UNIT2DAY5 VDB

Thursday, October 04, 2012
8:35 AM

Vanden Bout/LaBrake

CH301

ELECTRONS and COMPOUNDS

UNIT 2 Day 5

Important Information

HW06 Posted Due Tue 9AM

LM19 Posted DUE Tue 9AM – LEWIS STRUCTURES

(NGLM10-Ionic-Covalent Compounds & NGLM11-Nomenclature)

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

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

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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

12

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

lowest score ... ^

QUIZ: CLICKER QUESTION 4

Naming Compounds

Choose the formula that corresponds to:
sulfur trioxide.

= valent

a) SO
b) SO_3^{2-}
c) SO

Choose the formula that corresponds to:

sulfur trioxide.

= covalent

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

QUIZ: CLICKER QUESTION 5

Naming Compounds

Choose the formula that corresponds to:

~~sulfur trioxide~~ sulfite

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

QUIZ: CLICKER QUESTION 6

Naming Compounds

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

98%

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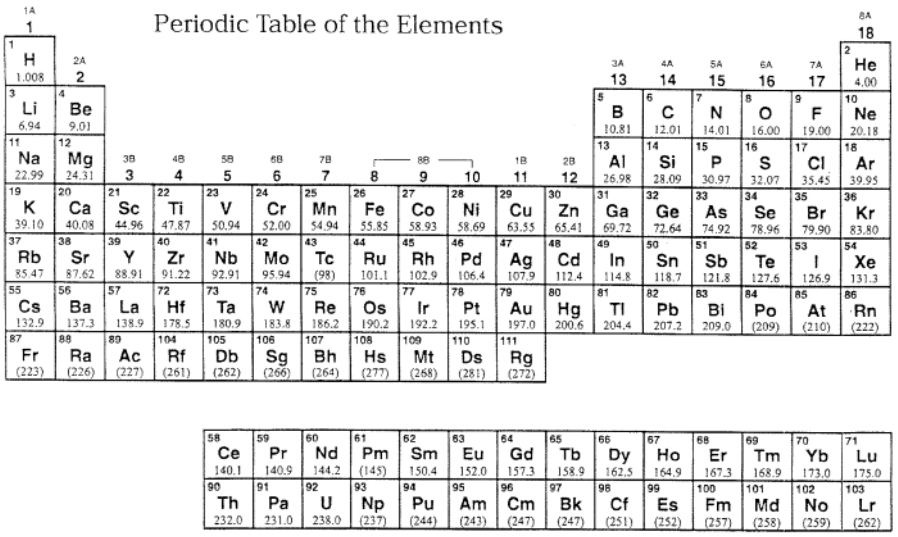

FRIEND

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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Covalent Compounds

Characterize the bond….

Bond Length ✓

Bond Strength ✓

Short bonds normally stronger BUT not always

Electron Pair Shared Equally?

YES – PURE COVALENT

NO – POLAR COVALENT

SHOW THE SIMULATOR…..

