remove one oxygen	No change to charge
Hypo--ite	Remove two oxygens from the (-ate)	No change to charge
Per--ate	Add two oxygens to the (-ate)	No change to charge

Anion Rule 2		
Bi-	Add an H	Charge increases by 1
Monohydrogen or hydrogen	Add an H	Charge increases by 1
Dihydrogen	Add two H	Charge increases by 2

Anion Rule 3		
thio-	Replace an O with an S	No change to charge

3) Nomenclature Review

There are three types of substances that you will need to name, ionic compounds, covalent binary molecules and acids. Each has their own naming system.

<table>
<tr><td>Acids - Start with H</td><td>Ionic - Metal + nonmetals</td><td>Binary Molecular - Two nonmetals</td></tr>
<tr><td>H(s) + Anion</td><td>Cation + Anion</td><td>Two nonmetals</td></tr>
<tr><td>If the anion name ends with -ate
Then the acid is named -ic acid
Example:
HNO_3 contains the nitrate anion.
It would be named nitric acid</td><td rowspan="3">Name the cation first, using a roman numeral if the ion forms multiple charges.
Name the anion second.
Example:
KBr
potassium bromide

KNO_3
potassium nitrate

$CuNO_3$
copper (I) nitrate

$Cu(NO_3)_2$
copper (II) nitrate</td><td>Nonmetals can combine in many different ratios so the name needs to describe the amount of each element that are present in the formula.</td></tr>
<tr><td>If the anion name ends with -ite
Then the acid is named -ous acid
Example:
H_2SO_3 contains the sulfite anion.
It would be named sulfurous acid</td><td>Prefix List<table>
<tr><td>1</td><td>mono</td><td>6</td><td>hexa</td></tr>
<tr><td>2</td><td>di</td><td>7</td><td>hepta</td></tr>
<tr><td>3</td><td>tri</td><td>8</td><td>octa</td></tr>
<tr><td>4</td><td>tetra</td><td>9</td><td>nona</td></tr>
<tr><td>5</td><td>penta</td><td>10</td><td>deca</td></tr>
</table></td></tr>
<tr><td>If the anion name ends with -ide
Then the acid is named hydro - ic acid
Example:
HCl contains the chloride anion.
It would be named hydrochloric acid.</td><td>Use the prefix to indicate the number and then name the first element. (Drop the “o” or “a” if the element starts with a vowel)
Then use the prefix to indicate the number and name the second element, change the suffix of the second element to “-ide”.
Examples:
PCl_3 = Phosphorus trichloride
N_2O_4 = Dinitrogen tetroxide
N_2O = Dinitrogen monoxide</td></tr>
</table>

4) Sig Figs and Uncertainty

<u>SF Rules</u>

1. All non-zero numbers are significant
   - 2.35 mL ← 3 significant figures
   - 1215 g ← 4 significant figures
2. Sandwiched zeros are ALWAYS significant
   - 1.05 mL ← 3 significant figures
   - 8008 kg ← 4 significant figures
3. Leading zeros are NEVER significant
   - 0.00529 cm ← 3 significant figures
   - 0.8091 L ← 4 significant figures
4. Trailing zeros are ONLY significant IF there is a decimal point
   - 1.80 mm ← 3 significant figures
   - 2896000 g ← 4 significant figures
5. Counting numbers and conversion factors have infinite significant figures
   - 15 pencils ← ∞ significant figures
   - 1 L = 1000 mL ← ∞ significant figures

<u>SF Math Rule - Addition and Subtraction</u>

When you add or subtract values, you report the same number of decimal places (or simply places) as the one with the value that is least certain.

Example:

120 mL ← Known to the tens place
<u>+ **5.52** mL</u> ← Known to the hundredths place
125.52 mL (Unrounded answer)

130 mL ← Known to the tens place

Example:

120.2 mL ← Known to the tenths place
<u>+ **5.52** mL</u> ← Known to the hundredths place
125.72 mL (Unrounded answer)

125.7 mL ← Known to the tenths place

<u>SF Math Rule - Multiplication and Division</u>

When you multiply or divide values, you report the same number of significant figures as the value with the least significant figures.

