Grade 7 Science

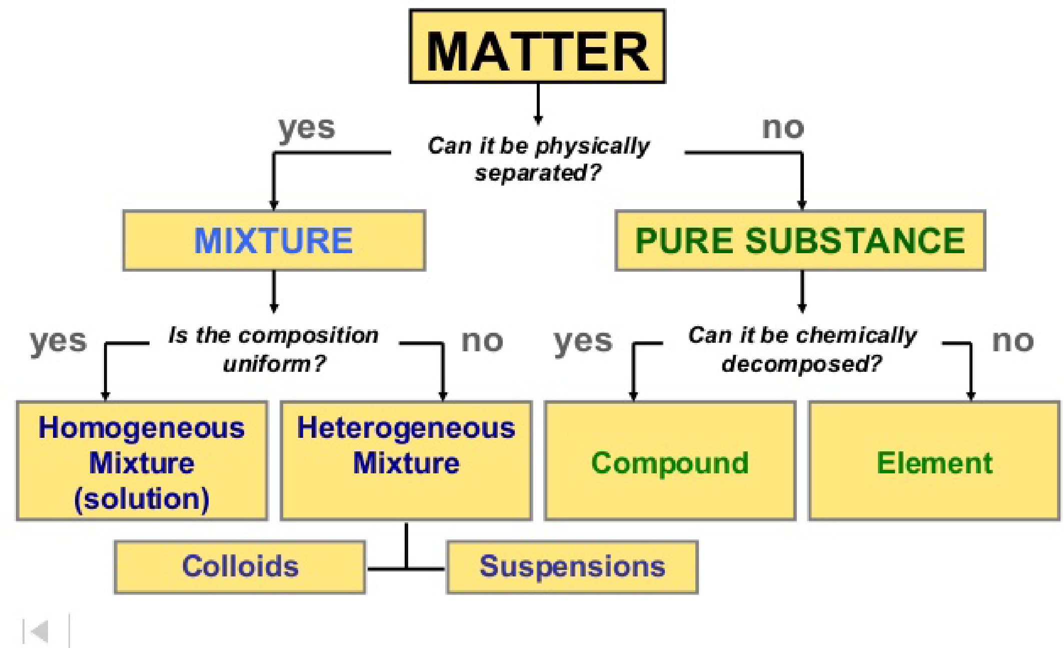
Week of November 2 – November 6

<u>Pure Substances</u>

Welcome to grade 7 Chemistry!

Chemistry is the study of matter. **Matter** is anything that has mass and takes up space.

The image below shows the classification of matter. In Grade 7, we will focus on pure substances (elements and compounds).



Courtesy Christy Johannesson www.nisd.net/communicationsarts/pages/chem

In past grades you have learned about some of the following big ideas.

- Everyday materials that you interact with are made of matter.
- Matter has useful properties. For example, solids keep their shape and liquids and gases flow.
- Materials can be changed physically and chemically.
- Matter is made of particles called atoms.
- Matter has mass and takes up space.
- Matter has different phases (solids, liquids and gases).
- Matter can change phase.
- Solutions are homogeneous mixtures.
- Everyday materials are often mixtures.

What is an Atom?

Watch this video to learn about what an atom is: https://youtu.be/R1RMV5qhwyE

How Pure Substances are Different from Mixtures

Most of the substances that we know of are made of two or more elements, for example, water, salt, carbon dioxide, and baking soda. It is possible for these substances to exist because atoms of different elements can link with each other. As you already know, there are 115 or more elements. These can combine to make millions and millions of different substances.

The formula for water, H_2O is probably the most well known of all chemical formulas.

Before starting this lesson, be sure to have a copy of the periodic table "of the elements" available.

The dominant feature of a mixture is that it has a variable composition, this means that it does not always have the same amounts of each ingredient. For example, soup has variable composition, even if it is taken from the same pot. Your dish may contain more noodles than someone else's, or today's soup may be saltier than yesterday's. Hence, soup is a mixture. On the other hand, pure water (a pure substance) is not a mixture because its composition never varies; 18 g of H_2O **always** contains 2 g of hydrogen atoms and 16 g of oxygen atoms.

