

Chapter 7 Part 1

Dr. Turner

Covalent Bonding

- Atoms held together by sharing of electrons to fulfill the octet rule
- Primarily between nonmetals
- Involves electron sharing

Covalent Bonding

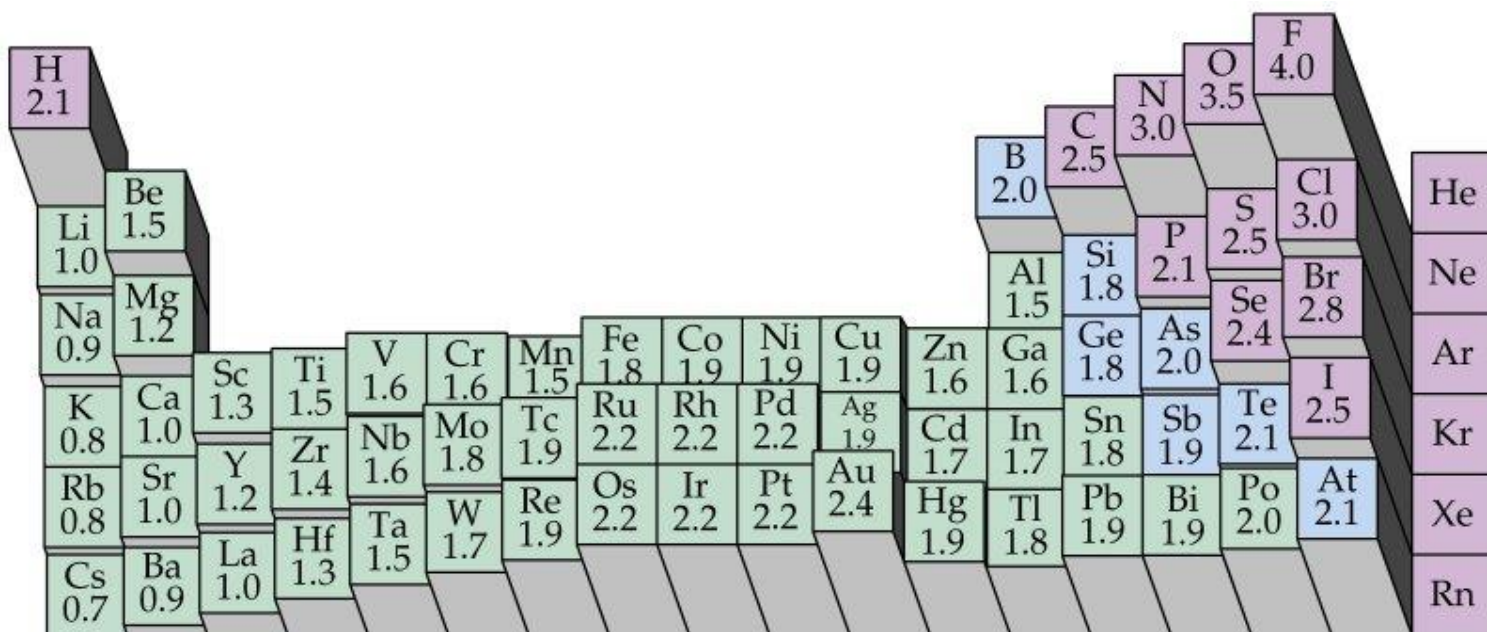
- As the atoms come together to form a molecule and share electrons, they become more stable.
- Atoms gain, lose, or share electrons to achieve a stable, noble-gas electron configuration, ns^2np^6 .
- This general trend to achieve eight valence electrons is known as the octet rule.
- Hydrogen and helium, which have valence electrons in the first shell, $1s^2$, follow the duet rule.

