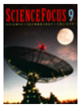

Matter and Chemical Change

Unit B

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- Mixtures of Matter

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Matter Links Science In Action

Topic 1 Exploring Matter

Safety First

A good science lab is a safe one. All of the procedures, equipment and chemicals you use have been designed to help you understand the science principles you are investigating.

Go over the safety notes provided (link below) and be prepared to take the safety test in class (do the practice test - link below - to help prepare you – the test in class will be slightly different). Do the two activities in the Science Focus textbook as well (p. 93 Put Safety First & p. 94 Fasten Your Safety Seat Belt)

Notes: http://www.edquest.ca/Labs/labsafety.html
Practice Test: http://www.edquest.ca/Tests/safety.html

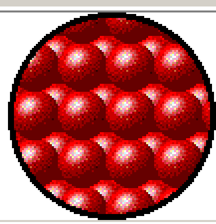
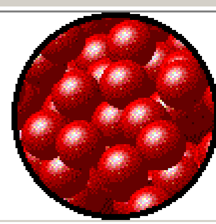
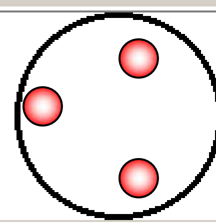
Classifying Matter

The particle model of matter is an important part of what you will be learning in this unit.
Recall that:

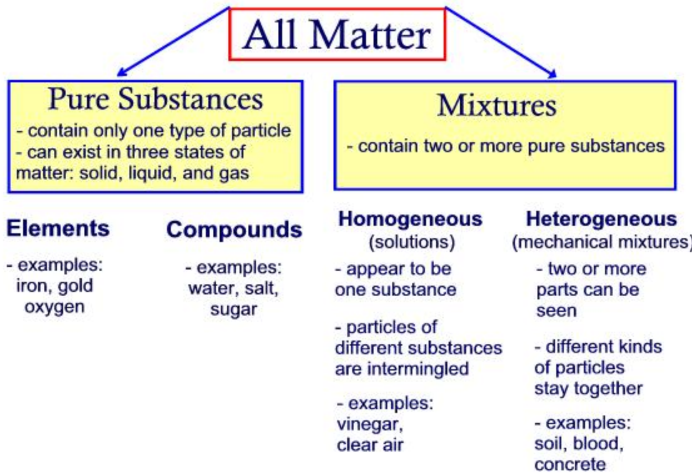
- All matter is made up of tiny particles.
- All the particles in a substance are the same; different substances are made of different particles.
- There are attractive forces among particles-these attractions may be strong or weak.
- The particles are always moving; the more energy the particles gain, the faster they move.
- There are spaces among the particles.

The Particle Model of Matter is a scientific model which helps to visualize a process we cannot see directly. The first two points help us to understand that particles make up matter. The other three points help to explain density and how matter behaves when temperature changes.

Matter exists in three states: solid, liquid, or gas.
The Particle Model of Matter is useful in explaining the differences among solids, liquids, and gases. Illustrations such as these help to clarity the particle theory.

		
Solids have a definite shape and volume because the particles of a solid can move only a little. They vibrate back and forth, but strong forces hold them in fixed positions.	Liquids take the shape of its container because the particles can move around more freely than they can in solids. A liquid's particles are held together by strong attractions to each other, so a liquid, like a solid, occupies a definite volume.	Gases always fill whatever container they are in. The attractions among the particles of a gas are so weak that individual particles are quite far apart, with spaces among them. Since gas particles are moving constantly and randomly in all directions, they spread throughout their container, no matter what its shape and volume.

Mixtures of Matter



A pure substance is made up of only one kind of matter and has its own unique set of physical properties.

Types of Pure Substances

- element

- cannot be broken down into any simpler substance

- compound

- is a combination of two or more elements in fixed proportions

A mixture is a combination of 2 or more pure substances

Types of Mixtures

- mechanical (***heterogenous***)

- each substance in the mixture is visible

- solution (***homogeneous***)

- each substance is not clearly visible
(A substance dissolved in water is called an aqueous solution)

- suspension

- is a cloudy mixture in which tiny particles are held (suspended) with another substance, and can be filtered out

- colloid (emulsions)

- is also a cloudy mixture, but the particles are so small that they cannot be filtered out easily (emulsions are types of colloids in which liquids are dispersed in liquids)

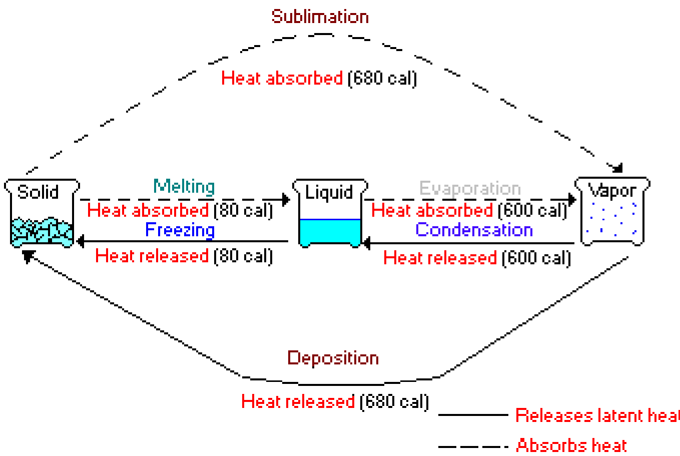
Whether a mixture is a solution, colloid or suspension depends on the size of the particles, solubility and mixing ability (miscibility)

Topic 2 - Changes In Matter

Matter can change from one form to another, or create new materials.

