

2. ATOMS, MOLECULES, AND IONS

2.5 The Periodic Table

2.7 Ions and Ionic Compounds



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The Periodic Table

1A 1	2A 2																		3A 13	4A 14	5A 15	6A 16	7A 17	8A 18
1 H																								2 He
2 Li	3 Be																							10 Ne
3 Na	4 Mg	3B 3	4B 4	5B 5	6B 6	7B 7	8B 8 9 10			1B 11	2B 12	13B 13	14B 14	15B 15	16B 16	17B 17	18B 18							18 Ar
4 K	5 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							36 Kr
5 Rb	6 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							54 Xe
6 Cs	7 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							86 Rn
7 Fr	8 Ra	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112	113	114	115	116									118

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
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

Metals (shaded yellow)

Metalloids (shaded purple)

Nonmetals (shaded green)

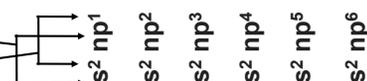


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$ns^1 ns^2$

Valence shell
Valence electrons



1A 1	2A 2																		3A 13	4A 14	5A 15	6A 16	7A 17	8A 18
1 H $1s^1$																								2 He $1s^2$
2 Li $2s^1$	3 Be $2s^2$																							10 Ne $2s^2 2p^6$
3 Na $3s^1$	4 Mg $3s^2$	3B 3	4B 4	5B 5	6B 6	7B 7	8B 8 9 10			1B 11	2B 12	13B 13	14B 14	15B 15	16B 16	17B 17	18B 18							18 Ar $3s^2 3p^6$
4 K $4s^1$	5 Ca $4s^2$	21 Sc $4s^2 3d^1$	22 Ti $4s^2 3d^2$	23 V $4s^2 3d^3$	24 Cr $4s^1 3d^5$	25 Mn $4s^2 3d^5$	26 Fe $4s^2 3d^6$	27 Co $4s^2 3d^7$	28 Ni $4s^2 3d^8$	29 Cu $4s^1 3d^9$	30 Zn $4s^2 3d^10$	31 Ga $4s^2 3d^10 4p^1$	32 Ge $4s^2 3d^10 4p^2$	33 As $4s^2 3d^10 4p^3$	34 Se $4s^2 3d^10 4p^4$	35 Br $4s^2 3d^10 4p^5$	36 Kr $4s^2 3d^10 4p^6$							36 Kr $4s^2 3d^10 4p^6$
5 Rb $5s^1$	6 Sr $5s^2$	39 Y $5s^2 4d^1$	40 Zr $5s^2 4d^2$	41 Nb $5s^2 4d^4$	42 Mo $5s^1 4d^5$	43 Tc $5s^2 4d^5$	44 Ru $5s^2 4d^6$	45 Rh $5s^1 4d^7$	46 Pd $5s^0 4d^9$	47 Ag $5s^1 4d^9$	48 Cd $5s^2 4d^10$	49 In $5s^2 4d^10 5p^1$	50 Sn $5s^2 4d^10 5p^2$	51 Sb $5s^2 4d^10 5p^3$	52 Te $5s^2 4d^10 5p^4$	53 I $5s^2 4d^10 5p^5$	54 Xe $5s^2 4d^10 5p^6$							54 Xe $5s^2 4d^10 5p^6$
6 Cs $6s^1$	7 Ba $6s^2$	57 La $6s^2 5d^1$	72 Hf $6s^2 5d^2$	73 Ta $6s^2 5d^3$	74 W $6s^2 5d^4$	75 Re $6s^2 5d^5$	76 Os $6s^2 5d^6$	77 Ir $6s^2 5d^7$	78 Pt $6s^1 5d^9$	79 Au $6s^1 5d^9$	80 Hg $6s^2 5d^10$	81 Tl $6s^2 5d^10 6p^1$	82 Pb $6s^2 5d^10 6p^2$	83 Bi $6s^2 5d^10 6p^3$	84 Po $6s^2 5d^10 6p^4$	85 At $6s^2 5d^10 6p^5$	86 Rn $6s^2 5d^10 6p^6$							86 Rn $6s^2 5d^10 6p^6$
7 Fr $7s^1$	8 Ra $7s^2$	89 Ac $7s^2 6d^1$	104 Rf $7s^2 6d^2$	105 Db $7s^2 6d^3$	106 Sg $7s^2 6d^4$	107 Bh $7s^2 6d^5$	108 Hs $7s^2 6d^6$	109 Mt $7s^2 6d^7$	110 Ds $7s^2 6d^8$	111 Rg $7s^2 6d^9$	112	(113)	114	(115)	116	(117)	(118)							

