

Unit 1: Chemistry (4.1)

SNC2DP



**Chapter 4: Developing
Chemical Equations**

**Chapter 5: Classifying
Chemical Reactions**

**Chapter 6: Acids and
Bases**

Developing Chemical Equations

In this chapter, you will investigate how to:

- *identify, name, and write the formulas of ionic and molecular compounds*
- *write and **balance** chemical equations*
- *describe how balanced chemical equations demonstrate the Law of Conservation of Mass*

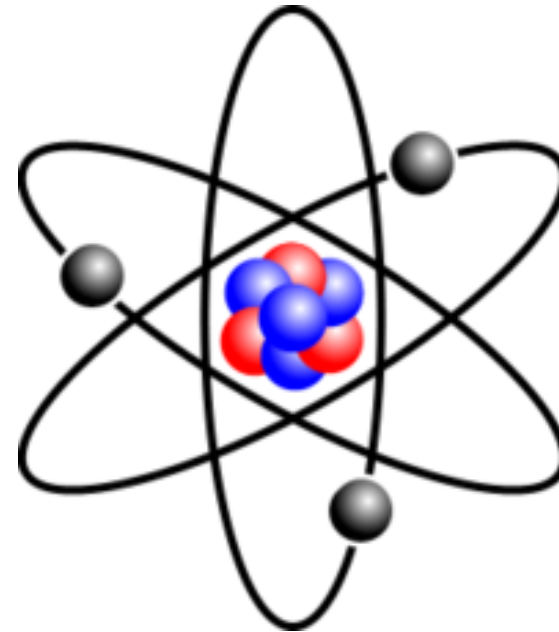
Atoms and their Subatomic Particles

All matter is composed of extremely small particles called **atoms** which is the smallest unit of any given element.

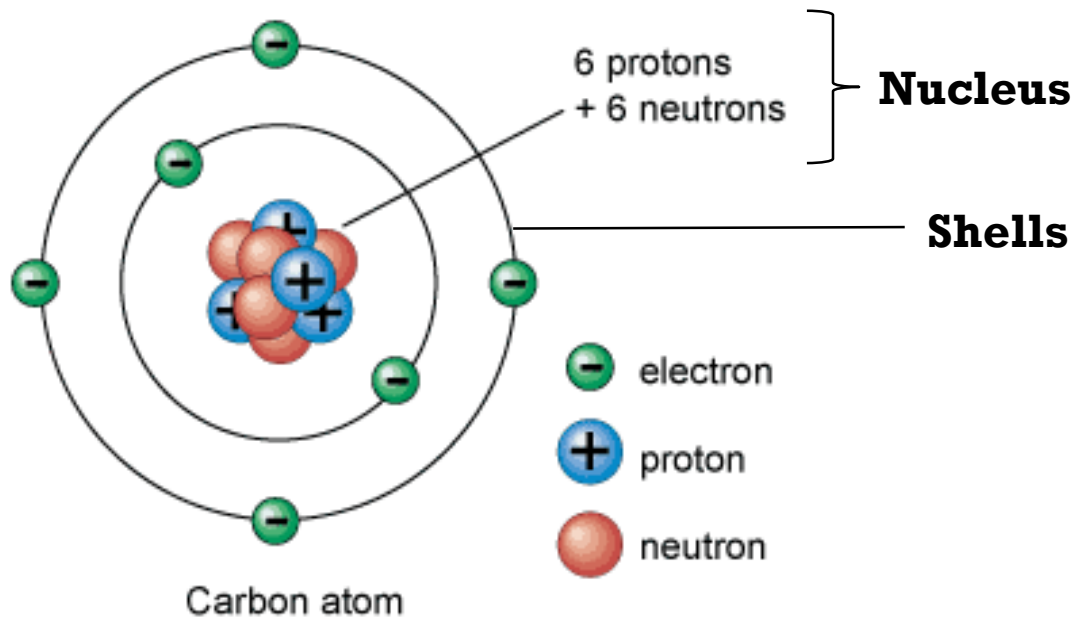
Every atom has the same basic structure:

