

**( 2 ) Today**

Sections 1.1 – 1.3  
electrons, valence vs core electrons

Review Periodic Trends

**Next Class ( 3 )**

Section 1.4  
Introduction to Chemical Bonding Theories  
octet rule etc

Sections 1.5-1.10  
Valence Bond Theory

**( 4 ) Second Class from Today**

Sections 1.5-1.10  
Valence Bond Theory

Skipping Section 1.11 for now  
An introduction to Molecular Orbital Theory

Sections 1.12  
Drawing Chemical Structures

**Third Class from Today ( 5 )**

Sections 1.12  
Drawing Chemical Structures

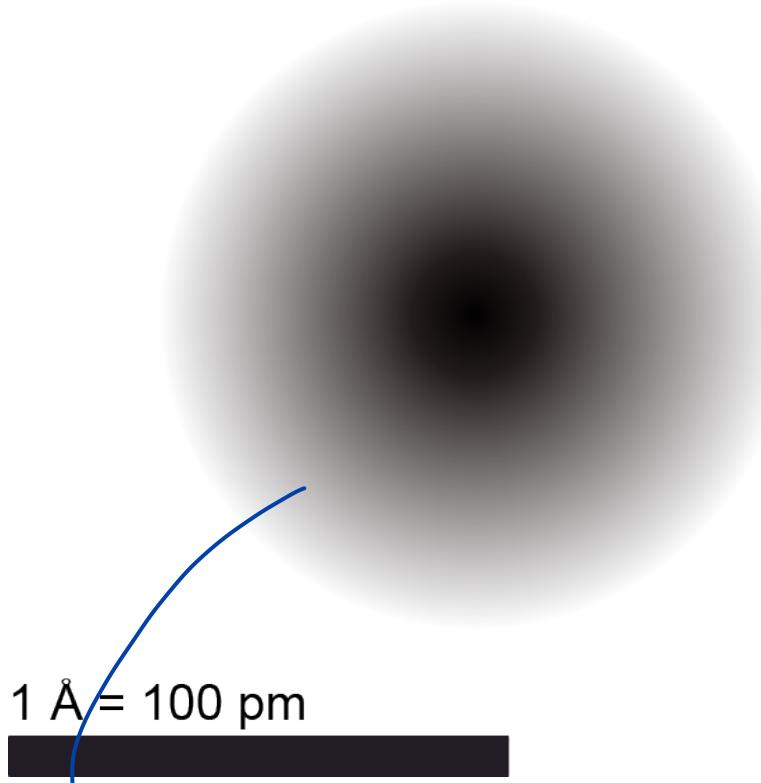
**Lab starts on Monday, September 8**

**Goggles and lab coats will be required starting Monday, September 22.**

# And Where Are the Electrons Again?

Sections 1.1 – 1.3

## Wave/Quantum Mechanical Model



Fuzzy because the exact path + location of an  $e^-$  can't be known  
We can only know the probability of finding an  $e^-$  somewhere in space

Further, as  $n$  gets larger more orbital shapes ( $l$ 's) become available and as more shapes become available, those shapes have more possible orientations ( $m_l$ 's).

Image derived from 1[https://en.wikipedia.org/wiki/Atom#/media/File:Helium\\_atom\\_QM.svg](https://en.wikipedia.org/wiki/Atom#/media/File:Helium_atom_QM.svg)

Bohr had 1 quantum number.

the electron is in the  $n = 1$  or  $2$  or  $3$  or  $4\dots$  shell

Quantum Mechanics requires four quantum numbers to describe an electron:  $n$ ,  $l$ ,  $m_l$ , and  $m_s$ .

$n$  is the principal energy level

$l$  describes the shape of the orbital

$m_l$  describes the orientation of the orbital and  $m_s$  indicates the spin of the electron.

# And Where Are the Electrons Again? The Quantum Mechanical Model

Sections 1.1 – 1.3

The H atom's only electron:

$$n = \underline{1}, l = \underline{0}, m_l = 0, \text{ and } m_s = \underline{\frac{1}{2}}$$

electron configuration



He's two e<sup>-</sup>'s:

$$\begin{aligned} n &= \underline{1}, l = \underline{0}, m_l = 0, \text{ and } m_s = \underline{\frac{1}{2}} \\ n &= \underline{1}, l = \underline{0}, m_l = 0, \text{ and } m_s = \underline{-\frac{1}{2}} \end{aligned}$$



B's five e<sup>-</sup>'s:

$$\begin{aligned} n &= 1, l = 0, m_l = 0, \text{ and } m_s = \frac{1}{2} \\ n &= 1, l = 0, m_l = 0, \text{ and } m_s = -\frac{1}{2} \\ n &= \underline{2}, l = \underline{0}, m_l = 0, \text{ and } m_s = \frac{1}{2} \\ n &= \underline{2}, l = \underline{0}, m_l = 0, \text{ and } m_s = -\frac{1}{2} \\ n &= \underline{2}, l = \underline{1}, m_l = 1, \text{ and } m_s = \frac{1}{2} \end{aligned}$$