A pure substance is always made up of the exact same amounts of the same ingredients.

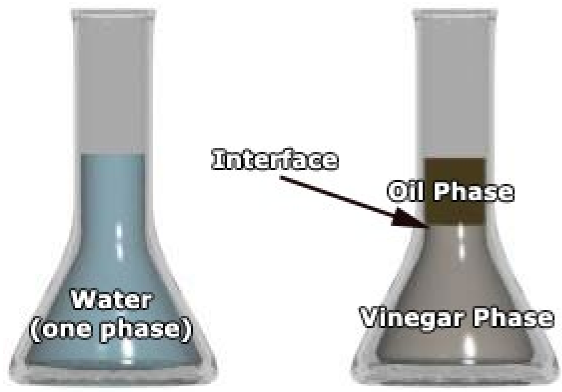
A mixed substance always has different amounts of the same things.

Because these types of substances are different, there are many noticeable differences between them. They can be seen in the table below.

Pure Substance	Mixture
Has constant physical properties. (Color, odor, density, melting point, boiling point, etc.)	Has variable physical properties.
Has constant chemical properties. (reactivity, toxicity, kindling temperature, etc.)	Has variable chemical properties.
Can be described by a formula. (H_2O, $C_{12}H_{22}O_{11}$, etc.)	Can be described only by a recipe. (salad dressing = 3 parts oil, 1 part vinegar, etc.)
Are chemically combined so that individual component properties are "lost" in compounds. (CuS is neither copper in color nor yellow.)	Are physically combined so that individual components retain their properties. (Oil and vinegar in the dressing can be detected by eye, nose, and tongue.)
Are chemically combined. (You need a chemical reaction to separate them)	Are physically combined, or mixed together. (You could use a filter to separate them)
Are homogeneous and so exhibit one phase. (all liquid, all gas, or all solid).	May be homogeneous (solutions) or heterogeneous (mechanical mixture). If heterogeneous, it may have several phases, like salad dressing (some liquid, some solid)

*Homogeneous** means it looks like it is made of one thing. For example, soda looks it is made up of one thing, but we know it is made up of water, sugar, and flavor and more. Remember, this could be either a pure substance OR a mixture.

*Heterogeneous** means that the substance looks like it is made of a mixture of things. For example, breakfast cereal we can see the differences between the milk and the cereal so it is heterogeneous. This is a mixture.

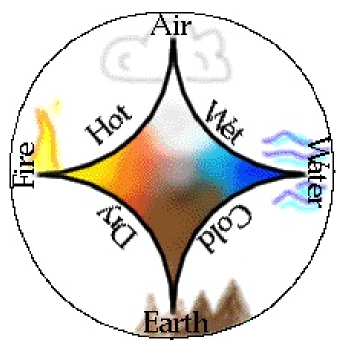


Pure Substance vs Mixture

One can usually differentiate between pure substances and mixtures by asking the question, "Does this substance come in more than one form (apart from solid, liquid, and gas)?" If the answer is "yes," then the substance is generally a mixture. Ink, for instance, can be purchased in various colours, viscosities (thick for ball-point pens, thin for fountain pens), and peculiarities (washable).

Pause for a moment and consider the various forms of matter which you eat, drink, breathe, wear, or use during a typical day. Are they pure substances or mixtures? Do they come in more than one form?

History of Elements



Different philosophers had different ideas about what substance made up of all of the other substances. Thales suggested water; Anaximenes proposed air; and Heraclitus argued for fire. Empedocles thought earth. Empedocles combined all of these ideas by suggesting the existence of four elements: water, air, fire, and earth.

This idea was proposed over 2 400 years ago, and it was based on the observations and logic of the philosophers. It can be easy to relate their ideas to chemistry today if we translate the philosopher's elements into gas (air), liquid (water), solid (earth), and energy (fire).

Aristotle, perhaps the greatest Greek philosopher, agreed with Empedocles' four terrestrial elements (water, air, fire, earth) and suggested a fifth element, called ether, for the heavenly bodies. Aristotle agreed with the idea that anything on earth could be made by different combinations of the four terrestrial elements.