Subatomic Particles:

- _____ and _____
- Orbiting cloud of _____



Atoms and their Subatomic Particles

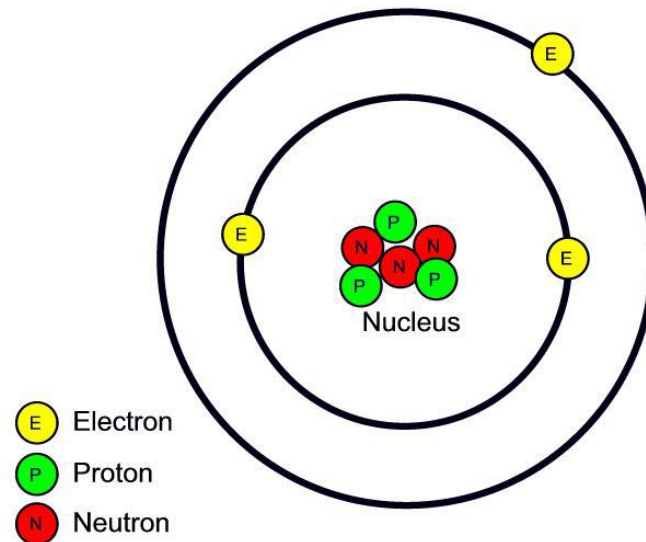


Subatomic Particles

Subatomic Particle	Charge	Weight
Neutron (n^0)	_____	1.7×10^{-24} g
Proton (p^+)	_____	1.7×10^{-24} g
Electron (e^-)	_____	0