Example:

1.56 cm ← Known to three significant figures

x **5.5** cm ← Known to two significant figures

8.58 cm² (Unrounded answer)

8.6 cm^2 ← Known to two significant figures

Example:

2.50 g ← Known to three significant figures

0.**59** mL ← Known to two significant figures

4.237288136 g/mL (Unrounded answer)

4.2 *g/mL* ← Known to two significant figures

SF Math Rule - Logs (pH etc.)

When you take a log of a number the significant figures are the values after the decimal point. The numbers before the decimal point (the characteristic) are describing the order of magnitude of the value, while the numbers after the decimal point (the mantissa) describe the value.

Example:

-log [2.55×10^{-4} M] ← Concentration is known to three significant figures

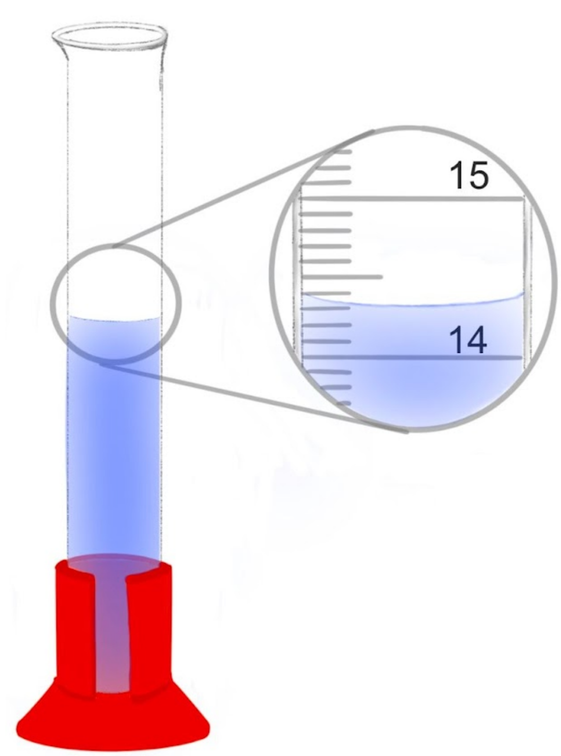
= 3.59345982 (Unrounded answer)

3.593 ← Known to three significant figures

Making Measurements

When you are recording a measurement made with an analog device (like a graduated cylinder) you have to record all the values that are known, plus one guess digit. If the device is digital, you do not include the guess digit, simply report all of the given values.

If there is a meniscus, you will read the value from the center of the meniscus, usually the lowest point, unless you are working with mercury, which is unlikely!