Every kind of matter has its own distinguishing characteristic properties that can be used to identify the kind of matter it is. Properties are characteristics that can be used to describe how a substance behaves substance. These properties can be physical or chemical.
Changes that matter can undergo fall into two classification categories: physical change and chemical change.

A **physical change** occurs when a material changes form but not composition. A change of state is an example of a physical change where energy is used or released.



No new substances are formed. The change is not permanent.
Dissolving is also a physical change.

A **chemical change** occurs when two or more substances react and create one or more new substances. It is often permanent, although not always. Combustion is an example.

Can You Ever Be Sure About Changes?

It is often difficult to decide if a change is physical or chemical, so certain clues will help you decide if a chemical change has occurred.

- Change in colour
- Change in odour
- Formation of a gas (bubbles) in a liquid
- Formation of a solid (precipitate) in a liquid
- Release or absorption of energy (heat)
- Materials you started with are used up
- A new material is formed
- The change is difficult to reverse

The only evidence that will guarantee a chemical change has occurred is that a new substance has been formed.

Properties: Chemical or Physical?

Any property that can be observed without forming a new substance is a physical property. These can include: color, texture, luster, smell, state, melting point, boiling point, hardness, malleability, ductility, crystal shape, viscosity, solubility, density and conductivity (electrical and heat).

Any property that describes how a substance reacts with another substance when forming a new substance is a chemical property. Chemical properties include: reaction with acids, ability to burn (combustibility), reaction with water, behaviour in air and reaction to heat, toxicity, stability.

Topic 3 What Are Elements

The original 'elements' were earth, air, fire and water.

Ancient Greek philosophers thought matter was made out of these four 'elements'. They thought all things were made from these four elements with varying degrees of hotness, coldness, dryness and wetness.

Alchemists (part pharmacist and part mystic) developed many useful procedures, including distillation, and they described the properties of many different materials. They also thought they could change lead and copper into gold. They used special symbols to prevent others from finding out their secrets.

The current view of matter began with Sir Francis Bacon, who stated that all science should be based on experimental evidence, rather than thought. Robert Boyle recognized that elements could combine to form compounds. Bacon and Boyle motivated others to search for elements.

Taking Apart Matter

Scientists began using heating, burning, mixing, and cooling to take matter down until it could not be broken down any further, to determine if a substance was a pure substance or a mixture. Antoine Lavoisier defined elements as pure substances that could not be decomposed into simpler substances by means of a chemical change. In this way he identified 23 pure substances as elements. Lavoisier was one of the first chemists to use a balanced view of chemical change, which we now call …

The Law of Conservation of Mass

In a chemical reaction, the total mass of the reactants,
is always equal to the total mass of the products.

This law ties in well with the atomic theory, which states that atoms are never created or destroyed. In a chemical reaction the atoms and molecules are simply rearranged.
This law of conservation of mass however does not apply to nuclear reactions, because there Is some loss of mass: ***the mass is changed into energy***. This was first suggested by **Albert Einstein** in his famous equation:

$$E = MC^2$$

(**E** Is Energy, **M** is Mass, $\mathbf{C^2}$ is a large number)
A very tiny amount of mass is equal to a very large amount of energy
In an **open system** some of the mass seems to disappear, when it is in the form of a gas.

Other scientists followed up on the law of conservation of mass by stating the …
Law of Definite Composition

Compounds are pure substances that contain two or more elements
combined together in fixed (or definite) proportions.

Water is an example of this law. Pure water always contains 11% Hydrogen and 89% Oxygen.

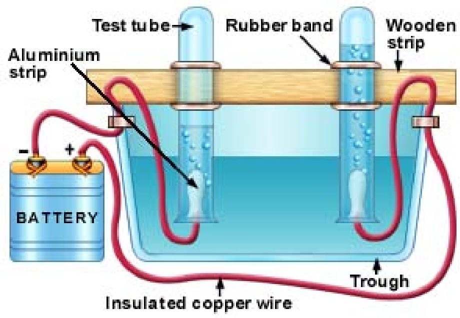
Chemistry Tutorials http://www.chemistrycoach.com/tutorials-2.htm

Law of Multiple Proportions *states that the masses of one element, which combine with a fixed mass of the second element, are in a ratio of whole numbers.*

Pure substances have constant composition and properties. An unknown substance can be identified by measuring a property of the substance (eg. density) and compare it to known values of other substances. If the test property matches a known value, it is likely that substance, because each substance has its own distinguishing properties unique to that substance.