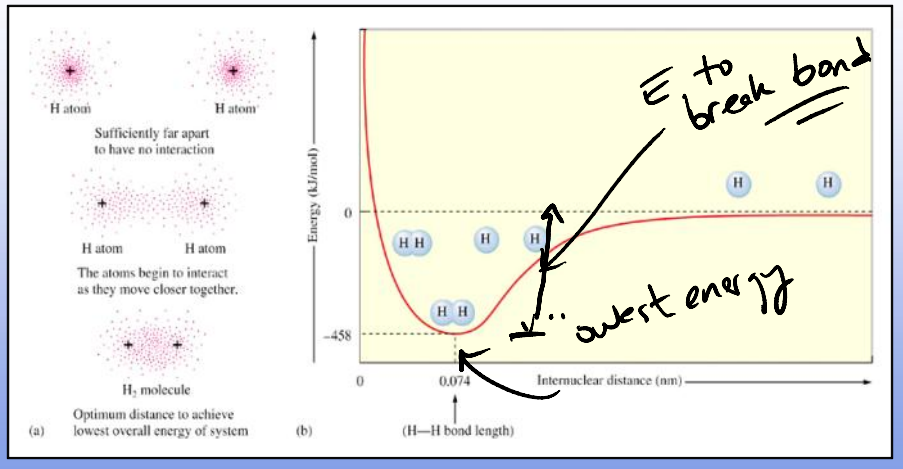


Diagram in Learning Module

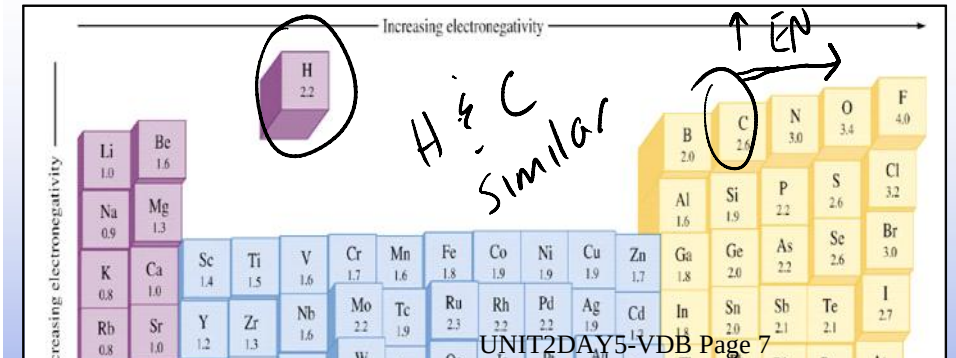
Electronegativity-electron pulling power of an atom when it is part of a molecule

Bigger Z_{eff} stronger attraction of e-

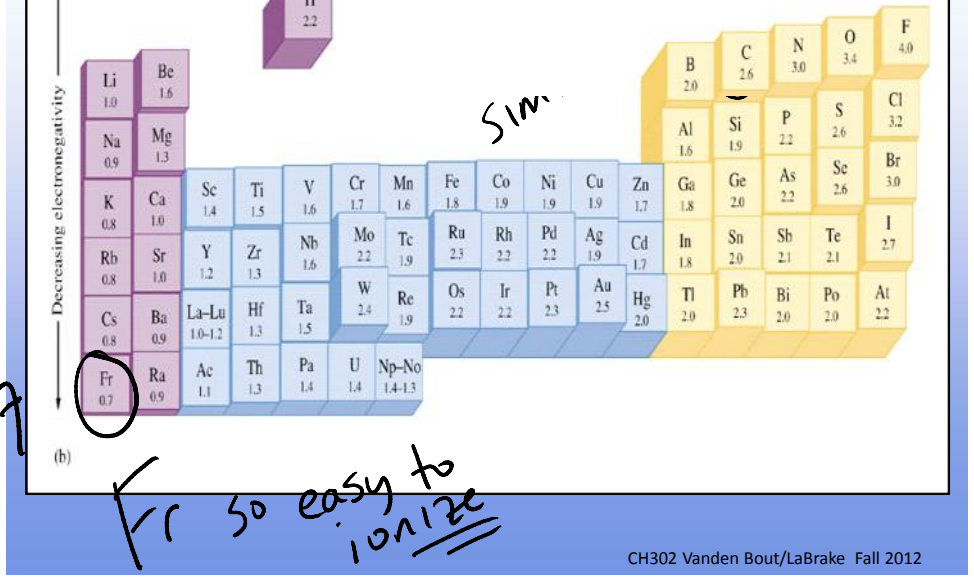
- When one atom is more electronegative than another in a bond, a polar covalent bond is formed. Degree of polarity is dependent on difference in electronegativities.

EN ↑

↓EN



high 4 most electronegative atom



low

Fr so easy to ionize

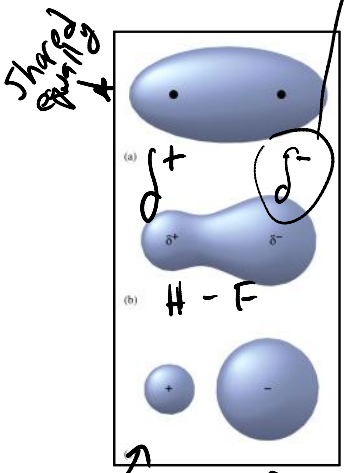
electron... atom

F

PERIODIC TABLE FRIEND

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.