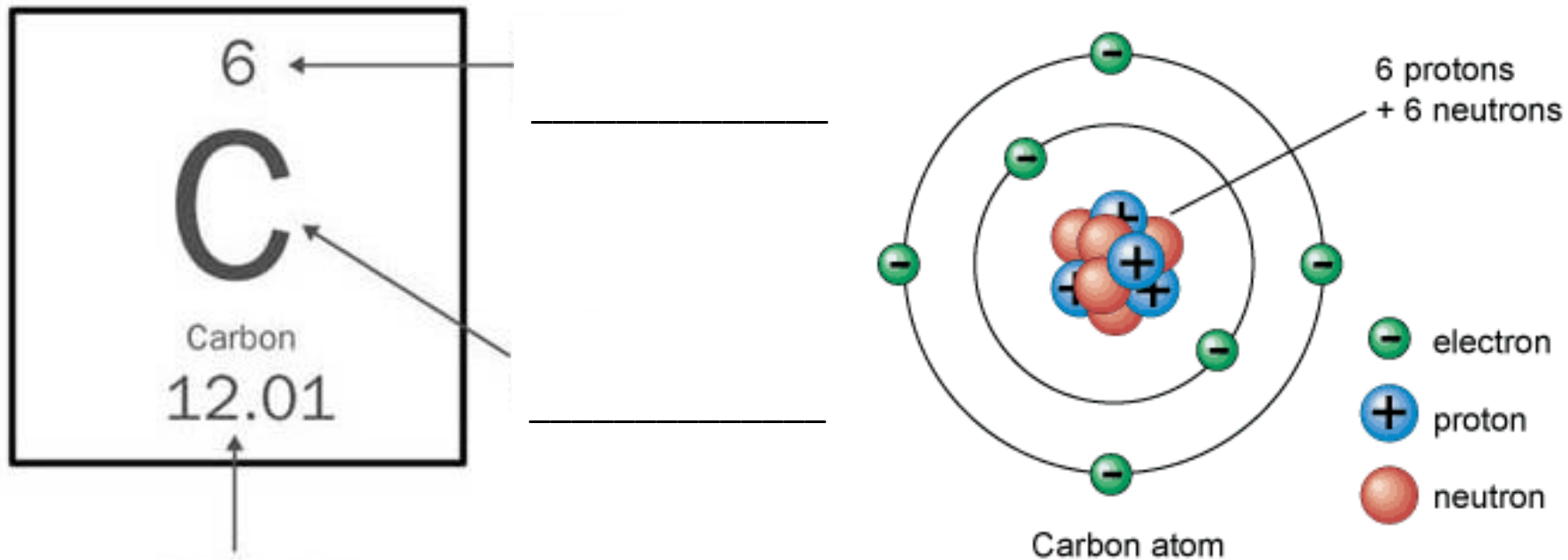
Atoms and their Subatomic Particles

- Neutrons and protons are packed together to form a dense core known as the '_____'
- _____ move at the speed of light around the nucleus in a different orbital.



Elements and Periodic Table

Each element has a symbol associated with it that is recognized worldwide.



Periodic Table

Groups or Families (1-18)

hydrogen 1 H 1.0079																	helium 2 He 4.0026
lithium 3 Li 6.941	beryllium 4 Be 9.0122											boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305											aluminum 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29
caesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 *	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]
francium 87 Fr [223]	radium 88 Ra [226]	89-102 * *	lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [269]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	ununilium 110 Uun [271]	unununium 111 Uuu [272]	ununbium 112 Uub [277]	ununquadium 114 Uuq [289]				

Periods
(1-7)

* Lanthanide series

lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
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** Actinide series

actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]
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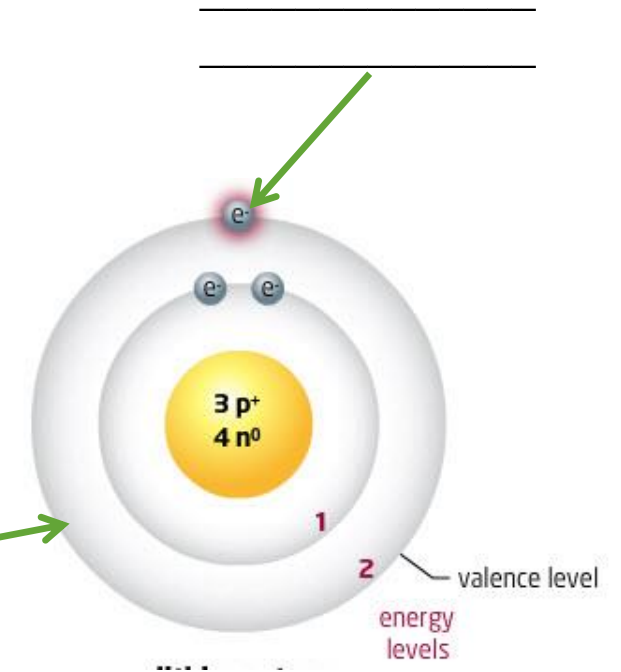
Periodic Table

The **periodic table** is arranged so that elements in the same **group (family)** have the same number of _____.

1									18
1	H								He
2	Li	Be	B	C	N	O	F	Ne	
3	Na	Mg	Al	Si	P	S	Cl	Ar	

Valence electrons are electrons occupying the outermost occupied energy level (electron shell).

outermost (valence) energy level



Periodic Table - METALS



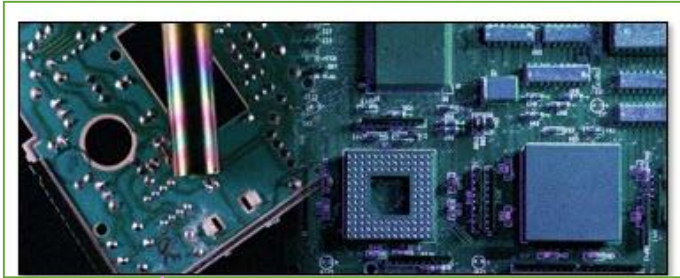
Properties of Metals:

- Good conductors of _____ and _____
- Lustrous
- Almost all are _____
- Malleable
- Ductile