New Discoveries

Allesandro Volta made the first practical battery (the voltaic pile) around 1800, by piling zinc and copper plates on top of each other, separating them with electrolyte-soaked paper discs.
When this voltaic pile was hooked up to transfer the electricity through water, they discovered hydrogen and oxygen gases could be produced and the water level dropped slightly. Using electricity to split molecules into their elements was a process called **electrolysis.** Scientists used electrolysis to isolate the elements potassium, sodium, magnesium, calcium, strontium, and barium.



Dalton's Atomic Theory

John Dalton developed a theory that helped explain what happened in the electrolysis of water and was a new way to explain chemical facts and laws. His Atomic Theory was widely accepted.

- All matter is made up of tiny particles called atoms
- Atoms cannot be created, destroyed, or divided into smaller particles.
- All atoms of the same element are identical in mass and size. Atoms of one element are different in mass and size from the atoms of other elements.
- Compounds are created when atoms of different elements link together in definite proportions

An element is a pure substance made up of only one type of particle, or atom. Each element has its own unique set of distinguishing properties and cannot be broken down into simpler substances by means of a chemical change.
A compound is a pure substance made up of 2 or more elements chemically combined together. Compounds can be broken down into the elements that they are composed of.

Laws, Theories, Models, and Observations

In science, *laws* do not explain anything. They simply describe and summarize what happens.

Theories are imaginative ways to explain why something happens the way it does.

Theories are developed over the course of many observations and hundreds of experiments before other scientists will accept it.

Observations → *Hypothesis* → *Experiments as many times as needed* → *Theory* → *Time* → *Revised Theory*

revised Hypothesis

Scientific ideas may change over time as more evidence is gathered. Most of Dalton's atomic theory has stood the test of time, however, smaller particles (subatomic) have been discovered and Dalton's Theory needed to be revised.

Scientific models help others to visualize structures or processes that cannot be seen directly.

Some of the atomic models are illustrated on p. 113 in the Science Focus 9 textbook.

A Brief Timeline of Atomic Theory

Year	Evolving Theory of Matter	3D Model
8000 B.C.	***(Stone Age) Matter was made up of solid material, which could be fashioned into tools.***	***Stone implements***
6000-1000 B.C.	***Chemists investigated the properties of only those materials that were of high value to humans. (gold and copper)***	**Metals**
4500 B.C	***(Bronze Age) The effect of heat on copper, lead to the creation of a strong material (bronze) for use as tools.***	**Bronze tools**
1200 B.C.	***(Iron Age) Iron combined with carbon to make steel, for even stronger tools.***	**Steel**
350 B.C.	***Everything was made out of Air – Water - Earth – Fire (atomos particles)***	**Earth/Wind/Fire/Ice**
1500	***Theory of Matter was based more on experimentation. (History of Alchemy)***	**States of Matter**
1660	***Particles can be compressed. (Boyle)***	**Particles**
1770	***System for the naming of chemicals was developed. (Lavoisier)***	**Molecule**
1780	***Air is necessary for combustion to occur.***	**Molecules**
A Brief History Atomic Models (p. 113 SF9)		
1808	***Observation principles during experimentation.***	**Dalton's Atomic Theory (billiard ball model)**
1897	***Raisin bun model with charged particles.***	**JJ Thomson Raisin bun (plum pudding model)**
(1904) 1911	***Negatively charged particles orbiting around nucleus.***	**Ernest Rutherford (planetary model)**
1913 (1922)	***Electrons rotate randomly around the nucleus.***	**Niels Bohr (atomic model)**
Today	***the atom is a cloud of electrons around a nucleus***	**'quantum model'**

Topic 4 Classifying Elements

Element Symbols

History of Chemical Symbols **-** http://www.vanderkrogt.net/elements/chemical_symbols.html

New elements continue to be discovered. Finding a pattern in an unknown helps scientists to organize ideas and information. It also helps scientists to interpret what the information means and explain these ideas, based on what they have learned.

Early chemists used symbols of the sun and the planets to identify the elements known to them. This later was a problem, when more elements were discovered, because they ran out of planets.

Metal	**gold**	**silver**	**iron**	**mercury**	**tin**	**copper**	**lead**
Symbol	○	☾	♂	Ŏ		♀	
Celestial Body	**Sun**	**Moon**	**Mars**	**Mercury**	**Jupiter**	**Venus**	**Saturn**

John Dalton developed a new set of symbols in the early 1800's to improve communication between chemists.

Symbol	⊙	○	●	Ⓖ	Ⓢ	◌
Element	**hydrogen**	**oxygen**	**carbon**	**gold**	**silver**	**mercury**

Daltons 1808AD symbols and formulae.