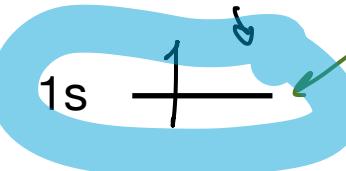


## And Where Are the Electrons Again? Energy Level Diagrams

Sections 1.1 – 1.3

H  $n = 1, l = 0, m_l = 0$ , and  $m_s = 1/2$

$1s^1$



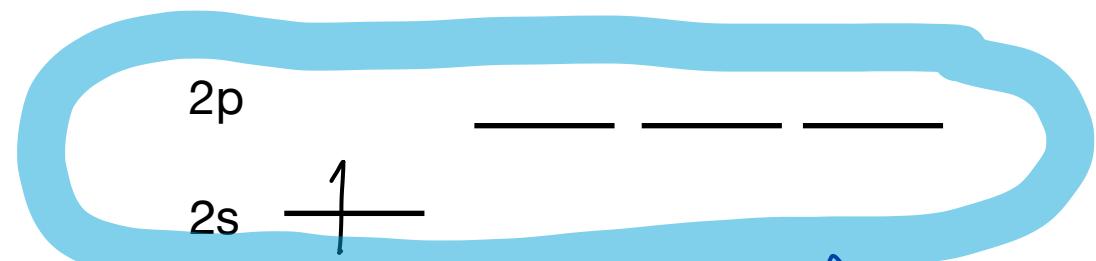
the line represents  
the orbital/energy  
level

Li  $n = 1, l = 0, m_l = 0$ , and  $m_s = 1/2$

$n = 1, l = 0, m_l = 0$ , and  $m_s = -1/2$

$n = 2, l = 0, m_l = 0$ , and  $m_s = 1/2$

$1s^2 2s^1$



N  $n = 1, l = 0, m_l = 0$ , and  $m_s = 1/2$

$n = 1, l = 0, m_l = 0$ , and  $m_s = -1/2$

$n = 2, l = 0, m_l = 0$ , and  $m_s = 1/2$

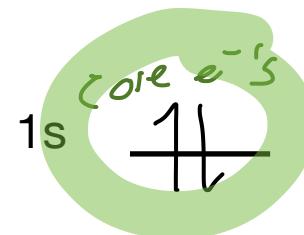
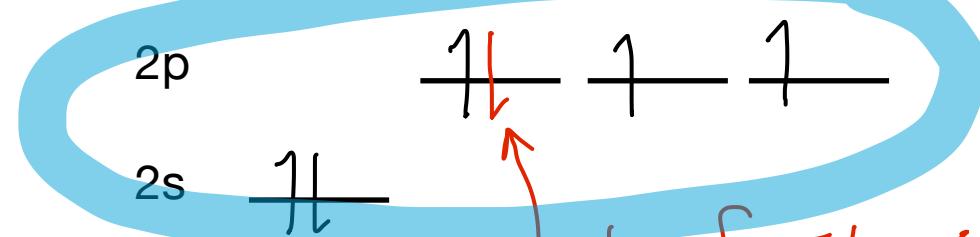
$n = 2, l = 0, m_l = 0$ , and  $m_s = -1/2$

