Unit2Day5-VandenBout

Tuesday, October 01, 2013
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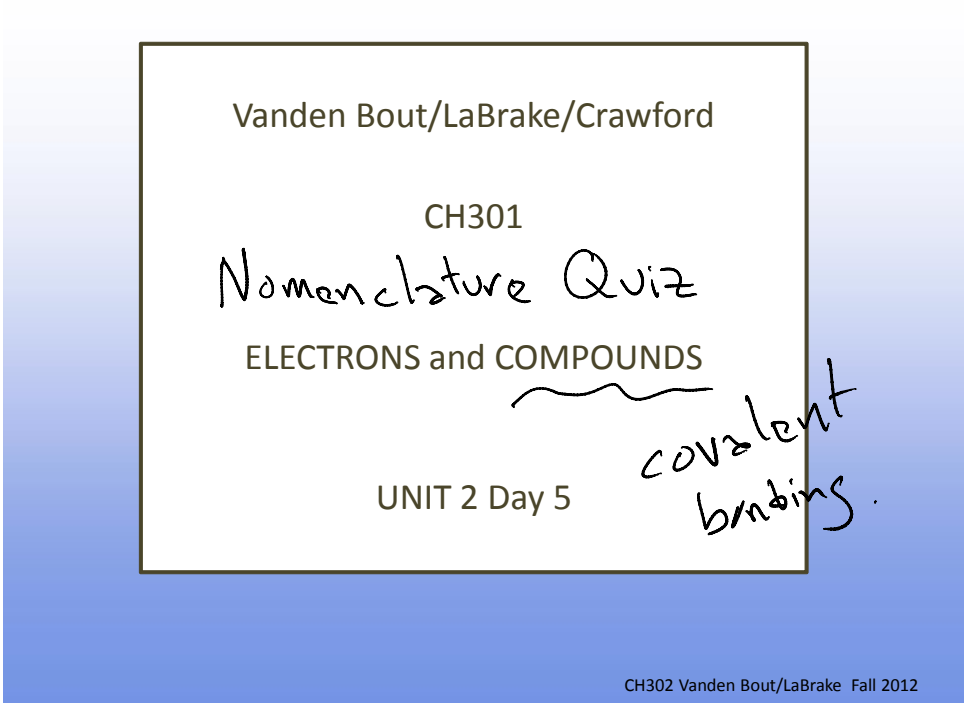

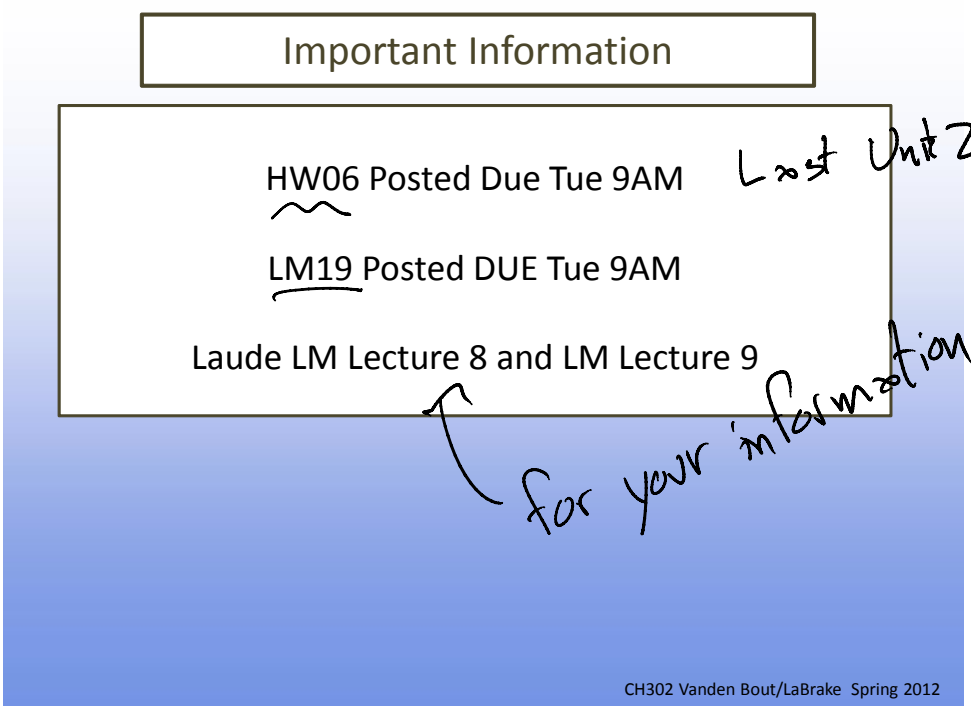

What are we going to learn today?

