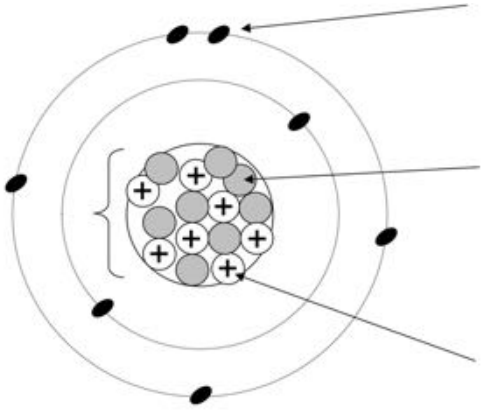
Introduction to Chemistry

Chemistry is the study of _____: its _____ (what it is made of), its _____ (characteristics) and _____ (how it can change).

Matter is anything that has _____ and _____ (takes up space). Matter is the science word for "stuff".

The **Atomic Theory of Matter** states that all matter is made up of _____. An **atom** is the smallest unit of matter that we deal with in "every-day" chemistry.

Atoms, in turn, are made up of three types of sub-atomic particles: _____, _____ and _____.



The number of protons in the nucleus of an atom is called the "_____". The atomic number determines the identity of that atom.

All of the different types of atoms (also called "elements") are arranged by atomic number on the Periodic Table of the Elements.

eg. atomic number	6	_____	79	_____
	7	_____	80	_____

When an atom is in a _____ (uncharged) form, the number of electrons is _____ to the number of protons.

Electrons are arranged in _____ (energy levels) around the nucleus as shown in "Bohr-Rutherford" diagrams. The electron shells are filled in order, moving out from the nucleus:

- The first shell can hold _____electrons.
- The second shell ____
- The third shell ____
- The fourth shell ____

The electrons in the outer shell are called _____

The Elements

All known types of atoms are shown on the _____.
Each type of atom (element) has a different number of _____.

The number of protons in the nucleus of an atom is called the _____.
The atomic number determines the _____ of that atom.

eg. atomic number 7 (7 protons) is _____
atomic number 47 is _____
atomic number 78 is _____

In an uncharged (_____) atom, the number of electrons is _____ the number of protons. The electrons are found in _____ (energy levels) around the nucleus, as shown in _____ diagrams. The electrons in the outer shell are called _____.

The number of _____ determines an atom's _____ and _____ (how the atom will behave).

The number of protons plus the number of neutrons is called the _____.
Atoms may have the same number of protons (that is, they are the _____ _____) but they may have _____. All that this means is that some atoms of an element are _____ but they still have the same _____ properties.

Atoms that have the same _____, but different _____ are called "_____".

Chemists use the following short form for elements and their isotopes:

mass number: _____

12 ←
C ← _____ eg. "C" is the chemical symbol for _____
6 ← **atomic number: _____**

Summary:
# of protons = the atomic number, this determines the type of atom (element)
# of electrons = the # of protons in an uncharged (neutral) atom
# of neutrons = the mass number – the atomic number

eg. $^{40}_{18}Ar$ $^{41}_{18}Ar$ $^{42}_{18}Ar$

Grade 10 Science
Review of Atomic Structure #1

Chemistry is the study of matter, its properties and its transformations (how it can change).
Matter is anything that takes up space and has mass.

The smallest particle of matter that we are concerned with in "normal" chemistry is the atom. Over the centuries, many researchers did experiments (remember Crookes, Thomson, Rutherford and Bohr?) and discovered that the atom is made up of two different regions: a very dense central nucleus which is made up of protons and neutrons, and a "cloud" area around the nucleus that is mostly empty space, but contains the electrons. The three different types of sub-atomic particles (protons, neutrons and electrons) have the following characteristics:

(1) Protons are found in the atom's nucleus, have +1 unit of electrical charge and weigh about 1 atomic mass unit, u. The number of protons in atoms distinguishes the elements from one another. The number of protons, called the **atomic number**, varies from 1 for the element hydrogen to over 100. The atomic number, then, identifies the element.

(2) Neutrons are also found in the atom's nucleus and, as their name suggests, are electrically neutral i.e. their charge is zero. Their mass is about 1 u. There is no relationship between the numbers of neutrons and protons. However, since these two particles give most of the mass to an atom, the total number of neutrons and protons is called the **mass number**.

(3) Electrons are found in the space around the nucleus and have -1 unit of electrical charge. They are some 2000 times smaller than protons and neutrons. For this reason their mass is quite often given as 0 u. In a neutral atom the number of electrons equals the number of protons. In an electrically charged atom (an ion) the number of electrons can be more or less than the number of protons. For example, the electric charge on an atom with 20 protons and 18 electrons is +2.

There are 105 unique elements that have been discovered, to date. Each element is identified by the number of protons in the nucleus, or its atomic number. An atom that has the atomic number " one" has one proton in its nucleus is always the element, hydrogen. An atom with the atomic number "two" has two protons and is always helium, three protons is lithium etc. The elements are arranged in order of increasing atomic number in the Periodic Table of the Elements. The number of neutrons and electrons is not important in identifying the element.

Each element has been given a one or two letter abbreviation. Often, the abbreviation is written with additional information in the following format:

$^{12}_{6}C$: -"C" is the chemical symbol for carbon
- 6 is the **atomic number, Z**, this is the number of protons in the nucleus
- 12 is the **mass number, A**, this is the number of protons plus the number of neutrons in the nucleus
- for an uncharged or neutral atom, the number of electrons equals the number of protons

Some elements have different numbers of neutrons in their nuclei (remember, the same element always has the same number of protons or atomic number). The different numbers of neutrons in the nuclei mean that the nuclei will be heavier, or have a larger mass number. Atoms that have the same number of protons, but different numbers of neutrons are called **isotopes**.

The **atomic mass** for an element is the average mass of the atoms (isotopes) for that element, and this is the number reported on the Periodic Table.

Review of Atomic Structure #1

1. The three sub-atomic particles in an atom are _____ , _____ and _____ .

2. Complete the following chart comparing the three types of sub-atomic particles:

Name of Particle	Location in Atom	Mass	Charge

3. Which type of sub-atomic particle determines the identity of an atom? _____

4. Atoms having the same number of protons but different numbers of neutrons are called _____ .

5. The mass number of an atom having 20 protons, 20 electrons and 22 neutrons is _____ .

6. Complete the following chart, for the following neutral (uncharged) atoms:

Name of Element	Symbol for Element	Atomic Number	Number of Protons	Number of Electrons	Number of Neutrons	Mass Number
	Be					9
		16			17	
Silicon					14	
	Fe			26		56
				55		133
		84		84	124	
			13			27
Krypton					48	84

7. What information does each of the following symbols tell us about the following neutral atoms?

Symbol	Name of Element	Atomic #	Mass #	# of Protons	# of Neutrons	# of Electrons
$^{16}_{8}O$						
$^{31}_{15}P$						
$^{25}_{12}Mg$						
$^{40}_{19}K$						
$^{20}_{10}Ne$						

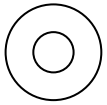
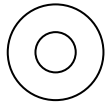
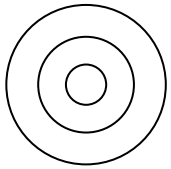
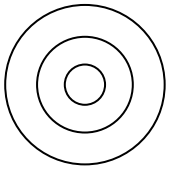
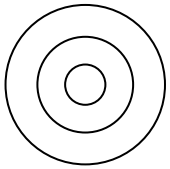
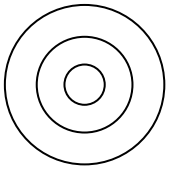
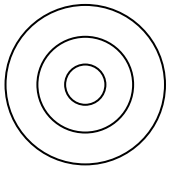
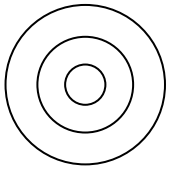
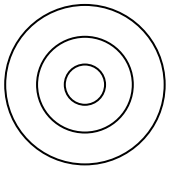
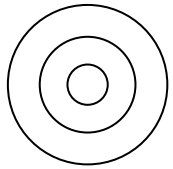
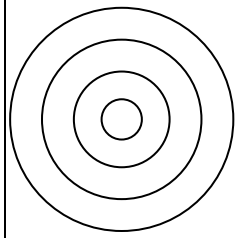
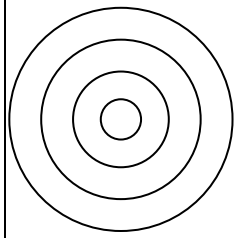
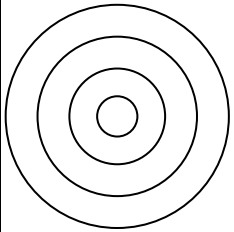
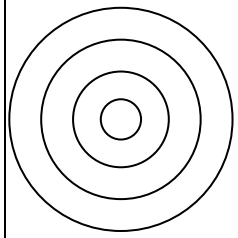
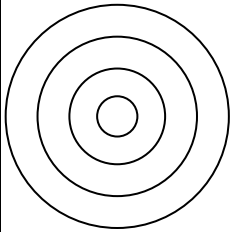
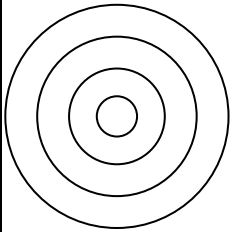
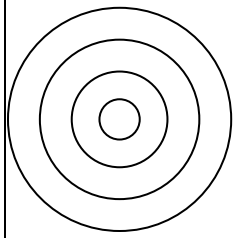
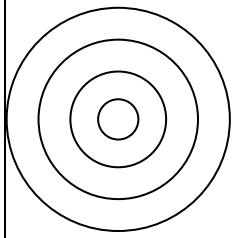
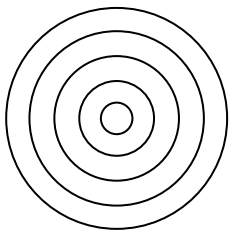
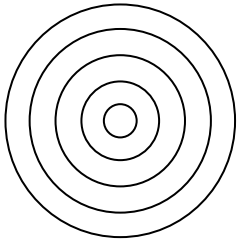
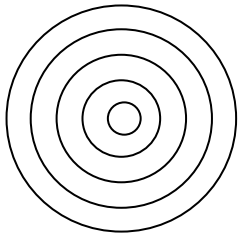
8. Refer to your note from class to complete the following chart comparing metals and non-metals:

Characteristic	**Metals**	**Non-metals**
Found on which side of the Periodic Table?		
How many valence electrons do they have?		
What is their usual state at room temperature?		
What is their usual colour?		
Are they shiny or dull?		
Do they conduct electricity?		
Are they malleable or brittle as solids?		

9. Predict five properties (characteristics) of the element hafnium (Hf).

The Periodic Table: Rutherford-Bohr Diagrams

1. Write the number of protons (atomic number) in the nucleus of each atom.
2. The number of electrons equals the number of protons in a neutral atom. Draw the electrons in the shells:
   a) the first shell holds up to ____ electrons
   b) the second shell holds up to ____ electrons
   c) the third shell holds up to ____ electrons
   d) the fourth shell holds up to ____ electrons

$_{1}H$ 							$_{2}He$ 
$_{3}Li$ 	$_{4}Be$ 	$_{5}B$ 	$_{6}C$ 	$_{7}N$ 	$_{8}O$ 	$_{9}F$ 	$_{10}Ne$ 
$_{11}Na$ 	$_{12}Mg$ 	$_{13}Al$ 	$_{14}Si$ 	$_{15}P$ 	$_{16}S$ 	$_{17}Cl$ 	$_{18}Ar$ 
$_{19}K$ 	$_{20}Ca$ 	$_{21}Sc$ 					

Questions:

1. What pattern do you notice about the number of valence electrons as you go down each column? _____
2. Which elements have **one** valence electron? _____, _____, _____ & _____
3. Which elements have **two** valence electrons? _____, _____ & _____ (_____)
4. Which elements have **three** valence electrons? _____, _____ & _____
5. Which elements have **seven** valence electrons? _____ & _____
6. Which elements have a **full** outer shell (stable octet)? _____, _____ & _____

Organization of the Periodic Table

The elements on the Periodic Table are organized in four main ways:

1. By increasing _____ (increasing number of _____).
2. Into _____ (horizontal rows):
   -all elements in a Period have the same number of _____.
   (For example: all elements in the second Period have___ shells, while those in the fourth Period have ___ shells)
3. Into _____ or _____ (vertical columns):
   -all elements in a Group have the same number of _____, which gives them similar _____ and _____ properties.
   -the Group number tells us how many _____ the atoms in the Group have. (For example: Group I elements have ___ valence electron, while Group VII elements have ___ valence electrons).
4. By the "_____" into Metals, Non-metals and Metalloids:
   a) <u>Metals</u>
      -found on the _____ side of the "staircase" line
      -have ___, ___ or ___ valence electrons
      -are usually _____, _____, _____, _____-coloured and are _____ conductors of electricity
      -tend to _____ valence electrons (form _____ charged ions called _____)
   b) <u>Non-Metals</u>
      -found on the _____ side of the "staircase" line
      -have ___, ___, ___ or ___valence electrons
      -are usually _____, _____, can be any _____, any _____ and are _____ conductors of electricity
      -tend to _____ valence electrons (form _____ charged ions called _____)
   c) <u>Metalloids</u>
      -found _____ the "staircase" line
      -have ___, ___ or ___ valence electrons
      -have properties of both _____ and _____
      -can either _____ or _____ valence electrons
      -_____ is an example

The Periodic Table

The Periodic Table of the Elements was originally developed, in the form that we are familiar with, by a Russian chemist named Dmitri Mendeleev. His table was based on observations of the chemical and physical properties of the elements known at the time. Mendeleev noticed that these properties repeated themselves over and over again when the elements were arranged in order of increasing atomic numbers. It was this repetition that led to the choice of the name "periodic".

For our purposes, the table organizes the elements in three main ways:

Metals and Non-Metals

Elements that tend to lose electrons and become positively charged ions are found on the left side of the periodic table. These elements are the **metals** and have the characteristic properties of metals: they are shiny, solid at room temperature, malleable, good conductors of heat and electricity, and have high melting points.

Elements that tend to gain electrons and become negatively charged ions are found on the right side of the periodic table. These elements are **non-metals** and have the characteristic properties of non-metals: they are dull (not shiny), liquid or gas at room temperature, brittle as solids, poor conductors of heat and electricity, and have low melting points.

There is no clear-cut division between the two types of elements but the "staircase" line, toward the right hand side of the table, separates the metallic elements from the non-metallic elements.

Elements near to this line may have properties of both types of elements, and are called **metalloids**.

Families or Groups

The vertical columns in the periodic table organize the elements into groups or families based on the number of electrons in the outer (valence) shell. Each group is identified by a Roman Numeral (and may, or may not, use a letter of the alphabet as well).

Groups of elements have similar chemical and physical properties due to their similar electron arrangements. In groups of metals, the most reactive element is at the bottom of the family. In groups of non-metals, the most reactive element is at the top of the family.

The elements of one family, group VIII (also known as the INERT GASES or NOBLE GASES), are almost completely non-reactive because they have the stable octet electron arrangement (all of their electron shells are "full").

Periods

These are the horizontal rows across the table. In a period there is a gradual change from metals to non-metals as the atomic number increases and as the number of electrons in the valence shell increases. A period always starts with an element having one electron in the valence shell and ends with 8 electrons in this outer shell. (Period I is the only exception to this as the valence shell is the first shell which is capable of holding only 2 electrons).

Homework: Answer the following questions in **full sentences** in your **notebook**.

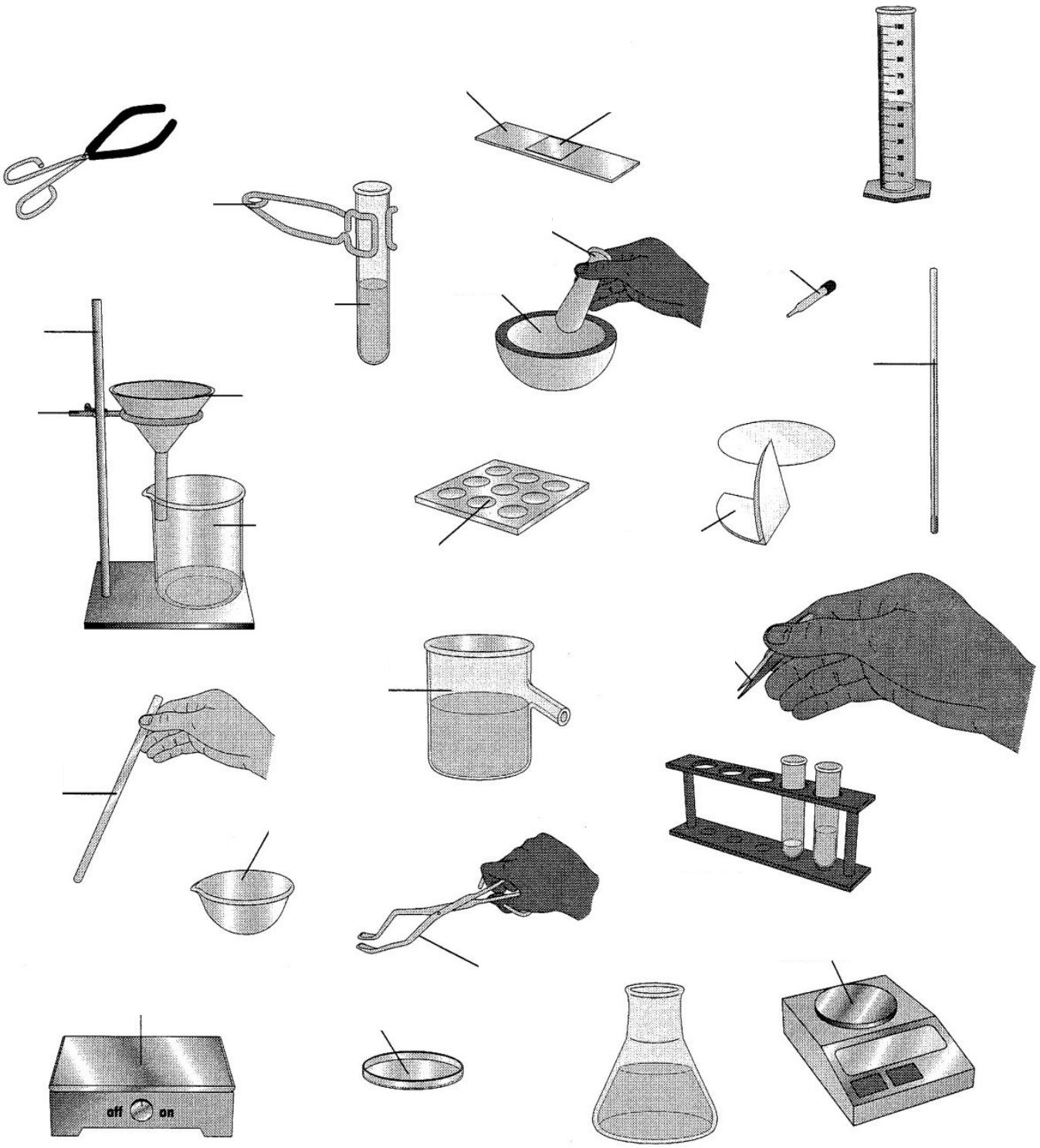
1. a) What are **metals** and what type of ion do they form?
   b) What are **non-metals** and what type of ion do they form?
   c) Prepare a chart comparing the properties of metals and non-metals.
   d) What are **metalloids** and where are they located on the Periodic Table?
2. a) What are **Groups** or **Families** of elements?
   b) Why are the elements in a Group so similar in their properties?
   c) Where in the column would you find the **most** reactive: 1) metal 2) non-metal
3. What is special about the Group VIII elements and why is this?
4. What are **Periods** in the Periodic Table and what occurs as you move across a Period?