$n = 2, l = 1, m_l = 1$ , and  $m_s = 1/2$

$n = 2, l = 1, m_l = 0$ , and  $m_s = 1/2$

$n = 2, l = 1, m_l = -1$ , and  $m_s = 1/2$

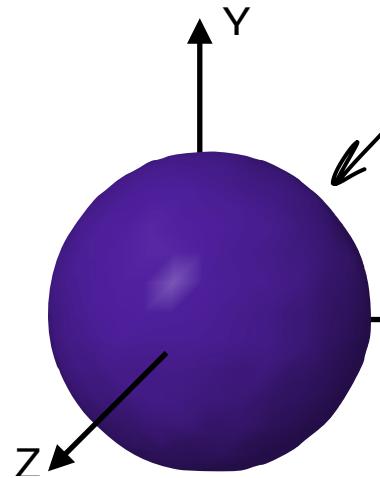
$1s^2 2s^2 2p^3$



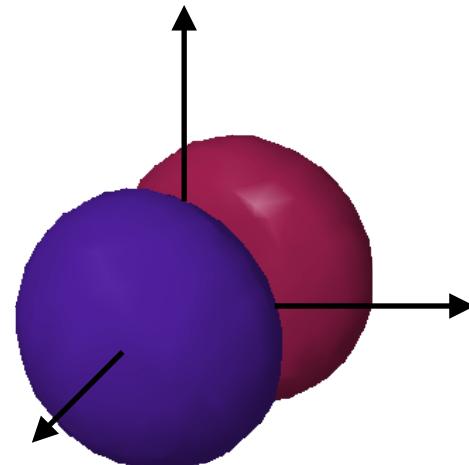
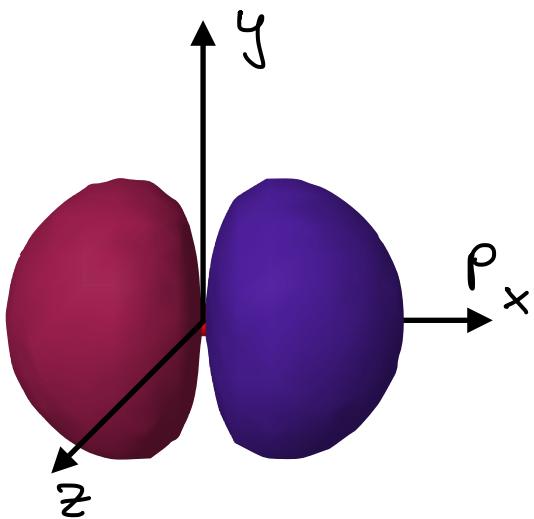
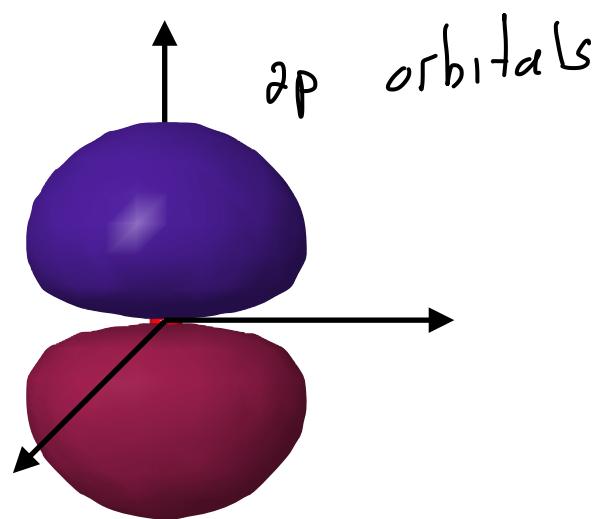
NO! If  $e^-$ 's can  
spread out into  
degenerate orbitals  
they typically do

## And Where Are the Electrons Again? Orbital Shape

Sections 1.1 – 1.3



all 5 orbitals are spherically symmetrical  
x the  $2s$  ( $n=2 l=0$ ) is larger and has a nodal surface inside the sphere



3 + 4 p orbitals are bigger versions of the same shape  
but 3 + 4 p orbitals have 1 + 2 nodal surfaces in them

Use the periodic table to determine electron configurations

Use the periodic table to determine the number of valence electrons

Use the periodic table to identify metals and non-metals

Use the periodic table to remember trends in size

Use the periodic table to remember trends in electronegativity

Use the periodic table to predict likely charges of ions

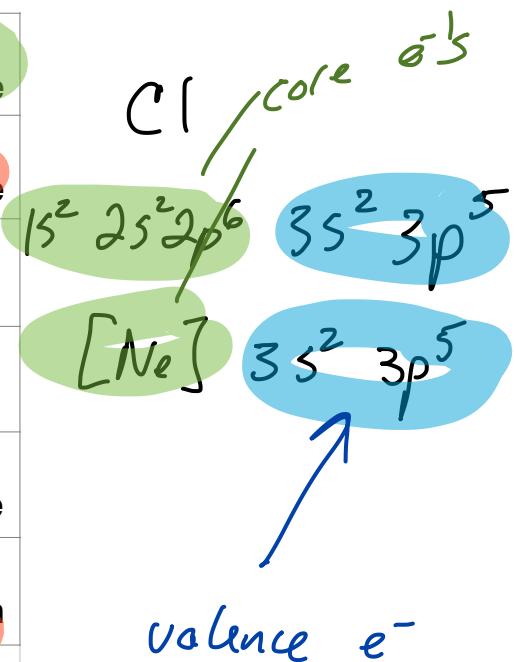
Use the periodic table to predict likely bond formation

Use trends in size, electron configuration, and nuclear charge to explain electronegativity trend

Introduce Valence Bond Theory (hybridization)

# The Periodic Table Is Your Friend

## Sections 1.1 – 1.3



58 $\Delta=4$ 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 $\Delta=5$	91	92	93	94	95	96	97	98	99	100	101	102	103 Lr
Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No		

2 block lags / level  
behind

f block lags 2 levels  
behind

Remember how electrons are distributed/electron configuration  
Remember the importance of valence electrons/the valence shell