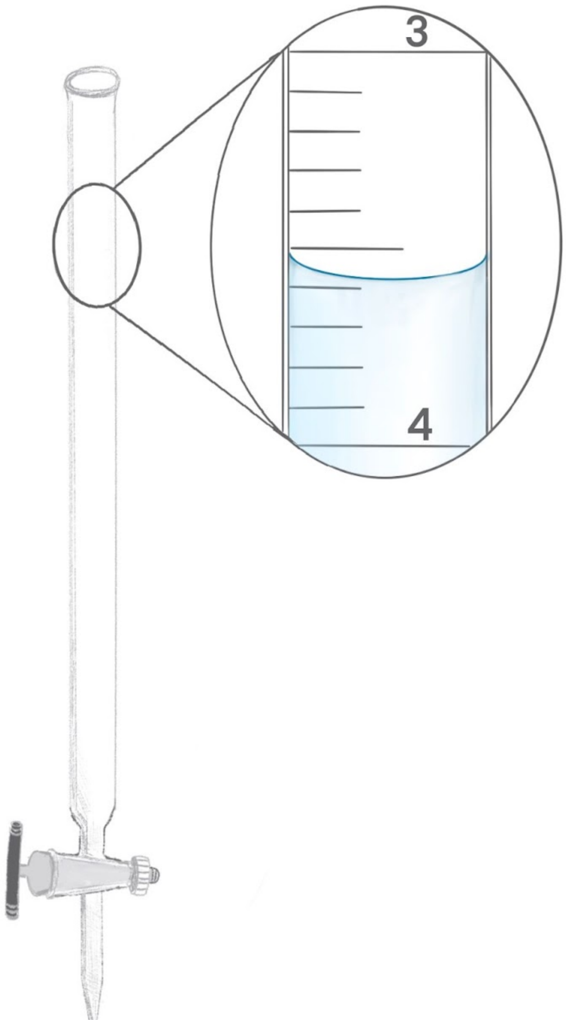


The measurement for this graduated cylinder would be:

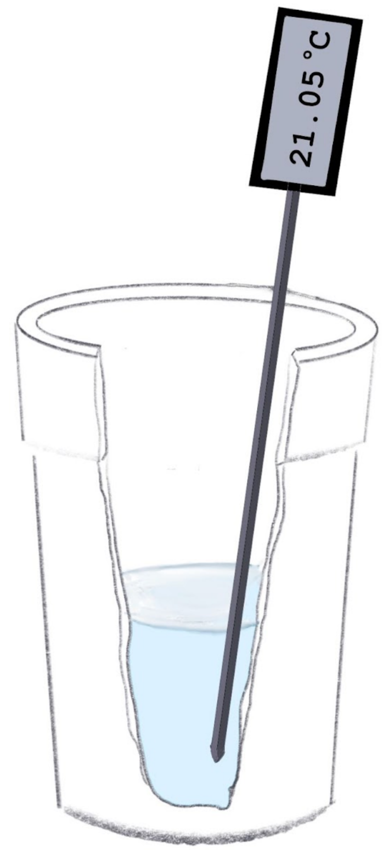
14.32 mL

(14.3 are the known digits, while the 2 in the hundredths place is the guess or uncertain digit)

This next example is a 50 mL buret, the measurements run from 0 at the top to 50 mL near the bottom. As such you record the volume of air in the buret to make the calculations easier when the liquid is dispensed.
The measurement for the liquid in this buret would be: 3.58 mL. The 3.5 are certain, while the 8 is a guess or uncertain digit.



The digital thermometer has a measurement of 21.05°C. All digits would be recorded.



Uncertainty is not tested on the AP exam, however you will be using uncertainty when we perform labs this year.

Uncertainty in Measurement

Different courses will use different techniques to determine the uncertainty in a measurement. In this course we will use the following two rules:

- For a digital device the measured uncertainty is the smallest increment on the device.
- For an analog device the measured uncertainty is half of the smallest division.

The uncertainties for the images and measurements above would be:

Graduated Cylinder: 14.32 mL ± 0.05

Buret: 3.58 mL ± 0.05

Digital Thermometer: 21.05°C. ± 0.01

Calculations with Uncertainty

Uncertainty always increases.

Addition and Subtraction

If you perform addition or subtraction, you add the measured uncertainties.

Example:

$$\begin{array}{rl} & 12.34 \text{ mL} \pm 0.05 \\ + & \underline{43.21 \text{ mL} \pm 0.05} \\ & 55.55 \text{ mL} \pm 0.10 \end{array}$$

Multiplication and Division

If you perform multiplication or division, you add the percent uncertainties. To calculate the percent uncertainty, divide the measured uncertainty by the measurement and then multiply by 100%.

Example:

Mass = 2.50 g ± 0.01 (±0.4 %) ← (0.01/2.50 x100)

Volume = 0.59 mL ± 0.05 (±8 %) ← (0.05/0.59 x100)

$$\frac{2.50 \text{ g } (\pm 0.4\ \%)}{0.59 \text{ mL } (\pm 8\ \%)} = 4.2 \text{ g/mL } (\pm 8\ \%)$$

5) Dimensional Analysis and Stoichiometry

Dimensional analysis (or unit analysis) is a problem-solving strategy that allows you to convert between different units of measurement. It is often used in stoichiometry.