Robert Boyle suggested that the term element should be applied only to matter which could not be broken down into simpler substances. This idea enabled chemists to discover simpler substances, also known as elements. In 1814 Jons Jakob Berzelius (1779-1848) introduced the modern system of written chemical symbols. By that time 46 elements had been identified and the four original Aristotelian elements were no longer in use.

Names of Elements

In chemistry, elements are represented by symbols. This is a quicker way of describing things. It is also a way that scientists around the world—speaking different languages—can understand each other.

The symbols are based on the elements' names in Latin. Although it might seem strange to use Latin sixteen hundred years after the Empire ended, most early scientists used Latin to describe their work, and it has been convenient to keep the names they gave to elements. Below are some interesting examples of elements and their Latin names.

Notice the first two elements on this list. They are quite easy to remember, as the Latin word is much like the English word. The others are harder, and just have to be memorized. Most students find that they learn **chemical symbols** gradually as they use them and become more familiar with them. If you find a symbol you don't know while taking the course, or if you are asked to use a symbol and can't remember it, look it up on your periodic table.

Element	Latin Name	Meaning	Symbol
carbon	carbo	coal	C
lithium	lithos	stone	Li
silver	argent	silver	Ag
gold	aurum	gold	Au
copper	cuprum	cyprian	Cu
mercury	hydragyrum	liquid silver	Hg
potassium	kalium	potash	K
lead	plumbum	lead	Pb

You should have noticed that some symbols have one capital letter only: C for *carbo* (carbon), and K for *kalium* (potassium). This is because they are the only elements with a Latin name beginning with that letter. The others have two letters, a capital letter and a lowercase letter. The capital letter is the first letter of the element's name in Latin, and the lowercase letter is usually the second letter in the Latin name. Two examples are Au for *aurum* (gold) and Cu for *cuprum* (copper).

Sometimes there are two elements with the same first two letters, like argon and argent (silver). In that case, a different lowercase letter must be used for one of the elements. Argon is Ar and argent (silver) is Ag.

The table below has more information to help you to become familiar with the symbols and the history of many of the elements. Certain elements in the list below have been marked with an asterisk (*). These elements are common and ones you may know already. You will progress more quickly in Chemistry if you memorize some names and symbols. However, you can always look up the symbols on a periodic table - even when you write chemistry tests!

Element	**Symbol**	**Origin**	**Discovery**
Actinium	Ac	Greek, aktis (ray)	1899
*Aluminum	Al	Latin, alumen (astringent)	1825
Americium	Am	for America (discovered there)	1944
Antimony	Sb	Latin, stibium (mark)	1450
Argon	Ar	Greek, argos (inactive)	1894
Arsenic	As	Greek, arsenikon (bold)	1250
Astatine	At	Greek, astatos (unstable)	1940
Barium	Ba	Greek, barys (heavy)	1808
Berkelium	Bk	for Berkeley, Calif.	1949
Beryllium	Be	from mineral beryl	1798
*Bismuth	Bi	Germany weisse Masse (white mass)	1450
Bohrium	Bh	after Niels Bohr (Danish physisist)	1981
Boron	B	Persian, burah (white)	1808
*Bromine	Br	Greek, bromos (stench)	1826
Cadmium	Cd	Latin, cadmia (calamine mineral)	1817
*Calcium	Ca	Latin, calcis (lime)	1808
Californium	Cf	for the state of California	1950
*Carbon	C	Latin, carbo (coal)	B.C.
Cerium	Ce	for asteroid Ceres	1803
Cesium	Cs	Latin, caesius (sky blue)	1860
*Chlorine	Cl	Greek, chloros (greenish-yellow)	1774

