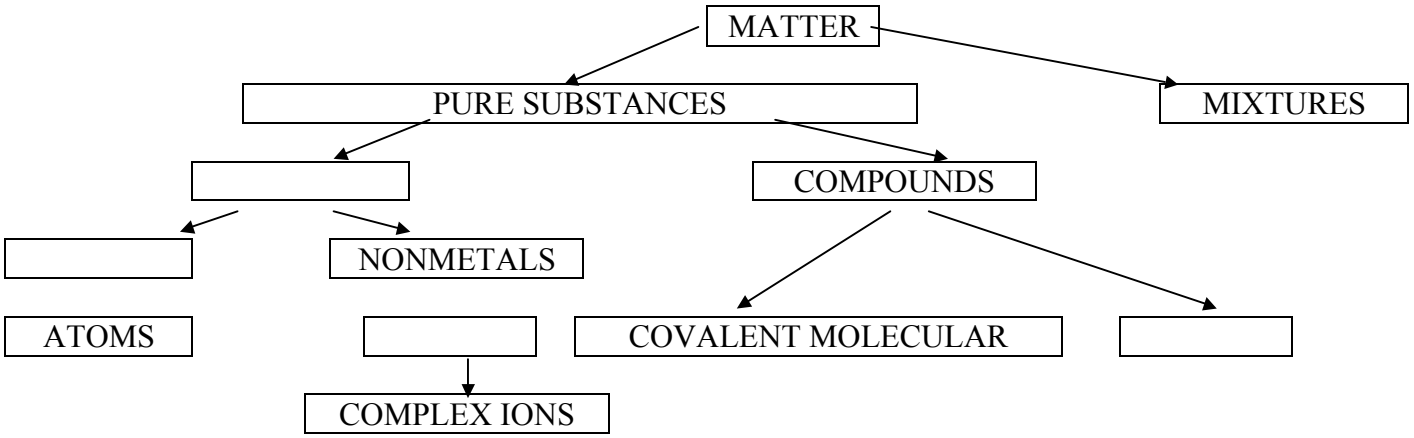
Chemistry 20 Science 10 Review

Name _____ Date _____

After you complete each section, check your answers with the answer key. If you don't understand the mistakes you made, ask your teacher for help with this section.

A. Classification of Matter: Matter is anything that has mass and takes up space. Matter can be classified according to its properties.

1. Fill out the chart below that shows some of the classifications of matter.



* Check your answers in the answer key.

B. Arrangement of the Periodic Table Examine the periodic table in your Data Booklet. It is important to understand how the table is arranged in order to be able to use it effectively. The horizontal rows are called **periods.** Elements in the same period have the same number of electron shells or orbitals. The vertical rows are called **groups** or **families**. Elements in the same group or family have similar chemical properties.

1. Name the elements that are in the same period as silicon (Si).

2. Name the elements that are in the same family (group) as bromine (Br).

Examine the **key box** in the lower left of the periodic table. It tells the kind of information that is given about each substance. Note that the top half of each box gives information about **elements** while the lower half gives information about **ions**. Ion symbols are always written with a charge in the superscript (exponent) position. Element and ion symbols always begin with a capital (upper case) letter. This capital letter may or may not be followed by one or two small (lower case) letters. **You should memorize the names (correctly spelled) and symbols of elements 1-20. No capitals with names.**

3. Write the symbols of the following elements.

   sulphur _____ beryllium _____ hafnium _____ silver _____

4. Write the element names for the following symbols.

   B _____ Cl _____ Au _____ K _____

5. Write the symbols for the following **ions**.

   barium _____ phosphide _____ sodium _____ hydride _____

6. Write the ion names of the following symbols.

   H^+ _____ Au^{3+} _____ O^{2-} _____ As^{3-} ___

7. Which elements in the periodic table seldom form ions? (HINT: Which elements do not have charges)

Substances on the periodic table each have two numbers. The **atomic number** tells the number of **protons** that an element or ion contains. The **atomic mass number** tells the mass of an atom of an element.