Example:

Convert 890. mL into gallons. One gallon contains 4 quarts, 1.06 quarts is 1 liters, and you should know the metric conversions.

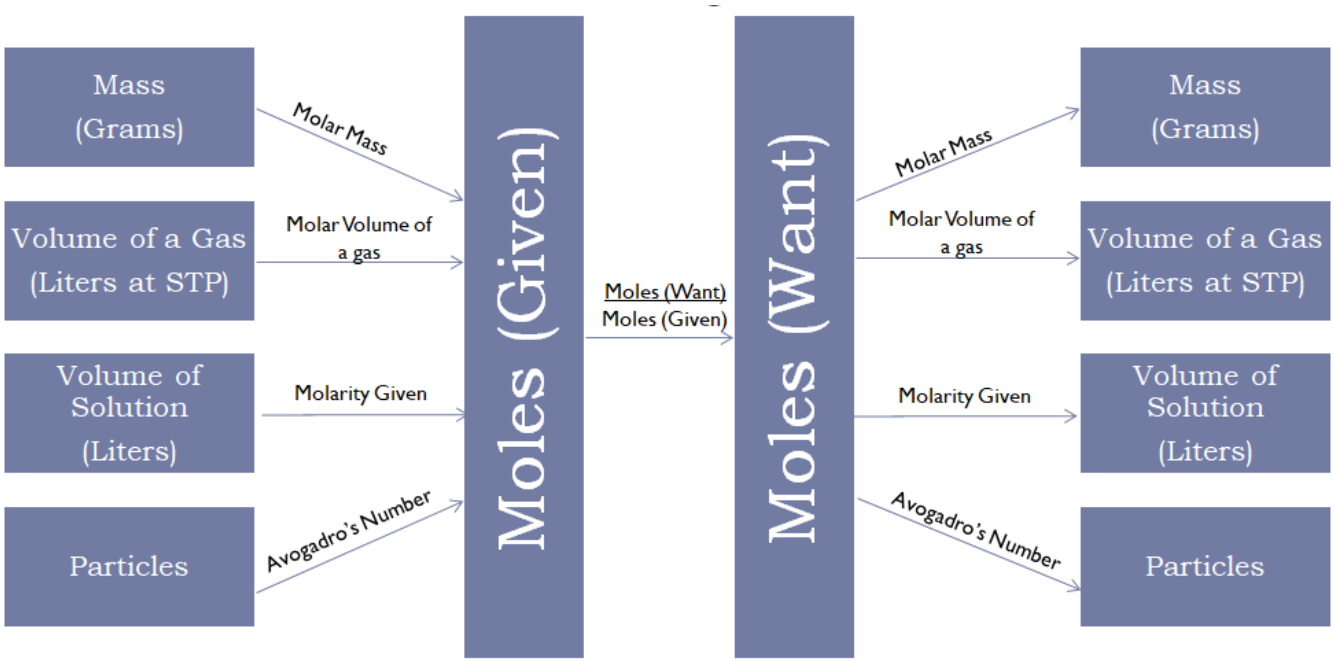
$$\underline{890.\ \text{mL}} \times \frac{1\ \text{L}}{1000\ \text{mL}} \times \frac{1.06\ \text{quarts}}{1\ \text{L}} \times \frac{1\ \text{gallon}}{4\ \text{quarts}} = 0.239\ \text{gallons}$$

Example:

If you have 200. mL of 0.123 M hydrochloric acid, HCl, how many liters of hydrogen gas, H_2, at STP would be formed?

$$2\ HCl_{(aq)} + Mg_{(s)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$$

$$\underline{200.\ \text{mL HCl}} \times \frac{1\ \text{L HCl}}{1000\ \text{mL HCl}} \times \frac{0.123\ \text{moles HCl}}{1\ \text{L HCl}} \times \frac{1\ \text{mole}\ H_2}{2\ \text{moles HCl}} \times \frac{22.4\ \text{L}H_2}{1\ \text{mole}\ H_2} = 0.276\ \text{L}\ H_2$$



