**AP CHEMISTRY summer**

**Task 1: Complete Worksheets**

Free online textbook:
https://www.ck12.org/book/CK-12-Chemistry-Intermediate/

**Task 2: Memorize the names of the elements and their corresponding symbols**

- You need to know elements 1-56, plus Pt, Au, Hg, Pb, Rn, Fr, Ra, U, Pu
- Many of these elements you will already know
- Making flashcards is helpful!
- It's important to know these elements because the periodic table you are provided has only the symbols and not the names of the elements.

**Task 3: Memorize the ionic charges of the basic ions**

- **Think** about the valance electrons!
- **Think** about the common elements/ions in that group
  - Group 1 ions = +1
  - Group 2 ions = +2
  - Group 15 (5A) ions (N and P) = -3
  - Group 16 (6A) ions (O and S) = -2
  - Group 17 (7A)/ halogens = -1
  - Zn = +2
  - Ag = +1
  - Cu = +1 or +2
  - Fe = +2 or +3
  - Pb = +2 or +4
  - Sn = +2 or +4

**Task 4: Memorize the names, symbols, and charges of Polyatomic ions below:**

- Oxyanions – polyatomics containing oxygen, names end in *-ate* or *-ite*
- *-ate* is used for the most common form
- *-ite* is used for the form with the same charge, but one less oxygen
  - Example:
    - $NO_3^-$ = nitrate
    - $NO_2^-$ = nitrite
- Prefixes are also used
  - *Per-* indicates one more oxygen than the *-ate* form (think "perfect = overachieving", ie = more)
  - *Hypo-* indicates one fewer oxygen than the *-ite* form
  - Example:
    - $ClO_4^-$ = perchlorate (b/c it has one more O than the –ate form)
    - $ClO_3^-$ = chlorate (b/c it is the most common)
    - $ClO_2^-$ = chlorite (b/c it has one less oxygen than – ate form)
    - $ClO_4^-$ = hypochlorite (b/c it has one less oxygen than the –ite form)
  - F, Cl, Br, I all behave the same
    - Therefore, if chlorate is $ClO_3^-$, the bromate ion is…
    - $BrO_3^-$!!!!
    - Simply substitute one halogen for the other
    - If you learn the chlorate series, you also automatically know the bromate, iodate, and fluorate series
- Hydrogen can be added to -2 or -3 ions to make a "new ion" i.e. $H_2PO_4^{-1}$ is dihydrogen phosphate (note the – charge went up 1 for each $H^+$ added)

| | | |
|---|---|---|
| +1<br>ammonium, $NH_4^+$ | | |
| -1<br>acetate, $C_2H_3O_2^-$, or $CH_3COO^-$<br>bromate, $BrO_3^-$<br>chlorate, $ClO_3^-$<br>chlorite, $ClO_2^-$<br>cyanide, $CN^-$<br>hydrogen carbonate, $HCO_3^-$<br>(also called bicarbonate)<br>hydroxide, $OH^-$<br>hypochlorite, $ClO^-$<br>iodate, $IO_3^-$<br>nitrate, $NO_3^-$<br>nitrite, $NO_2^-$<br>permanganate, $MnO_4^-$<br>perchlorate, $ClO_4^-$<br>thiocyanate, $SCN^-$ | -2<br>carbonate, $CO_3^{-2}$<br>chromate, $CrO_4^{-2}$<br>dichromate, $Cr_2O_7^{-2}$<br>oxalate, $C_2O_4^{-2}$<br>peroxide, $O_2^{-2}$<br>sulfate, $SO_4^{-2}$<br>sulfite, $SO_3^{-2}$ | -3<br>phosphate, $PO_4^{-3}$<br>phosphite, $PO_3^{-3}$<br>arsenate, $AsO_4^{-3}$ |