8. Write the atomic numbers of the following elements.
   boron _____ Co _____ lithium _____ C _____ iron _____ Ca _____
9. How many protons does an atom of each of the following elements contain?
   oxygen _____ Zn _____ manganese _____ F _____ lead _____
10. Write the atomic mass of each of the following elements.
    aluminum _____ P _____ chromium _____ S _____
11. Identify the elements with the following atomic masses.
    1.01 _____ 22.99 _____ 4.00 _____

* Check your answers in the answer key.

C. Atomic Structure and the Periodic Table

An **atom** is the smallest neutral particle of an element that can exist and still have all the properties of that element. Atoms, in turn, consist of smaller particles: protons, neutrons and electrons. The small, extremely dense center of an atom is called the **nucleus** and contains **protons** which have a **positive charge** and **neutrons** which have **no charge**. A large electron "cloud" circles the nucleus and consists of rapidly moving, highly energetic **electrons** which have a **negative charge**. Because a atom is neutral, it is made up of **equal numbers** of electrons and protons

1. The atomic number tells the number of _____ in an atom.
2. The atomic number may also tell how many _____ an atom has.
3. Fill in the following chart.

element name	element symbol	atomic number	number of protons	number of electrons
sulphur				
	N			
			21	

Each proton and each neutron has an **atomic mass** of **1 a.m.u.** (atomic mass unit). Electrons are so incredibly small that their mass contribution to an atom is negligible. For our purposes, the atomic mass of an atom of an element is equal to the **sum** of the masses of its protons and neutrons. To determine the number of neutrons in an atom, subtract the number of protons from the atomic mass number.

# of neutrons = atomic mass number - # of protons

Note that the atomic mass of most elements is not a whole number. This is because the number of neutrons can vary from one atom of an element to another of the same element. Variations in the number of neutrons in elements are called **isotopes**. The atomic mass number is an **average** of the atomic masses of all the isotopes of an element. When using atomic mass numbers to determine the number of neutrons in an atom of an element, round the atomic mass number to the nearest whole number.

4. How many neutrons does an atom of each of the following elements contain?
   Al _____ tin _____ I _____ platinum _____

5. Fill in the following chart

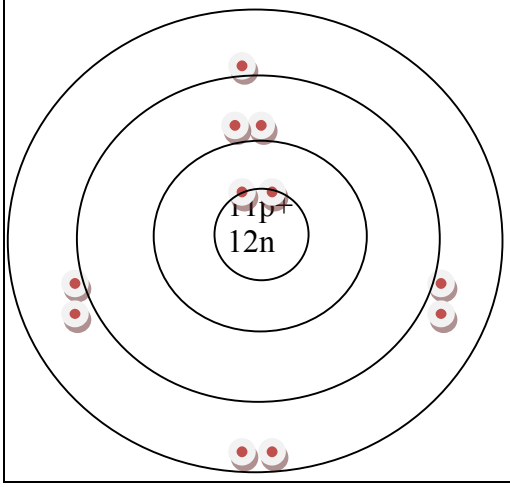
element name	element symbol	atomic number	mass number (a.m.u.)	number of protons	number of neutrons	number of electrons
gold						
	C					
		19				

Some elements are not found in single atoms. The atoms of these elements travel in groups and the symbols always indicate this condition. You must memorize these **polyatomic and diatomic** elements. ("Poly" means many and "di" means two.)

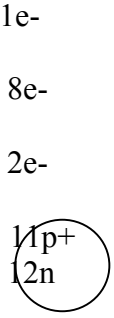
6. Write down the names and symbols of the elements which are polyatomic and diatomic.