–Electron Configuration and Bonding

- Master using Lewis structures to predict bonding in compounds
- Employ the concept of resonance
- Use formal charge to help predict best possible Lewis structure

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QUIZ: CLICKER QUESTION 1

Referring to the position of Sr and P on the periodic table, would you predict these elements would come together to:

A) Form a metallic compound
B) Form a covalent compound
C) Form an ionic compound

metal + metal
non-metal + non-metal
metal + non-metal

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QUIZ: CLICKER QUESTION 1

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QUIZ: CLICKER QUESTION 2

Naming Compounds

Choose the formula that corresponds to:
strontium and phosphorus.

a) SrP
b) SrP_2
c) Sr_2P
d) Sr_3P_2
e) Sr_2P_3

Sr^{2+} 3x P^{3-} 2x

Neutral compound
NO CHARGE

QUIZ: CLICKER QUESTION 3

Naming Compounds

Choose the formula that corresponds to:
potassium dichromate.

a) $KCrO_4$
b) KCr_2O_7
c) K_2CrO_4
d) $K_2Cr_2O_7$
e) K_3Cr_2O

K^{+} $Cr_2O_7^{2-}$

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QUIZ: CLICKER QUESTION 4

Naming Compounds

Choose the formula that corresponds to:
sulfur trioxide.

covalent compound

a) SO
b) SO_3^{2-}
c) SO_3
d) S_2O_3
e) SO_4^{2-}

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QUIZ: CLICKER QUESTION 5

Naming Compounds

Choose the formula that corresponds to:
sulfite.

a) SO
b) SO_3^{2-} ← sulfite
c) SO_3
d) S_2O_3
e) SO_4^{2-} ← sulfate

QUIZ: CLICKER QUESTION 6

Naming Compounds

NH_4^+ , OH^-

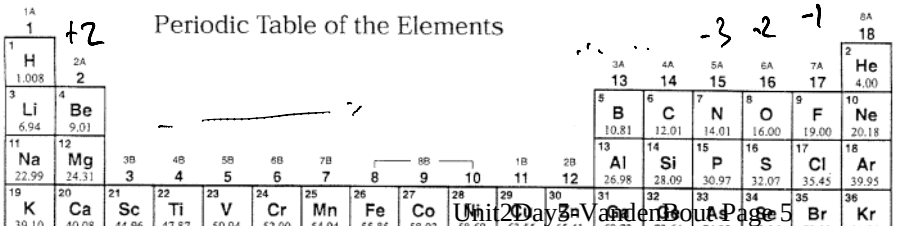
Choose the name that corresponds to: NH_4OH.

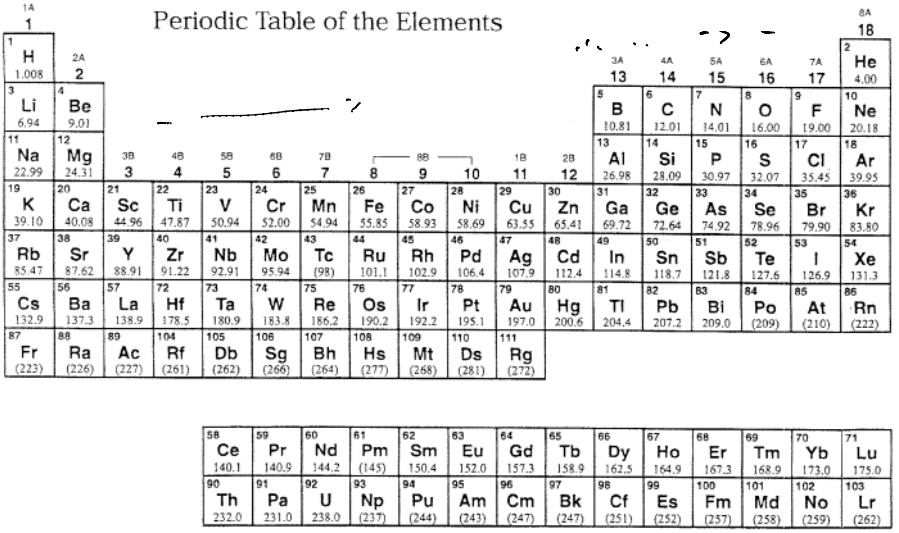
a) nitrogen tetrahydrogen oxygen hyrdride
b) nitrogen pentahydrogen oxide
c) ammonium hydroxide
d) ammonia oxyhydrogen
e) hydronitrideoxide