Chromium	Cr	Greek, chroma (colour)	1797
Cobalt	Co	German, Kobold (goblin)	1735
*Copper	Cu	Latin, Cuprum (island of Cyprus)	B.C.
Curium	Cm	for Pierre and Marie Curie	1944
Dubnium	Db	after Dubna, USSR	1967
Dysprosium	Dy	Greek, dysprositos, hard to get at	1886
Einsteinium	Es	for Albert Einstein	1952
Erbium	Er	for Ytterby, Sweden	1842
Europium	Eu	for Europe	1890
Fermium	Fm	for Enrico Fermi	1952
*Fluorine	F	Latin/Fr. fluere, flow or flux	1886
Francium	Fr	for France	1939
Gadolinium	Gd	from mineral gadolinite	1880
Gallium	Ga	Latin, Gallia, France	1875
Germanium	Ge	Latin, Germania, Germany	1886
Gold	Au	Latin, aurum, shining dawn	B.C.
Hafnium	Hf	Latin, Hafnia, Copenhagen	1923
Hassium	Hs	Latin Hassias for German state "Hess"	1984
*Helium	He	Greek, helios, the Sun	1895
Holmium	Ho	Latin, Holmia, Stockholm	1878
*Hydrogen	H	Greek, hydrogenes, water-forming	1766
Indium	In	for indigo spectral line	1863
*Iodine	I	Greek, iodes (violet)	1811
Iridium	Ir	Latin, iridis (rainbow)	1804
*Iron	Fe	Latin, ferrum (iron)	B.C.

Krypton	Kr	Greek, kryptos (hidden)	1898
Lanthanum	La	Greek, lanthanein (concealed)	1839
Lawrencium	Lr	for Ernest 0. Lawrence	1961
*Lead	Pb	Latin, plumbum (lead)	B.C.
*Lithium	Li	Greek, lithos (stone)	1817
Lutetium	Lu	Latin, Lutetia (Paris)	1907
*Magnesiun	Mg	Latin, Magnesia Key (place in Thessaly)	1808
*Manganese	Mn	Latin, magnes (magnet)	1774
Meitnerium	Mt	for Lise Meitner (Austrian physisist.)	1982
Mendelevium	Md	for Dmitri Mendeleev	1955
*Mercury	Hg	Latin, hydrargyrum (liquid silver)	B.C.
Molybdenum	MD	Greek, molybdos (lead)	1782
Meodymium	Nd	Greek, neosdidymo s (new twin)	1885
*Neon	Ne	Greek, neos (new)	1898
Neptuniun	Np	for the planet	1940
*Nickel	Ni	German, nickel (devil)	1751
Niobium	Nb	for Niobe (Greek god)	1801
*Nitrogen	N	Greek, nitro genes (native soda-born)	1772
Nobelium	No	for Alfred Nobel	1958
Osmium	Os	Greek, osme (smell)	1804
*Oxygen	O	Greek, oxygen (sharp born)	1774
Palladium	Pd	for planetoid Pallas	1803
*Phosphorus	P	Greek, phosphoros (light bringer)	1669
Platinum	Pt	Spanish, plata (silver)	1735
Plutonium	Pu	for planet Pluto	1940
Polonium	Po	for Poland	1898

*Potassium	K	Latin, Kalium (potash)	1807
Praseodymium	Pr	Greek, praseos (leek green)	1885
Promethium	Pm	for Prometheus	1945
Protactinium	Pa	Greek, protos-actinium (first actinium)	1913
*Radium	Ra	Latin, radius (ray)	1898
Radon	Rn	from Radium	1900
Rhenium	Re	Latin, Rhenus (Rhine)	1925
Rhodium	Rh	Greek, rhodon (rose)	1803
Rubidium	Rb	Latin, rubidus (red)	1861
Ruthenium	Ru	Latin, Ruthenia (Russia)	1845
Rutherfordium	Rf	for Rutherford	1964
Samarium	Sm	for mineral samarskite	1879
Scandium	Sc	for Scandinavia	1876
Seaborgium	Sg	for Seaborg (American nuclear scientist)	1974
Selenium	Se	Greek, selene (moon)	1817
*Silicon	Si	Latin, silex (flint)	1823
*Silver	Ag	Latin, argentum (silver)	B.C.
*Sodium	Na	Latin, natrium (soda)	1807
Strontium	Sr	for Strontian, Scotland	1808
*Sulfur	S	Latin, sulfur	B.C.
Tantalum	Ta	for Tantalus, Greek god	1802
Technetium	Tc	Greek, technetos (artificial)	1937
Tellurium	Te	Latin, tellus (earth)	1782
Terbium	Th	for Ytterby, Sweden	1843
Thallium	Tl	Greek, thallos (young shoot)	1861
Thorium	Th	for Thor, Swedish god	1828