Electrons travel in **orbitals or shells** around the nucleus of an atom. Each orbital can contain a maximum number of electrons. The first orbital, the **K-shell**, can hold a maximum of 2 electrons. The first period (horizontal row) on the periodic table contains the elements which only have electrons in the K-shell. Hydrogen has one electron and is at the top of the first group or family. All members of this group, 1 or 1A , have only one electron in their outermost shell. Helium has two electrons and is at the top of the last group or family. All members of this group, VIIIA or 18, have completely filled outer shells. The second orbital, the **L-shell** can contain a maximum of 8 electrons. All members of the second period have a full K-shell plus one or more electrons in the L-shell. The third orbital, the **M-shell**, also can contain a maximum of 8 electrons. All elements in the third period have full K- and L-shells plus one or more electrons in the M-shell. There are two main ways to represent these atoms and their orbitals. The Bohr diagram has a central circular nucleus with the correct number of protons (p+) and neutrons (n) placed in the middle for that element. Surrounding the nucleus are circles representing the orbitals with the correct number of electrons (e-) placed in each orbital as dots. The Energy level diagram has a circular nucleus with the correct number of protons (p+) and neutrons (n) placed in the middle for that element. ABOVE the nucleus the number of electrons are written for each orbital starting with the K-shell. Below are an example of each diagram for element sodium.

sodium: Bohr diagram



Energy Level Diagram



7. Draw the Bohr diagram & energy level diagram for each of the following elements.
beryllium silicon oxygen

8. List all the elements that have one less electron than needed to have a full shell.

Periods greater than number three have complex arrangements of electrons that you don't need to learn about. But, in each of these periods the number used for a **full shell** is **8 electrons**. Look at the **staircase line** that starts at Boron, B. Elements to the left of the staircase are called **metals** because they have **less than 4 electrons in their outer shell**. Elements to the right of the staircase are called **non-metals** because they have **more than 4 electrons in their outer shell**. There are some elements that have four electrons in their outer shell and these are classified as either metals or nonmetals depending upon other characteristics. Always check the periodic table when you need to know if an element is a metal or a non-metal.

9. Put a "M" beside the metal elements and an "N" beside the non-metal elements.
Li ____ P ____ Co ____ Kr ____ Au ____ Se ____

* Check your answers in the answer key.

D. Ions

Atoms prefer to have full outer shells. For this reason, atoms tend to lose or gain electrons to form ions. Remember that **atoms** are **neutral** because they contain equal numbers of electrons (negative) and protons (positive). An **ion** of an element has a **charge**, either positive or negative, because the number of electrons has changed. Atoms will either gain or lose the fewest number of electrons needed to have a full outer ring. **Metallic ions** form when metals **lose electrons**. Because the number of protons always stays the same in the nucleus, metallic ions have a net **positive charge and are called cations**. **Non-metallic ions** form when non-metals **gain electrons**. Because the number of protons always stays the same in the nucleus, non-metallic ions have a net **negative charge and are called anions**. Metals in group !A all lose one electron while metals in group IIA all lose two electrons. This same pattern follows for all metals. Non-metals in group VA all gain three electrons; those in VIA gain two electrons; those in VIIA gain three electrons. All ions use the element symbol with the charge (negative/positive) and number in the superscript (exponent) position, e.g. Ca^{2+}. The number always comes before the charge (+/-). Ions have different physical and chemical properties than atoms.

1. Draw the Energy Level diagrams for the following: Li, Li^{1+} S, S^{2-}

Some elements do not form ions. Look at **boron**, **carbon**, and **silicon**. Note that these non-metals, although they do not have full shells, do not form ions. These elements will, however, take part in chemical reactions and form compounds

Look at group VIIA or 18. All the elements in this group already have complete outer shells. These elements usually do not take part in chemical reactions and do not usually form compounds. Only under extreme laboratory conditions can these **inert elements** react.