Useful Conversion Information			
Molar Mass	Molar Volume of a gas	Molarity	Avogadro's Number
Using the formula and periodic table, find the mass for one mole.	For Gases at STP	The molarity is given in the problem.	Number of Particles in one mole
$\frac{\#\ \text{grams}}{1\ \text{mole}}$	$\frac{22.4\ \text{Liters}}{1\ \text{mole}}$	$\frac{\#\ \text{moles}}{1\ \text{Liter}}$	$\frac{6.022 \times 10^{23}\ \text{particles}}{1\ \text{mole}}$

Note: in a limiting reagent problem, you will perform the stoichiometry twice and choose the smaller result.

6) Net Ionic Equations

A net ionic equation is useful to show the reacting species and removes any spectator ions that are not participating in the reaction. Spectator ions are ions that are in aqueous solution on both sides of the equation. You can construct both an overall ionic equation and a net ionic equation from the balanced equation.

You need to memorize that the following ions will always dissociate and be aqueous. Sodium (Na^+), Nitrate (NO_3^-), Ammonium (NH_4^+) and Potassium (K^+). (SNAP ions are always aqueous as solutions)

Over the course of next year we will add the following solubility rules.

- *Strong acids will also dissociate.*
  - *They are H_2SO_4 (only the first H^+, so $H^+ + HSO_4^-$), HI, HBr, HNO_3, HCl, $HClO_4$.*
  - *mnemonic = **SO**, **I Br**ought **NO Cl**ean **ClO**thes*
- *Substances with K_{sp} values that are greater than 1, will dissociate. The larger the Ksp value, the greater the solubility.*
- *The strong bases will also dissociate if they dissolve, they are the group 1 and 2 hydroxides.*

For the net ionic equation quiz in September we will only focus on knowing that the SNAP ions will fully dissociate in solution.

Example:

A reaction occurs between solutions of potassium chloride (KCl) and lead (II) acetate ($Pb(CH_3COO)_2$) forming a white precipitate.

Write the balanced chemical equation.

$$2\ KCl_{(aq)} + Pb(CH_3COO)_{2(aq)} \rightarrow 2\ KCH_3COO_{(aq)} + PbCl_{2(s)}$$

Write the overall ionic equation

$$2\ K^+_{(aq)} + 2\ Cl^-_{(aq)} + Pb^{2+}_{(aq)} + 2\ CH_3COO^-_{(aq)} \rightarrow 2\ K^+_{(aq)} + 2\ CH_3COO^-_{(aq)} + PbCl_{2(s)}$$

Write the net ionic equation

$$2\ Cl^-_{(aq)} + Pb^{2+}_{(aq)} \rightarrow PbCl_{2(s)}$$

Sample Quizzes

The answers to the quizzes are on the subsequent pages.

Sample Ion Quiz

If you are given the formula, provide the name of the ion. If you are given the name, provide the formula.

1. Hydronium
2. Cu^{2+}
3. Acetate
4. Al^{3+}
5. Nitrite
6. OH^{-}
7. Hydrogen carbonate
8. ClO_2^{-}

Write the formula for the ionic compound.

9. Tin (II) fluoride
10. Potassium carbonate

The periodic table that you will use can be found on page 243 of this document:

AP Chemistry Course and Exam Description, Effective Fall 2020

Sample Nomenclature Quiz

If you are given the name, write the formula and vice versa.