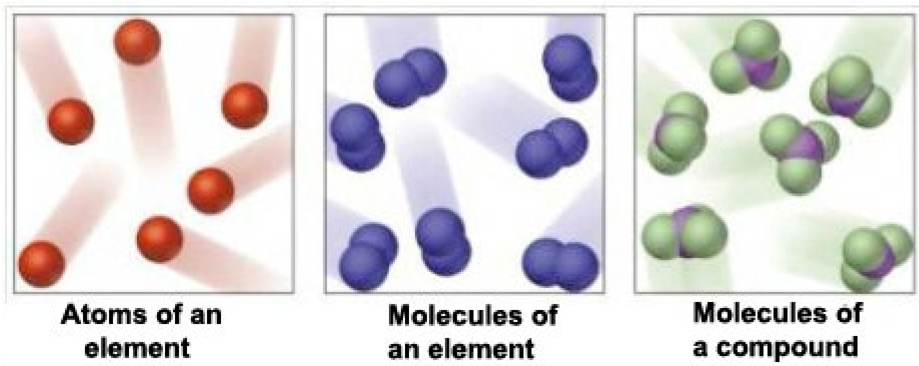
Thulium	Tm	Latin, Thule (Scandinavia)	1879
*Tin	Sn	Latin, stannum (tin)	B.C.
Titanium	Ti	for Titans, Greek gods	1791
Tungsten	W	from mineral wolframite	1783
*Uranium	U	for planet Uranus	1789
Vanadium	V	for Vanadis, Scandinavian goddess	1801
Xenon	Xe	Greek, xenos (strange)	1898
Ytterbium	Yb	for Ytterby, Sweden	1907
Yttrium	Y	for Ytterby, Sweden	1794
*Zinc	Zn	German, Zink (Zinc)	B.C.
Zirconium	Zr	Arabian, zerk (precious stone)	1789
110	Ds	Darmstadtium	1994
111	Rg	Roentgenium	1994
112	Cn	Copernicium	1996
114	Nh	Nihonium	1998
116	Fl	Flerovium	2000
118	Og	Oganesson	

Element or a Compound?

Elements and compounds are pure chemical substances found in nature. You can identify a pure substance as an element or compound by looking at the atoms.

An element is made of one type of atom. Examples of elements include iron, copper, hydrogen, oxygen and all other elements on the periodic table. Each element on the periodic table has a unique atomic number that identifies it.

A compound is made of two or more different elements and so it has two or more different types of atoms. The atoms in a compound are always found in the same proportions. For example the compound water always has two hydrogen atoms and one oxygen atom as shown by the formula (H2O) while table salt or sodium chloride always has one sodium atom and one chlorine atom as shown by the formula (NaCl).



Elements

As you know, everything around you is made up of matter. Most matter is made up of two or more kinds of atoms. Some matter is made up of only one kind of atom. Matter that is made up of only one kind of atom is called an element. An element is a simple substance that cannot be broken down into simpler substances, they can be found on the periodic table.

- Click here for a full list and description of the elements.

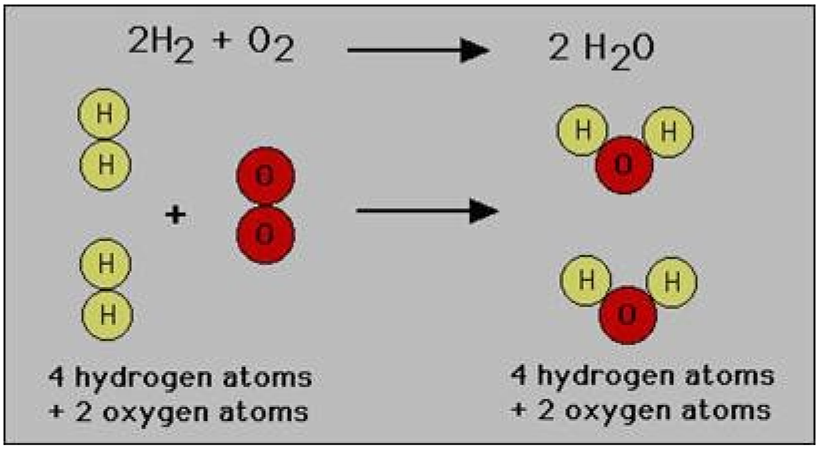
Did You Know...?