2. List symbols of the inert gases.

*Check your answers in the answer key

E. Metallic and Non-metallic Ions Form Ionic Compounds

Ions that have opposite charges are attracted to each other. **Metallic ions** and **non-metallic ions** will form **ionic bonds** to create **ionic compounds**. The total number of protons and electrons in ionic compounds is equal and thus ionic compounds are **neutral**. For example, Na^+ and Cl^- will bond together to form NaCl, a neutral ionic compound. NaCl has different chemical and physical properties than either Na^+ or Cl^-. The **formula** of an ionic compound always have the metallic ion first and the non-metallic ion second. Ionic compounds are named by writing the metallic ion name first, leaving a space, and writing the non-metallic ion name second. Check the periodic table for the names of the ions. For example, the name of NaCl is sodium chloride. Note that all ionic compounds involving only two elements always have the name ending in **-ide**. Ionic compounds **never use numerical prefixes**.

2. Fill in the chart below with the chemical formulas and names of the ionic compounds formed.

metallic ions nonmetallic ions	Li^+ formula and name	Na^+ formula and name
H^-		
F^-		
Cl^-		

Always choose the smallest number of positive and negative ions to make a neutral formula. For example, Mg^{2+} and O^{2-} form MgO, magnesium oxide. If the charge on the two ions is not the same, e.g. Li^+ and O^{2-}, use **least common multiples** to determine how many of each ion are needed to make a neutral formula. The LCM of 1 and 2 is 2. Therefore 2 positive and 2 negative charges are needed: Li^+ and Li^+ and O^{2-}. The formula is written Li_2O. The subscript number indicates the number of ions of the **previous** element.

3. Write the formulas and names of the ionic compounds formed from the following ions.

	formula	name
Na^+ and P^{3-}		
Mg^{2+} and S^{2-}		
Al^{3+} and O^{2-}		

Some metallic elements can rearrange their electrons so that more than one ion can form. Look at elements numbered 22 - 29, 41, 44, 46, 50, 51, 78-84. Note that each of these has two possible ions. In order to differentiate when naming compounds, a Roman numeral is placed in brackets after the ion name. If the charge is 1+, the Roman numeral is I; if the charge is 2+, the Roman numeral is II; if the charge is 3+, the Roman numeral is III etc. If oxygen combines with iron, there are two possible types of iron oxide: iron (II) oxide and iron (III) oxide.

4. Write the formulas and names formed from the following ions. Be sure to include Roman numerals when more than one ion of an element exists.

formula name

Ti^{3+} and S^{2-}

Co^{2+} and As^{3-}

*Check your answers in the answer key.

F. Polyatomic (Complex) Ions

Some ions form groups called **complex ions** also known as polyatomic ions on your periodic table. The complex ions form bonds so strong they act as if they were single ions. Like single ions, complex ions have a charge. There is only one positive complex ion: **NH^+**, named **ammonium**. As it has a positive charge, ammonium will always be the first ion in an ionic compound. All the other complex ions have negative charges. They will always come after the positive ion in an ionic compound. The names are given in your periodic table. Note that most of the negative complex ions contain oxygen as the last element. The names of these always end in either **-ate** or **-ite**. There is one negative complex ion without the -ate/-ite name ending. It is **OH^-** and is called **hydroxide**. Formulas of compounds containing complex ions are written in and named in the same way as other ionic compounds.

1. Write formulas and names for the ionic compounds formed from the following ions.

Metalic ions	K^+	H^+	Na^+
	name and formula	name and formula	name and formula
nonmetallic ions OH^-			
CO_3^{2-}			
NO_2^-			

When more than one complex ion is required to balance a formula, **brackets** need to be used with a subscript outside to indicate how many complex ions are needed. For example: Ca^{2+} and CH_3COO^- form calcium acetate with a formula $Ca(CH_3COO)_2$. The subscript 2 indicates two entire acetate ions are needed.

2. Write formulas and names for the ionic compounds formed from the following ions.

formula name

Ca^{2+} and OH^-

Al^{3+} and CrO_4^{2-}

*Check your answers with the answer key.