Workplace Hazardous Materials Information System (WHMIS) symbols were developed to standardize the labeling of dangerous materials used in all workplaces, including schools.

Laboratory Equipment

You can do many science investigations using everyday materials and equipment. In your science classroom, there are other pieces of equipment. Some of these are illustrated.



Identify the Safety Hazards

1	9
2	10
3	11
4	12
5	13
6	14r
7	15
8	16

OUTLINE FOR LAB REPORTS

1. Each lab report is to be started on a new piece of paper.
2. Record data neatly in PEN, on the observation chart. Do NOT rely on others to make observations and notes for you. Keep your own records as you perform the work.
3. Lab marks will be given, in part, for neatness, completeness and accuracy of results. Another part of the mark will be for "participation".
4. Do not use personal pronouns in a lab report.
5. The format of the lab reports should be as follows:

TITLE: The title must be at the top of your lab report, and should fully describe the experiment that is being performed.

PURPOSE: The purpose must be written out in full and state the reason for doing the lab. This is usually found in the lab instructions.

METHOD: This section is a description of how the lab was performed. Explain the procedures as if you were instructing another person how to do the lab.

If the method is given to you in detail in your lab handout, you do not need to write it out again. Under the "Method" subheading, simply write: "Refer to lab handout".

OBSERVATIONS: This is the most important part of a lab report.

- Present your findings in an appropriate form. Numerical data, for example, is most often presented in a chart or table. All numerical data must include units.
- If you are recording your observations in a data table or chart, under the "Observation" subheading, write "Refer to Observation Table".
- Observation tables or charts must have a detailed title.
- It is good practice to describe the physical properties of the reactants before a reaction and then describe the products after the reaction. Include **AT LEAST** the state, colour and clarity of the reactants and products.
- DO NOT include calculations, interpretations or conclusions in this section.

QUESTIONS: Answer the questions that accompany the experiment in **full sentence format**.

CALCULATIONS: When calculations are necessary, you must show all of your work and include units.

CONCLUSIONS: This is a brief summary of the results of the experiment that relates back to the purpose of the experiment. Are the results reasonable considering the possible sources of error? Very often the answers to the questions and the answers to the calculations following the experiment will lead you to the conclusions for the lab.

ERRORS: Basically, an error statement is an explanation of why your results may be different from someone else who is doing the same experiment.

- Unless you are told otherwise, discuss three (or more) sources of ***unavoidable*** error in the experiment. All equipment, for example, has a certain, built-in error depending on its "quality".
- Pay attention when you are doing the experiment to observations that are difficult to measure or interpret; these are common sources of error.
- A statement of error should include both the **cause** of the error and what the **effect** of that error was on the lab results. For example, "When timing the runners, each person would start their stopwatch at a slightly different time, so there would be slight errors in the reported times."
- "Did the math wrong on my calculator." or "The glassware was not clean." are not acceptable sources of error. These are both **bad technique** and within your control.

At the end of a lab, you will be notified of when the lab report is due. Please hand in labs on time!!

Labs will no longer be accepted for marking after the marked labs have been returned to the class.

Groups on the Periodic Table

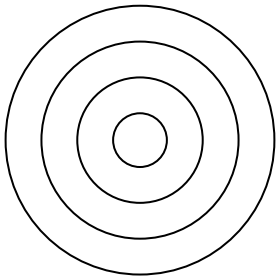
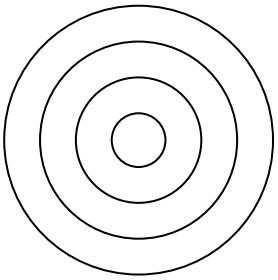
Group VIII: _____ ( )

- have a _____ outer electron shell, which is known as a _____
- these elements tend not to _____ or _____ electrons
- they are _____ or _____ and _____ with other elements

All atoms will _____, _____ or _____ valence electrons to achieve a _____ electron arrangement like the Noble Gases.

Group I: _____ ( )

- elements in Group I have _____
- to achieve a stable octet arrangement, Group I elements tend to _____

$_{11}Na$  $_{11}Na$ 

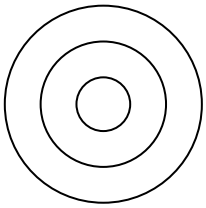
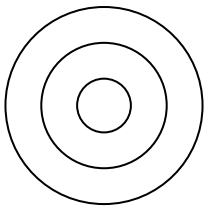
# of protons
# of electrons _____

Overall Charge

The sodium atom loses one electron so it has _____. It still has _____ (the number of protons _____). It is now a "_____" or "_____". The ion is written:_____

Group II Elements: _____ ( )

- elements in Group II have _____
- to achieve a stable octet arrangement, Group II elements tend to _____

$_{4}Be$  $_{4}Be$ 

# of protons
# of electrons _____

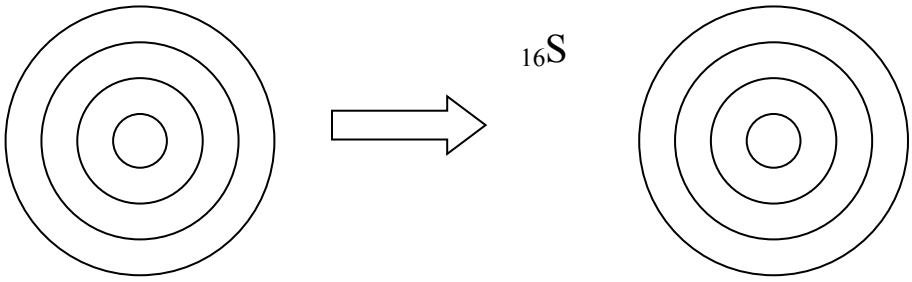
Overall Charge

The beryllium atom loses two electrons so it has _____. It still has _____ (the number of protons _____). It is now a "_____" or "_____". The ion is written:_____

_____

Group VI Elements ( )

- elements in Group VI have _____
- to achieve a stable octet arrangement, Group VI elements tend to _____

$_{16}S$  $_{16}S$

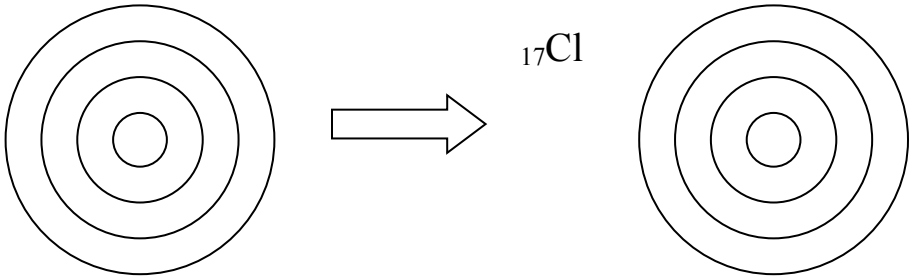
# of protons
# of electrons ____

Overall Charge

The sulfur atom gains two electrons so it has _____. It still has _____ (the number of protons _____). It is now a "_____" or "_____". The ion is written:_____

Group VII Elements: _____ ( )

- elements in Group VII have _____
- to achieve a stable octet arrangement, Group VII elements tend to _____