Your body is made up of many elements: oxygen (0), carbon (C), hydrogen (H), nitrogen (N), calcium (Ca), phosphorus (P), potassium (K), sulfur (S), sodium (Na), magnesium (Mg), copper (Cu), zinc (Zn), selenium (Se), molybdenum (Mo), fluorine (F), chlorine (Cl), iodine (I), manganese (Mn), cobalt (Co), iron (Fe), lithium (Li), strontium (Sr), aluminum (Al), silicon (Si), lead (Pb), vanadium (V), arsenic (As), and bromine (Br).

Compounds

A **compound** is a pure substance made of two or more different elements joined together. The elements in the compound lose their own properties. The compound now has new or different properties.

For example, water is made of hydrogen gas (a clear gas) and oxygen gas (also a clear gas). The two gases join together to make water, a clear liquid.



Compounds have different properties than the elements that they are made from.

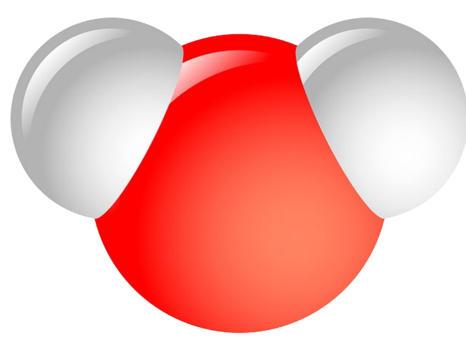
A Molecule of an Element and a Molecule of a Compound are shown below.

Molecules

Molecules are particles made up of two or more atoms. These molecules can be elements with the same atoms or compounds with different atoms. The atoms join or bond together in different ways to create different types of molecules. Just as letters combine to make words, atoms combine to make molecules.

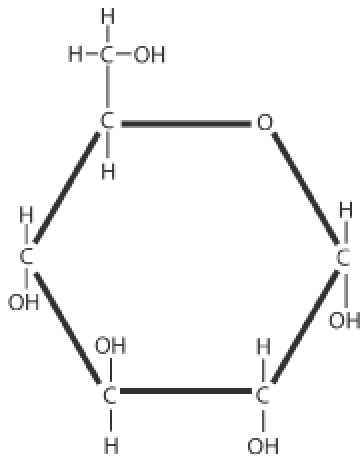
A molecule of water

A glass of water contains millions of molecules of water. One molecule of water contains three atoms: 1 oxygen and 2 hydrogen atoms.

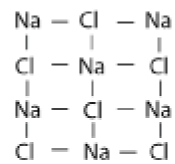


Sugar and Salt Molecules

Have you wondered why sugar and salt look the same yet they taste so different? This is due to the different atoms that combine to make their molecules.



sugar molecule



salt molecule

Early the concept that all matter is made up of atoms was introduced. In this lesson, you will learn that all ***molecules*** are made up of arrangements of atoms too.

