

# **Ions and Ionic Compounds**

# Ionic and Molecular Compounds

Ionic compounds are usually formed between metals and nonmetals.

Molecular compounds are usually formed between two nonmetals.

# Ions

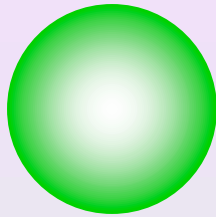
**When electrons are removed from or added to a neutral atom or molecule, a charged particle called an ion is formed.**

Positively charged ions are called  
**cations**

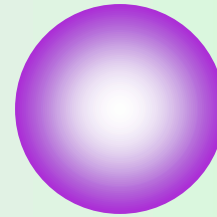
Negatively charged ions are called  
**anions**

# Atoms vs Ions

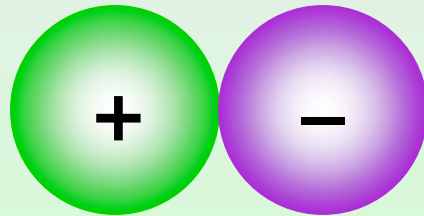
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Na: 11 protons;  
11 electrons



Cl: 17 protons;  
17 electrons



Na<sup>+</sup>: 11 protons;  
10 electrons

Cl<sup>-</sup>: 17 protons;  
18 electrons

# Ions

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positively charged: cations

most common type is metal cation

$\text{Na}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{Al}^{3+}$ ,  $\text{Fe}^{2+}$ ,  $\text{Fe}^{3+}$

negatively charged: anions

most common type is nonmetal anion

$\text{Cl}^-$ ,  $\text{O}^{2-}$

Li<sup>+</sup>, Mg<sup>2+</sup>

Na<sup>+</sup>, Ca<sup>2+</sup>

K<sup>+</sup>, Cs<sup>2+</sup>

Rb<sup>+</sup>, Sr<sup>2+</sup>

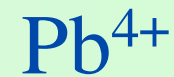
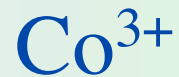
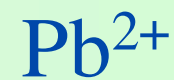
F<sup>-</sup>

Cl<sup>-</sup>

N<sup>3-</sup> O<sup>2-</sup> Br<sup>-</sup>

Al<sup>3+</sup> P<sup>3-</sup> S<sup>2-</sup> I<sup>-</sup>

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

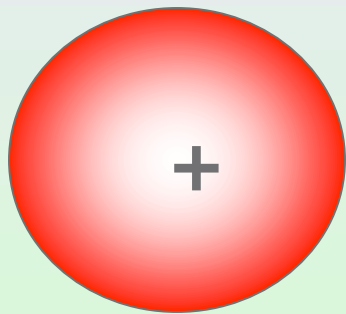


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Period																				
1	1 H																			2 He
2	3 Li	4 Be												5 B	6 C	7 N	8 O	9 F	10 Ne	
3	11 Na	12 Mg												13 Al	14 Si	15 P	16 S	17 Cl	18 Ar	
4	19 K	20 Ca		21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr	
5	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	
6	55 Cs	56 Ba	*	71 Lu	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	
7	87 Fr	88 Ra	**	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Uub	113 Uut	114 Uuq	115 Uup	116 Uuh	117 Uus	118 Uuo	
<b>lanthanides</b>			*	57 La	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			
<b>actinides</b>			**	89 Ac	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			

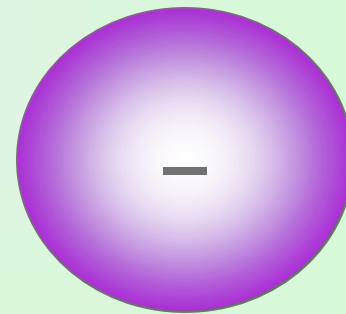
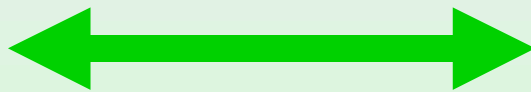
# Ionic Bonding

