

Chapter 3

Electronic Structure of Atoms & Ionic Compounds

Atoms & Elements Part 2a - The Electrons

Matter is anything with mass and volume.

What else have we learned about electrons?

1)

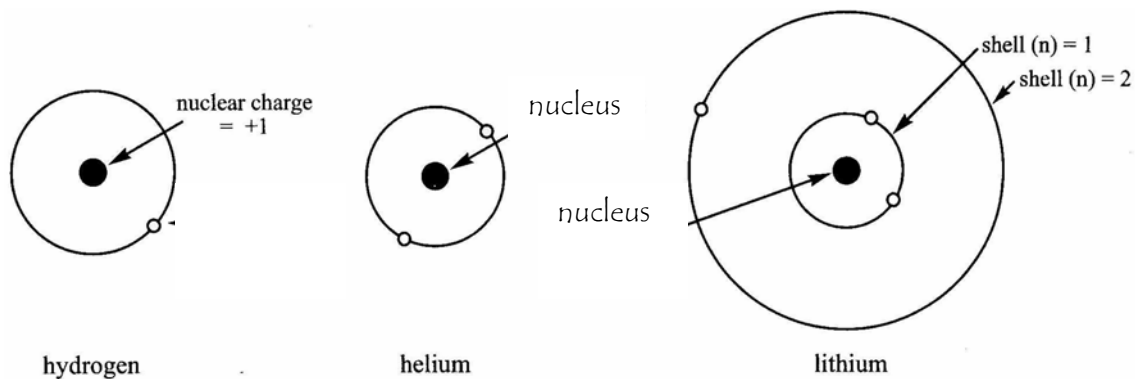
2)

3)

Electronic structure can be viewed as a peace agreement between electrons who want to share a nucleus.

Electrons travel in mathematically defined regions around the nucleus. These regions are called _____.

Shells are described by the letter 'n'.



The larger the value of 'n', the more electrons a shell can hold.

$2n^2$ = maximum number of electrons a shell can hold

where n is the shell number.

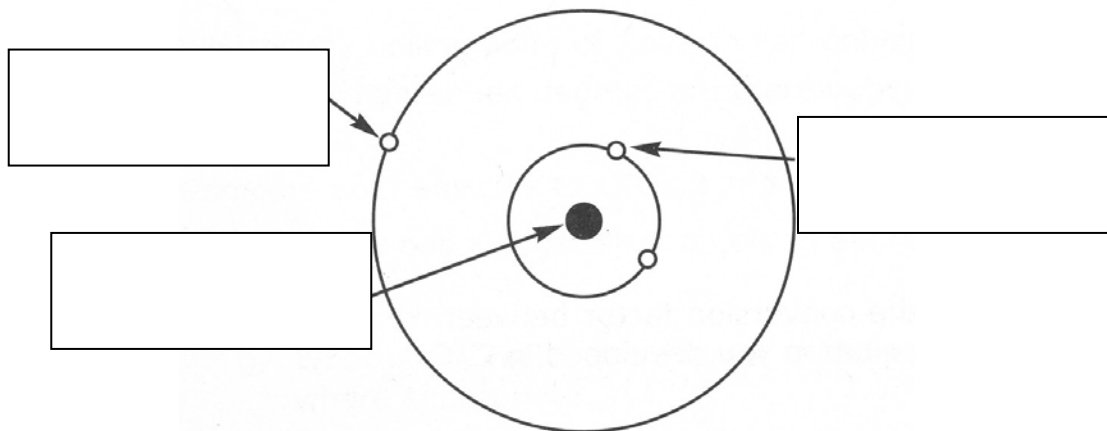
Electron shell	Max Number of electrons
n = 1	
n = 2	
n = 3	
n = 4	

Not all electrons are equal.

Valence electrons:

Core electrons:

Li Atom



How many electrons are in the valence shell of Li?

How many inner shell (core) electrons does Li have?

How many protons are in ${}^6_3\text{Li}$?

How many neutrons are in ${}^6_3\text{Li}$?

Atoms & Elements Part 2b – Valence Electrons & the Octet Rule

Elements with same number of valence electrons occur in the same column.

of valence electrons =

Metals lose their valence electrons to empty their valence shell.

Non-metals gain valence electrons to fill their valence shell.

The dark, stair-step line separates the metals from the non-metals.

All of the elements touching the stair-step are called metalloids EXCEPT aluminum. Hydrogen is a Non-Metal.

1 Group IA												18 Group VIIIA					
1 H 1.01	2 Group IIA											13 Group IIIA	14 Group IVA	15 Group VA	16 Group VIA	17 Group VIIA	18 Group VIIIA
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.30	3 Group IIIB	4 Group IVB	5 Group VB	6 Group VIB	7 Group VIIB	8 Group VIII	9 Group VIII	10 Group VIII	11 Group IB	12 Group IIB	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.84	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.41	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (269)	109 Mt (268)	110 Ds (271)	111 Nh (272)	112 Fl (277)	114 Lv (289)					

What is the charge of the ion formed when the following atoms lose their valence electrons?

- a) Ca
- b) Al

What is the charge of the ion formed when the following atoms gain valence electrons to form an octet?

- a) O
- b) Br

Chemical properties are determined by the number of valence electrons.

