

## Chemistry 6A Fall 2007

Dr. J. A. Mack

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# Monday

10/1/07

## Exam 1: Friday 10/5/07 (here in lecture)

*Bring a scamtron form 882 (100 question jobby-doo)*

How many questions will be on the exam?

enough to keep you busy for 50 min

**Some of you will finish early**  
**Some of you will have just enough time**  
**Some of you will not finish on time**

As always, it depends upon your level of preparation...

## Exam 1: Friday 10/5/07 (here in lecture)

What will be covered on the exam?

What do I need to bring?

- Chapter 1-3 (all)
- Chapter 4: (4.1-4.5 and 4.10)
- Any thing from lab as well

Bring a Pencil, Eraser, Calculator and scamtron form 882

**YOU NEED TO KNOW YOUR LAB SECTION NUMBER!**

How should I prepare for the exam...

1. Get some sleep the night before.
2. Go over your quizzes.
3. look at your HW
4. look over additional HW problems
5. Focus on what you know first

What should I not do...

1. Put off studying until Thursday night
2. Party Thursday night! (*there will be plenty of time for that later*)
3. Snarf down 4 doughnuts and 3 red-bulls right before the exam!

There will be none of this...



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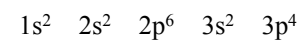
Last time...

What is the electron configuration of sulfur?

1 H 1.00794																	1 H 1.00794	2 He 4.002602	
3 Li 6.941	4 Be 9.012182													5 B 10.811	6 C 12.0107	7 N 14.00674	8 O 15.9994	9 F 18.9984032	10 Ne 20.1797
11 Na 22.98976928	12 Mg 24.3050													13 Al 26.9815385	14 Si 28.0855	15 P 30.9737615	16 S 32.066	17 Cl 35.4527	18 Ar 39.948
19 K 39.0983	20 Ca 40.078	21 Sc 44.955910	22 Ti 47.867	23 V 50.9415	24 Cr 51.9961	25 Mn 54.938045	26 Fe 55.845	27 Co 58.933200	28 Ni 58.6934	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.92160	34 Se 78.96	35 Br 79.904	36 Kr 83.80		
37 Rb 85.4678	38 Sr 87.62	39 Y 88.90585	40 Zr 91.224	41 Nb 92.90638	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.90550	46 Pd 106.42	47 Ag 107.8682	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.90447	54 Xe 131.29		
55 Cs 132.90545	56 Ba 137.327	57 La 138.9055	72 Hf 178.49	73 Ta 180.9479	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.078	79 Au 196.96655	80 Hg 200.59	81 Tl 204.3833	82 Pb 207.2	83 Bi 208.98038	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 (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 (269)	111 (272)	112 (277)			114 (289)	116 (289)				

last electron to fill:  $3p^4$

electron configuration:



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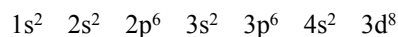
Last time...

Electron Configurations are written by shell even though the electrons fill by the periodic table:

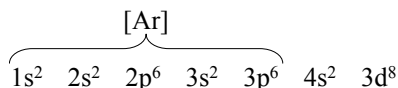
1 H $1s^1$																	2 He $1s^2$		
3 Li $2s^1$	4 Be $2s^2$													5 B $2s^2 2p^1$	6 C $2s^2 2p^2$	7 N $2s^2 2p^3$	8 O $2s^2 2p^4$	9 F $2s^2 2p^5$	10 Ne $2s^2 2p^6$
11 Na $3s^1$	12 Mg $3s^2$													13 Al $3s^2 3p^1$	14 Si $3s^2 3p^2$	15 P $3s^2 3p^3$	16 S $3s^2 3p^4$	17 Cl $3s^2 3p^5$	18 Ar $3s^2 3p^6$
19 K $4s^1$	20 Ca $4s^2$	21 Sc $4s^2 3d^1$	22 Ti $4s^2 3d^2$	23 V $4s^2 3d^3$	24 Cr $4s^1 3d^5$	25 Mn $4s^2 3d^5$	26 Fe $4s^2 3d^6$	27 Co $4s^2 3d^7$	28 Ni $4s^2 3d^8$	29 Cu $4s^1 3d^{10}$	30 Zn $4s^2 3d^{10}$	31 Ga $4s^2 3d^{10} 4p^1$	32 Ge $4s^2 3d^{10} 4p^2$	33 As $4s^2 3d^{10} 4p^3$	34 Se $4s^2 3d^{10} 4p^4$	35 Br $4s^2 3d^{10} 4p^5$	36 Kr $4s^2 3d^{10} 4p^6$		

last electron to fill:  $3d^8$

electron configuration by filling:



electron configuration by shell: (write this way)



