

13B Chemical Formulas

Why do atoms combine in certain ratios?

Chemists have long noticed that groups of elements behave similarly. The periodic table is an arrangement of the elements grouped according to similar behavior. In this investigation, you will discover how the arrangement of electrons in atoms is related to groups on the periodic table. You will also learn why atoms form chemical bonds with other atoms in certain ratios.

Materials

- Periodic Table Tiles
- Periodic table with oxidation numbers
- Special Bonds card

1 Oxidation numbers and ions

An element's oxidation number indicates how many electrons are lost or gained when chemical bonding occurs. The oxidation number is equal to the charge an atom has when it *ionizes*, that is, gains or loses electrons to become an *ion*. The partial periodic table below shows the most common oxidation numbers of the elements. The oxidation numbers are written above the group number above each column on the table. The most common oxidation numbers for the main group elements are shown.

Oxidation Numbers from the Periodic Table

NOTE: Many elements have more than one possible oxidation number.

1+																		3+		4+		3-		2-		1-																							
H 1 hydrogen	Li 3 lithium	Be 4 beryllium																	B 5 boron	C 6 carbon	N 7 nitrogen	O 8 oxygen	F 9 fluorine	Ne 10 neon																									
Na 11 sodium	Mg 12 magnesium																	Al 13 aluminum	Si 14 silicon	P 15 phosphorus	S 16 sulfur	Cl 17 chlorine	Ar 18 argon																										
K 19 potassium	Ca 20 calcium	Sc 21 scandium	Ti 22 titanium	V 23 vanadium	Cr 24 chromium	Mn 25 manganese	Fe 26 iron	Co 27 cobalt	Ni 28 nickel	Cu 29 copper	Zn 30 zinc	Ga 31 gallium	Ge 32 germanium	As 33 arsenic	Se 34 selenium	Br 35 bromine	Kr 36 krypton																																
Rb 37 rubidium	Sr 38 strontium	Y 39 yttrium	Zr 40 zirconium	Nb 41 niobium	Mo 42 molybdenum	Tc 43 technetium	Ru 44 ruthenium	Rh 45 rhodium	Pd 46 palladium	Ag 47 silver	Cd 48 cadmium	In 49 indium	Sn 50 tin	Sb 51 antimony	Te 52 tellurium	I 53 iodine	Xe 54 xenon																																
Cs 55 cesium	Ba 56 barium			Hf 72 hafnium	Ta 73 tantalum	W 74 tungsten	Re 75 rhenium	Os 76 osmium	Ir 77 iridium	Pt 78 platinum	Au 79 gold	Hg 80 mercury	Tl 81 thallium	Pb 82 lead	Bi 83 bismuth	Po 84 polonium	At 85 astatine	Rn 86 radon																															
Fr 87 francium	Ra 88 radium			Rf 104 rutherfordium	Db 105 dubnium	Sg 106 seaborgium	Bh 107 bohrium	Hs 108 hassium	Mt 109 meitnerium	Uun 110 ununnium	Uuu 111 ununium	Uub 112 unubium	Uuq 113 ununquadium	Uuq 114 ununquadium	Uus 115 ununseptium	Uuh 116 ununhexium	Uuo 117 ununoctium	Uu118 118 ununvigium																															
<table><tr><td>La 57 lanthanum</td><td>Ce 58 cerium</td><td>Pr 59 praseodymium</td><td>Nd 60 neodymium</td><td>Pm 61 promethium</td><td>Sm 62 samarium</td><td>Eu 63 europium</td><td>Gd 64 gadolinium</td><td>Tb 65 terbium</td><td>Dy 66 dysprosium</td><td>Ho 67 holmium</td><td>Er 68 erbium</td><td>Tm 69 thulium</td><td>Yb 70 ytterbium</td><td>Lu 71 lutetium</td></tr><tr><td>Ac 89 actinium</td><td>Th 90 thorium</td><td>Pa 91 protactinium</td><td>U 92 uranium</td><td>Np 93 neptunium</td><td>Pu 94 plutonium</td><td>Am 95 americium</td><td>Cm 96 curium</td><td>Bk 97 berkelium</td><td>Cf 98 californium</td><td>Es 99 einsteinium</td><td>Fm 100 fermium</td><td>Md 101 mendelevium</td><td>No 102 nobelium</td><td>Lr 103 lawrencium</td></tr></table>																				La 57 lanthanum	Ce 58 cerium	Pr 59 praseodymium	Nd 60 neodymium	Pm 61 promethium	Sm 62 samarium	Eu 63 europium	Gd 64 gadolinium	Tb 65 terbium	Dy 66 dysprosium	Ho 67 holmium	Er 68 erbium	Tm 69 thulium	Yb 70 ytterbium	Lu 71 lutetium	Ac 89 actinium	Th 90 thorium	Pa 91 protactinium	U 92 uranium	Np 93 neptunium	Pu 94 plutonium	Am 95 americium	Cm 96 curium	Bk 97 berkelium	Cf 98 californium	Es 99 einsteinium	Fm 100 fermium	Md 101 mendelevium	No 102 nobelium	Lr 103 lawrencium
La 57 lanthanum	Ce 58 cerium	Pr 59 praseodymium	Nd 60 neodymium	Pm 61 promethium	Sm 62 samarium	Eu 63 europium	Gd 64 gadolinium	Tb 65 terbium	Dy 66 dysprosium	Ho 67 holmium	Er 68 erbium	Tm 69 thulium	Yb 70 ytterbium	Lu 71 lutetium																																			
Ac 89 actinium	Th 90 thorium	Pa 91 protactinium	U 92 uranium	Np 93 neptunium	Pu 94 plutonium	Am 95 americium	Cm 96 curium	Bk 97 berkelium	Cf 98 californium	Es 99 einsteinium	Fm 100 fermium	Md 101 mendelevium	No 102 nobelium	Lr 103 lawrencium																																			

2 Stop and think

- a. Describe the groups on the periodic table according to their valence electrons.

- b. Why do elements in group 2 have an oxidation number of 2+?

- c. Why do elements in group 17 have an oxidation number of 1-?

- d. Why do the oxidation numbers in the first two groups tend to be positive?

3 Predicting chemical formulas

A binary compound is composed of two different elements. Predict the chemical formulas for the binary compounds that are made up of the pairs of elements in the table below. Use the following steps:

1. Using the periodic table on the previous page, determine the ion formed by each element.
2. Figure out how many periodic table tiles of each element will be needed to make the compound electrically neutral.

3. Form the compound with your tiles and write the chemical formula for each compound based on the number of tiles of each element.

Table 1: Writing chemical formulas for binary compounds

Element 1	Element 2	Oxidation number 1	Oxidation number 2	Number of tiles of element 1	Number of tiles of element 2	Chemical formula
hydrogen	fluorine					
magnesium	sulfur					
calcium	bromine					
aluminum	oxygen					
potassium	chlorine					
lithium	argon					
rubidium	sulfur					

4 Naming compounds

Naming binary ionic compounds is very simple if you follow these rules:

1. Write the name of the element with a positive oxidation number first.
2. Write the root name of the element with a negative oxidation number second. For example, *chlor-* is the root name of chlorine. Subtract the *-ine* ending.
3. Add the ending *-ide* to the root name. *Chlor-* becomes chloride.

Using these rules, write the name of each of the compounds in Table 1.