1) $Fe(ClO_3)_2$

2) Carbon tetrachloride

3) HI

4) Lithium sulfate

5) N_2O_3

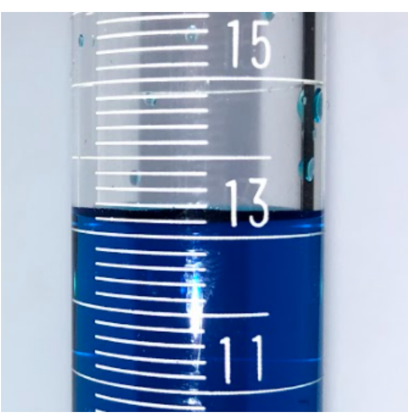
6) Acetic Acid

Sample Sig Figs and Uncertainty Quiz

1) How many significant figures are there in the following:
   a) 3.080
   b) 2.9185
   c) 0.000080
   d) 2.90×10^{23}

2) Complete these operations without a calculator
   a) 10.0 m * 6.8 m
   b) 6.06 g ÷ 2.000 mL
   c) 1.05 mL + 15.0 mL + 0.0025 mL
   d) $(2.0 \times 10^{10})(3.0\times10^{4})$

3) Record the volume in these graduated cylinders with the correct uncertainty. (all are in mL)

<table>
<tr><td colspan="2">
</td><td colspan="2">
</td><td colspan="2">
</td></tr>
<tr><td>Measurement</td><td>Uncertainty</td><td>Measurement</td><td>Uncertainty</td><td>Measurement</td><td>Uncertainty</td></tr>
</table>

4) Add all of the measurements in 3 together. Report with the correct sig figs and uncertainty

<u>Sample Dimensional Analysis and Stoichiometry Quiz</u>

1) Convert 2.41 km into inches using dimensional analysis. (1.61 km = 1 mile, 1 mile = 5280 ft, 1 ft = 12 in)

2) Convert 0.0345 m^2 into $feet^2$ using dimensional analysis. (Use the conversions from #1)

3) 15.0 grams of calcium carbonate, $CaCO_3$, reacts with 250.0 mL of 0.565 M nitric acid, HNO_3, to form carbon dioxide gas, CO_2, water, H_2O and an aqueous solution of calcium nitrate. What is the volume of carbon dioxide (in liters) that is formed?

Sample Net Ionic Equations Quiz

A reaction occurs between solutions of sodium carbonate (Na_2CO_3) and calcium nitrate ($Ca(NO_3)_2$) forming a white precipitate.

Write the balanced chemical equation.

Write the overall ionic equation

Write the net ionic equation

Answers to Sample Quizzes

Sample Ion Quiz

If you are given the formula, provide the name of the ion. If you are given the name, provide the formula.

1. Hydronium

   H_3O^+

2. Cu^{2+}

   Copper (II)

3. Acetate

   CH_3COO^-

4. Al^{3+}

   Aluminum

5. Nitrite

   NO_2^-

6. OH^-

   Hydroxide

7. Hydrogen carbonate

   HCO_3^-

8. ClO_2^-

   Chlorite

Write the formula for the ionic compound.

9. Tin (II) fluoride

   SnF_2

10. Potassium carbonate

    K_2CO_3

The periodic table that you will use can be found on page 243 of this document:

AP Chemistry Course and Exam Description, Effective Fall 2020

<u>Sample Nomenclature Quiz</u>

If you are given the name, write the formula and vice versa.

1) $Fe(ClO_3)_2$

Iron (II) chlorate

2) Carbon tetrachloride

CCl_4

3) HI

Hydroiodic acid

4) Lithium sulfate

Li_2SO_4

5) N_2O_3

Dinitrogen trioxide

6) Acetic Acid

HCH_3COO

Sample Sig Figs and Uncertainty Quiz

1) How many significant figures are there in the following:

   a) 3.080

   4

   b) 2.9185

   5

   c) 0.000080

   2

   d) 2.90×10^{23}

   3

2) Complete these operations without a calculator

   a) 10.0 m * 6.8 m

   68 m^2

   b) 6.06 g ÷ 2.000 mL

   3.03 g/mL

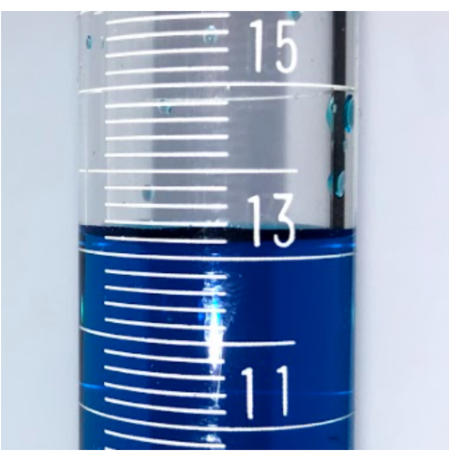
   c) 1.05 mL + 15.0 mL + 0.0025 mL

   16.1 mL

   d) $(2.0 \times 10^{10})(3.0 \times 10^{4})$

   6.0×10^{14}

3) Record the volume in these graduated cylinders with the correct uncertainty. (all are in mL)