NH_5O

+1 +2 -3 -2 -1

Periodic Table of the Elements





Think About How Covalent Compounds Are Put Together

Characterize the bond….

- Bond Length
- Bond Strength
- Electron Pair Shared Equally?
  - YES – PURE COVALENT
  - NO – POLAR COVALENT

What about compounds that aren't ionic.. Covalent?

How are they formed? Are electrons lost????

No.. They are "shared"……
(two non-metals…
two elements with similar electronegativities)

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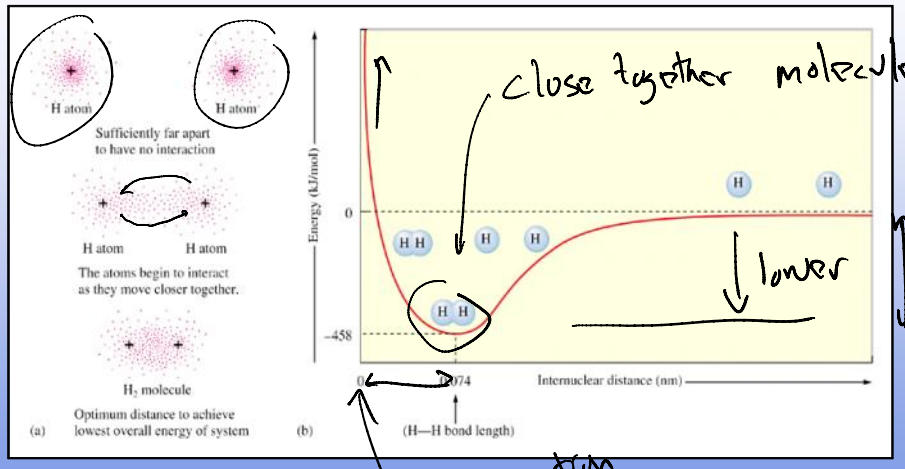
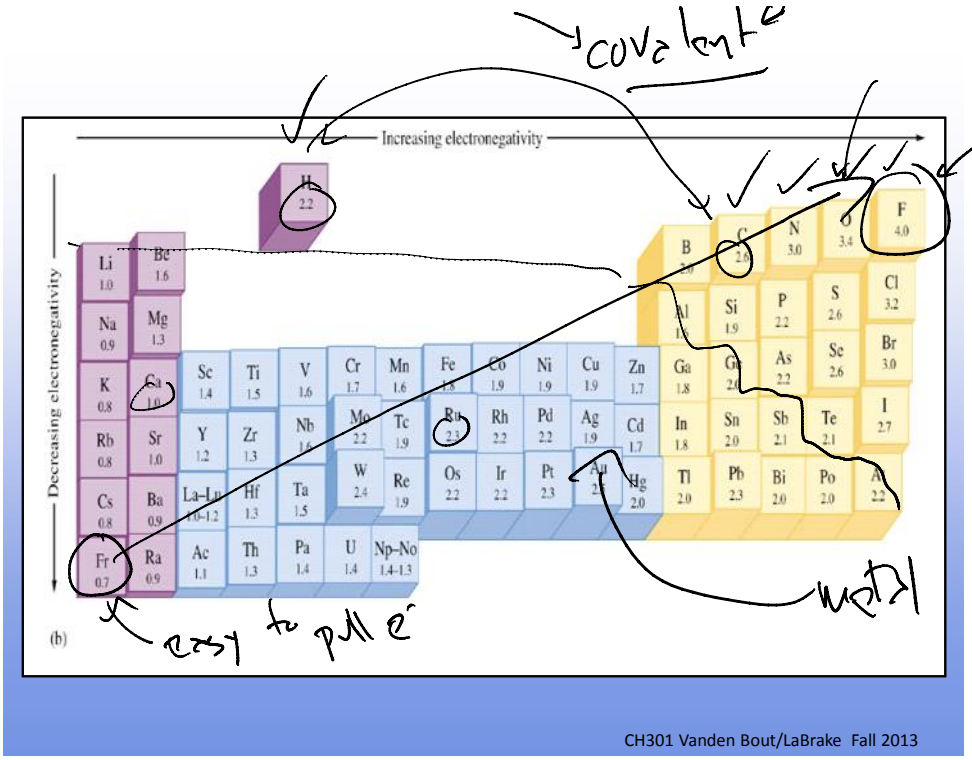
Small electronegativity