***Be able to name polyatomic ions using the rules above such as these below:***

$HPO_4^{-2}$ _____ $HSO_3^{-1}$ _____

$FO_3^{-1}$ _____ $HCO_3^{-1}$ _____

***Be able to write formulas for polyatomic ions using the rules above such as these below:***

Bromite _____ periodate _____

Dihydrogen phosphite _____ hydrogen chromate _____

# Significant Figures in Measurement and Calculations

A successful chemistry student habitually labels all numbers, because the unit is important. Also of great importance is the number itself. Any number used in a calculation should contain only figures that are considered reliable; otherwise, time and effort are wasted. Figures that are considered reliable are called *significant figures*. Chemical calculations involve numbers representing actual measurements. In a measurement, significant figures in a number consist of:

Figures (digits) definitely known + One estimated figure (digit)

In class you will hear this expressed as "all of the digits known for certain plus one that is a guess."

## Recording Measurements

When one reads an instrument (ruler, thermometer, graduate, buret, barometer, balance), he expresses the reading as one which is reasonably reliable. For example, in the accompanying illustration, note the reading marked *A*. This reading is definitely beyond the 7 cm mark and also beyond the 0.8 cm mark. We read the 7.8 with certainty. We further *estimate* that the reading is five-tenths the distance from the 7.8 mark to the 7.9 mark. So, we estimate the length as 0.05 cm more than 7.8 cm. All of these have meaning and are therefore significant. We express the reading as 7.85 cm, accurate to three significant figures. All of these figures, *7.85*, can be used in calculations. In reading B we see that 9.2 cm is definitely known. We can include one estimated digit in our reading, and we estimate the next digit to be zero. Our reading is reported as 9.20 cm. It is accurate to three significant figures.


## Rules for Zeros

If a zero represents a measured quantity, it is a significant figure. If it merely locates the decimal point, it is not a significant figure.

**Zero Within a Number**. In reading the measurement 9.04 cm, the zero represents a measured quantity, just as 9 and 4, and is, therefore, a significant number. A zero between any of the other digits in a number is a significant figure.

**Zero at the Front of a Number**. In reading the measurement 0.46 cm, the zero does not represent a measured quantity, but merely locates the decimal point. It is not a significant figure. Also, in the measurement 0.07 kg, the zeros are used merely to locate the decimal point and are, therefore, not significant. Zeros at the first (left) of a number are not significant figures.

**Zero at the End of a Number**. In reading the measurement 11.30 cm, the zero is an estimate and represents a measured quantity. It is therefore significant. Another way to look at this: The zero is not needed as a placeholder, and yet it was included by the person recording the measurement. It must have been recorded as a part of the measurement, making it significant. Zeros to the right of the decimal point, and at the end of the number, are significant figures.

**Zeros at the End of a Whole Number**. Zeros at the end of a whole number may or may not be significant. If a distance is reported as 1600 feet, one assumes two sig figs. Reporting measurements in scientific notation removes all doubt, since all numbers written in scientific notation are considered significant.

| | | |
|---|---|---|
| 1 600 feet | $1.6 \times 10^3$ feet | Two significant figures |
| 1 600 feet | $1.60 \times 10^3$ feet | Three significant figures |
| 1 600 feet | $1.600 \times 10^3$ feet | Four significant figures |

**Sample Problem #1**: Underline the significant figures in the following numbers.

| | | | |
|---|---|---|---|
| (a) 0.0420 cm | answer = 0.0420 cm | (e) 2 403 ft. | answer = 2 403 ft. |
| (b) 5.320 in. | answer = 5.320 in. | (f) 80.5300 m | answer = 80.5300 m |
| (c) 10 lb. | answer = 10 lb. | (g) 200. g | answer = 200 g |
| (d) 0.020 ml | answer = 0.020 ml | (h) $2.4 \times 10^3$ kg | answer = $2.4 \times 10^3$ kg |

## Rounding Off Numbers

In reporting a numerical answer, one needs to know how to "round off" a number to include the correct number of significant figures. Even in a series of operations leading to the final answer, one must "round off" numbers. The rules are well accepted rules:

1. If the figure to be dropped is less than 5, simply eliminate it.
2. If the figure to be dropped is greater than 5, eliminate it and raise the preceding figure by 1.
3. If the figure is 5, followed by nonzero digits, raise the preceding figure by 1
4. If the figure is 5, not followed by nonzero digit(s), and preceded by an odd digit, raise the preceding digit by one
5. If the figure is 5, not followed by nonzero digit(s), and the preceding significant digit is even, the preceding digit remains unchanged

**Sample Problem #2**: Round off the following to three significant figures.

| | | | |
|---|---|---|---|
| (a) 3.478 m | answer = 3.48 m | (c) 5.333 g | answer = 5.33 g |
| (b) 4.8055 cm | answer = 4.81 cm | (d) 7.999 in. | answer = 8.00 in. |

## Multiplication

In multiplying two numbers, when you wish to determine the number of significant figures you should have in your answer (the product), you should inspect the numbers multiplied and find which has the least number of significant figures. This is the number of significant figures you should have in your answer (the product). Thus the answer to 0.024 x 1244 would be rounded off to contain two significant figures since the factor with the lesser number of significant figures (0.024) has only *two* such figures.

**Sample Problem #3**: Find the area of a rectangle 2.1 cm by 3.24 cm.

Solution: Area = 2.1 cm x 3.24 cm = 6.804 $cm^2$

We note that 2.1 contains two significant figures, while 3.24 contains three significant figures. Our product should contain no more than *two* significant figures. Therefore, our answer would be recorded as 6.8 $cm^2$

**Sample Problem #4**: Find the volume of a rectangular solid 10.2 cm x 8.24 cm x 1.8 cm

Solution: Volume = 10.2 cm x 8.24 cm x 1.8 cm = 151.2864 $cm^3$

We observe that the factor having the least number of significant figures is 1.8 cm. It contains two significant figures. Therefore, the answer is rounded off to 150 $cm^3$.

## Division

In dividing two numbers, the answer (quotient) should contain the same number of significant figures as are contained in the number (divisor or dividend) with the least number of significant figures. Thus the answer to 528 ÷ 0.14 would be rounded off to contain *two* significant figures. The answer to 0.340 ÷ 3242 would be rounded off to contain three significant figures.

**Sample Problem #5**: Calculate 20.45 ÷ 2.4

Solution: 20.45 ÷ 2.4 = 8.52083

We note that the 2.4 has fewer significant figures than the 20.45. It has only *two* significant figures. Therefore, our answer should have no more than two significant figures and should be reported as 8.5.

## Addition and Subtraction

In adding (or subtracting), set down the numbers, being sure to keep like decimal places under each other, and add (or subtract). Next, note which column contains the first estimated figure. This column determines the last decimal place of the answer. After the answer is obtained, it should be rounded off in this column. In other words, round to the least number of decimal places in you data.

**Sample Problem #6**: Add 42.56 g + 39.460 g + 4.1g

Solution:

42.56 g
39.460 g
<u>4.1 g</u>
Sum = 86.120 g

Since the number 4.1 only extends to the first decimal place, the answer must be rounded to the first decimal place, yielding the answer 86.1 g.

## Average Readings

The average of a number of successive readings will have the same number of decimal places that are in their sum.

**Sample Problem #7**: A graduated cylinder was weighed three times and the recorded weighings were 12.523 g, 12.497 g, 12.515 g. Calculate the average weight.

Solution:

12.523 g
12.497 g
<u>12.515 g</u>
37.535 g

In order to find the average, the sum is divided by 3 to give an answer of 12.51167. Since each number extends to three decimal places, the final answer is rounded to three decimal places, yielding a final answer of 12.512 g. Notice that the divisor of 3 does not effect the rounding of the final answer. This is because 3 is an exact number - known to an infinite number of decimal places.