⊙ *Hydrogen*	*Soda*	⊙ *Ammonia*
Nitrogen	*Pot Ash*	⊙● *Olefiant*
● *Carbon*	○ *Oxygen*	○● *Carbonic Oxide*
⊕ *Sulphur*	Ⓒ *Copper*	○●○ *Carbonic Acid*
Phosphorus	Ⓛ *Lead*	*Sulphuric Acid*
Alumina	⊙○ *Water*	

http://www.chemsoc.org/exemplarchem/entries/2001/robson/symbolspart1.htm

Berzelius later revised **Dalton's** symbols by replacing them with *letters*, instead of pictures. He represented the elements by their first letter (capitalized) or their first two letters (first one capitalized and the second letter lower case).

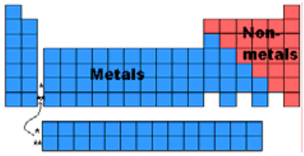
Elements were listed in order of their atomic mass. **Atomic mass** is the mass of one atom of an element. It is represented in ***atomic mass units*** (**amu**).

John Newland's "***law of octaves***" identified the pattern in which the properties of the elements seemed to repeat at regular intervals, similar to the octave scale in music.

Demitri Mendeleev later revised the pattern in 1869, when he organized the elements into the first periodic table.

Different Kinds of Elements

One way of classifying elements is to sort them into categories, based on their distinct properties. Long before anyone knew any detail about the atoms or any of the periodic properties the elements were divided into two broad categories ⟶ metals and non-metals.



Distinct properties of *metals* were malleability and ductility, shiny luster and were solid at room temperature (except mercury).
Non-metals: some were gases, solids or liquids; solid non-metals are brittle; they are flexible, dull and non-conductors of electricity or heat.
In-between elements were called *'metalloids'*, having properties of both metals and non-metals.

Transition Metals - The 38 elements in groups 3 to 12 are called transition metals. The only elements in this group known to produce a magnetic field are iron, cobalt and nickel.

Other Metals - There are 7 elements considered "other metals" in groups 13 to 15. All these elements are solid with a high density. Examples are tin, aluminum and lead.

Metalloids - These elements have both metal and non-metal properties. Some of them are semi-conductors, which means, they can carry an electrical charge under special conditions. Metalloids are great for computers and calculators.

Non-Metals - These fall into groups 14 to 16 in the periodic table. They can't conduct heat or electricity very well and are brittle. They also can't be made into wire or sheets. At room temperature, non-metals turn into gasses and solids.

Rare Earth Elements - There are 30 rare earth elements. Many of them are synthetic or man-made. They're found in group three of the periodic table and the sixth and seventh groups.

Chemical Families

Chemical family is a term used to describe a group of related elements that have similar properties.

Alkali Metals - These are group 1 in the periodic table. They don't occur freely in nature and are softer than most metals. Like all metals, they are great heat conductors and can even explode if exposed to water – they are very reactive and need special storage. They easily give off an unpaired electron by forming a compound.

Alkaline Earth Metals - These are group 2 in the periodic table. Because they're extremely reactive, they aren't found freely in nature. An example of an alkaline earth metal is radium.

Noble Gases - The 6 noble gases are in group 18. All of them have the maximum number of electrons possible in their outer shell which makes them stable. Examples of noble gases are helium, neon and krypton.

Halogens - All 5 halogens are non-metallic elements. Compounds that contain halogen are called *'salts'.* At room temperature, they are in three states of matter: solid, liquid and gas.

Topic 5 The Periodic Table

Mendeleev Builds a Table

The system of using atomic mass to classify and organize all the elements known and undiscovered was created based on Dalton's Theory, by Dmitiri Mendeleev (1834-1907)

Mendeleev collected the 63 elements known at the time and arranged them according to their atomic mass - *the average mass of an atom of an element* - (which he wrote on a file card).

He then arranged the cards into a 'solitaire-like' table. He played with them, by sorting and arranging the elements in many different combinations.

Mendeleev was able to identify gaps where elements, not yet discovered, would be able to fit.

Find out more about Dmitri Mendeleev *Blast From The Past* @ http://www.edquest.ca/content/view/214/

			Ti=50	Zr=90	?[2]=180
			V=51	Nb=94	Ta=182
			Cr=52	Mo=96	W=186
			Mn=55	Rh=104,4[3]	Pt=197,4[4]
			Fe=56	Ru=104,4	Ir=198
			Ni=Co=59	Pd=106,6	Os=199
H=1[5]			Cu=63,4	Ag=108	Hg=200
	Be=9,4	Mg=24	Zn=65,2	Cd=112	
	B=11	Al=27,4	?[6]=68	Ur=116[7]	Au=197?
	C=12	Si=28	?[8]=70	Sn=118	
	N=14	P=31	As=75	Sb=122	Bi=210?
	O=16	S=32	Se=79,4	Te=128?	
	F=19	Cl=35,5	Br=80	J=127[9]	
Li=7	Na=23	K=39	Rb=85,4	Cs=133	Tl=204
		Ca=40	Sr=87,6	Ba=137	Pb=207
		?[10]=45	Ce=92[11]		
		?Er=56	La=94		
		?Yt=60	Di=95		
		?In=75,6	Th=118?		