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electrostatic attraction between oppositely charged ions



cation



anion

# Ionic Compounds

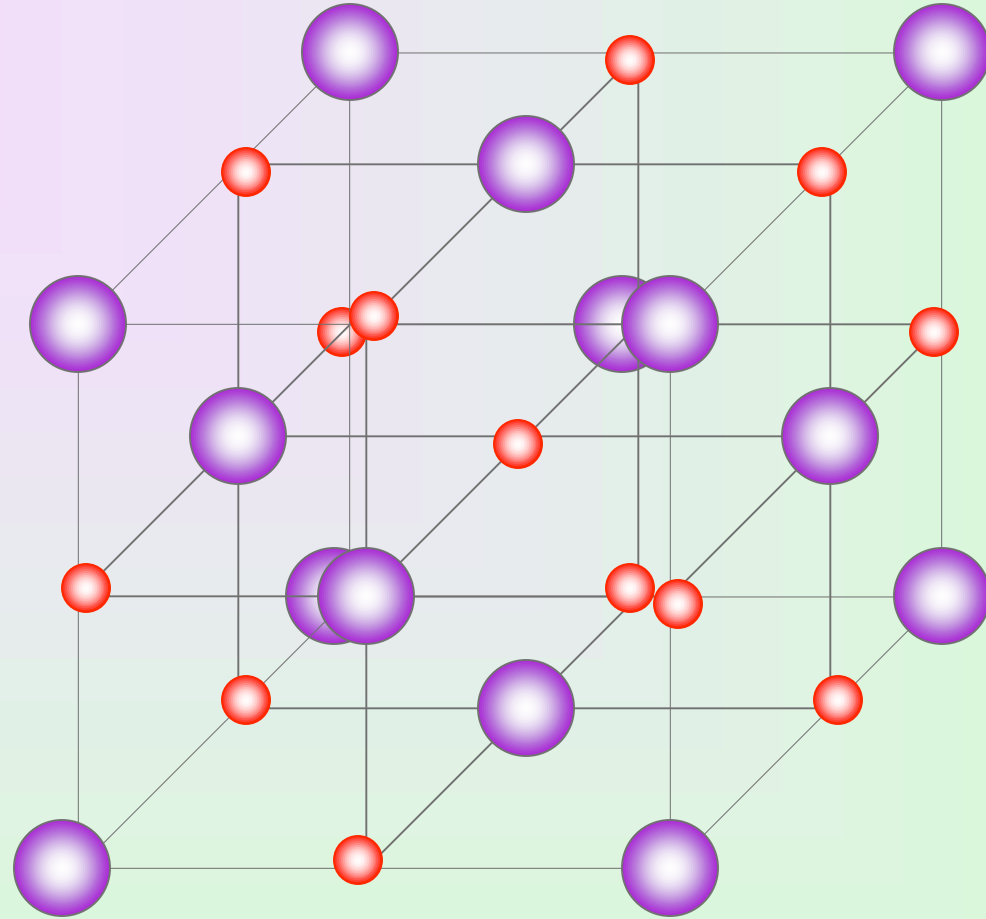
discrete molecules are not present, so ionic compounds are represented by their **empirical formulas**

some times referred to as **formula units**

# Chemical Formulas

Express the composition of molecules and ionic compounds in terms of the symbols for the elements they contain.

**Empirical formula** tells us which elements are present and the simplest whole-number ratio of their atoms.



**Structure of solid NaCl. In reality, the cations are in contact with the anions. The smaller spheres (red) represent Na<sup>+</sup> ions and the larger spheres (purple) the Cl<sup>-</sup> ions.**

**Molecules:  
Atoms in Combination**

## Definition

**Molecule** —is an aggregate of at least **two** atoms in a definite arrangement held together by chemical forces.

bonds



structure



A molecule is not necessarily a compound.