How to Count Atoms in a Formula

This video shows how to find the total number of oxygen atoms if you are given a simple chemical formula, a formula containing brackets, or a formula with a coefficient written in front: https://youtu.be/ruVeO0Ukh-E

PERIODIC TABLE OF THE ELEMENTS

METALS ← | → NON-METALS

	22 4+ 3+ **Ti** Titanium 47.9
Atomic Number →	22
Symbol →	Ti
Name →	Titanium
Atomic Mass →	47.9
Ion charge(s) ←	4+ 3+

1 + **H** Hydrogen 1.0																1 – **H** Hydrogen 1.0	2 0 **He** Helium 4.0
3 + **Li** Lithium 6.9	4 2+ **Be** Beryllium 9.0											5 **B** Boron 10.8	6 **C** Carbon 12.0	7 3– **N** Nitrogen 14.0	8 2– **O** Oxygen 16.0	9 – **F** Fluorine 19.0	10 0 **Ne** Neon 20.2
11 + **Na** Sodium 23.0	12 2+ **Mg** Magnesium 24.3											13 3+ **Al** Aluminum 27.0	14 **Si** Silicon 28.1	15 3– **P** Phosphorus 31.0	16 2– **S** Sulphur 32.1	17 – **Cl** Chlorine 35.5	18 0 **Ar** Argon 39.9
19 + **K** Potassium 39.1	20 2+ **Ca** Calcium 40.1	21 3+ **Sc** Scandium 45.0	22 4+ 3+ **Ti** Titanium 47.9	23 5+ 4+ **V** Vanadium 50.9	24 3+ 2+ **Cr** Chromium 52.0	25 2+ 3+ 4+ **Mn** Manganese 54.9	26 3+ 2+ **Fe** Iron 55.8	27 2+ 3+ **Co** Cobalt 58.9	28 2+ 3+ **Ni** Nickel 58.7	29 2+ 1+ **Cu** Copper 63.5	30 2+ **Zn** Zinc 65.4	31 3+ **Ga** Gallium 69.7	32 4+ **Ge** Germanium 72.6	33 3– **As** Arsenic 74.9	34 2– **Se** Selenium 79.0	35 – **Br** Bromine 79.9	36 0 **Kr** Krypton 83.8
37 + **Rb** Rubidium 85.5	38 2+ **Sr** Strontium 87.6	39 3+ **Y** Yttrium 88.9	40 4+ **Zr** Zirconium 91.2	41 3+ 5+ **Nb** Niobium 92.9	42 2+ 3+ **Mo** Molybdenum 95.9	43 7+ **Tc** Technetium (98)	44 3+ 4+ **Ru** Ruthenium 101.1	45 3+ 4+ **Rh** Rhodium 102.9	46 2+ 4+ **Pd** Palladium 106.4	47 1+ **Ag** Silver 107.9	48 2+ **Cd** Cadmium 112.4	49 3+ **In** Indium 114.8	50 4+ 2+ **Sn** Tin 118.7	51 3+ 5+ **Sb** Antimony 121.8	52 2– **Te** Tellurium 127.6	53 – **I** Iodine 126.9	54 0 **Xe** Xenon 131.3
55 + **Cs** Cesium 132.9	56 2+ **Ba** Barium 137.3	57 3+ **La** Lanthanum 138.9	72 4+ **Hf** Hafnium 178.5	73 5+ **Ta** Tantalum 180.9	74 6+ **W** Tungsten 183.8	75 4+ 7+ **Re** Rhenium 186.2	76 3+ 4+ **Os** Osmium 190.2	77 3+ 4+ **Ir** Iridium 192.2	78 4+ 2+ **Pt** Platinum 195.1	79 3+ 1+ **Au** Gold 197.0	80 2+ 1+ **Hg** Mercury 200.6	81 1+ 3+ **Tl** Thallium 204.4	82 2+ 4+ **Pb** Lead 207.2	83 3+ 5+ **Bi** Bismuth 209.0	84 2+ 4+ **Po** Polonium (209)	85 – **At** Astatine (210)	86 0 **Rn** Radon (222)
87 + **Fr** Francium (223)	88 2+ **Ra** Radium (226)	89 3+ **Ac** Actinium (227)	104 **Rf** Rutherfordium (261)	105 **Db** Dubnium (262)	106 **Sg** Seaborgium (263)	107 **Bh** Bohrium (262)	108 **Hs** Hassium (265)	109 **Mt** Meitnerium (266)								Halogens	Noble Gases
Alkali Metals	Alkaline Earth Metals																