Putting the Elements in Order

When Mendeleev arranged the elements in order of their mass he found that the properties of the elements repeated at periodic intervals. This enabled him to group elements into families. The gaps he left in the organization of the elements in his table were filled in many years later when more elements were discovered. In 1875 gallium was discovered and proved that Mendeleev's organization of the elements worked, because it fit in where he had placed a (**?**). The next (**?**) was not replaced until 1939 when francium was discovered. In 1915 the Modern Periodic Table was reorganized with a focus on atomic structure and included more information about each element.

Atomic Number – The number of protons an atom has is called the atomic number.
An element is defined by the number of protons it has. Carbon atoms have six protons, hydrogen atoms have one proton and oxygen atoms have eight protons. The chemical behavior of an element depends on the number of protons in an atom.

Mass Number - The atomic mass number of an element is simply the sum of the protons and neutrons in the nucleus of 1 atom of the element.

Atomic Symbol - These are almost always one or two letters that represent an element. They're used worldwide and usually relate to the name of the element or the Latin name of the element. An example of this is "O" for Oxygen and "Ca" for Calcium.

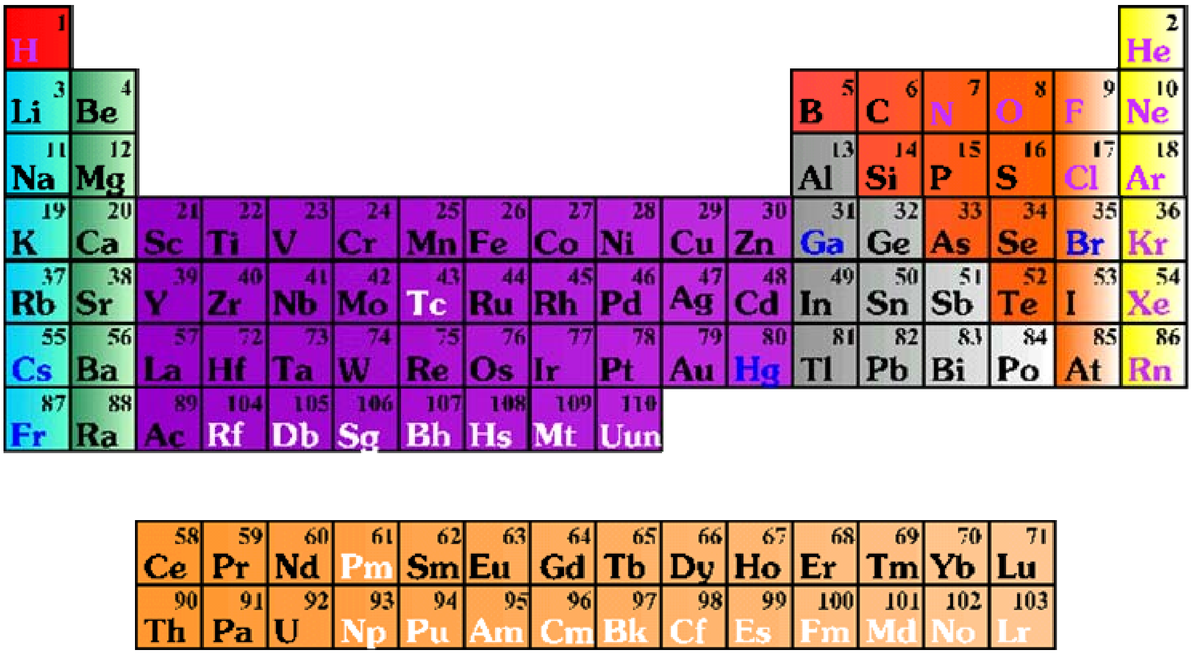
Atomic Mass – To find the average number of neutrons for an element, simply subtract the number of protons (atomic number) from that atomic mass.
The average mass of an element in atomic mass units (amu.) The mass in an atom is roughly the mass of one proton or neutron. The atomic mass is a decimal number on the Periodic Table because it's an average of the various isotopes (one or more atoms that have the same atomic number but different mass numbers) of an element.

Periodic Table Models

About 112 elements are known today.

They are organized into what is called **'The Periodic Table of Elements'**

Understanding the Periodic Table (Web Elements.com)



Horizontal rows are called **periods** (*numbered* 1-7)
Vertical columns form a **group**, or **family** of elements (*numbered* 1-18)

There are so many good resources available to help you look into the details of the Periodic Table and also to help you with **Think and Link Investigation 2-D (**Science Focus pgs. 129-133**)** **Meet the Modern Periodic Table**, that you should have access to the Internet when you complete the investigation.