$_{17}Cl$  $_{17}Cl$

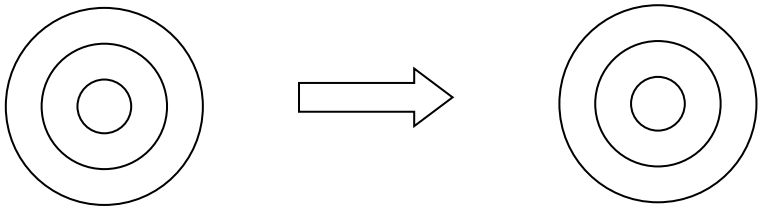
# of protons
# of electrons ____

Overall Charge

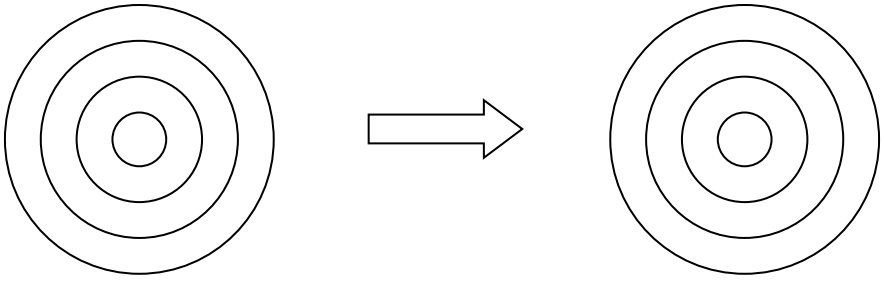
The chlorine atom gains one electron so it has _____. It still has _____ (the number of protons _____). It is now a "_____" or "_____". The ion is written:_____

Other examples:

$_{7}$**N**
(GroupV)



$_{13}$**Al**
(Group III)



Worksheet: The Periodic Table and the Formation of Ions

1. Complete the following definitions and statements:

a) A horizontal row on the Periodic Table is called a _____.
b) A vertical column on the Periodic Table is called a _____ or _____.
c) All elements in the same period have the same number of _____ _____.
d) All elements in the same group have the same number of _____ _____.
e) A full outer electron shell (often with eight electrons) is called a _____ _____.
f) A charged atom is called a(n) _____.
g) Metals are found on the (left/right) _____ side of the staircase line on the Periodic Table.
h) Non-metals tend to (gain/lose) _____ electrons to complete a stable octet electron arrangement.
i) Metals tend to form (positive/negative) _____ ions called _____.
j) Non-metals are found on the (left/right) _____ side of the staircase line on the Periodic Table.
k) In a neutral atom, the number of electrons is _____ to the number of protons in the nucleus.
l) Sulfur has _____ valence electrons, it is in Group _____ and is a (metal/non-metal) _____.

2. Draw Rutherford-Bohr diagrams to show the formation of ions for:
   a) Mg b) S c) Ca d) N e) K f) Sc

3. Refer to the periodic table to answer the following:

a) An uncharged magnesium atom has ____ electron(s) in its outer shell.
   - It will tend to (gain/lose) _____ electrons to obtain a stable octet arrangement.
   - The resulting ion will have _____ protons, _____ electrons and an overall charge of _____.

b) An uncharged chlorine atom has _____ electron(s) in its outer shell.
   - It will tend to (gain/lose) _____ electrons to obtain a stable octet arrangement.
   - The resulting ion will have _____ protons, _____ electrons and an overall charge of _____.

c) An uncharged potassium atom has _____ electron(s) in its outer shell.
   - It will tend to (gain/lose) _____ electrons to obtain a stable octet arrangement.
   - The resulting ion will have _____ protons, _____ electrons and an overall charge of _____.

d) An uncharged oxygen atom has _____ electron(s) in its outer shell.
   - It will tend to (gain/lose) _____electrons to obtain a stable octet arrangement.
   - The resulting ion will have _____ protons, _____ electrons and an overall charge of _____.

4. Complete the following chart:

Element	Chemical Symbol	Atomic Number	# of Protons	# of Electrons	Total Charge	# of Neutrons	Mass Number
Carbon				6		6	
		33			3 -		74
	Mn			23		31	
			15	18			30
				18	1 -	20	
Gold				79			197
		29			1 +		63
	Ag			46		60	
				22	2+		51
			36		0	48	
	Cu			27		36	

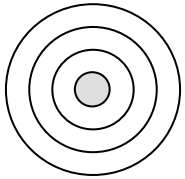
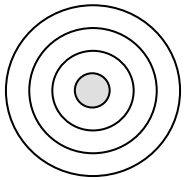
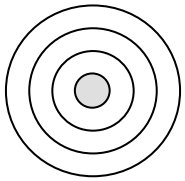
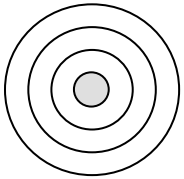
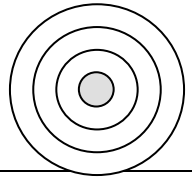
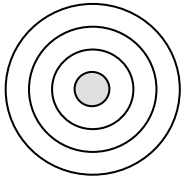
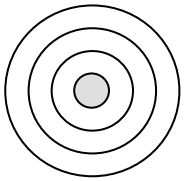
5. From the chart in question 4: identify two isotopes of the same element.

DRAWING ELECTRON DOT DIAGRAMS

Complete the following table, as shown in the examples:

Element	Group #	# of Valence Electrons	Electron Dot Diagram of Neutral Atom	Electron Dot Diagram of Ion this atom forms. (Include its charge)
Mg	2	2	Mg	Mg^{2+} (or $Mg^{+2)}$
F	7	7	F	F (or F)
B				
O				
Cl				
P				
Al				
Be				
H				
a Group 3 element with symbol "X"				
C				

Review for Quiz #1: Atomic Structure (How it all Fits Together)

Element	Atomic Number	# of Electrons in a Neutral Atom	Rutherford-Bohr Diagram	# of Valence Electrons	Group # on Periodic Table	Electron Dot Diagram of Neutral Atom	Metal or Non-Metal?	Tends to Gain or Lose Electrons?	Charge on the Ion
Na									
F									
Mg									
O									
Al									
Be									
S									

The Formation of Ionic Compounds

- atoms will _____ or _____ electrons to achieve a _____ electron arrangement
- when metal atoms _____ electrons, the electrons must be _____ to _____ atoms
- the number of electrons lost by the _____ atoms _____ the number of electrons gained by the _____ atoms
- when metal atoms _____ electrons, they form _____ charged ions called _____
- when non-metal atoms _____ electrons, they form _____ charged ions called _____
- the positive and negative ions are _____ to each other by _____ attraction (attracts)
- together, the positive and negative ions form an _____
- the attraction between positive and negative ions is an _____

An **ionic compound** is a substance that forms when _____ and _____ ions are held together by _____ attraction (an _____).

Showing the formation of ionic compounds using electron dot diagrams (EDDs):

Step 1: Draw EDDs for the elements as _____ atoms. Draw arrows to show how the _____ will move.

Step 2: Draw EDDs for the _____ that form. Include the _____ on the ions. Be sure that the number of positive charges _____ the number of negative charges.

Step 3: Write the _____ for the ionic compound. Always write the _____ first!!! If there is more than one of either of the ions, write a _____ after that element to indicate the number of each ion.

eg. show the formation of the ionic compound between calcium and fluorine:

Step 1 **Step 2** **Step 3**

eg. show the formation of the ionic compound between sulfur and lithium:

Step 1 **Step 2** **Step 3**

eg. aluminum and phosphorus:

Step 1 **Step 2** **Step 3**

Naming Ionic Compounds:

1. Name the _____ first. Use its regular name.
2. Name the _____ second. Change the ending of the non-metal to "_____". Only non-metals get the "ide" name!

Homework: Follow the steps above to show the formation of the ionic compounds between the following elements. Name each compound:

1. K and O
2. Mg and I
3. Sc and N
4. Na and Cl
5. Sr and P
6. Al and S

Investigation – The Properties of Ionic Compounds – Formula Determination

Complete this chart to show the formation of each ionic compound being investigated. Name each compound. (An example has been done for you). Write both the **name** and the **chemical formula** of the compound from the "Step 3" column in your Observation chart.

Ionic Compound	Elements involved	Step 1	Step 2	Step 3
Example	sodium phosphorus			
A	lithium sulfur			
B	sodium chloride			
C	calcium phosphorus			
D	aluminum bromine			
E	magnesium nitrogen			
F	potassium oxygen			

NAMES AND FORMULAS OF IONIC COMPOUNDS

Compounds containing _____ are called

_____. Scientists have agreed on a **universal** way to name these compounds.

Some Rules we need to know:

1. The **metal** ion ***always*** appears _____ in the name or the formula of the compound.
2. The name of a **cation** (metal ion) is _____ the name of the **neutral atom**.

   (eg: sodium → _____)

   The name of an **anion** (non-metal ion) takes the name of the **neutral atom** and _____

   _____. (eg: chlorine → _____)
3. When a formula for a compound contains a number in the _____ (_____)

   position, this number tells us _____ ions of that type are in the compound.