G. Covalent Molecular Compounds

Some **non-metals** form compounds in which electrons are **shared** rather than lost or gained as in ionic compounds. These compounds are called **covalent molecular compounds** and always involve only two non-metallic elements. The first element in the compound retains its atomic name. The second element's name ends in **-ide**. Prefixes are always used to tell how many atoms of the second element are in the compound. When more than one atom of the first element named is used, prefixes are also used.
Examples: CO carbon monoxide CO_2 carbon dioxide P_2S_5 diphosphorus pentasulphide

1. Name the following compounds.

CS_2 SO_2

CBr_4 P_2O_5

2. Write the formulas of the following compounds

carbon tetrachloride
nitrogen trichloride
phosphorus pentabromide

*Check your answers in the answer key

H. Naming Acids - optional section. (Check with your teacher before doing this section.)

Ionic compounds that contain **hydrogen** as the **non-metallic ion** form **acids** when they are dissolved in water. There is a special naming system for these. The first step is to write the ionic compound name as you have already learned to do it. If there are **only two elements** in the acid, then the name hydrogen becomes **hydro-** and the second element's name ends in **-ic**. Both element names form one word. The word acid is added separately at the end. Eg) HCl has the ionic name of hydrogen chloride. The acid name is hydrochloric acid.

1. For each of the following compounds, give the ionic compound name and the acid name.

	ionic name	acid name
HBr		
HI		
H_2S		
HF		

Acids which contain complex ions are a little more difficult to name. All of these acids **drop** the **hydrogen name**. If the suffix of the complex ion was **-ite**, the acid name ends in **-ous**. The word acid is added separately at the end. For example: H_2SO_3 has the ionic name of hydrogen sulphite. The acid name is sulphurous acid.

2. For each of the following compounds, give the ionic compound name and the acid name.

	ionic name	acid name
HNO_2		
$HClO_2$		

If the suffix of the complex ion was **-ate**, the acid name ends in **-ic**. The word acid is added separately at the end. Eg): H_2SO_4 has the ionic name hydrogen sulphate. The acid name is sulphuric acid.

3. For each of the following compounds, give the ionic compound name and the acid name.

	ionic name	acid name
HNO_3		
$HClO_3$		
H_2CO_3		

*Check your answers in the answer key.

I. Chemical Reactions and Equations

Chemical equations are used to show what happens in a chemical reaction.
Most chemical equations have the following format.

reactants → products

Chemical equations must be **balanced** in order to show that matter is conserved. This means that there must be exactly the same number of atoms/ions of each type of element on both sides of the equation.
For example: $2Na + Cl_2 \rightarrow 2NaCl$

The large **coefficient** number tells how many atoms or molecules are used/produced. In the equation above, 2 sodium atoms react with one chlorine molecule. (Remember that chlorine is a polyatomic element and occurs in molecules made up of 2 atoms,) Two molecules of sodium chloride are produced.
To check if an equation is balanced, list the elements and the number of ions/atoms.
For example: $2Na + Cl_2 \rightarrow 2NaCl$

Na	2	|	Na	2
Cl	2	|	Cl	2

Another example: $Mg(OH)_2 + 2Na \rightarrow 2NaOH + Mg$

Mg	1	|	Mg	1
OH	2	|	OH	2
Na	2	|	Na	2

*Note that is the complex ion is unchanged, it can be listed as a single ion

1. Which of the following equations are balanced?
   $S_8 + 12Cl_2 \rightarrow 8SCl_3$ balanced? _____
   $2C_8H_{18} + 24O_2 \rightarrow 16CO_2 + 18H_20$ balanced? _____

There are five basic types of chemical reactions that you must be able to recognize:

- simple composition or synthesis
  - element + element → compound
  - A + B → AB
- simple decomposition
  - compound → element + element
  - AB → A + B
- single replacement
  - compound + element → compound + element
  - AB + C → AC + B (either the two metals or the two non-metals trade places)
- double replacement
  - compound + compound → compound + compound
  - AB + CD → AD + BC (either the two metals or the two non-metals trade places)
- hydrocarbon combustion
  - hydrocarbon + $O_2 \rightarrow H_2O + CO_2$

1. Classify each of the following reactions.
   $Mg + I_2 \rightarrow MgI_2$ _____
   $H_2S + 2KOH \rightarrow K_2S + 2HOH$ _____
   $CaCl_2 + Br_2 \rightarrow CaBr_2 + Cl_2$ _____
   $C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$ _____
   $2Na_2F \rightarrow 4Na + F_2$ _____

*Check your answers in the answer key.