Electronegativity-electron pulling power of an atom when it is part of a molecule

- When one atom is more electronegative than another in a bond, a polar covalent bond is formed. Degree of polarity is dependent on difference in electronegativities.

covalent



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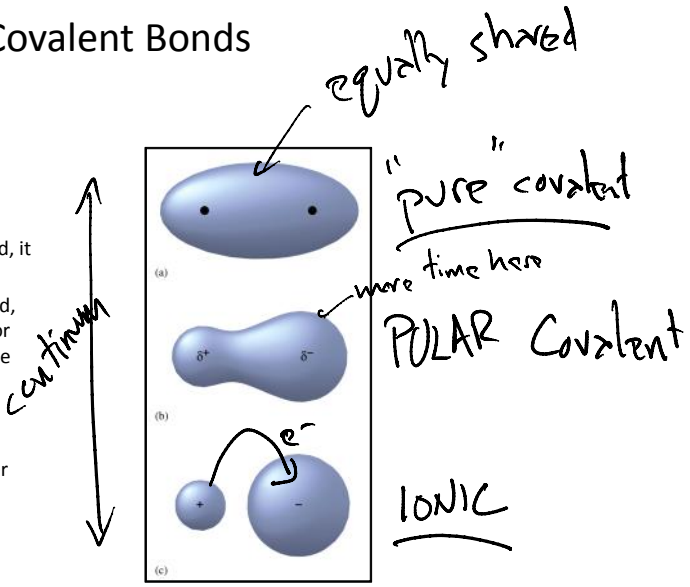
Ionic vs Covalent Bonds

- All bonds can be viewed as hybrids between purely ionic and purely covalent
- When two identical atoms are bound, it is purely covalent.
- When two different atoms are bound, one may have a greater attraction for electrons, and have a partial negative charge.
- Polar covalent bond – degree is measured as dipole moment
- When one atom has a much stronger attraction to the electrons than the other, an electron may be donated yielding an ionic bond.



POLL: CLICKER QUESTION 7

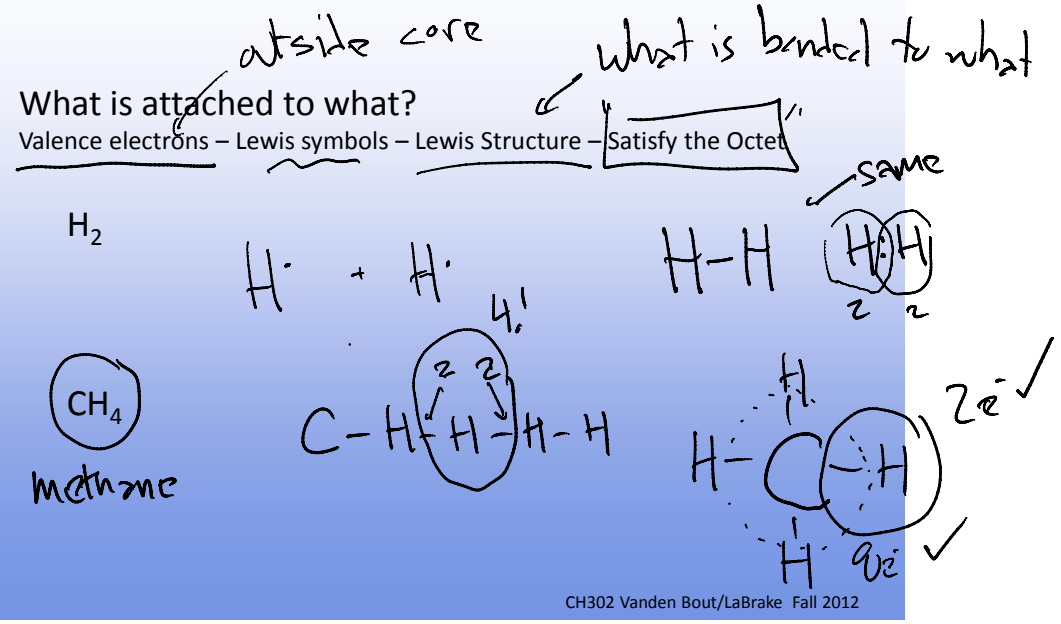
When drawing molecular structures a little dash between two atoms in the structure is representing:

a)An ionic "bond"
b)A shared pair of electrons
c)A little stick or spring that you would use with a molecular model kit
d)A nonbonding pair of electrons

Covalent Compounds

What is attached to what?

Valence electrons – Lewis symbols – Lewis Structure – Satisfy the Octet



LEWIS STRUCTURE RULES

Determine total number of valence electrons

LEWIS STRUCTURE RULES

Determine total number of valence electrons

Predict total number of Bonds: S = N – A rule

Draw Skeletal Structure

Place nonbonding electrons

Fix the number of bonds

shared e⁻

available e⁻

"needed e⁻"

Available = sum of valences

Needed = sum for noble gas for all atoms

Demonstrate using the rules to show how to put together Lewis structures.

CH_4

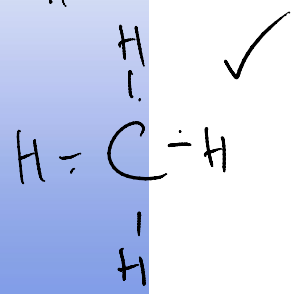
C 4 A = 8

H 1x4 = 4 N = 8 + 4(2) = 16

C H

S = N – A = 16 – 8 = 8

C_2H_6



Examples from Activity

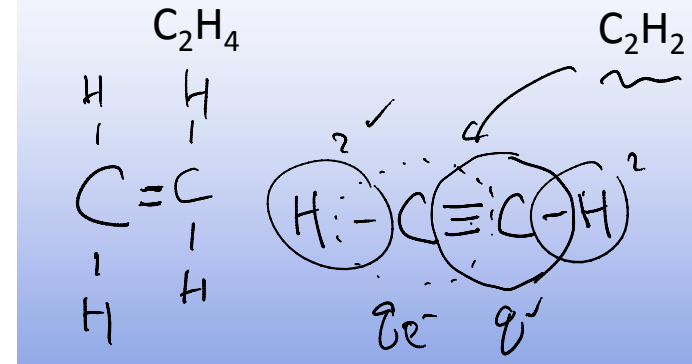
C_2H_6

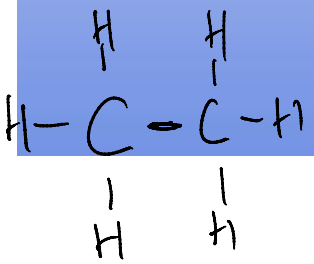
C_2H_4

C_2H_2

N 2 A = 2(8) = 16

Examples from Activity





N $2C = 2(8) = 16$
$2H = 2(2) = 4$
20

A $2C = 2(4) = 8$
$2H = 2(1) = 2$
10

$S = N - A = 20 - 10 = 10$

5 Bonds ✓

Take a little moment….

	Bond Strength (kJ mol⁻¹)	Bond Length (pm)
C-C Single	348 kJ mol⁻¹	154
C=C Double	614 kJ mol⁻¹	134
C≡C Triple	839	120

Examples 4, 5 and 6 from Activity

C_2H_6O

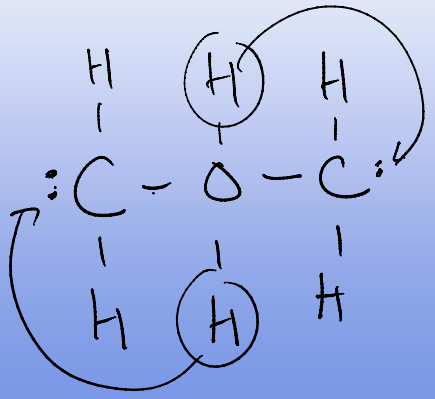
condense

Structural formulas

CH_3OCH_3 ↔ C_2H_5OH

C_2H_6O CH_3OCH_3 C_2H_5OH

condense formula (no hint to structure)