Measurement	Uncertainty	Measurement	Uncertainty	Measurement	Uncertainty
13.2 mL	± 0.1	7.21 mL	± 0.05	48.5 mL	± 0.5

4) Add all of the measurements in 3 together. Report with the correct sig figs and uncertainty

68.9 mL ± 0.7

Sample Dimensional Analysis and Stoichiometry Quiz

(Set up can differ)

1) Convert 2.41 km into inches using dimensional analysis. (1.61 km = 1 mile, 1 mile = 5280 ft, 1 ft = 12 in)

$$2.41\ km \times \frac{1\ mile}{1.61\ km} \times \frac{5280\ ft}{1\ mile} \times \frac{12\ in}{1\ ft} = 94800\ in$$

2) Convert 0.0345 m^2 into $feet^2$ using dimensional analysis. (Use the conversions from #1)

$$0.0345\ m^2 \times \frac{1\ km}{1000\ m} \times \frac{1\ km}{1000\ m} \times \frac{1\ mile}{1.61\ km} \times \frac{1\ mile}{1.61\ km} \times \frac{5280\ ft}{1\ mile} \times \frac{5280\ ft}{1\ mile} = 0.371\ ft^2$$

3) 15.0 grams of calcium carbonate, $CaCO_3$, reacts with 250.0 mL of 0.565 M nitric acid, HNO_3, to form carbon dioxide gas, CO_2, water, H_2O and an aqueous solution of calcium nitrate. What is the volume of carbon dioxide (in liters) that is formed?

$$CaCO_3 + 2\ HNO_3 \rightarrow CO_2 + H_2O + Ca(NO_3)_2$$

$$15.0\ g\ CaCO_3 \times \frac{1\ mole\ CaCO_3}{100.01\ grams\ CaCO_3} \times \frac{1\ mole\ CO_2}{1\ mole\ CaCO_3} \times \frac{22.4\ L\ CO_2}{1\ mole\ CO_2} = 3.36\ L\ CO_2$$

$$250.0\ mL\ HNO_3 \times \frac{1\ L\ HNO_3}{1000\ mL\ HNO_3} \times \frac{0.565\ moles\ HNO_3}{1\ L\ HNO_3} \times \frac{1\ mole\ CO_2}{2\ mole\ HNO_3} \times \frac{22.4\ L\ CO_2}{1\ mole\ CO_2} = 1.58\ L\ CO_2$$

HNO_3 produced less CO_2 so it is the limiting reagent and 1.58 L of CO_2 are produced.

Sample Net Ionic Equations Quiz

A reaction occurs between solutions of sodium carbonate (Na_2CO_3) and calcium nitrate ($Ca(NO_3)_2$) forming a white precipitate.

1) Write the balanced chemical equation.

$$Na_2CO_{3(aq)} + Ca(NO_3)_2 \rightarrow 2\ NaNO_{3(aq)} + CaCO_{3(s)}$$

2) Write the overall ionic equation

$$2\ Na^+_{(aq)} + CO_3^{2-}{}_{(aq)} + Ca^{2+}_{(aq} + 2NO_3^-{}_{(aq)} \rightarrow 2\ Na^+_{(aq)} + 2NO_3^-{}_{(aq)} + CaCO_{3(s)}$$

3) Write the net ionic equation

$$CO_3^{2-}{}_{(aq)} + Ca^{2+}_{(aq} \rightarrow CaCO_{3(s)}$$