J. Molar Mass and the Mole

The **molar mass** of an element is the atomic mass expressed in **grams**. One molar mass is called a **mole**. For example, the atomic mass of lithium is 6.94 and its molar mass is 6.94 g. For a compound, the molar mass is equal to the **sum** of all the atomic masses of the elements making up that compound. For example sodium chloride NaCl has a molar mass equal to 22.99 g for Na + 35.45 g for Cl. This adds up to 58.44 g for one mole of NaCl. We need to know molar mass in order to determine the mass of reactants and products in a chemical reaction.

1. Calculate the mass of one mole of each of the following elements or compounds.

O_2	_____ g	Ca	_____ g
CCl_4	_____ g	P_4	_____ g

2. Which element has a molar mass of:

196.97 g ? _____ 1.01 g ? _____

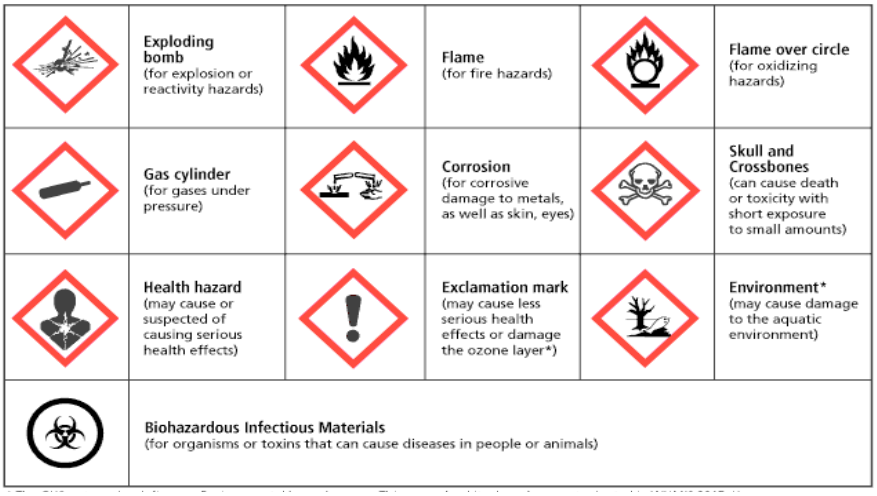
3. If you have 36.03 grams of carbon, how many moles do you have? Use n=m/M

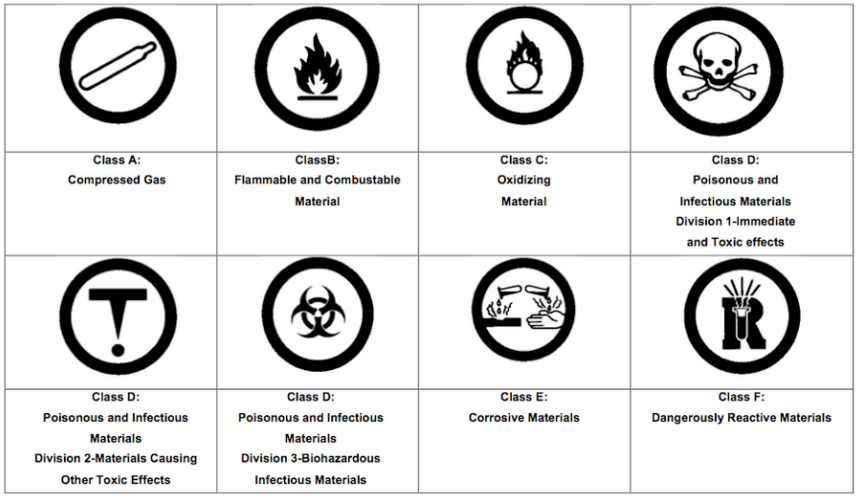
*Check you answers in the answer key.