Partial negative charge

Shared equally

Pure Covalent

Polar Covalent

Ionic

full charge

full charge

Covalent Compounds - Naming

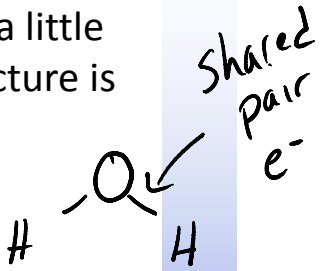
Prefix	Number Indicated
mono-	1
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8

POLL: CLICKER QUESTION 7

CODE for COVALENT

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

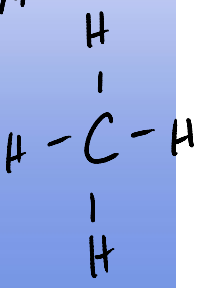


Covalent Compounds

What is attached to what?

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

H_2 H – H H is connected to H thats it

CH_4 C – H – H – H – H or  NEED RULES

LEWIS STRUCTURE RULES

Abridged version " Guidelines "

- 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

few basic rules

S = # shared e⁻

N = # needed to satisfy "octet" or noble configuration

A = Actually Available = total # valence e⁻

Get to work…

S = N – A

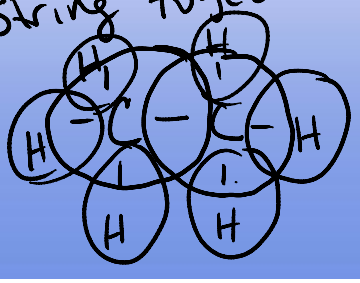
C_2H_6

2 x C = 2 x 4 = 8

6 x H = 6 x 1 = 6

C_2H_6

H are terminal they do not string together



$6 \times H = 6 \times 1 = 6$

$S = 28 - 14 = 14$

$A = 14$

$\#B = \frac{14}{2} = 7$ bonds

$2 \times C = 2 \times 8 = 16$

$6 \times H = 6 \times 2 = 12$

$N = 28$

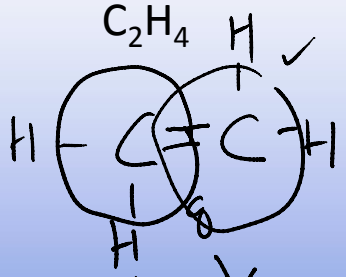
have you satisfied the octets? ✓

Get to work…

shared = needs − available

$S = N - A$

C_2H_4



6 bonds.

$A = 2 \times C = 2 \times 4 = 8$, $+4 \times H = 4 \times 1 = 4$, $= 12$

$N = 2 \times C = 2 \times 8 = 16$, $4 \times H = 4 \times 2 = 8$, $= 24$

$S = 24 - 12 = 12$

Get to work…

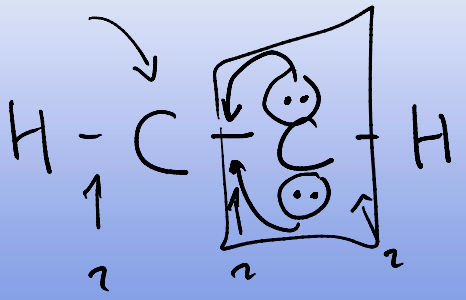
$S = N - A$

$S = 20 - 10 = 10$

5 bonds

$A = 10!$

C_2H_2



$H-C\equiv C-H$

Take a little moment….

	Bond Strength	Bond Length
Single	348 kJ mol^{-1}	154 pm
Double	614 kJ mol^{-1}	134 pm
Triple	839 kJ mol^{-1}	120 pm

Get to back to work…

$S = N - A$

C_2H_6O

2xC	2x4 = 8
6xH	6x1 = 6
1xO	1x6 = 6
	A = 20

Condense molecular

Conver... molecular formula

$S = 36 - 20 = 16$

N = 20

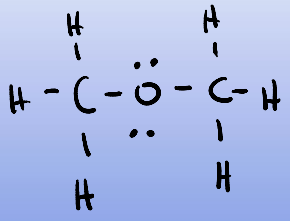
N = 36

8 bonds

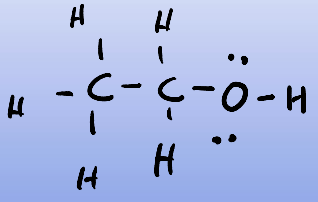
Get to back to work….