Name _____

Give the number of significant figures in each of the following:

| | | |
|---|---|---|
| ____ 402 m | ____ 34.20 lbs | ____ 0.03 sec |
| ____ 0.00420 g | ____ 3 200 liters | ____ 0.0300 ft. |
| ____ $5.1 \times 10^4$ kg | ____ 0.48 m | ____ 1 400.0 m |
| ____ 78 323.01 g | ____ 1.10 torr | ____ 760 mm Hg |

Multiply each of the following, observing significant figure rules:

17 m x 324 m = _____ 1.7 mm x 4 294 mm = _____

0.005 in x 8 888 in = _____ 0.050 m x 102 m = _____

0.424 in x .090 in = _____ 324 000 cm x 12.00 cm = _____

Divide each of the following, observing significant figure rules:

23.4 m ÷ 0.50 sec = _____ 12 miles ÷ 3.20 hours = _____

0.960 g ÷ 1.51 moles = _____ 1 200 m ÷ 12.12 sec = _____

Add each of the following, observing significant figure rules:

| | | |
|---|---|---|
| 3.40 m | 102.45 g | 102. cm |
| 0.022 m | 2.44 g | 3.14 cm |
| 0.5 m | 1.9999 g | 5.9 cm |

Subtract each of the following, observing signigicant figure rules:

| | | |
|---|---|---|
| 42.306 m | 14.33 g | 234.1 cm |
| 1.22 m | 3.468 g | 62.04 cm |

Work each of the following problems, observing significant figure rules:

Three determinations were made of the percentage of oxygen in mercuric oxide. The results were 7.40%, 7.43%, and 7.35%. What was the average percentage?

A rectangular solid measures 13.4 cm x 11.0 cm x 2.2 cm. Calculate the volume of the solid.

If the density of mercury is 13.6 g/ml, what is the mass in grams of 3426 ml of the liquid?

A copper cylinder, 12.0 cm in radius, is 44.0 cm long. If the density of copper is 8.90 $g/cm^3$, calculate the mass in grams of the cylinder. (assume pi = 3.14)

# PERIODIC TABLE OF THE ELEMENTS

| 1 | | | | | | | | | | | | | | | | | 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **H** | | | | | | | | | | | | | | | | | **He** |
| 1.008 | | | | | | | | | | | | | | | | | 4.00 |
| 3 | 4 | | | | | | | | | | | 5 | 6 | 7 | 8 | 9 | 10 |
| **Li** | **Be** | | | | | | | | | | | **B** | **C** | **N** | **O** | **F** | **Ne** |
| 6.94 | 9.01 | | | | | | | | | | | 10.81 | 12.01 | 14.01 | 16.00 | 19.00 | 20.18 |
| 11 | 12 | | | | | | | | | | | 13 | 14 | 15 | 16 | 17 | 18 |
| **Na** | **Mg** | | | | | | | | | | | **Al** | **Si** | **P** | **S** | **Cl** | **Ar** |
| 22.99 | 24.30 | | | | | | | | | | | 26.98 | 28.09 | 30.97 | 32.06 | 35.45 | 39.95 |
| 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
| **K** | **Ca** | **Sc** | **Ti** | **V** | **Cr** | **Mn** | **Fe** | **Co** | **Ni** | **Cu** | **Zn** | **Ga** | **Ge** | **As** | **Se** | **Br** | **Kr** |
| 39.10 | 40.08 | 44.96 | 47.90 | 50.94 | 52.00 | 54.94 | 55.85 | 58.93 | 58.69 | 63.55 | 65.39 | 69.72 | 72.59 | 74.92 | 78.96 | 79.90 | 83.80 |
| 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 |
| **Rb** | **Sr** | **Y** | **Zr** | **Nb** | **Mo** | **Tc** | **Ru** | **Rh** | **Pd** | **Ag** | **Cd** | **In** | **Sn** | **Sb** | **Te** | **I** | **Xe** |
| 85.47 | 87.62 | 88.91 | 91.22 | 92.91 | 95.94 | (98) | 101.1 | 102.91 | 106.42 | 107.87 | 112.41 | 114.82 | 118.71 | 121.75 | 127.60 | 126.91 | 131.29 |
| 55 | 56 | 57 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 |
| **Cs** | **Ba** | ***La** | **Hf** | **Ta** | **W** | **Re** | **Os** | **Ir** | **Pt** | **Au** | **Hg** | **Tl** | **Pb** | **Bi** | **Po** | **At** | **Rn** |
| 132.91 | 137.33 | 138.91 | 178.49 | 180.95 | 183.85 | 186.21 | 190.2 | 192.2 | 195.08 | 196.97 | 200.59 | 204.38 | 207.2 | 208.98 | (209) | (210) | (222) |
| 87 | 88 | 89 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | | | | | | | |
| **Fr** | **Ra** | **†Ac** | **Rf** | **Db** | **Sg** | **Bh** | **Hs** | **Mt** | **Ds** | **Rg** | | | | | | | |
| (223) | 226.02 | 227.03 | (261) | (262) | (266) | (264) | (277) | (268) | (271) | (272) | | | | | | | |

| | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Lanthanide Series | **Ce** | **Pr** | **Nd** | **Pm** | **Sm** | **Eu** | **Gd** | **Tb** | **Dy** | **Ho** | **Er** | **Tm** | **Yb** | **Lu** |
| | 140.12 | 140.91 | 144.24 | (145) | 150.4 | 151.97 | 157.25 | 158.93 | 162.50 | 164.93 | 167.26 | 168.93 | 173.04 | 174.97 |
| | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 |
| †Actinide Series | **Th** | **Pa** | **U** | **Np** | **Pu** | **Am** | **Cm** | **Bk** | **Cf** | **Es** | **Fm** | **Md** | **No** | **Lr** |
| | 232.04 | 231.04 | 238.03 | (237) | (244) | (243) | (247) | (247) | (251) | (252) | (257) | (258) | (259) | (262) |

Name: _____ Date: _____

AP Chemistry Summer Assignment

## Worksheet #1 – Math Skills

**Significant Figures (Sig Figs)**

1. How many sig figs are in the following numbers?

   a) 0.0450 _____

   b) 790 _____

   c) 32.10 _____

2. Solve the following problems. Round your answer to the correct number of sig figs (and use the correct unit on your answer).
   a) 825 cm x 32 cm x 0.248 cm _____
   b) $\frac{15.68\ g}{2.885\ mL}$ _____

**Density** (round your answers to correct number of sig figs and show all work with units)

3. A cube of ruthenium metal 1.5 cm on a side has a mass of 42.0 g. What is the density in $g/cm^3$? Will ruthenium metal float on water?

4. The density of bismuth metal is 9.8 $g/cm^3$. What is the mass of a sample of bismuth that displaces 65.8 mL of water?

**Conversions** (round answers correctly and show work with units)

5. Make the following conversions:
   a) 16.2 m to km

   b) 5.44 nL to mL

   c) 45.7 mL/s to kL/hr

**Reactions**

6. Balance the following and equations and tell what type of reaction it is (synthesis, decomposition, single replacement, double replacement, or combustion) Replacement = Displacement

   a) ___ $KNO_3$ → ___ $KNO_2$ + ___ $O_2$ _____

   b) ___ $AgNO_3$ + ___ $K_2SO_4$ → ___ $Ag_2SO_4$ + ___ $KNO_3$ _____

   c) ___ $CH_3NH_2$ + ___ $O_2$ → ___ $CO_2$ + ___$H_2O$ + ___ $N_2$ _____

   d) ___ $N_2O_5$ + ___ $H_2O$ → ___$HNO_3$ _____

   e) ___ Na + ___ $Zn(NO_3)_2$ → ___ Zn + ___ $NaNO_3$ _____

7. What are diatomic molecules? List the 7.

**Average Atomic Mass**

8. Magnesium consists of 3 naturally occurring isotopes with the masses 23.98504, 24.98584, and 25.98259 amu. The relative abundances of these three isotopes are 78.70%, 10.13 %, and 11.17% respectively. Calculate the average atomic mass.