K. WHMIS Symbols

You must know all the NEW (1st picture) & OLD (2nd picture)WHMIS symbols.

1. WHMIS stands for _____
2. Write one example of where you might find each WHMIS symbol.





L. SKILL #1: Significant Digits & Unit Conversions

Name: _____ Due Date: _____ Score: _____

Definition of Significant digits

Significant digits indicate how accurate a measurement is. Significant digits are the digits that are certain plus one uncertain digit (the last digit). Significant digits are NOT defined as important digits.

Counting Significant Digits

When counting significant digits, count all the digits from 1 to 9 plus zeroes in between and zeroes following these digits. DO NOT count zeroes in front of a 1 to 9 because they only serve to set the decimal place.
Constants and ***exact numbers*** have infinite number of significant digits.

ie) *0.02050 kg The two zeros in front are NOT significant. This number has 4 significant digits.*
x x√√√√ √ = ***significant digit*** x = ***not significant digit***

Rounding off when using significant digits

When the next digit (after those that are kept as significant) is less than 5, all the digits remain the same. When the next digit is 5 or greater, the last digit that is kept is increased by one.
Ie.) 19.95 m with 3 significant digits would be rounded off to 20.0 m. 129.49 g with 3 significant digits would be not be rounded off and remain 129 g

Scientific notation

Scientific notation is the method of expressing values as a number between 1 and 10 multiplied by a power of ten. (#.## x $10^{\#}$) Scientific notation is used for very large numbers or very small numbers with a few significant digits.

Ie) 1490 m with 2 significant digits would be expressed as 1.5 x 10^{3} m ***The decimal moved 3 places to the left***
0.0015678 g with 1 significant digit would be expressed as 2 x 10^{-3} g ***The decimal moved 3 places to the right.***

NOTE: There is always only one digit (other than 0) and then the decimal when using scientific notation. The digits in $10^{\#}$ are not significant.

SI (System International) Prefixes & Unit Conversions

SI prefixes are often used to replace the power of ten in scientific notation. Here are the most common prefixes. These and other prefixes are also located in your databook on page 1.

Giga (G) = 10^{9}	***centi (c) = 10^{-2}***
Mega (M) = 10^{6}	***milli (m) = 10^{-3}***
Kilo (k) = 10^{3}	***micro (u) = 10^{-6}***

Scientists need to be able to convert from one prefix to another.
Ie) 1.5 x 103 m → 1.5 km 2 x 10^{-3} g → 2 mg

Addition & Subtraction significant digit rules

Add/subtract and then round off the answer to the <u>least</u> number of <u>decimal</u> places contained in the question.
Ie) 26.5 m + 7.01 m = 33.51 m ***Rounded = 33.5***
(1 dec.) (2 dec.) (1 dec.)

Multiplication & Division significant digit rules

Multiply/divide and then round off the answer to the <u>least</u> number of <u>total</u> significant digits contained in the question. Decimal places are NOT considered for significant digits when you multiply or divide.
Ie) 100 s x 5.0 m/s = 500 m ***Rounded = 5.0 x10^{2} m***
dig)