   (The **absence** of a number means there is just _____ ion of that type).

   eg: Na_2O eg: $CaCl_2$

4. The overall charge on the compound is _____, since the charge on the individual ions _____.

see "Ion Chart"

Naming Ionic Compounds:

Examples: $NaCl \rightarrow$ _____

$CaO \rightarrow$ _____

$BeF_2 \rightarrow$ _____

$K_2S \rightarrow$ _____

Writing Formulas for Ionic Compounds:

The "Criss-cross" method:

-write the ions side by side (include the **value** and **type** of charge):

-"criss cross" the **value** of the charges (= subscripts):

(-leave out the signs since the charges balance out)

NAMING AND WRITING FORMULAS OF IONIC COMPOUNDS # 1

1. Name each of the following compounds:
   a) Na_2O
   b) Li_4C
   c) $MgBr_2$
   d) CsI
   e) KF
   f) $CaCl_2$
   g) BaO
   h) Be_3N_2
   i) $AlBr_3$
   j) H_2S

2. Write the formula for each of the following compounds:
   a) beryllium fluoride
   b) sodium nitride
   c) calcium sulfide
   d) aluminum chloride
   e) lithium oxide
   f) magnesium nitride
   g) barium sulfide
   h) potassium phosphide

NAMING AND WRITING FORMULAS OF IONIC COMPOUNDS #2

1. Name each of the following compounds:

   a) H_2O

   b) Rb_3N

   c) BaS

   d) KCl

   e) AlF_3

   f) $SiCl_4$

   g) MgO

   h) LiBr

   i) Be_3P_2

   j) Cs_4C

2. Write the formula for each of the following compounds:

   a) potassium oxide

   b) aluminum sulfide

   c) beryllium chloride

   d) strontium bromide

   e) magnesium sulfide

   f) calcium phosphide

   g) sodium sulfide

   h) cesium nitride

Naming with Roman Numerals

Some metals can form ions with more than one charge:

- nickel can be _____ or _____
- copper can be _____ or _____
- gold can be _____ or _____
- lead can be _____ or _____

How do you know which ion you have? The charge of the metal ion is written in Roman Numerals after the name of the metal.

ex. Fe_2O_3 ex. CuS

eg. Write the chemical formulas for the following ionic compounds:

a) nickel (III) sulfide: _____

b) copper (II) oxide: _____

c) lead (IV) carbide: _____

d) gold (I) nitride: _____

e) mercury (II) phosphide: _____

f) chromium (II) fluoride: _____

eg. Write the name for the following ionic compounds. If a metal has more than one possible charge, indicate the charge using Roman Numerals:

a) HgO

b) PbI_2

c) FeP

d) Ni_2S_3

e) Na_3N

f) SnO_2

Homework:

1. Handout: Naming Compounds using Roman Numerals

NAMING AND WRITING FORMULAS OF IONIC COMPOUNDS #3

1. Name each of the following compounds:
   a) $CuCl$
   b) Fe_3N_2
   c) PbO
   d) HgF_2
   e) $MgBr_2$
   f) ZnO
   g) AlP
   h) CaS

2. Write the formula for each of the following compounds:
   a) chromium (II) oxide
   b) lead (IV) sulfide
   c) sodium bromide
   d) cobalt (II) chloride
   e) iron (III) fluoride
   f) tin (IV) carbide
   g) silver oxide
   h) nickel (II) iodide

NAMING AND WRITING FORMULAS OF IONIC COMPOUNDS #4

1. Name each of the following compounds:

   a) Cr_2O_3

   b) CoS

   c) Ag_2O

   d) SnF_4

   e) Hg_2S

   f) Zn_3P_2

   g) $PbCl_2$

   h) Bi_2O_5

2. Write the formula for each of the following compounds:

   a) nickel (III) bromide

   b) aluminum oxide

   c) manganese (IV) sulfide

   d) chromium (II) sulfide

   e) potassium chloride

   f) iron (III) phosphide

   g) arsenic (V) oxide

   h) antimony (III) fluoride

NAMING IONIC COMPOUNDS

1. Write the formula for the following binary compounds:

sodium fluoride	zinc nitride
silver nitride	strontium oxide
aluminum chloride	aluminum carbide
barium oxide	lithium sulfide
magnesium bromide	beryllium iodide
calcium sulfide	hydrogen bromide
lithium oxide	potassium chloride
barium sulfide	silver sulfide
potassium phosphide	zinc carbide
magnesium carbide	boron nitride

2. Name the following binary compounds:

Na_2O	Zn_3P_2
Li_4C	Ba_3N_2
$MgBr_2$	MgO
CsI	CaS
Ag_3N	BeO
Sr_2C	$ZnBr_2$
$CaCl_2$	NaF
BaO	Sr_3P_2
$AlBr_3$	AgI
H_2S	AlN

NAMING COMPOUNDS USING ROMAN NUMERALS

1. Write the formula for the following binary compounds:

copper (I) chloride	tin (IV) oxide
iron (II) nitride	copper (II) fluoride
lead (II) oxide	chromium (II) phosphide
mercury (II) fluoride	mercury (I) carbide
magnesium bromide	gold (III) chloride
manganese (IV) sulfide	cobalt (II) bromide
manganese (II) carbide	phosphorus (V) nitride
gold (I) iodide	nickel (III) phosphide
iron (II) bromide	copper (II) sulfide
aluminum sulfide	zinc iodide

2. Name the following binary compounds:

Cu_2O	P_2O_5
Hg_4C	Sn_3N_2
$AuBr_3$	CoO
Mn_3N_4	MnS_2
Ag_3N	Pb_2C
FeF_2	Sr_3P_2
$NiCl_2$	CuF
HgO	$NiBr_3$
$CoBr_3$	AgI
CrS	FeN

WRITING FORMULAS FOR POLYATOMIC COMPOUNDS

Polyatomic compound: a type of ionic compound that…

- consists of more than two different elements
- the first half of the compound is a metal
- the second half of the compound is a "polyatomic ion", made up of non-metals, but with one overall charge

1. The **metal** ion is always positive, and is written **first**.
2. The "**combo"/polyatomic** ion is usually negative, and is written **second**. (You will find these on your periodic table/ion chart.)

*** The easiest way to make the formula of the compound is to use the **CROSSOVER RULE.***

Sample Question:
"Give the formula for the compound formed between sodium and phosphate***." (The ate ending should tell you that this is a polyatomic ion! Look at your ion chart!)***

Step 1:
· write the symbols for each of the substances in the compound, spaced apart, with the metal on the left and the non-metal combo on the right.

Step 2:
· write the ionic charge of each of the substances on the TOP OF IT!! (from the P.T., count how many steps to perfection to get this number). This is just your working step.

Step 3:
· cross the numbers over to the bottom of the opposite one. Drop the brackets ONLY if there is a number "1" outside of the polyatomic ion.

******* Now, squish them together!*******
The final formula for the polyatomic compound of Na and PO_4 will be:

Try these ones:

- *Calcium nitrate*
- *Aluminum carbonate*
- *Ammonium sulfide*
- *Chromium (III) hydrogen carbonate*
- *Scandium phosphate*
- *Lead (IV) sulfate*
- *Ammonium hydroxide*

NAMING POLYATOMIC COMPOUNDS

1. Name the following compounds (remember to use Roman Numerals, where necessary):

Na_2SO_4	$Ni(OH)_3$
$Al_2(CO_3)_3$	$Pb(NO_3)_2$
KNO_3	$HgHCO_3$
Li_3PO_4	Cu_2SO_4
Ag_2HPO_4	$NiSO_4$
$(NH_4)_4C$	$CoPO_4$
$BaSO_4$	$AuNO_3$
$Zn_3(PO_4)_2$	$Pb(HCO_3)_4$
$Be(OH)_2$	$Fe_2(CO_3)_3$
$Mg(NO_3)_2$	$Mn(SO_4)_2$
$Si(NO_3)_4$	$NiPO_4$
$ZnCO_3$	NH_4OH
$(NH_4)_2SO_4$	$Sn(HPO_4)_2$

2. Write the chemical formulas for the following ionic compounds:

zinc hydrogen carbonate	aluminum hydroxide
calcium phosphate	beryllium hydrogen phosphate
iron (III) sulfate	mercury (II) carbonate
sodium hydrogen phosphate	magnesium hydroxide
iron (II) nitrate	cobalt (II) carbonate
tin (IV) nitrate	sodium nitrate
lead (IV) hydroxide	silver sulfate
ammonium sulfate	manganese (IV) phosphate
nickel (III) carbonate	nickel (II) hydrogen phosphate
lead (II) phosphate	ammonium carbonate
mercury (I) hydrogen phosphate	gold (III) hydroxide

FINAL REVIEW: CHEMICAL NAMES AND FORMULAS

1. Name these compounds:

$LiCl$	K_2S
AlI_3	ZnS
BaF_2	Mg_3N_2
MgO	Na_2O
H_3P	Au_3P
NH_4F	K_3PO_4
$FeSO_4$	$Cu(OH)_2$
$Al_2(SO_4)_3$	$Ca(NO_3)_2$
$Pb(OH)_2$	$Sr_3(PO_4)_2$
$Fe(NO_3)_3$	$(NH_4)_2SO_4$
$Pb(HCO_3)_2$	$BaCO_3$
$CuSO_4$	$NiHPO_4$

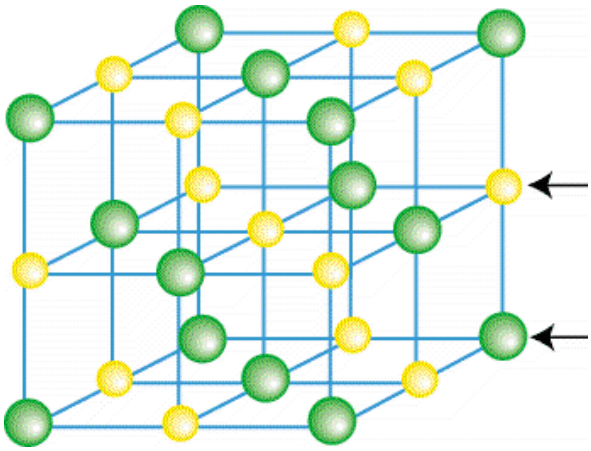
2. Write the chemical formula for:

sodium fluoride	calcium iodide
lithium oxide	rubidium bromide
potassium bromide	barium iodide
aluminum chloride	hydrogen phosphide
iron(II) nitride	silver sulfide
iron(III) sulfide	zinc chloride
silver chloride	barium sulfate
potassium carbonate	iron (III) sulfide
iron(II) iodide	calcium carbonate
magnesium phosphate	copper (II) bromide
sodium hydrogen carbonate	silver nitrate
nickel(II) nitrate	copper(II) sulfate
tin(IV) hydroxide	ammonium chloride
chromium(III) oxide	cobalt(III) chloride
iron(III) sulfate	mercury(II) iodide
nickel(II) hydroxide	zinc sulfate
ammonium hydrogen phosphate	sodium nitride
aluminum fluoride	ammonium nitrate
barium phosphate	gold(III) sulfate

Explaining the Properties of Ionic Compounds

Ionic compounds are made of positive metal ions and negative non-metal ions which are attracted to one another by their charges.