1 1A	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	18 8A																												
1 H												13 Al	14 Si	15 P	16 S	17 Cl	18 Ar																												
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne																												
11 Na	12 Mg	3 Sc	4 Ti	5 V	6 Cr	7 Mn	8 Fe	9 Co	10 Ni	11 Cu	12 Zn	13 Ga	14 Ge	15 As	16 Se	17 Br	18 Kr																												
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr																												
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe																												
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn																												
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Uub	(113) Uuq	(114) Uuq	(115) Uuh	(116) Uuh	(117) Uuo	118 Uuo																												
Metals Metalloids Nonmetals																																													
<table border="1"> <tr> <td>58 Ce</td> <td>59 Pr</td> <td>60 Nd</td> <td>61 Pm</td> <td>62 Sm</td> <td>63 Eu</td> <td>64 Gd</td> <td>65 Tb</td> <td>66 Dy</td> <td>67 Ho</td> <td>68 Er</td> <td>69 Tm</td> <td>70 Yb</td> <td>71 Lu</td> </tr> <tr> <td>90 Th</td> <td>91 Pa</td> <td>92 U</td> <td>93 Np</td> <td>94 Pu</td> <td>95 Am</td> <td>96 Cm</td> <td>97 Bk</td> <td>98 Cf</td> <td>99 Es</td> <td>100 Fm</td> <td>101 Md</td> <td>102 No</td> <td>103 Lr</td> </tr> </table>																		58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr
58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu																																
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr																																
<table border="1"> <tr> <td>11 Na</td> <td colspan="17"></td> </tr> </table>																		11 Na																											
11 Na																																													

Examples: Gold, Aluminum, Silver, Copper, and Sodium

Periodic Table – METALLOIDS



1 1A	2 2A												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
H	He												B	C	N	O	F	Ne
Li	Be												Al	Si	P	S	Cl	Ar
11 Na	12 Mg	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9	10	11 1B	12 2B	13 3B	14 4B	15 5B	16 6B	17 7B	18 8B	
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr	
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe	
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn	
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Uub	(113)	114 Uuq	(115)	116 Uuh	(117)	118 Uuo	
			58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu		
			90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr		

Metalloids have properties of both _____ and _____.

They can be metallic or non-metallic, malleable or non-malleable.

Semiconductors normally will not conduct electricity.

Examples: Boron, Silicon, Arsenic, and Antimony

Periodic Table of the Elements

1 IA 1A																	18 VIIIA 8A
1 H Hydrogen 1.008	2 IIA 2A											13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VII B 7B	8 VIII 8	9 VIII 8	10 VIII 8	11 IB 1B	12 IIB 2B	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 83.798
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.711	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.294
55 Cs Cesium 132.905	56 Ba Barium 137.328	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.085	79 Au Gold 196.967	80 Hg Mercury 200.592	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [278]	110 Ds Darmstadtium [281]	111 Rg Roentgenium [280]	112 Cn Copernicium [285]	113 Nh Nihonium [286]	114 Fl Flerovium [289]	115 Mc Moscovium [289]	116 Lv Livermorium [293]	117 Ts Tennessine [294]	118 Og Oganesson [294]

Lanthanide Series	57 La Lanthanum 138.905	58 Ce Cerium 140.116	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.243	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.055	71 Lu Lutetium 174.967
Actinide Series	89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]