1. Identify how many significant digits are in each of the following measurments:

Ie) 0.005060 4 significant digits (zeros in front of the 5 are not significant)

a. 15.8 g _____

b. 0.167 m/s _____

c. 1.50 km/h _____

d. 23.005 g/L _____

e. 0.0061 mol/L _____

f. 1.54×10^{6} km _____

g. 1200 cm _____

h. 5.00×10^{-3} t _____

i. 0.08 hectares _____

j. 14.03 C _____

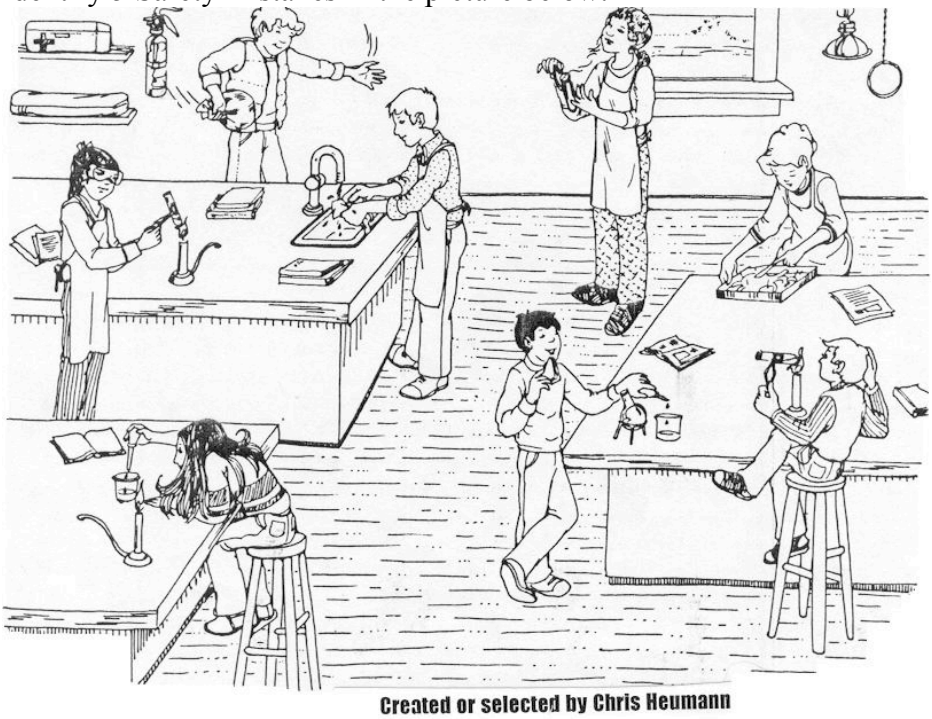
2. Perform the following calculations.

		Unrounded	Rounded	SI Prefix
Ie. 35.7 mol x 168.92 g/mol =		***6030.44g***	***6.03×10^{3} g***	***6.03 kg***
a. **16.75 s x 85 m/s**	=	_____	_____	_____
b. **0.00085 L x 1.3111 g/L**	=	_____	_____	_____
c. **0.000118 mol x 18.02 g/mol**	=	_____	_____	_____
d. **0.12×10^{6} mol x 22.4 L/mol**	=	_____	_____	_____
e. **0.178 g /12.01 g/mol**	=	_____	_____	_____
f. **0.1456 mol / 2.3 L**	=	_____	_____	_____
g. **452.65 g / 58.06 g/mol**	=	_____	_____	xxxxxxxxxxxx
h. **1.12×10^{-5} mol / 2.5 mol/L**	=	_____	_____	_____
i. **1.28×10^{6} g x 3.33 x10^{3}J/g**	=	_____	_____	_____
j. **0.0088 mol / 179 L**	=	_____	_____	_____
k. **760 m + 42.6 m**	=	_____	_____	_____
l. **9.99 mol + 1510.9 mol**	=	_____	_____	_____
m. **14.76 mL – 4 mL**	=	_____	_____	xxxxxxxxxxxx
n. **129 g – 29.5 g**	=	_____	_____	_____
o. **CHALLENGE: 942 m – 1.2 km**	=	_____	_____	xxxxxxxxxxxx

HINT: convert to the highest unit first.

SKILL 2: LAB SAFETY: Learn the safety rules illustrated below.

Identify 5 Safety mistakes in the picture below.



Created or selected by Chris Heumann

Skill 3: Identify Lab equipment. Describe one use for each of the following pieces of equipment.