## Example



A compound is not necessarily molecular.

**ionic compounds**

## Molecular formula

shows the exact number of atoms of each element in the smallest unit of a substance

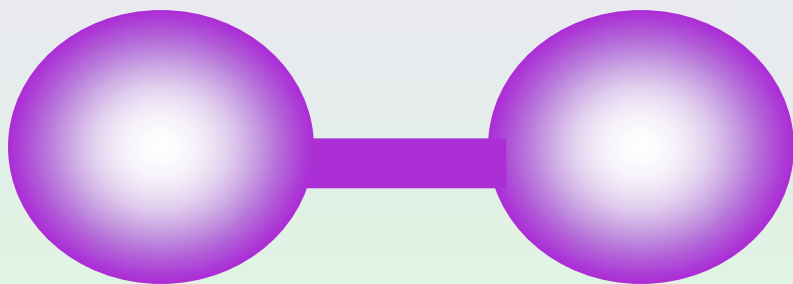
# Hydrogen

stable form of element is diatomic  
molecule  $H_2$

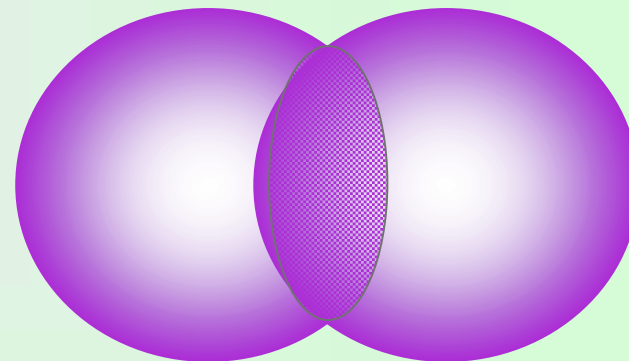
# Hydrogen

the stable form of the element is diatomic a molecule  $H_2$

The subscript indicates the number of atoms in the formula



ball-and-stick model

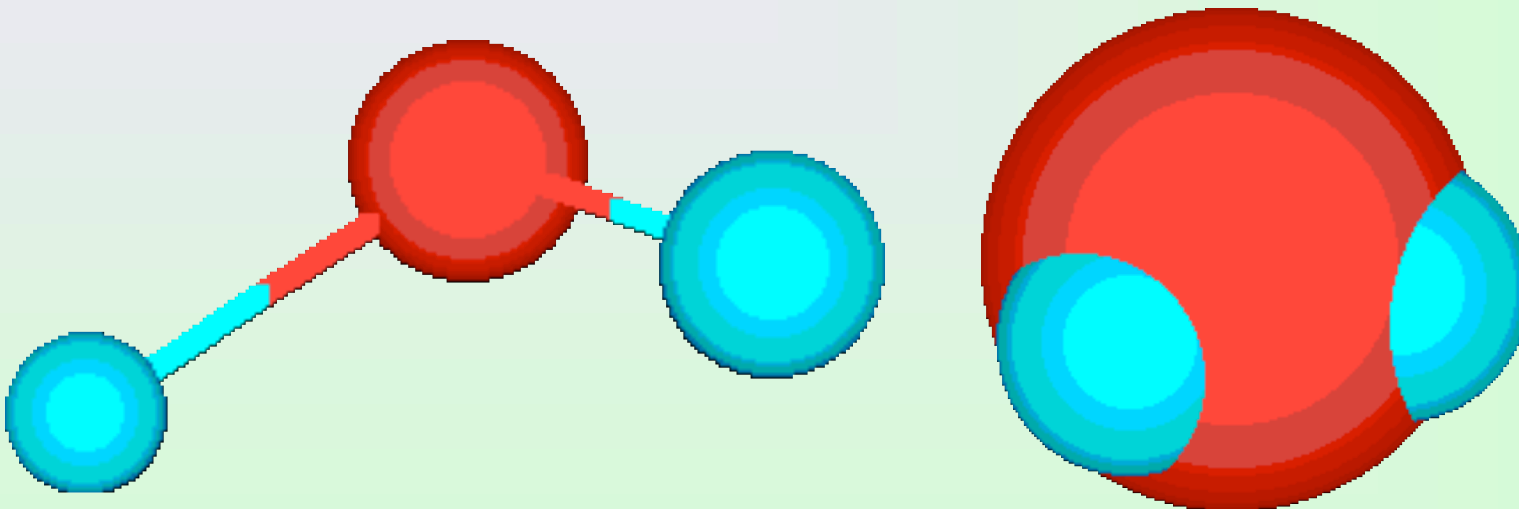


space-filling model