Bohr-Rutherford Diagram

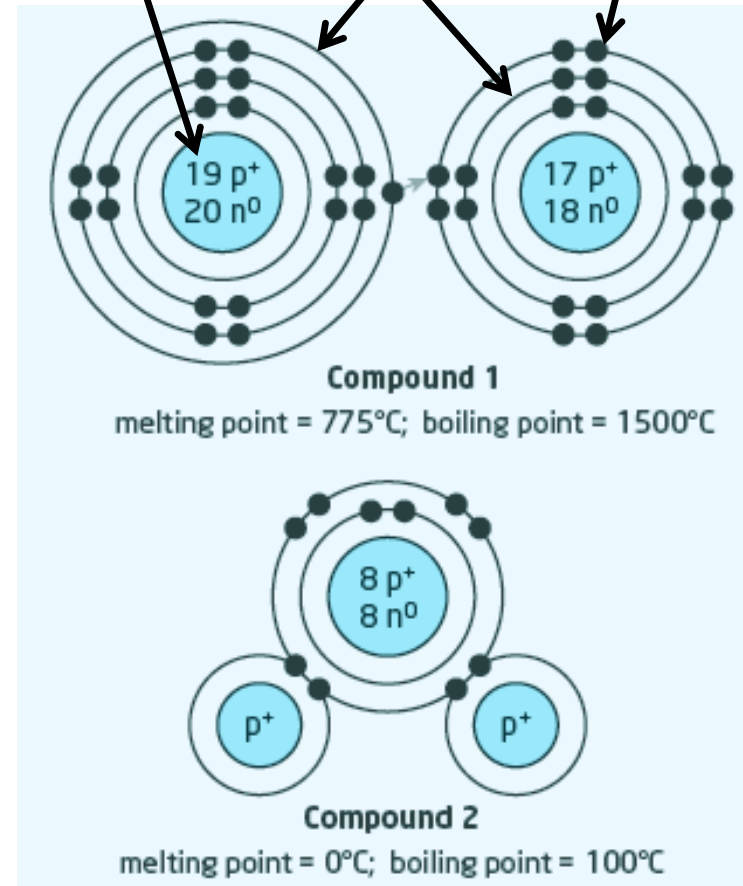
Bohr-Rutherford diagrams illustrate the structure of atoms.

- _____: shown as a solid circle at the centre of the atom.
- _____ and _____: written inside the nucleus.
- _____: place dots () in the appropriate **orbital** or **energy level** around the nucleus.

Nucleus (*with **proton** and **neutron** numbers*)

orbitals

electron



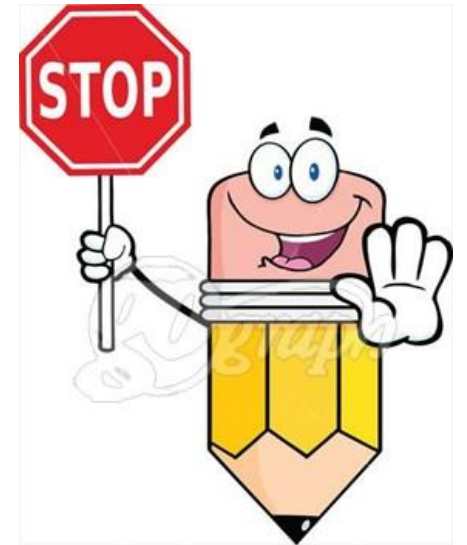
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Draw the Bohr-Rutherford Diagram for the following atoms:

A) Aluminum

B) Magnesium

C) Oxygen



Chemical Reactions

What conditions are required for a chemical reaction to occur?

How do you know if a chemical reaction has occurred?

What evidence might indicate that a chemical reaction has occurred?

Will mass change during a chemical reaction?