Core notation:  $[Ar] 3d^8 4s^2$

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## Chapter 4: Forces between particles

Learning Objectives

After completing this chapter, you should be able to:

1. Draw Lewis structures for simple molecules.
2. Relate ion charge to the nearest ideal gas element electron configuration.
3. Write and name the formulas for ionic compounds and covalent molecules.
4. Draw Lewis structures for molecules and polyatomic ions and apply VSEPR theory to predict molecular and ionic shapes.
5. Use electronegativities and the VSEPR model to determine the type of bonding and geometry of a compound and, if covalent, if the molecule is polar.
6. Relate melting points and boiling points of pure substances to the strengths and types of inter-particle forces present.

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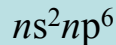
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## Electron Configurations of the Noble gases:

$ns$		$np$													
1 1A 1 H 1.00794	2 2A 2 He 4.00260														
11 Na 22.9898	12 Mg 24.3050	13 Al 26.9815	14 Si 28.0855	15 P 30.9738	16 S 32.066	17 Cl 35.4527	18 Ar 39.948								
19 K 39.0983	20 Ca 40.078														
37 Rb 85.4678	38 Sr 87.62														
55 Cs 132.905	56 Ba 137.327														
87 Fr (223)	88 Ra 226.025														
*Lanthanide series		Ce 140.115	Pr 140.908	Nd 144.24	Pm (145)	Sm 150.36	Eu 151.965	Gd 157.25	Tb 158.925	Dy 162.50	Ho 164.930	Er 167.26	Tm 168.934	Yb 173.04	Lu 174.967
†Actinide series		Th 232.038	Pa 231.036	U 238.029	Np 237.048	Pu (244)	Am (243)	Cm (247)	Bk (251)	Cf (252)	Es (257)	Fm (258)	Md (261)	No (260)	Lr (260)
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Each Noble gas has a valence electron configuration:



For a total of 8 valence electrons (octet)  
and  $n$  = the shell number

## Electron Configurations of the Noble gases:

$+1$		$+2$						$+3$		$-3$		$-2$		$-1$																	
1 H 1.00794	2 He 4.00260							13 Al 26.9815	14 Si 28.0855	15 P 30.9738	16 S 32.066	17 Cl 35.4527	18 Ar 39.948	19 K 39.0983	20 Ca 40.078	21 Sc 44.9559	22 Ti 47.88	23 V 50.9415	24 Cr 51.9961	25 Mn 54.9381	26 Fe 55.847	27 Co 58.9332	28 Ni 58.693	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.4678	38 Sr 87.62							55 Cs 132.905	56 Ba 137.327	57 La 138.905	58 Ce 140.115	59 Pr 140.908	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.965	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.967							
87 Fr (223)	88 Ra 226.025							89 Ac 227.028	90 Th 232.038	91 Pa 231.036	92 U 238.029	93 Np 237.048	94 Pu 239.048	95 Am (243)	96 Cm (247)	97 Bk (251)	98 Cf (252)	99 Es (257)	100 Fm (260)	101 Md (260)	102 No (260)	103 Lr (260)									
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The atoms gain or lose  
electrons to attain the  
electron configuration of the  
nearest Noble gas.

This explains the charges we see for atomic ions:

\*Lanthanide series

†Actinide series

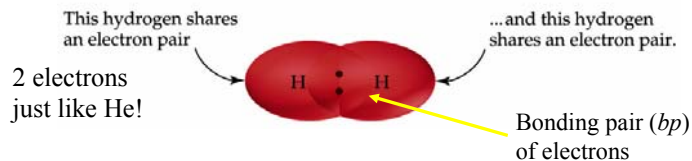
## Covalent Bonds (Diatomic Molecules)

Covalent chemical bonds involve the sharing of a pair of valence electrons by two atoms.

Covalent bonds lead to stable molecules if they share electrons in such a way as to create a noble gas configuration for each atom.

(*octet*:  $ns^2np^6$ )

Hydrogen gas ( $H_2$ ) forms the simplest covalent bond in the diatomic hydrogen molecule.



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## Lewis Theory: 1916-1919 - Lewis, Kossel, and Langmuir

### Elements of the theory:

1. Valence electrons play a fundamental role in chemical bonding.
2. **Ionic bonding** involves the *transfer* of one or more electrons from one atom to another.
3. **Covalent bonding** involves *sharing* of electrons between atoms.
4. Electrons are transferred or shared such that each atom gains an electron configuration of a noble gas ( $ns^2np^6$ ), i.e. having 8 outer shell (valence) electrons.
5. This arrangement is called the *octet rule*.