Periodic City – A Site that shows many different versions of the Period Table
http://www.mpcfaculty.net/ron_rinehart/periodic.htm
[Other versions] http://chemlab.pc.maricopa.edu/periodic/foldedtable.html
Los Alamos Periodic Table
Visual Elements (Flash Version)
Pictorial Periodic Table - http://chemlab.pc.maricopa.edu/periodic/periodic.html

Topic 6 - Chemical Compounds

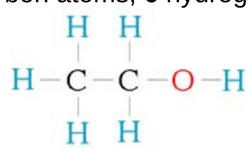
When any of the 112 elements combine into groups of 2 or more they form compounds. If an atom of an element transfers electrons to another atom of a different element, an ionic compound is formed. If atoms of elements are shared, a molecular compound is formed.

Understanding Formulas for Compounds

The combination of elements to form compounds has a chemical formula and a chemical name. The chemical formula uses symbols and numerals to identify which elements and how many atoms of each element are present in the compound.

For example:

ethanol ($\mathbf{C_2H_6O}$) has **2** carbon atoms, **6** hydrogen atoms and **1** oxygen atom



To determine a chemical name, a standardized chemical naming system, or nomenclature, is used. Guyton de Morveau in France developed it in 1787. The metal name is always first. Since 1920, the **IUPAC** (*International Union of Pure and Applied Chemistry*) is responsible for determining the appropriate name for each compound.

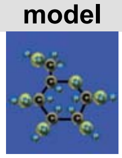
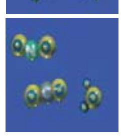
If you know the formula for a compound you can determine its chemical name
If you know its name, you can determine its formula.

Write the **chemical formula** as determined by the **name** of the compound.
(If a poly atomic ion is part of the formula, keep the poly-atomic ion intact)

Aluminum oxide	2 - Al	3 - O	Al_2O_3
Calcium nitrite	1 - Ca	2 - NO_2	$Ca(NO_2)_2$
Sodium Chloride	1 - Na	2 – Cl_2	NaCl

If the compound contains a metal the compound is ionic.
If the compound does not contain a metal, it is molecular.
Write the **name** of the compound as determined by the **chemical formula**.

Al_2O_3	2 - Al	3 - O	Aluminum oxide
$Ca(NO_2)_2$	1 - Ca	2 - NO_2	Calcium nitrite
NaCl	1 - Na	2 – Cl_2	Sodium Chloride

Chemical Name & Physical State	Atomic model	Chemical Formula
Glucose (s) - solid		$\mathbf{C_6H_{12}O_6}$ The chemical formula for glucose tells us that each molecule is made of 6 carbon atoms, 12 hydrogen atoms, and 6 oxygen atoms.
Nitrogen dioxide (g) - gas **Carbon dioxide** (g) - gas **Water** (l) – liquid		$\mathbf{NO_2}$ $\mathbf{CO_2}$ $\mathbf{H_2O}$

(aq) – **aqueous solution** This is used when substances are dissolved in water.
A saltwater solution would be **NaCl** (aq)

Molecular Compounds

A molecule is the smallest independent unit of a pure substance. Diatomic molecules are molecules made up of 2 atoms of the same element (oxygen O_2, nitrogen N_2, hydrogen H_2). Most molecular compounds do not form large structures.

When *non-metals* combine, they produce a pure substance called a molecule, or molecular compound. They can be solids, liquids, or gases at room temperature. The bonding between atoms is strong, but the attraction between the molecules is weak.

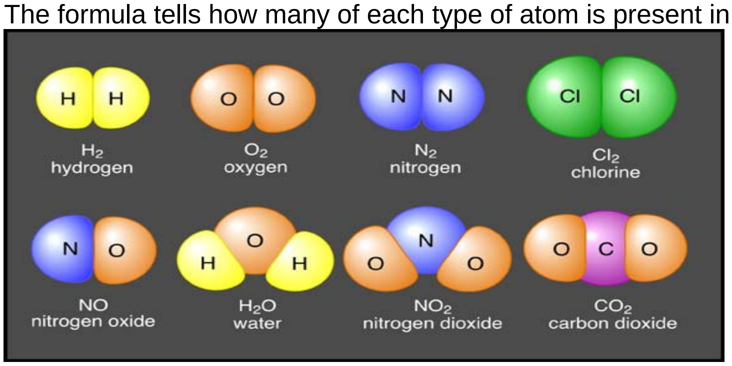
Examples: sugar ($C_{12}H_{22}O_{11(s)}$)
acetylene, water

Properties of **molecular compounds**
- Low melting point
- Low boiling point
- Good insulators
- Poor conductors
- Distinct crystal shape

Of the 10 million compounds discovered so far, about 9 million are molecular compounds

Writing Formulas For Molecular Compounds

The formula tells how many of each type of atom is present in the molecule.



How Are Molecular Compounds Named?

A compound made from two elements is called a binary compound.