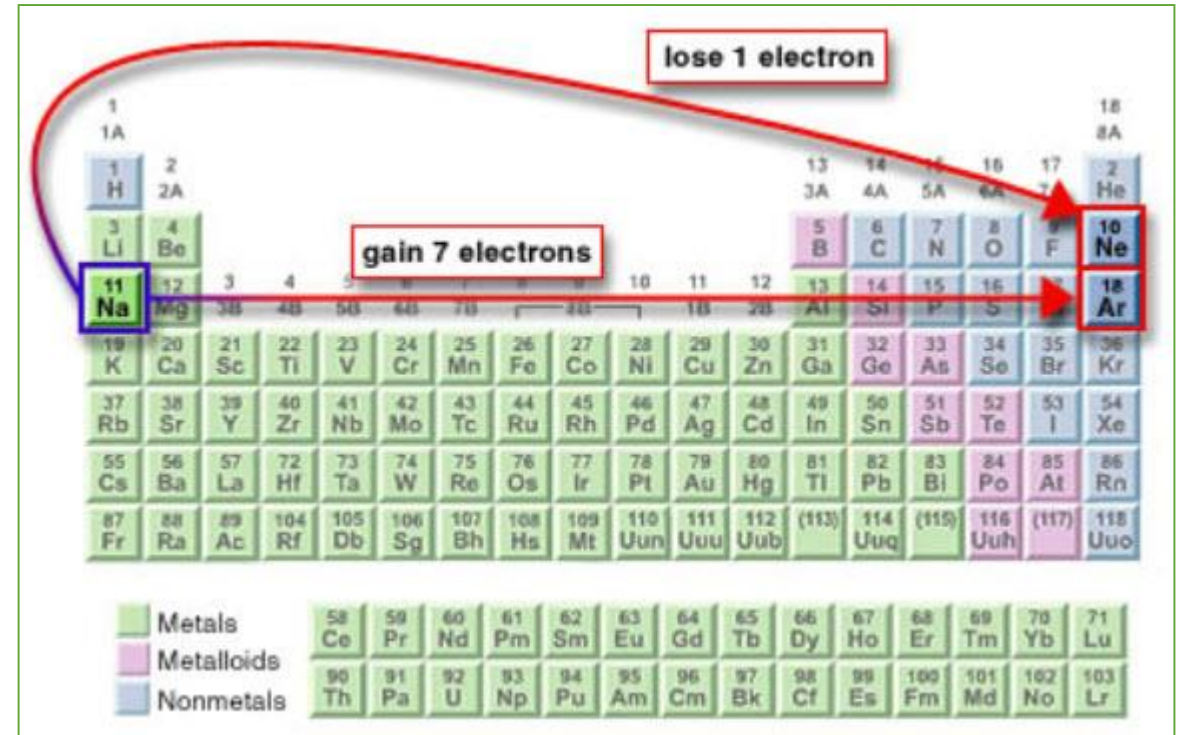


Reactions require the right conditions in order to occur.

Ionic Compounds

Ionic compounds:

- **Non-metals** gain electrons from the **metal**. (_____)
- **Metals** lose (or lend) electrons to the **non-metal**. (_____)



Naming Ionic Compounds

Binary ionic compounds are composed of only two different elements, a **metal cation** and a ***non-metal anion***.

Rules for Naming Binary Ionic Compounds:

1. The first name is **ALWAYS** the _____ (positive ion)
2. The second name is **ALWAYS** the _____ (negative ion).
 - The suffix of the second name must be replaced with _____.

Examples: Binary Ionic Compounds

Name the following Ionic Compounds:

1. magnesium and phosphorus:

2. sodium and chlorine:

3. calcium and bromine:

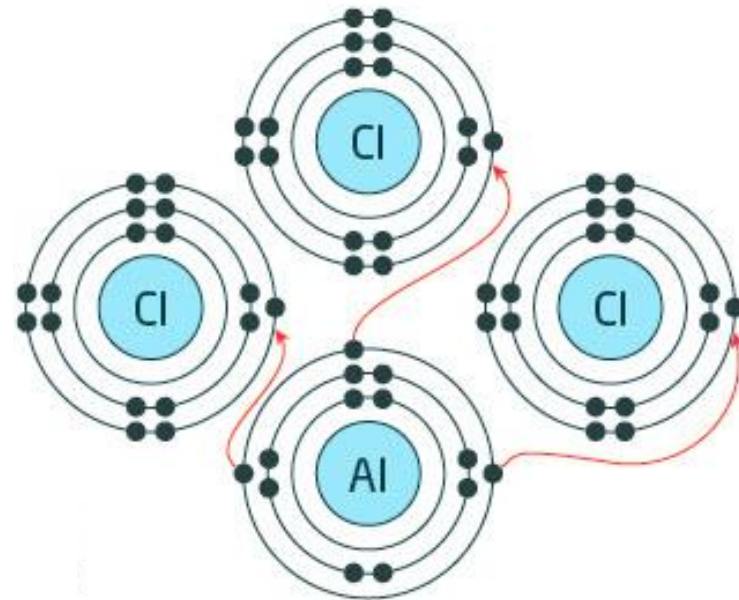
Table 4.1 Examples of Names of Non-Metal Ions