Exceptions to the octet rule do exist and will be explored later.

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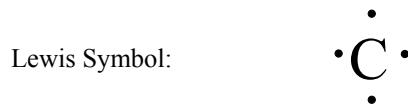
**Lewis Symbols** represent the resulting structures that accommodate the octet rule.

		1A(1)	2A(2)								
		$ns^1$	$ns^2$								
		3A(13)	4A(14)	5A(15)	6A(16)	7A(17)	8A(18)				
		$ns^2np^1$	$ns^2np^2$	$ns^2np^3$	$ns^2np^4$	$ns^2np^5$	$ns^2np^6$				
Period	2	• Li •	• Be •	• B •	• C •	• N •	• O •	• F •	• Ne •		
	3	• Na •	• Mg •	• Al •	• Si •	• P •	• S •	• Cl •	• Ar •		

In a Lewis symbol, an element is surrounded by up to **8 dots**. The elemental symbol represents the nucleus and the dots represent the valence electrons.

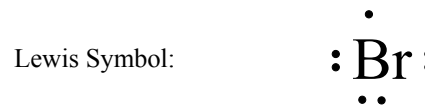
Draw the Lewis dot representations for the following element:

Element	electron configuration	# of valence electrons
carbon	$1s^22s^22p^2$	4 $(2s^22p^2)$



Draw the Lewis dot representations for the following element:

Element	electron configuration	# of valence electrons
Bromine	$[\text{Ar}]3d^{10}4s^24p^5$	7 $(4s^24p^5)$



### Drawing Lewis Structures:

Since hydrogen has only one electron in its valence, it satisfies the *octet rule* with a *duet*.

H-atom:



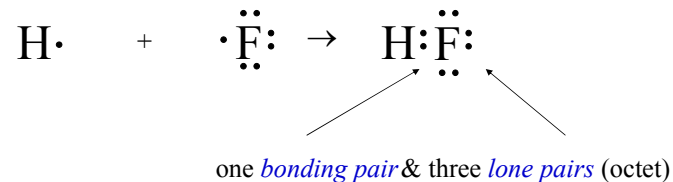
H<sub>2</sub> molecule:



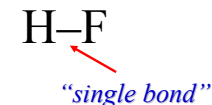
The “dash” represents a *bonding pair (bp)* of electrons.

When other covalent species form, there are additional electron pairs that do not participate in bonding.

These are called “*lone pairs (lp)*”



hydrogen fluoride: HF

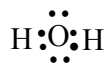


Example: H<sub>2</sub>O (water)

Each hydrogen atom has one electron (1 dot)

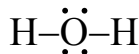
The oxygen atom has six electrons (6 dots)

Since H can only have one bond, O must be in the center:



Now connect the atoms to achieve octets (duet for H).

2 (bp)



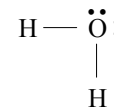
2 (lp)

Example: H<sub>2</sub>O (water)

Since H can only have one bond, O must be in the center:

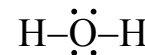
You can also draw the structure this way:

2 (bp)



The flat *Lewis dot* structures will be the same when represented in 3-D!

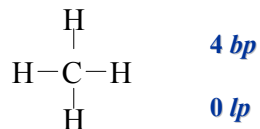
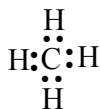
2 (lp)



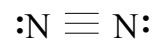
# CH<sub>4</sub>

Period	1A(1)	2A(2)	3A(13)	4A(14)	5A(15)	6A(16)	7A(17)	8A(18)
	ns <sup>1</sup>	ns <sup>2</sup>	ns <sup>2</sup> np <sup>1</sup>	ns <sup>2</sup> np <sup>2</sup>	ns <sup>2</sup> np <sup>3</sup>	ns <sup>2</sup> np <sup>4</sup>	ns <sup>2</sup> np <sup>5</sup>	ns <sup>2</sup> np <sup>6</sup>
2	• Li •	• Be •	• B •	• C •	• N •	• O •	• F •	• Ne •
3	• Na •	• Mg •	• Al •	• Si •	• P •	• S •	• Cl •	• Ar •

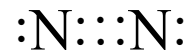
Since hydrogen (H) can only form one bond, carbon (C) must be in the center



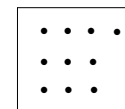
N<sub>2</sub> Each nitrogen atom needs 8 electrons to complete an octet...  
But each nitrogen has only 5 valence electrons!  
As a result, the electrons must be shared.



Triple bond!



*There are 10  
electrons available*



*N<sub>2</sub> needs 16  
electrons (2×8)*

Therefore 6 electrons must be shared (16–10)

The rest are lone pairs that complete the octet.