other diatomic elements include  
 $O_2$ ,  $N_2$ ,  $F_2$ ,  $Cl_2$ ,  $Br_2$ , and  $I_2$

# Water (H<sub>2</sub>O)

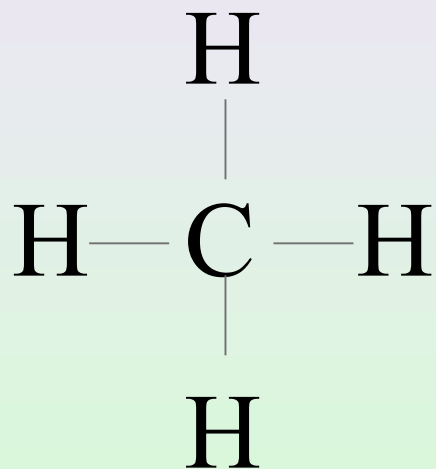
is a polyatomic molecule (contains three atoms connected in the order HOH).



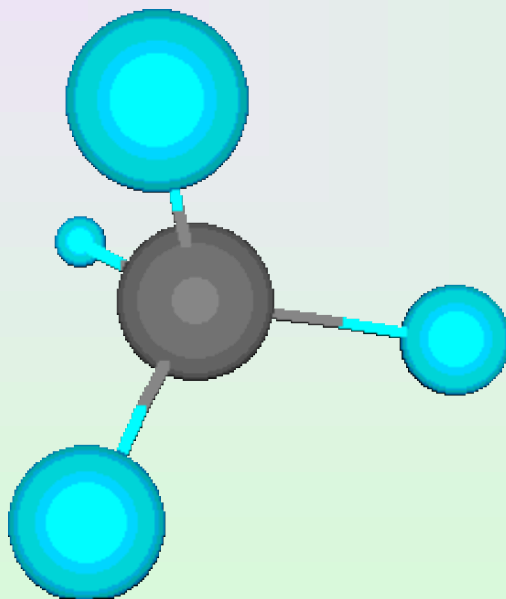
# Methane

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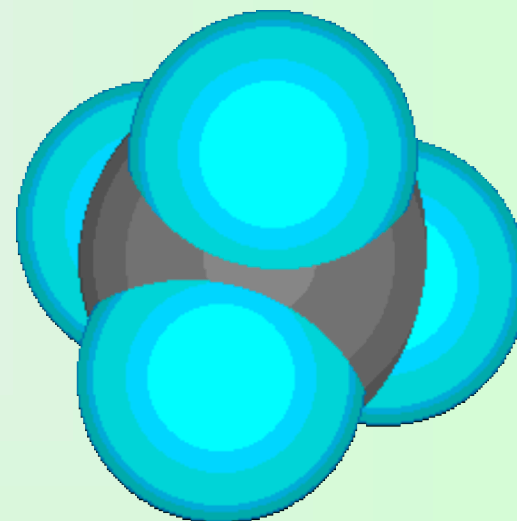
Molecular formula:  $\text{CH}_4$   
*shows the way in which the atoms are joined*



structural formula



ball-and-stick model



space-filling model