Octet Rule:

Chemical Bond: the attractive force that holds two atoms together in a compound

Ionic Compounds

Covalent Compounds

Comparing Ionic and Covalent Bonds

<u>Ionic Bonds</u>	vs	<u>Covalent Bonds</u>
Metal + Non-metal		2 Non-metals
e ⁻ transfer		e ⁻ sharing
no discrete molecules "formula unit"		molecule is the basic structural unit

Atoms & Elements Part 3 – Introducing Oxidation & Reduction

Ionic compounds form by the transfer of electrons.

Metals _____ electrons and non-metals _____ electrons.

The overall charge on each side of the reaction must be equal.

reactants → product

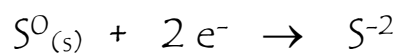
Loss of Electrons is Oxidation



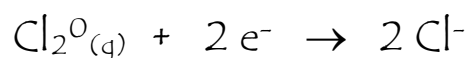
Variable Charge Metals can lose different numbers of e-s.



Gain of Electrons is Reduction



Diatomic Elements (H_2 , N_2 , F_2 , O_2 , I_2 , Cl_2 , Br_2) show both atoms when they gain or lose electrons. (Stay tuned for the next series of videos.)



Whether electrons are gained or lost, they are always added to the reaction.

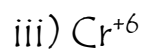
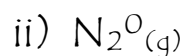
Gained electrons appear on the reactant side.

Lost electrons appear on the product side.

Complete the reactions below.

- ADD the correct number of electrons to the reactant or product side.
- Classify the reactions as "oxidation" or "reduction".
- Write the name of each ion below its symbol.

Oxidation or Reduction?



Anions to memorize

1 Group IA												13 Group IIIA		14 Group IVA	15 Group VA	16 Group VIA	17 Group VIIA	18 Group VIIIA													
1 H 1.01	2 Group IIA											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18														
3 Li 6.94	4 Be 9.01											11 Na 22.99	12 Mg 24.30	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95												
		3 Group IIIB	4 Group IVB	5 Group VB	6 Group VIB	7 Group VIIB	8 Group VIII		9 Group VIII		10 Group	11 Group IB	12 Group IIB	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.84	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.41	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
		37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29												
		55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)												
		87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (269)	109 Mt (268)	110 Ds (271)	111 - (272)	112 - (277)	114 - (289)																	

- 1		- 2		- 3	
Fluoride	F ⁻	Oxide	O ²⁻	Nitride	N ³⁻
Chloride	Cl ⁻	Sulfide	S ²⁻	Phosphide	P ³⁻
Bromide	Br ⁻	Carbonate	CO ₃ ²⁻		
Iodide	I ⁻				
Hydride	H ⁻	Hydrogen phosphate (Biphosphate)	HPO ₄ ²⁻	Phosphate	PO ₄ ³⁻
Hydroxide	OH ⁻				
Cyanide	CN ⁻	Peroxide	O ₂ ²⁻		
Acetate	CH ₃ CO ₂ ⁻ or C ₂ H ₃ O ₂ ⁻	Sulfate	SO ₄ ²⁻		
Nitrate	NO ₃ ⁻				
Nitrite	NO ₂ ⁻				
Hypochlorite	ClO ⁻				
Bicarbonate	HCO ₃ ⁻ (Hydrogen carbonate)				
Bisulfate	HSO ₄ ⁻ (Hydrogen sulfate)				
Dihydrogen phosphate	H ₂ PO ₄ ⁻				

Polyatomic Anions

1 Group IA												13 Group IIIA					14 Group IVA	15 Group VA	16 Group VIA	17 Group VIIA	18 Group VIIIA
1 H 1.01	2 Group IIA											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18				
3 Li 6.94	4 Be 9.01											11 Na 22.99	12 Mg 24.30	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95		
3 Group IIIB		4 Group IVB		5 Group VB		6 Group VIB		7 Group VIIB		8 Group VIIIB		9 Group IIIB		10 Group IIB		11 Group IB		12 Group IIB			
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.84	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.41	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80				
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29				
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)				
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (269)	109 Mt (268)	110 Ds (271)	111 - (272)	112 - (277)						114 - (289)				

A trick to help memorize some of the polyatomic anions:

consonants = # oxygen atoms

vowels = charge of ion

Nick the Camel ate Supper in Phoenix.

Acetate

Compounds Part 1:

Ionic Compounds: Formula Units and Nomenclature

Ions – Atoms can gain or lose electrons to become ions.

Cation:

Anion:

The Octet Rule for Ionic Bonds

atoms gain or lose electrons to achieve a full valence shell of 8 electrons

Metals lose e^- to form _____.

Non-metals can gain e^- to form _____.

Ions create neutral salts through Electrostatic Forces.

Chemical formulas give us the ratio of ions to create a neutral compound.

Names follow the same pattern as the chemical formula

Write the formula unit and name for the ionic compounds (salts) formed by the following pairs of ions.

Ions	Formula	Name
K^+ with Br^-		

Mg^{2+} with OH^-

Fe^{2+} with PO_4^{3-}

Pb^{4+} with CO_3^{2-}

Ionic compounds are solids in their pure state. The ions are locked in the crystal lattice created by the cations and anions maximizing their attractive forces and minimizing their repulsive forces.

However, when an ionic compound dissolves in water, the ions become completely independent of each other.

Predict how many ions are released into an aqueous solution when 1 formula unit is dissolved in water. Write your answer by completing the reaction for each compound below.