Rules for naming binary molecular compounds:

1. The first element in the compound uses the element name
2. The second element has a suffix – **ide** –
3. When there is more than 1 atom in the formula, a prefix is used which tells how many atoms there are:
4. Exception to #3 above – when the first element has only 1 atom the prefix mono is not used

# of Atoms	Prefix
1	mono
2	di
3	tri
4	tetra
5	penta
6	hexa-
7	hepta-
8	octa-
9	nona-
10	deca-

Examples: $CO_{2(g)}$ carbon **di**oxide $CCl_{4(l)}$ carbon **tetra**chloride $SiO_{2(s)}$ Silicon **di**oxide

If you are changing from the written name to the chemical symbol:

1. Write the symbols for the elements in the same order as they appear in the name.
2. Use subscripts to indicate the numbers of each type of atom.

Some molecular compounds are better known by their common names rather than their chemical names, example: water H_2O is actually dihydrogen oxide, propane C_3H_8 is tricarbon octahydride. The bracketed symbol following the chemical formula represents what state (solid, liquid, gas) the compound is in. (aq) means aqueous (water) solution.

Ionic Compounds

Ionic compounds are pure substances formed as a result of the attraction between particles of opposite charges, called **ions**. When an atom gains or loses electrons, the atom is no longer neutral – it is an ion, either positively or negatively charged.

Properties of ionic compounds

- High melting point
- Good electrical conductivity
- Distinct crystal shape
- Solid at room temperature

Sodium Chloride (table salt) – **NaCl** – is an **ionic compound**. When it is dissolved in water, the metal (**Na**) loses an electron – to become positively charged - and the nonmetal (**Cl_2**) gains an electron – to be negatively charged - forming an aqueous solution of ions. Conductivity is the ability of a substance to carry an electric current. The ionic salt solution provides good conductivity. Positive sodium ions attract negative chloride ions to form a cube-shaped arrangement (ionic model). The force holding them together is called ionic bonds.

Ion Charges

A superscript (**+**) or a (**–**) are used to indicate the charge. **Na^+** and **Cl^-**
Some ions can also form when certain atoms of elements combine. These ions are called **polyatomic** ions (*poly* meaning "*many*"). Polyatomic atoms are a group of atoms acting as one.
Example:

1 carbon atom reacting with 3 oxygen atoms produces
1 carbonate group of atoms, which act as one. **CO_3^{2-}**

Then, when carbonate ions react with calcium atoms they produce calcium carbonate, or known by its common name - limestone. **Ca CO_3^{2-}**

How Are Ionic Compounds Named?

Two rules:

1. The chemical name of the metal or positive ion goes first, followed by the name of the non-metal or negative ion.
2. The name of the non-metal negative ion changes its ending to **ide**.

NB: *one exception* – Where negative ions are polyatomic ions, the name remains unchanged.
Some elements with *more than one ion charge* use a roman numeral in its chemical name to clearly show which ion is being used. **Cu(II)SO_4** (Copper II Sulfate)

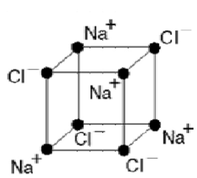
Using Ion Charges and Chemical Names To Write Formulas

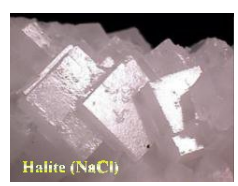
Step 1 – Print the metal element's name, symbol and ion charge, then the non-metals name, symbol and ion charge
Step 2 – Balance the ion charges (the positive ion must balance with the negative ion
Step 3 – Write the formula by indicating how many atoms of each element are in it.

Ca^{2+} Cl^{1-}
Ca^{2+} Cl^{1-} Cl^{1-}
$CaCl_2$

Periodic Table Patterns:	ion charge
Alkali metals	1+
Halogens	1 -
Generally elements in a group all have the same ion charge (most consistency at either end of the table)	

All ionic compounds have ***distinct*** (different) ***crystal shapes***.





Topic 7 Chemical Reactions

Chemical Reaction Movies (So Cool!) Examples of Chemical Reactions
http://jchemed.chem.wisc.edu/jcesoft/cca/cca0/sampmovs.htm http://www.howe.k12.ok.us/~jimaskew/creact.htm
Chemical Reactions in the body (see figure 2.47 on page 146)
Cellular Respiration is a chemical reaction that takes place in the cells in your body.
Animations of cellular respiration

A **chemical reaction** takes place when two or more substances combine to form new substances. Different types of chemical reactions can occur, including ***combination***, ***decomposition***, ***displacement*** and ***exchange*** reactions. The substances at the beginning of the reaction are called **reactants**. The new materials produced by the reaction are called **products**. The properties of the products differ from those of the reactants, thus a chemical change has occurred. A **chemical change** results from a chemical reaction. Evidence that a chemical change has occurred include:

- A change in colour
- The formation of an odour
- The formation of a solid (precipitate) or a gas (bubbles)
- The release or absorption of energy
  - A chemical change, which **releases** energy, is called **EXOTHERMIC**.
  - A chemical change, which **absorbs** energy, is called **ENDOTHERMIC**

Chemical Equations

Chemical reactions can be written as **word equations** which gives the names of all the reactants (separated by a "plus' sign +) followed by an arrow which points to the names of all the products (separated by a 'plus' sign +)

eg. (***iron + oxygen + water → rust***)
(***Iron plus oxygen plus water produces rust***)
Reactants -> Products

Combustion is a chemical reaction that occurs when oxygen reacts with a substance to form a new substance and gives off energy.