Electronegativity

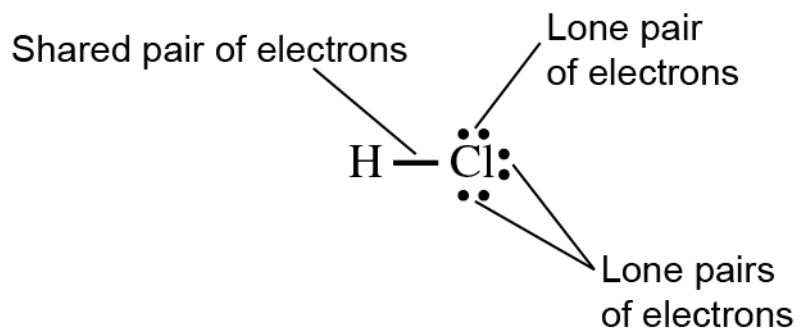
- ❑ The ability of an atom in a molecule to attract electrons to itself within a bond is called electronegativity
- ❑ Metals generally have low electronegativities
- ❑ Nonmetals generally have high electronegativities
- ❑ Electronegativity generally increases going up and to the right excluding the noble gases.

1 H 1.008																	2 He 4.002															
3 Li 6.94	4 Be 9.0122															5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.18											
11 Na 22.990	12 Mg 24.305	3	4	5	6	7	8	9	10	11	12	13 Al 26.982	14 Si 28.085	15 P 30.974	16 S 32.06	17 Cl 35.45	18 Ar 39.948															
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.939	28 Ni 58.693	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.630	33 As 74.922	34 Se 78.97	35 Br 79.904	36 Kr 83.798															
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.95	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	57-71 *	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)	89-103 #	104 Rf (265)	105 Db (268)	106 Sg (271)	107 Bh (270)	108 Hs (277)	109 Mt (276)	110 Ds (281)	111 Rg (280)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Mc (289)	116 Lv (293)	117 Ts (294)	118 Og (294)															
* Lanthanide series																																
<table><tr><td>57 La 138.91</td><td>58 Ce 140.12</td><td>59 Pr 140.91</td><td>60 Nd 144.24</td><td>61 Pm (145)</td><td>62 Sm 150.36</td><td>63 Eu 151.96</td><td>64 Gd 157.25</td><td>65 Tb 158.93</td><td>66 Dy 162.50</td><td>67 Ho 164.93</td><td>68 Er 167.26</td><td>69 Tm 168.93</td><td>70 Yb 173.05</td><td>71 Lu 174.97</td></tr></table>																		57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97
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# Actinide series																																
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Electronegativity

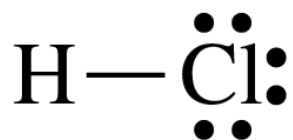


Lewis Structure of HCl



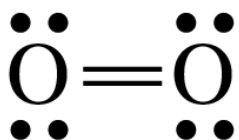
- ❑ An H atom has one valence electron and a Cl atom has seven.
- ❑ In the HCl molecule, these two atoms share one pair of electrons.
- ❑ H has access to a second electron (duet rule) via the shared pair.
- ❑ Cl has three unshared pairs, also referred to as lone pairs and one shared pair, forming a covalent bond.

Single, Double, and Triple Bonds



Single bond
2 shared
electrons

One shared
pair



Double bond
4 shared
electrons

Two shared
pairs



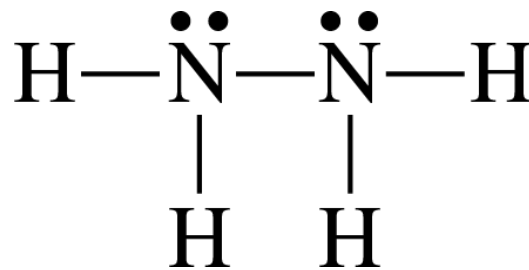
Triple bond
6 shared
electrons

Three shared
pairs

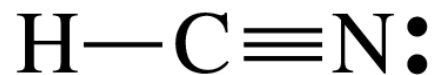
Shared and Unshared Electrons

Identify the numbers of shared electrons and unshared electrons in these Lewis structures.

A. hydrazine, N_2H_4



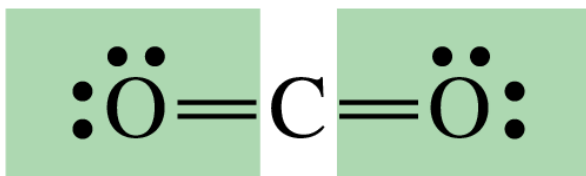
B. hydrogen cyanide, HCN



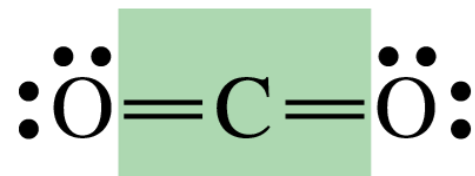
Characteristics of Valid Lewis Structures

- The number of electrons in a Lewis structure equals the total number of valence electrons in the atoms of the molecule.
- Atoms in a Lewis structure obey the octet/duet rule.