58 3+ 4+ **Ce** Cerium 140.1	59 3+ 4+ **Pr** Praseodymium 140.9	60 3+ **Nd** Neodymium 144.2	61 3+ **Pm** Promethium (145)	62 3+ 4+ **Sm** Samarium 150.4	63 3+ 2+ **Eu** Europium 152.0	64 3+ **Gd** Gadolinium 157.3	65 3+ 4+ **Tb** Terbium 158.9	66 3+ **Dy** Dysprosium 162.5	67 3+ **Ho** Holmium 164.9	68 3+ **Er** Erbium 167.3	69 3+ 2+ **Tm** Thulium 168.9	70 3+ 2+ **Yb** Ytterbium 173.0	71 3+ **Lu** Lutetium 175.0
90 4+ **Th** Thorium 232.0	91 5+ 4+ **Pa** Protactinium 231.0	92 6+ 4+ 5+ **U** Uranium 238.0	93 5+ 3+ 4+ 6+ **Np** Neptunium (237)	94 4+ 6+ 3+ 5+ **Pu** Plutonium (244)	95 3+ 4+ 5+ 6+ **Am** Americium (243)	96 3+ **Cm** Curium (247)	97 3+ 4+ **Bk** Berkelium (247)	98 3+ **Cf** Californium (251)	99 3+ **Es** Einsteinium (252)	100 3+ **Fm** Fermium (257)	101 2+ 3+ **Md** Mendelevium (258)	102 2+ 3+ **No** Nobelium (259)	103 3+ **Lr** Lawrencium (262)

Based on mass of C-12 at 12.00.

Any value in parentheses is the mass of the most stable or best known isotope for elements which do not occur naturally.

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Chemistry ~ Learning Guide Name: ________________

Instructions:

Using a pencil, complete the following notes as you work through the related lessons. Show ALL work as is explained in the lessons. Do your best and ask questions if you don't understand anything!

Pure Substances

1. List four ways pure substances are different from mixtures.

2. What were the four original elements proposed by the Greeks? What was the fifth element suggested by Aristotle?

3. Identify the correct element – symbol pairs below by giving them a check mark. For any that are incorrect please underline them and correct the symbol.
    a. Hydrogen –H.
    b. Helium – He.
    c. Boron – Bo.
    d. Carbon – Ca.
    e. Oxygen – O.
    f. Fluorine – F.
    g. Sodium – S.
    h. Aluminum – Al.
    i. Chlorine – Cl.
    j. Potassium – P.
    k. Titanium – Ti.
    l. Iron – Fe.
    m. Copper – Co.
    n. Arsenic – As.
    o. Krypton – K.

4. Write a summary of the rules for finding a symbol for an element.

5. Suggest a name and a symbol for your home town or city. Find a name and a symbol for an element named after you.

6. Suppose you are lucky enough to have a Gold ring. Is this Gold best described as an atom or an element?

7. What are the two types of pure substances? Include any differences and similarities.

8. Construct a pure substances concept map that includes definitions for atom, molecule, element and compound.

9. Classify each substance below as an element or a compound.

Pure Substance	Element or Compound
Mercury liquid.	
Carbon Dioxide gas.	
Water.	
Iron.	
Table Salt.	
Silver.	
Hydrogen gas.	
Methane gas.	

10. Fill in the blanks for the following table given the information provided. compound, formula, elements, number of each atom.

Compound	Formula	Element or Compound	Number of each atom
Oxygen gas	O_2		
Hydrochloric acid	HCl		
Copper (II) Sulphate	$CuSO_4$		
Table Sugar (Sucrose)	$C_{12}H_{22}O_{11}$		
	Au		
Table Salt (Sodium Chloride)			
	CO_2		
	Es		

11. Molecules in air table, nitrogen gas 78%, oxygen gas 21%, carbon dioxide gas 0.03%, water vapour - varies, argon gas – 1%. Table name, formula, element or compound, molecule or atom, number of atoms.

Component of Air	Formula	Element or Compound	Molecule or Atom	Number of Atoms
Nitrogen 78%	N_2			
Oxygen 21%	O_2			
Water vapour – up to 6%				
Argon				
Carbon Dioxide 0.03%				