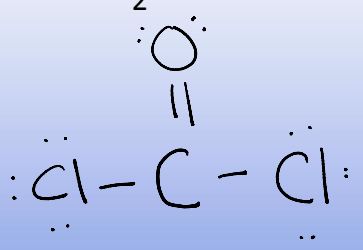
How can you be sure…. Formal Charge check

FC_{atom} = Group # – (bonds + nonbonded e^-)

# of valence

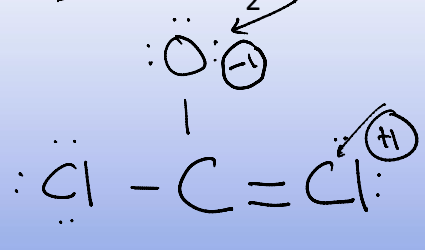
$\frac{1}{2}$ shared + nonbonded

A $COCl_2$



"correct"

B $COCl_2$



$FC_O = 6 - (1+6) = 6-7 = -1$

$FC_{Cl} = 7 - (2+4) = 7-6 = +1$

Structure minimizes FC! Sum FC on all atoms = charge compound

Put these on the board...Working for candy and fame

NO_3^-

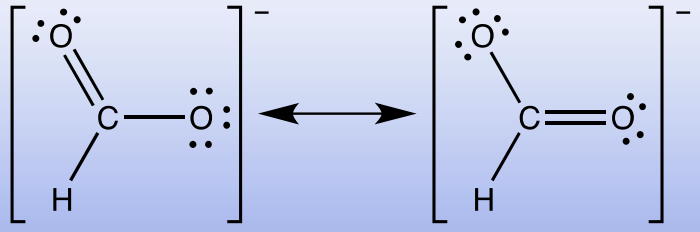
Put these on the board...Working for candy and fame

NO_3^-

Resonance structures for the formate ion are shown below. POLL: CLICKER QUESTION 8

An average C-O single bond is 0.143 nm in length
An average C=O double bond is 0.123 nm in length.

Which choice describes the actual bond lengths for the carbon-oxygen bonds in a formate ion?



A. Both carbon-oxygen bonds are 0.133 nm.
B. Both carbon-oxygen bonds are 0.143 nm.
C. One carbon-oxygen bond is 0.143 nm and the other is 0.123 nm.
D. Both carbon-oxygen bonds switch between 0.123 nm and 0.143 nm.

Think about it …. Ionic or covalent?

NaOH

Just when you were sure you had it nailed…

$RnCl_2$

$BeCl_2$

Periodic Table of the Elements

1A												3A	4A	5A	6A	7A	8A
1												13	14	15	16	17	18
1 H 1.008	2A 2																2 He 4.00
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 24.31	3B 3	4B 4	5B 5	6B 6	7B 7	8B 8	8B 9	8B 10	1B 11	2B 12	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	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 55.85	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 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	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 (277)	109 Mt (268)	110 Ds (281)	111 Rg (272)							

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

McCord (2006)

What have we learned?

ATOMS BEHAVE IN CERTAIN PREDICTABLE WAYS WHICH CAN BE CORRELATED TO THE ELECTRON CONFIGURATIONS

SATISFYING THE OCTET RULE IS A SOLID PREDICTOR OF BONDING IN IONIC AND COVALENT COMPOUNDS

RESONANCE IS THE AVERAGE OF THE EXTREMES – ELECTRONS ARE NOT TRAPPED IN THE LITTLE DASHES

FORMAL CHARGE HELPS PREDICT BEST LEWIS STRUCTURE FOR A GIVEN MOLECULAR FORMULA

Learning Outcomes

Draw the Lewis structures for molecular compounds and ions.

Use Lewis structures to predict and explain the relative bond Strength and lengths in compounds.

Recognize and apply exceptions to the octet rules.

Draw resonance structures for a molecule or polyatomic ion.

Apply formal charges to structures and use them to predict the most likely structure.