C_2H_6O

CH_3OCH_3

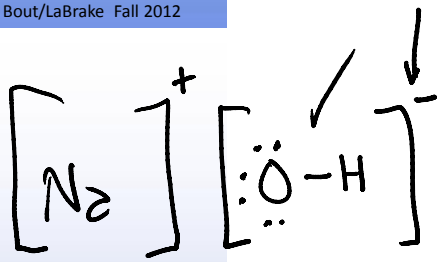


C_2H_5OH



must make sure you use up e-

Think about it …. Ionic or covalent?



NaOH

A. ionic

B. covalent

C. both

D. neither

N_2^+

OH^-

Ox1 = 6

Hx1 = 1

EXTRA e 1

8

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

NO^-

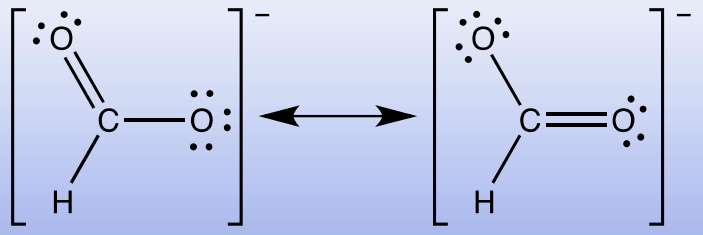
Put these on the board...Working for candy and fame

NO_3^-

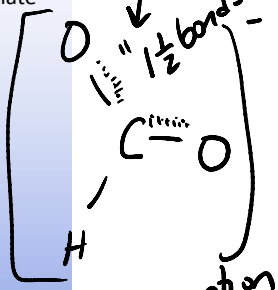
Resonance structures for the formate ion are shown below. POLL: CLICKER QUESTION 8

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?



Think like this

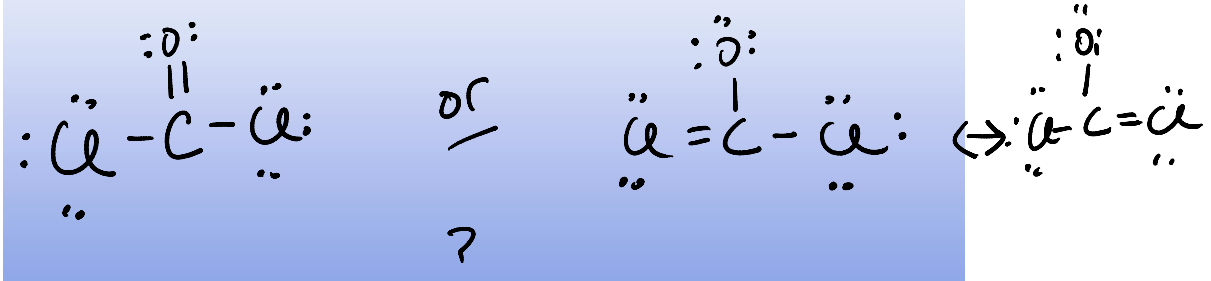


misconception

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.

How can you be sure….

$COCl_2$ $COCl_2$



?

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How can you be sure….

FORMAL CHARGE CHECK

$COCl_2$ $COCl_2$

memorize → $FC_{\text{atom}} = \text{Group \# atom} - \left(\text{Lone } e^- + \text{bonds}\right)$

Best case each atom Ø

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Just when you were sure you had it nailed…

expanded valence

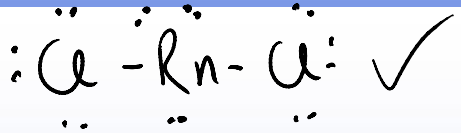
$RnCl_2$

over period 3

some exceptions

$S = N - A$

$24 - 22 = \frac{2}{2} = 1$ bond ☹



incomplete valence

$BeCl_2$

need

H weird $2e^-$

Be weird $4e^-$

B weird $6e^-$

to satisfy

:Cl-Rn-Cl: ✓

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.