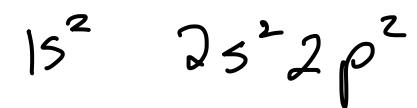
# Example Electron configurations

# Sections 1.1 – 1.3

$s^1 s^2$        $e^-$  config is similar to  
 Be, Mg, Ca ... but reactivity is similar to -  
 $p^1 p^2 p^3 p^4 p^5 p^6$   
 H He Ne Ar Kr

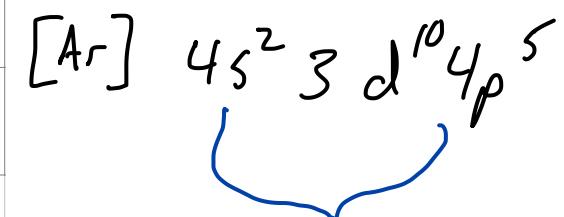
1	1 H	2 He																
2	3 Li	4 Be																
3	11 Na	12 Mg																
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	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
7	87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og

## C electron config and # of valence e<sup>-</sup>'s?



4 v e<sup>-</sup>'s

Br electron config  
and # of valence e<sup>-</sup>s?



? v e<sup>-13</sup>

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

# The Periodic Table Is Your Friend

Review

1	H															2	He																		
3	Li	4	Be													10	Ne																		
11	Na	12	Mg													18																			
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	
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	Ds	111	Rg	112	Cn	113	Nh	114	Fl	115	Mc	116	Lv	117	Ts	118	Og

58	59	60	61	62	63	64	65	66	67	68	69	70	71				
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu				
90	91	92	93	94	95	96	97	98	99	100	101	102	103				
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr				

Identify metals and non-metals

metals tend to gain or share  
non-metals tend to gain or share

metals tend

NaCl is an ionic compound

Na<sup>+</sup> Cl<sup>-</sup>

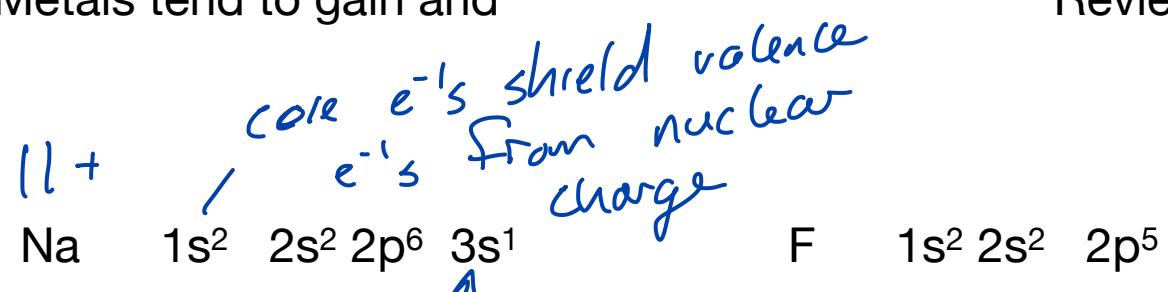
to lose

The Periodic Table Is Your Friend: Metals tend to gain and nonmetals tend to lose electrons

Review

1 H						2 He	
3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og

58 Ce	68 Er	69 Tm	70 Yb	71 Lu
90 Th	100 Fm	101 Md	102 No	103 Lr



valence e<sup>-</sup>'s  
don't experience  
the full  $\oplus$  of  
the nucleus

Why

# The Periodic Table Is Your Friend

# Review

1 H																	2 He
3 Li	4 Be																5 B
11 Na	12 Mg																6 C
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	7 N
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	8 O
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	36 Kr
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og

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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

Identify metals and non-metals

# The Periodic Table Is Your Friend: Size

Review

1																2						
	H															He						
3	4															5	6	7	8	9	10	
	Li	Be														B	C	N	O	F	Ne	
11	12															13	14	15	16	17	18	
	Na	Mg														Al	Si	P	S	Cl	Ar	
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36					
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr				
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54					
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe				
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86					
	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn				
87	88	89	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118					
	Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og				

58	59	60	61	62	63	64	65	66	67	68	69	70	71	
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	
90	91	92	93	94	95	96	97	98	99	100	101	102	103	
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	

Remember periodic trends

# The Periodic Table Is Your Friend: Electronegativity

Review

1																2					
	H															He					
3	4																10				
Li	Be															B	C	N	O	F	Ne
11	12															13	14	15	16	17	18
Na	Mg															Al	Si	P	S	Cl	Ar
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36				
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr				
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54				
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe				
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86				
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn				
87	88	89	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118				
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og				

58	59	60	61	62	63	64	65	66	67	68	69	70	71	
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	
90	91	92	93	94	95	96	97	98	99	100	101	102	103	
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	

Remember periodic trends

Why does electronegativity or the size of the atom matter?

Review

High energy electrons are reactive

low energy electrons are less reactive