Octets in Carbon Dioxide



(a)

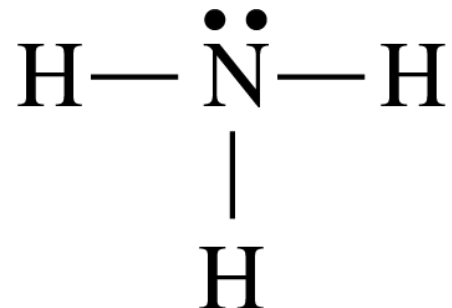


(b)

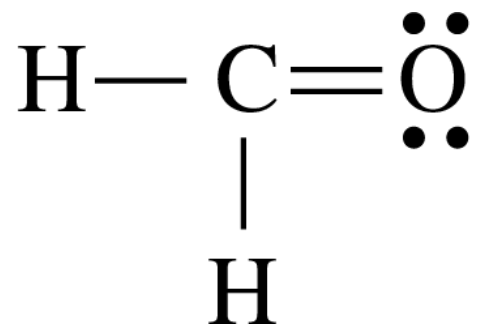
Verifying Valid Lewis Structures.

Verify that these are valid Lewis structures.

A. ammonia, NH_3



B. formaldehyde, H_2CO



Drawing Lewis Structures

1. Count the valence electrons.
2. Arrange atoms by placing the least electronegative elements in the middle
3. Add single bonds
4. Add remaining electrons
5. Check octet and duet rules to determine whether multiple bonds are needed

Drawing Lewis Structures (F_2)

1. Count the valence electrons
2. Arrange atoms by placing the least electronegative elements in the middle
3. Add single bonds
4. Add remaining electrons
5. Check octet and duet rules to determine whether multiple bonds are needed

Drawing Lewis Structures (CF₄)

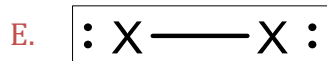
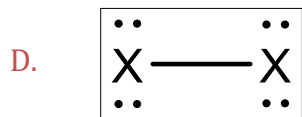
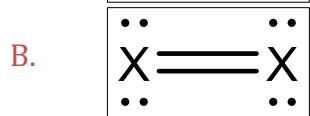
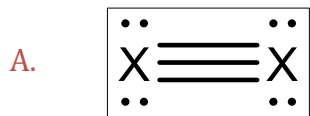
1. Count the valence electrons
2. Arrange atoms by placing the least electronegative elements in the middle
3. Add single bonds
4. Add remaining electrons
5. Check octet and duet rules to determine whether multiple bonds are needed

Drawing Lewis Structures (HCN)

1. Count the valence electrons
2. Arrange atoms by placing the least electronegative elements in the middle
3. Add single bonds
4. Add remaining electrons
5. Check octet and duet rules to determine whether multiple bonds are needed

Lewis Structures

Which structure satisfies the octet rule for a compound made of generic element X?



Lewis Structures of Polyatomic Ions

- Polyatomic ions consist of two or more atoms covalently bonded together that have a net positive or negative charge.
- Lewis structures for polyatomic ions are drawn following the same guidelines as for neutral molecules with a few minor additions.
- You must consider the charge when summing the valence electrons in step 1.
 - ▣ Add a valence electron for each negative charge on an anion.
 - ▣ Subtract a valence electron for each positive charge on a cation.
- Place the structure within brackets, with the charge indicated outside the brackets.

Drawing Lewis Structures (NH_4^+)

1. Count the valence electrons
2. Arrange atoms by placing the least electronegative elements in the middle
3. Add single bonds
4. Add remaining electrons
5. Check octet and duet rules to determine whether multiple bonds are needed

Drawing Lewis Structures (CN^-)

1. Count the valence electrons
2. Arrange atoms by placing the least electronegative elements in the middle
3. Add single bonds
4. Add remaining electrons
5. Check octet and duet rules to determine whether multiple bonds are needed