Name	Symbol
fluoride	F ⁻
chloride	Cl ⁻
oxide	O ²⁻
sulfide	S ²⁻
nitride	N ³⁻
phosphide	P ³⁻

Binary Ionic Compounds

Binary ionic compounds form when electrons are transferred from a metal to a non-metal.

The metal can only give up its electrons if there are enough non-metal atoms to receive them.



electrons lost by
aluminum (3) = electrons gained
by **chlorine (3)**

Example of Ionic Compounds

Using Bohr-Rutherford diagrams, illustrate the reaction between the following metals and non-metals:

1. sodium and chlorine:

2. lithium and bromine:

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Write the names of the following binary ionic compounds:



Chemical Formula for Binary Ionic Compounds

Rules for Method 1 (Neutralization of Charges):

The charges of the cation and anion must be _____.

1. Identify the charge of each ion.
2. Determine the total positive charge and negative charge that will cause the ions to neutralize.
3. Use subscripts to show the ratio of ions needed for neutralization.

Determine the chemical formula for the following ionic compounds:

a) **Aluminum Fluoride:**

b) **Magnesium Nitride:**

Chemical Formula for Binary Ionic Compounds

Rules for Method 2 (Cross-over Method):

1. Determine the charge of each ion.
2. Cross-over the amount of charge for each ion. (The charge will become a subscript)
3. Express the subscripts in simplest form.

Determine the chemical formula for the following ionic compounds:

a) magnesium chloride:

b) calcium oxide

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Write the chemical formula for each binary ionic compound:

**You may use any of the two methods*

A) potassium sulfide

B) lithium selenide

C) zinc oxide



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Show how the total charge of the following compounds is zero:

**Use method 1*

A) sodium oxide

B) lithium nitride

C) aluminum iodide



Multivalent Metals

Multivalent metals are metals with more than one _____. These elements can form different ions depending on the chemical reaction they undergo.



Copper (I) Oxide (contains Cu^{1+})

Copper (II) Oxide (contains Cu^{2+})

4		5		6		7		8		9		10		11		12		Aluminum 27.0	
22 Ti Titanium 47.9	4+ 3+	23 V Vanadium 50.9	5+ 4+	24 Cr Chromium 52.0	3+ 2+	25 Mn Manganese 54.9	2+ 3+ 4+	26 Fe Iron 55.8	3+ 2+	27 Co Cobalt 58.9	2+ 3+	28 Ni Nickel 58.7	2+ 3+	29 Cu Copper 63.5	2+ 1+	30 Zn Zinc 65.4	2+	31 Ga Gallium 69.7	3+
40 Zr Zirconium 91.2	4+	41 Nb Niobium 92.9	3+ 5+	42 Mo Molybdenum 95.9	2+ 3+	43 Tc Technetium (98)	7+	44 Ru Ruthenium 101.1	3+ 4+	45 Rh Rhodium 102.9	3+ 4+	46 Pd Palladium 106.4	2+ 4+	47 Ag Silver 107.9	1+	48 Cd Cadmium 112.4	2+	49 In Indium 114.8	3+
72 Hf Hafnium 178.5	4+	73 Ta Tantalum 180.9	5+	74 W Tungsten 183.8	6+	75 Re Rhenium 186.2	4+ 7+	76 Os Osmium 190.2	3+ 4+	77 Ir Iridium 192.2	3+ 4+	78 Pt Platinum 195.1	4+ 2+	79 Au Gold 197.0	3+ 1+	80 Hg Mercury 200.6	2+ 1+	81 Tl Thallium 204.4	1+ 3+