Because all of the positive ions are attracted to all of the negative ions, ionic compounds form a huge network called a "crystal lattice".



The positive and negative ions are locked together so tightly in the crystal lattice, ionic compounds have the following properties:

a) _____

b) _____

c) _____

d) _____

e) _____

f) _____

Introduction to Covalent Bonding

All atoms are most stable when they have a _____ (a _____ _____ electron arrangement).

Metals obtain a stable octet arrangement by _____ electrons.

Non-metals obtain a stable octet arrangement by _____ electrons. They can gain electrons in two ways:

1. Non-metals can _____ electrons from a _____ and form an _____ compound

2. Non-metals can _____ electrons with other _____ and form a _____ compound

When two or more non-metals are held together because they are _____ electrons, the bond is called a _____ bond, and the compound that forms is called a _____ compound.

Covalent compounds are also called _____. Technically, ionic compounds do not form _____.

You can tell if a compound is ionic or covalent from its chemical formula:

- Ionic compounds have a _____ as their first element
- Covalent compounds contain _____

You can also tell if a compound is ionic or covalent from its _____ or _____, as you will see in Lab #2.

Drawing covalent compounds:

1. Read the chemical formula to find how many of each type of atom must be bonded together. eg. NH_3 contains: _____
2. Draw the electron dot diagrams for all of the atoms. Usually, the first element will go in the centre of the molecule.
3. Draw lines to "pair up" the single electrons. Draw the lines in such a way that all of the single electrons get "paired up".
4. Draw the molecule using " " to represent the shared electrons.
5. Draw in all of the electron pairs that did not participate in bonding.

eg. NH_3

H_2O

$C\ell_2$

CO_2

C_2H_6

PF_3

Draw: $HC\ell$ H_2S OF_2 $CF_2C\ell_2$ O_2 N_2

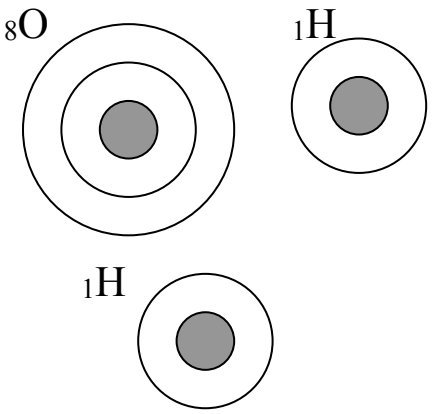
$NOC\ell_3$ CH_2O C_2H_4 H_2O_2 CO_2H_2

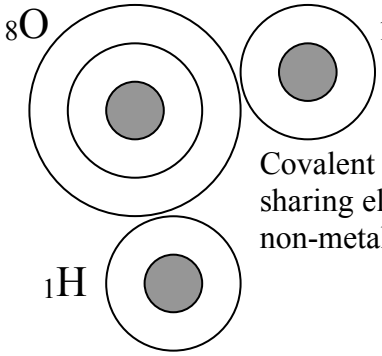
Grade 10 Science
Covalent Bonding

Elements are pure substances that contain only one type of atom.
Compounds are pure substances that contain two or more types of atoms, chemically combined in definite proportions.

There are two types of compounds:
1. Ionic compounds: these compounds form between the **ions** of metals and non-metals, based on electrostatic attraction between oppositely charged ions; for example: $MgCl_2$, NaF, CaO, Na_2S
2. Covalent compounds: these compounds are formed between two or more non-metal atoms, and are based on the non-metal atoms "sharing" electrons between them; for example, H_2O, CO_2, FCl, NO_2.

Example of Covalent Bonding, H_20:
A neutral oxygen atom has 8 electrons, 2 in the first shell and 6 in its outer shell.
A neutral hydrogen atom has 1 electron in its outer shell (hydrogen behaves as both a metal and a non-metal, it will often bond covalently with other non-metals).
The outer electrons arrange themselves so that they are positioned in between the atoms, completing the outer orbits of both atoms at the same time. The sharing of the electrons holds the atoms together and is called a **covalent bond**. There are no electrical charges involved in covalent bonding.





Covalent bonds formed by sharing electrons between non-metal atoms

Covalent compounds are uncharged and contain only non-metal atoms. Like ionic compounds, the atoms always combine in definite proportions, and the proportion depends on the number of electrons in the outer shell of the non-metal atoms. Covalent compounds are also called **molecules**.

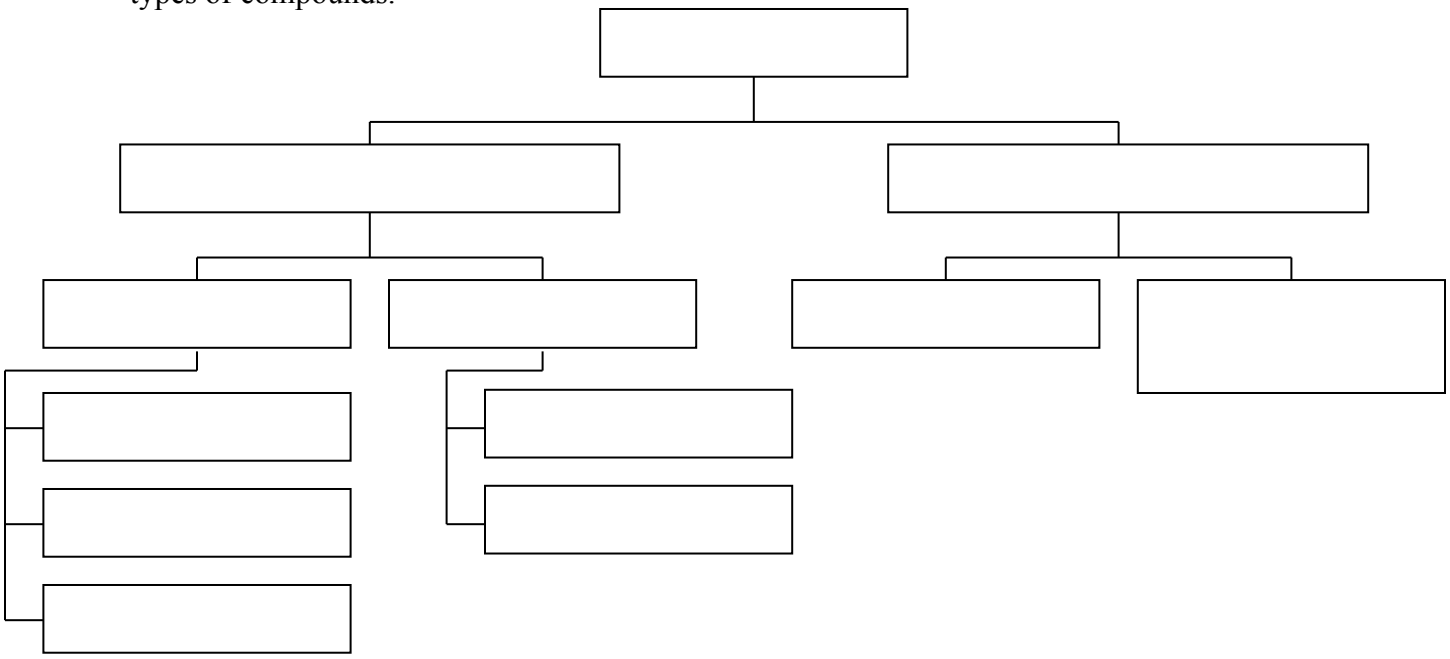
For both ionic and covalent compounds, the ratio of elements in the compound can be written in a short form called a **chemical formula.** The chemical formula indicates two pieces of information:
a) the type of elements which are combined to make up the compound
b) the number of each element present in the compound. The number written as a subscript after an element tells us the number of atoms of that element in the compound.