Identification Tests:

- *f*or OXYGEN

Light a wooden splint. Blow out the flame, allowing the splint to continue glowing. Hold the glowing splint in a small amount of the unknown gas. If the splint bursts into flame, then the gas being tested is oxygen.

- for HYDROGEN

Light a wooden splint. Hold the glowing splint in a small amount of the unknown gas. If you hear a "**pop**", then the gas being tested is Hydrogen.

- for CARBON DIOXIDE

If you put a burning splint into Carbon Dioxide, the flame will go out and you will know the gas is not oxygen or hydrogen, but you will not know for sure that it is Carbon Dioxide. The test for Carbon Dioxide is not a combustion test, but rather uses a liquid called **limewater** (a clear colorless solution of calcium hydroxide, or slaked lime). Bubble the unknown gas through the limewater solution, or add a few drops of the limewater solution to the gas and swirl it around. If the limewater turns ***milky***, the gas is Carbon Dioxide.

Although a chemical equation may look complicated, by knowing what you know now, it should be much easier to understand.

$$\underset{\text{(vinegar)}}{HC_2H_3O_{2(l)}} + \underset{\text{(baking soda)}}{NaHCO_{3(g)}} \rightarrow \underset{\text{(sodium acetate)}}{NaC_2H_3O_{2(aq)}} + \underset{\text{(water)}}{H_2O_{(l)}} + \underset{\text{(carbon dioxide)}}{CO_{2(g)}}$$

Breaking Chemical Bonds

Chemical bonds are forces that cause a group of atoms to behave as a unit. Energy is stored in these bonds. To break the bonds energy must be added. When bonds form, energy is released. All chemical reactions involve energy being absorbed ENDOTHERMIC**,** or released EXOTHERMIC. Photosynthesis is an endothermic reaction, because it needs light energy to occur, whereas combustion is an exothermic reaction, because it gives off light and heat.

Topic 8 Reaction Rate

The speed of a chemical reaction is called the **reaction rate**.

- **Temperature** of the reactants affects the rate of all reactions (The higher the temperature the faster the reaction rate)
- **Surface Area** of the reactants affects the reaction rate (The more surface in contact, the faster the reaction rate)
- **Concentration** of the reactants affects the reaction rate. (The higher the concentration, the faster the reaction rate)
- **The presence of a Catalyst** affects the reaction rate

Speeding Up a Reaction With Catalysts

A catalyst is a substance that help a reaction proceed faster and are not consumed in the reaction. Types of reactions involving catalysts can be found in living and non-living things. Enzymes are natural catalysts that help in the reactions in the body, which break down food. They also get rid of poison in the body. *Catalase* (an enzyme found in plant and animal cells) speeds up the breaking down of hydrogen peroxide into harmless oxygen and water.

Slowing Down a Reaction With Inhibitors

Inhibitors are substances that slow down chemical reactions. Plants have natural inhibitors in their seeds to prevent germination until the right conditions are present. Inhibitors are added to foods to slow down their decomposition.

Corrosion

Corrosion is a slow chemical change that occurs when oxygen in the air reacts with a metal. Corrosion is a chemical reaction in which the metal is decomposed (eaten away), when it reacts with other substances in the environment. The corrosion of iron is called '*rusting*'.

Many metals can corrode. The green roofs of the parliament buildings are an example of corrosion. The red-brown copper color is replaced with the green color because copper corrodes. Gold does not corrode. Solid solutions of metals (alloys) resist corrosion.

Preventing Corrosion

Corrosion protection (e.g. painting the metal) involves protecting metal from contact with the environment and the factors that affect the reaction rate of this chemical reaction. Coating a corrosive metal with a thin layer of zinc is called galvanization. The process of coating a corrosive metal with another metal through electrolysis (review p.110) is called electroplating.

Combustion

Combustion is the highly exothermic combination of a substance with oxygen. Combustion requires heat, oxygen, and fuel.

Products of Combustion

The burning of propane (C_3H_8) in a barbeque is an exothermic reaction that produces heat to cook the food. If the heat is too intense, the products being cooked will be changed into pure carbon (the meat will be burnt). The products of combustion are not always beneficial. Burning fossil fuels (such as propane) produces carbon monoxide, carbon dioxide, sulfur oxides, nitrogen oxides, smoke, soot, ash and heat. Some of these products are pollutants which will be covered in more detail in Environmental Chemistry – Unit C.

$$\begin{array}{ccccccccc} & & H & & H & & H & & \\ & & | & & | & & | & & \\ H & - & C & - & C & - & C & - & H \\ & & | & & | & & | & & \\ & & H & & H & & H & & \end{array} \qquad (\text{ Propane } C_3H_8 \text{ })$$