**Percent Composition**

9. Calculate the percent composition of $C_{12}H_{22}O_{11}$ (sugar). (Give Percent of each element.) Show all work.

**Moles**

10. Calculate the number of moles of the following: (SHOW WORK)

    a) 42.8 g of $KNO_3$

    b) 155.7 L of $CO_2$ at STP

    c) $9.25 \times 10^{26}$ molecules of $CaCl_2$

**Stoichiometry**

11. Using the following equation:

$$2\ NaOH + H_2SO_4 \rightarrow 2\ H_2O + Na_2SO_4$$

How many grams of sodium sulfate will be formed if you start with 200 grams of sodium hydroxide and you have an excess of sulfuric acid?

12. Using the following equation:

$$Pb(SO_4)_2 + 4\ LiNO_3 \rightarrow Pb(NO_3)_4 + 2\ Li_2SO_4$$

How many grams of lithium nitrate will be needed to make 250 grams of lithium sulfate, assuming that you have an adequate amount of lead (IV) sulfate to do the reaction?

13. Using the following equation: $Fe_2O_3 + 3\ H_2 \rightarrow 2\ Fe + 3\ H_2O$

Calculate how many grams of iron can be made from 16.5 grams of $Fe_2O_3$.

**Limiting Reactant & Percent Yield**

1. Determine the grams of sodium chloride produced when 10.0 g of sodium react with 10.0 g of chlorine gas according to the equation: $2\ Na + Cl_2 \rightarrow 2\ NaCl$

2. Determine the mass of lithium hydroxide produced when 50.0g of lithium are reacted with 45.0g of water according to the equation: $2\ Li + 2\ H_2O \rightarrow 2\ LiOH + H_2$

3. Determine the percent yield of water produced when 68.3 g of hydrogen reacts with 85.4g of oxygen and 86.4g of water are collected. $2\ H_2 + O_2 \rightarrow 2\ H_2O$

# Worksheet #2: Practice Naming Compounds

1. Provide names for the following ionic compounds:
    a. $AlF_3$ _____
    b. $Fe(OH)_2$ _____
    c. $Cu(NO_3)_2$ _____
    d. $Ba(ClO_4)_2$ _____
    e. $Li_3PO_4$ _____
    f. $Hg_2S$ _____
    g. $Cr_2(CO_3)_3$ _____
    h. $(NH_4)_2SO_4$ _____
2. Write the chemical formulas for the following compounds:
    a. Copper(I) oxide _____
    b. Potassium peroxide _____
    c. Iron(III) carbonate _____
    d. Zinc nitrate _____
    e. Sodium hypobromite _____
    f. Aluminum hydroxide _____
3. Give the name or chemical formula for each of the following molecular substances:
    a. $SF_6$ _____
    b. $XeO_3$ _____
    c. Dinitrogen tetroxide _____
    d. Hydrogen cyanide _____
    e. $IF_5$ _____
    f. Dihydrogen monoxide _____
    g. Tetraphosphorous hexasulfide _____
4. Give the name or chemical formula for the following compounds:
    a. Ammonium oxalate _____
    b. Manganese(III) dichromate _____
    c. $Ti(OH)_4$ _____
    d. $Ni(ClO_2)_3$ _____
    e. Dinitrogen pentoxide _____
    f. Aluminum oxide _____
    g. $Fe_2S_3$ _____

5. Name the following acids
    a. $H_2C_2O_4$ _____
    b. $HBrO_3$ _____
    c. HBr _____
    d. $HNO_2$ _____
    e. $H_2SO_4$ _____
    f. HClO _____
6. Write formulas for the following acids.
    a. hydrochloric acid _____
    b. sulfuric acid _____
    c. nitric acid _____
    d. phosphoric acid _____
    e. carbonic acid _____
    f. acetic acid _____