Your knowledge of metals and non-metals will tell you if the compound is an ionic compound or a molecule (covalent compound).

eg. **NaCl**: a metal plus a non-metal, so it is an ionic compound made of one sodium ion combined with one chloride ion
eg. **$MgBr_2$**: a metal plus a non-metal, so it is an ionic compound made of one magnesium ion combined with two bromine ions
eg. **SO_2**: two non-metal atoms, so it is a molecule (covalent compound) made of one sulfur atom with two oxygen atoms

Covalent Compounds

1. Complete the chart "Classification of Matter", including the three types of elements and the two types of compounds.



2. Define compound, ionic compound, covalent compound, molecule and electrolyte.

3. Complete the following chart, assuming that hydrogen is a non-metal. Use the chemical formula to find the number of atoms or ions of each element that are present in each compound.

Chemical Formula	Ionic or Covalent Compound	Number Of Each Type Of Atom Or Ion Present
K_2S		
$C_2H_2F_4$		
Na_2O		
NO_2		
Li_3N		
$Ba(NO_3)_2$		
$C_6H_{12}O_6$		
CO_2		
$PbSO_4$		
C_2H_6O		
$Ca(HCO_3)_2$		
PBr_3		
$Sn_3(PO_4)_4$		
CCl_4		

4. Would two metal atoms ever bond with each other? Why or why not?

5. Draw electron dot diagrams to show the electron arrangements in the following **molecules**:
a) ClF b) H_2S c) CH_4 d) H_2O e) PCl_3 f) $C_2H_4Cl_2$ g) CF_2Br_2

6. Summarize the properties of ionic and covalent compounds (from lab #1) including the presence of an odour, melting point, do they dissolve in water and do they conduct electricity in solution.

Naming Binary Covalent Compounds

- Ionic compounds form when _____ atoms bond with _____ atoms. They are named using the rules for naming ionic compounds that we have been learning up until now.
- Covalent (molecular) compounds form when two or more _____ atoms are bonded together. ***Binary*** covalent compounds have a different naming system, the _____ system.
- Remember, binary compounds (ionic or covalent) contain _____.

The Rules for the Prefix System:

1. Name the first element with its normal name. Indicate the number of atoms of the first element with a prefix. If there is only one atom of the first element, then a prefix is not used for that element:
   CO_2 is _____
   N_2H_4 is _____
2. Write the name of the second element, changing the end of its name to _____. Indicate the number of atoms of the second element with a prefix.
3. If the second element is oxygen and the prefix ends in an "o" or "a", then the "o" or "a" from the prefix is left off.

eg. CO is _____
P_2O_5 is _____
N_2O_4 is _____
$C\ell_2O_7$ is _____

Prefix
1 is
2 is
3 is
4 is
5 is
6 is
7 is
8 is
9 is
10 is

Examples:

SeO_3 is _____
S_2Cl_2 is _____
BH_3 is _____
P_4O_{10} is _____

carbon tetrachloride _____
diboron triphosphide _____
sulfur hexafluoride _____
dinitrogen pentoxide _____

Practice: Name the following binary covalent compounds using the prefix system:

SO_2	NF_3
CCl_4	N_2H_2
SO_3	P_2H_4
$C\ell F_3$	BI_3
PF_5	$SiBr_4$
SCl_6	NCl_3
N_2S_2	P_4S_{10}
PBr_3	SeF_4
C_3H_8	SiO_2
P_4S_3	N_2O
NO_2	CS_2
OF_2	PBr_5

Introduction to Chemical Reactions

Chemical reactions occur when the atoms in the _____ are rearranged to form new substances, called _____. The products have new _____.

A chemical reaction has occurred if:

1. there is a _____
2. a _____ is produced (_____ or _____). It may have an _____
3. energy is released or absorbed in the form of _____, _____, _____, or _____
4. a _____is formed (a solid that forms when two solutions are mixed). You know a _____ has formed if the mixture goes _____.

Note: changes of state (_____, _____, _____ or _____) are NOT chemical changes!

Chemical reactions can be written two ways:

1) as _____ using the names of the substances involved

("$\rightarrow$" means _____)

2) as _____ using the chemical formulas of the substances involved

We can write _____ equations and _____ equations from descriptions of chemical reactions.

eg. calcium chloride is broken down to produce chlorine gas (Cl_2) and calcium metal

Step 1: write the word equation

Step 2: use the criss-cross rule to convert the names of the substances into their chemical formulas

You need to memorize the following chemical formulas:

- oxygen gas is _____ (when things burn in air, they are really reacting with _____)
- nitrogen gas is _____
- hydrogen gas is _____
- pure metals are written as just their chemical symbols, with _____ and _____

  eg. sodium metal is _____ lead metal is _____
  copper metal is _____ iron metal is _____
  mercury metal is _____ tin metal is _____

When writing chemical equations, always follow these steps:

Step 1: write the word equation

Step 2: use the criss-cross rule to change the chemical names into chemical formulas

eg. when zinc metal reacts with hydrochloric acid (HCl), it produces hydrogen gas and zinc chloride

eg. when methane (CH_4) burns in air, it produces carbon dioxide and water vapour

eg. when silver nitrate is mixed with sodium chloride, silver chloride and sodium nitrate are formed

eg. when lead metal is placed in copper (II) nitrate, it forms copper metal and lead (II) nitrate

Homework: complete question sheet on chemical reactions

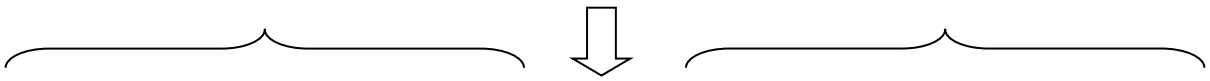
Balancing Chemical Equations

Chemical reactions occur when the atoms in the _____ are _____ to form new substances, called _____.

The _____ tells us that the _____ of the _____ of a chemical reaction is _____ to the _____ of the _____ before the chemical reaction.

That is, during a chemical reaction, the atoms are _____ to form new substances but the _____ and type of _____ that you have after a chemical reaction must be _____ what you started with. Atoms can not be _____ nor _____ during a chemical reaction.

For this reason, chemical reactions must be written in their _____ form.



$KI + Pb(NO_3)_2 \rightarrow KNO_3 + PbI_{2\ (s)}$

$CuSO_4 + NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$

$HgO \rightarrow Hg + O_2$

$Mg + S_8 \rightarrow MgS$

$N_2 + H_2 \rightarrow NH_3$

$P_4 + O_2 \rightarrow P_2O_5$

Hints for Balancing:

1. Start with the element (atom) that has the _____ subscript.
2. If an atom has "____ or ____" for a subscript, it may help to put a coefficient of ____ in front of that substance.
3. Balance the number of atoms of an element, using _____ in front of the substances. Do **NOT** change the _____ of the compounds.
4. Generally, balance elements that are by themselves last (H_2, O_2, Fe etc.)
5. "Ping-pong" back and forth between the reactants and products until all of the atoms are balanced.
6. Double check your work.

BALANCING EQUATIONS #1

1. $Al + S \rightarrow Al_2S_3$
2. $Sn + Cl_2 \rightarrow SnCl_4$
3. $ZnO \rightarrow Zn + O_2$
4. $H_2 + O_2 \rightarrow H_2O$
5. $Cu_2O \rightarrow Cu + O_2$
6. $Cu + S_8 \rightarrow Cu_2S$
7. $P_4 + O_2 \rightarrow P_4O_{10}$
8. $NO_2 \rightarrow N_2 + O_2$
9. $H_2 + I_2 \rightarrow HI$
10. $HgO \rightarrow Hg + O_2$
11. $H_2 + N_2 \rightarrow NH_3$
12. $NaCl + Br_2 \rightarrow NaBr + Cl_2$
13. $SiO_2 + HF \rightarrow SiF_4 + H_2O$
14. $Fe_2O_3 \rightarrow Fe + O_2$
15. $K + Br_2 \rightarrow KBr$
16. $Ca + HI \rightarrow CaI_2 + H_2$
17. $Na + O_2 \rightarrow Na_2O$
18. $BiCl_3 \rightarrow Bi + Cl_2$
19. $CO + O_2 \rightarrow CO_2$
20. $Mg + HCl \rightarrow H_2 + MgCl_2$
21. $H_2O_2 \rightarrow H_2O + O_2$
22. $Al_2O_3 \rightarrow Al + O_2$
23. $P_5 + H_2 \rightarrow PH_3$

BALANCING EQUATIONS #2

1. $CaS + KCl \rightarrow CaCl_2 + K_2S$
2. $Na + Cl_2 \rightarrow NaCl$
3. $Al + O_2 \rightarrow Al_2O_3$
4. $AlN + CaO \rightarrow Al_2O_3 \quad Ca_3N_2$
5. $AlCl_3 \rightarrow Al + Cl_2$
6. $N_2 + NH_4Cl \rightarrow (NH_4)_3N + Cl_2$
7. $Na_2CO_3 + Ca \rightarrow CaCO_3 + Na$
8. $Al(NO_3)_3 + Na_2CO_3 \rightarrow NaNO_3 + Al_2(CO_3)_3$
9. $(NH_4)_2O + Ca(NO_3)_2 \rightarrow NH_4NO_3 + CaO$
10. $AgNO_3 + K_2S \rightarrow KNO_3 + Ag_2S$
11. $BaCl_2 + Na_2CO_3 \rightarrow BaCO_3 + NaCl$
12. $Ca(NO_3)_2 + Li_3PO_4 \rightarrow Ca_3(PO_4)_2 + LiNO_3$
13. $Mg + CuSO_4 \rightarrow MgSO_4 + Cu$
14. $NH_4Br + Cl_2 \rightarrow NH_4Cl + Br_2$
15. $Zn + HCl \rightarrow ZnCl_2 + H_2$
16. $I_2 + KF \rightarrow KI + F_2$
17. $Li_2O + SO_2 \rightarrow Li_2SO_3$
18. $FeS + HCl \rightarrow FeCl_2 + H_2S$
19. $NH_4Cl + NaOH \rightarrow NH_4OH + NaCl$
20. $Na_2SO_3 + HNO_3 \rightarrow NaNO_3 + H_2SO_3$
21. $Fe_2(SO_4)_3 + NaOH \rightarrow Na_2SO_4 + Fe(OH)_3$
22. $Fe_2O_3 + C \rightarrow Fe + CO_2$
23. $NH_4Cl + Na_3PO_4 \rightarrow (NH_4)_3PO_4 + NaCl$

Writing and Balancing Chemical Equations

For the following chemical reactions:
Step 1. Write the word equation.
Step 2. Write the chemical equation (use the criss-cross rule to find the formulas of ionic compounds).
Step 3. Balance the chemical equation.