58 Ce $6s^2 4f^5d^1$	59 Pr $6s^2 4f^6$	60 Nd $6s^2 4f^7$	61 Pm $6s^2 4f^7$	62 Sm $6s^2 4f^6$	63 Eu $6s^2 4f^7$	64 Gd $6s^2 4f^7 5d^1$	65 Tb $6s^2 4f^9$	66 Dy $6s^2 4f^10$	67 Ho $6s^2 4f^11$	68 Er $6s^2 4f^12$	69 Tm $6s^2 4f^13$	70 Yb $6s^2 4f^14$	71 Lu $6s^2 4f^14 5d^1$
90 Th $7s^2 6d^2$	91 Pa $7s^2 5f^2 6d^1$	92 U $7s^2 5f^3 6d^1$	93 Np $7s^2 5f^4 6d^1$	94 Pu $7s^2 5f^6$	95 Am $7s^2 5f^7$	96 Cm $7s^2 5f^7 6d^1$	97 Bk $7s^2 5f^9$	98 Cf $7s^2 5f^10$	99 Es $7s^2 5f^11$	100 Fm $7s^2 5f^12$	101 Md $7s^2 5f^13$	102 No $7s^2 5f^14$	103 Lr $7s^2 5f^14 6d^1$

there is a repeating pattern of reactivity



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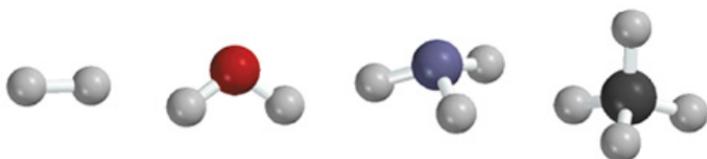
The Periodic Table

Atomic number	1	2	3	4	...	9	10	11	12	...	17	18	19	20	...
Symbol	H	He	Li	Be	...	F	Ne	Na	Mg	...	Cl	Ar	K	Ca	...
	Nonreactive gas	Nonreactive gas	Soft, reactive metal	Soft, reactive metal	...	Nonreactive gas	Nonreactive gas	Soft, reactive metal	Soft, reactive metal	...	Nonreactive gas	Nonreactive gas	Soft, reactive metal	Soft, reactive metal	...

Ions and Ionic Compounds

Molecule:

made from two or more atoms in a definite arrangement held together by chemical forces



H₂

H₂O

NH₃

CH₄



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Ions and Ionic Compounds

Diatomic Molecule:

contains only two atoms

H₂ N₂ HCl CO

Polyatomic Molecule:

contains more than two atoms

O₃ H₂O NH₃ CH₄



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Ions and Ionic Compounds

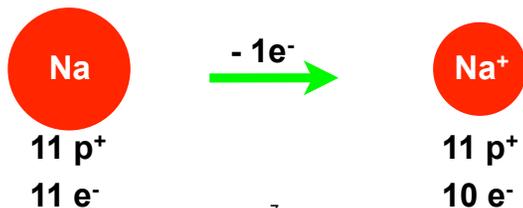
Ion:

an atom, or group of atoms, that has a net positive or negative charge.

Cation:

an ion with a positive charge.

results from removing an electron or more from a neutral atom.



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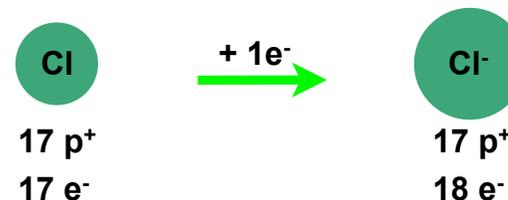
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Ions and Ionic Compounds

Anion:

an ion with a negative charge.

results from adding an electron or more to a neutral atom.



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Ions and Ionic Compounds

monatomic ion:

contains only one atom.



polyatomic ion:

contains more than one atom.



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Ions and Ionic Compounds

Predicting Ionic Charges

1A H^+	2A													3A Al^{3+}	4A	5A N^{3-}	6A O^{2-}	7A F^-	8A H^-		
Li^+														Transition metals							NOBLE GASES
Na^+	Mg^{2+}																S^{2-}	Cl^-			
K^+	Ca^{2+}																	Se^{2-}	Br^-		
Rb^+	Sr^{2+}																	Te^{2-}	I^-		
Cs^+	Ba^{2+}																				



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Ions and Ionic Compounds

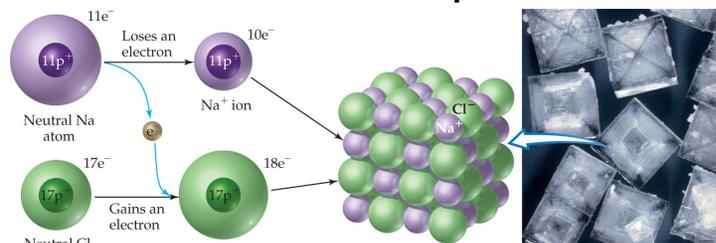
Molecular Compounds:

nonmetal + nonmetal = molecular compound



Ionic Compounds:

metal + nonmetal = ionic compound



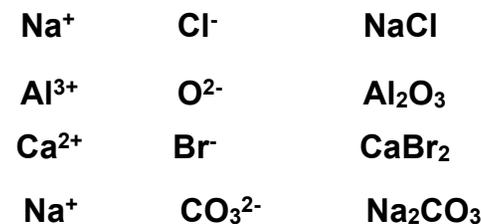
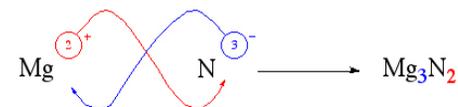
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Ions and Ionic Compounds

Ionic Compounds:

sum of charges on the cation(s) and anion(s) in each formula unit must equal zero.



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