Multivalent metals are typically found in the middle of the periodic table between groups 4-12

Naming Multivalent Metals

Number	Roman Numeral
1	I
2	II
3	III
4	IV
5	V
6	VI
7	VII

Rules for Naming Multivalent Metals:

1. Identify the metal and non-metal.
2. Identify their charges by doing a reverse cross-over.
3. Verify the periodic table to determine the possible charges of the multivalent metal and the charge of the non-metal.
4. If the charge on the anion does not agree with the charge on the periodic table, determine the charge the metal must have to balance the anion.
5. Write the name of the metal with the charge in roman numerals within a bracket.
6. Write the name of the non-metal and change its suffix to -ide.

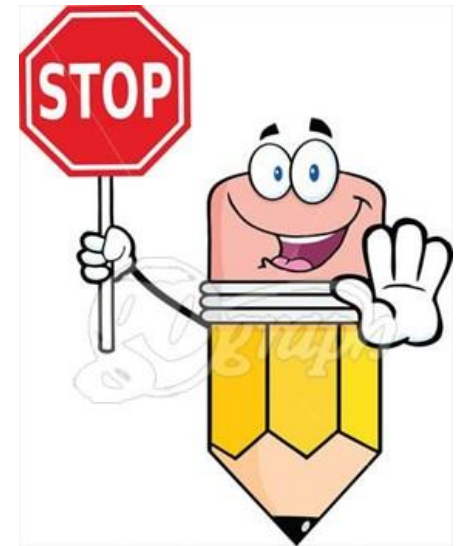
Example: Naming Multivalent Metals

Determine the chemical name for the following multivalent compounds:



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Name the following multivalent compounds:



Polyatomic Ions

Polyatomic ions are ions composed of more than one _____.
Polyatomic ions have distinct names.

Table 4.7 Common Polyatomic Ions

1+ Charge	3- Charge	2- Charge	1- Charge
<ul style="list-style-type: none">• ammonium, NH_4^+	<ul style="list-style-type: none">• phosphate, PO_4^{3-}• phosphite, PO_3^{3-}	<ul style="list-style-type: none">• carbonate, CO_3^{2-}• sulfate, SO_4^{2-}• sulfite, SO_3^{2-}• peroxide, O_2^{2-}	<ul style="list-style-type: none">• hydrogen carbonate (bicarbonate), HCO_3^-• hydroxide, OH^-• nitrate, NO_3^-• nitrite, NO_2^-• chlorate, ClO_3^-

_____a
re compounds composed of **three** different elements.
Whenever a **polyatomic ion** is involved in a reaction, a **ternary compound** is formed.

Chemical Formula for Polyatomic Ions

Rules for determining the chemical formula of tertiary compounds:

1. Determine the charge of the cation and anion.
2. Use the cross-over method to determine the number of ions for each ion. (i.e subscripts)
3. Place brackets around the polyatomic ion if its subscript is greater than 1.

Determine the chemical formula for the following tertiary compounds:

a) Aluminum carbonate:

b) Ammonium sulfate:

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Write the chemical formula for the following polyatomic ions:

A) ammonium chloride

B) calcium hydroxide

C) rubidium dichromate

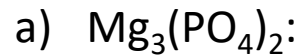


Naming Tertiary Compounds

Rules for naming tertiary compounds:

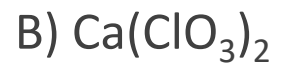
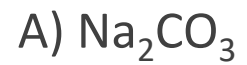
1. Determine the anion and cation.
2. Write the name of the cation first followed by the name of the anion.
3. If the anion is a polyatomic ion, DO NOT change its suffix. If the anion is not a polyatomic ion, change the suffix to -ide.

Name the tertiary compound below:



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Name the following polyatomic ions:



HOMework

Complete pg. 150 of your textbook.