1. Silver metal reacts with hydrogen sulfide (H_2S) to form silver sulfide and hydrogen gas.

2. When pentane (C_5H_{12}) burns in air, it produces carbon dioxide and water vapour.

3. When ammonia (NH_3) reacts with water it produces ammonium hydroxide.

4. When gold metal is placed in nitric acid (HNO_3) it produces gold (I) nitrate and hydrogen gas.

5. When lead metal is added to nickel (II) sulfate, it produces nickel metal and lead (II) sulfate.

6. When nonane (C_9H_{20}) burns in air, it produces carbon dioxide and water vapour.

7. When sodium azide (NaN_3) reacts, it produces nitrogen gas and sodium metal.

Types of Chemical Reactions

Chemical reactions can be classified into types. Four common types of reactions are:

1. **Synthesis Reactions:** two or more reactants combine to form _____ _____. (synthesis means _____)

In general:

Examples:

2. **Decomposition Reactions:** _____ breaks down to form two or more products.

In general:

Examples:

3. **Single Displacement Reactions:** the atoms from _____ reactants are _____ to form ____ different products. A single element replaces a similar element in a compound.

In general:

Examples:

4. **<u>Double Displacement Reactions</u>:** ____ reactants are rearranged to form _____ new products. The atoms in the reactants _____.

In general:

Examples:

Classify the following unbalanced reactions as synthesis (synth), decomposition (decomp), single displacement (SD) or double displacement (DD):

$Al + S \rightarrow Al_2S_3$ _____

$NaCl + Br_2 \rightarrow NaBr + Cl_2$ _____

$NO_2 \rightarrow N_2 + O_2$ _____

$Ca + HI \rightarrow CaI_2 + H_2$ _____

$NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$ _____

$SiO_2 + HF \rightarrow SiF_4 + H_2O$ _____

$Ba + S \rightarrow BaS_4$ _____

$Cu + SnSO_4 \rightarrow CuSO_4 + Sn$ _____

$AlN + CaO \rightarrow Al_2O_3 + Ca_3N_2$ _____

$Mg + Cu(SO_4) \rightarrow Mg(SO_4) + Cu$ _____

$Fe_2O_3 \rightarrow Fe + O_2$ _____

$C + Cl_2 + F_2 \rightarrow CCl_3F$ _____

$CaC_2 + O_2 \rightarrow Ca + CO_2$ _____

$(NH_4)Cl + Na_3PO_4 \rightarrow (NH_4)_3PO_4 + NaCl$ _____

$Na_3N \rightarrow Na + N_2$ _____

$P_4 + O_2 \rightarrow P_4O_{10}$ _____

Types of Chemical Reactions

Read pages 190 to 191 and 194 to 195 in your textbook. Answer the following questions.

1. Which type of chemical reaction has only one reactant? _____
2. Which type of chemical reaction has only one product? _____
3. Clearly distinguish between a single displacement and a double displacement reaction. How can you recognize each type?
4. Balance each of the following reactions and classify them as single or double displacement reactions:

a) $NaCl + Br_2 \rightarrow NaBr + Cl_2$ _____

b) $Ca + HI \rightarrow CaI_2 + H_2$ _____

c) $SiO_2 + HF \rightarrow SiF_4 + H_2O$ _____

d) $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$ _____

e) $N_2 + (NH_4)Cl \rightarrow (NH_4)_3N + Cl_2$ _____

f) $Al(NO_3)_3 + Na_2(CO_3) \rightarrow Na(NO_3) + Al_2(CO_3)_3$ _____

g) $Mg + Cu(SO_4) \rightarrow Mg(SO_4) + Cu$ _____

5. Balance each of the following equations and classify the reactions as synthesis, decomposition, single or double displacement reactions:

a) $H_2O_2 \rightarrow H_2O + O_2$ _____

b) $AlN + CaO \rightarrow Al_2O_3 + Ca_3N_2$ _____

c) $BN + F_2 \rightarrow BF_3 + N_2$ _____

d) $Ca + HI \rightarrow CaI_2 + H_2$ _____

e) $Fe + O_2 \rightarrow Fe_2O_3$ _____

f) $Cr_2(SO_4)_3 + NaOH \rightarrow Cr(OH)_3 + Na_2SO_4$ _____

g) $Fe_2O_3 + C \rightarrow Fe + CO_2$ _____

h) $NiCO_3 \rightarrow NiO + CO_2$ _____

i) $CaO + H_2O \rightarrow Ca(OH)_2$ _____

j) $H_2S \rightarrow H_2 + S_2$ _____

k) $Ca(OH)_2 + HCl \rightarrow CaCl_2 + HOH$ _____

Acids, Bases and Neutral Substances

All compounds can be classified as either _____, _____ or _____ substances. Each has specific _____ (characteristics) and _____.

Acids are compounds that dissolve in _____ to produce _____ ions. All acids have _____ as their first element.

Four common acids are:

1. **Hydrochloric acid** (_____)
- a _____ acid
- also known as "_____", which is used as a _____ and to treat the water in _____
- found in our _____, where it _____ and _____ in food

2. **Sulfuric acid** (_____)
- a _____ acid
- also known as "_____" because it is used in _____
- found in _____ and is produced when _____ from _____ (_____, _____, and _____) is burned

3. **Acetic acid** (_____)
- a _____ acid
- it is _____ (in _____ concentrations)
- _____ is a _____ solution of acetic acid

4. **Carbonic acid** (H_2CO_3)
- a _____ acid
- forms when _____ (_____) is dissolved in water
- used to "_____" _____ and make it "_____"

Other acids include:

Bases are compounds that dissolve in _____ to produce _____ (_____) ions. Bases are also called "_____" substances.

Four common bases are:

1. **Sodium hydroxide** (_____)
- a _____ base
- used in _____ and _____ (_____)

2. **Potassium hydroxide** (_____)
- a _____ base
- also known as "_____" which can be made from the _____
- used to make _____ (_____) and as a _____

3. **Ammonium hydroxide** (_____)
- a _____ base
- used in many _____ such as "_____" and _____ cleaners

4. **Sodium bicarbonate** (_____, _____)
- a _____ base
- also known as _____, which is used as a "_____ _____" for baking to make _____ and _____ rise

Neutral substances are substances that contain either:

a) _____ of _____ and _____ (_____) ions
eg. _____

b) neither _____ nor _____ ions
eg. _____, _____

Neutral substances are a _____ group of compounds that have _____ of the _____ of acids and bases.

Reactions of Acids and Bases

Acids and bases behave in predictable ways in many chemical reactions. For example:

1. When an acid reacts with a _____, the products of the reaction are always _____ ( ) and a _____.

A **salt** is an _____ compound that does not contain the _____ ( ) ion.

2. When an acid reacts with a _____ ( ), the products of the reaction are always _____ gas ( ), _____ and a _____.

Many antacids contain carbonates. Tums contains _____ ( ). Other antacids contain _____ ( ).

3. When an acid and a _____ are mixed, a _____ reaction occurs. The products are always _____ and a _____. The reactions of acids and bases are also called _____ reactions because the products are _____ and no longer have the properties of _____ and _____.

The reactions of acids and bases have many common applications. For example, the venom of insects often contains an _____. When the insect stings you, they inject you with their venom and the acid causes _____ and _____. "_____" is a product that contains _____ (a weak _____). It neutralizes the acid and takes away the pain.

Homework: Complete the worksheet: Reactions of Acids and Bases

Practice Writing Chemical Equations for Acids and Bases

Write word equations and balanced chemical equations for the following reactions:

1. Calcium metal reacts with nitric acid (HNO_3).

2. Potassium carbonate reacts with hydrobromic acid (HBr).

3. Hydrofluoric acid (HF) reacts with potassium hydroxide.

4. Cadmium metal reacts with sulfuric acid.

5. Calcium hydroxide reacts with carbonic acid.

6. Ammonium chloride reacts with barium hydroxide to produce ammonia gas (NH_3), water vapour and barium chloride.

7. Aluminum metal reacts with phosphoric acid (H_3PO_4).

8. Magnesium carbonate reacts with hydroiodic acid (HI).