

## Today's Reminders:

Read **Course Architecture** and **Lab Safety** before working on Pre-lab Assignment 1

Tutorial 2 (Assignment due next Monday, 9/21/09) is very helpful in understanding of Exp. 1

DQ #3 and answer key are now posted. Next five Lectures will cover Inorganic Reactions in Aqueous Solutions.v

**Tutorial #1 Homework is due before 5 pm today (9/14/09).**

**Lab room assignments and ChemID Finder are now posted. Don't forget to label the homework with your ChemID!!**

### Lecture 1 continues

1	1															2		
	H															He		
2	3	4											5	6	7	8	9	10
	Li	Be											B	C	N	O	F	Ne
3	11	12											13	14	15	16	17	18
	Na	Mg											Al	Si	P	S	Cl	Ar
4	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
5	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
6	55	56	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
	Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn

P:  $1s^2 2s^2 2p^6 3s^2 3p^3$

Ar:  $1s^2 2s^2 2p^6 3s^2 3p^6$

Ni:  $[\text{Ar}] 3d^8 4s^2$  But NOT:  $[\text{Ca}] 3d^8$

I:  $[\text{Kr}] 4d^{10} 5s^2 5p^5$

**Valence electrons** --- The electrons in the outermost shell of an atom.

**Stable electron configuration** --- An atom is more stable when its p, d, or f orbitals are completely filled or half-filled.

**It is most stable when the configuration of the outermost shell is  $ns^2 np^6$ , the configuration of noble gases.**

**Atoms form chemical bonds to achieve a more stable electron configuration.**

**Chem 151 Lecture 2**  
**Exp 1 Periodic Properties**

- **Metallic behavior and Non-metallic behavior**
- **Periodic Trends of**  
**Effective Nuclear Charge**  
**Atomic Size**  
**Electronegativity**
- **Simplified Model of Chemical Bonding**

**Metallic Behavior**

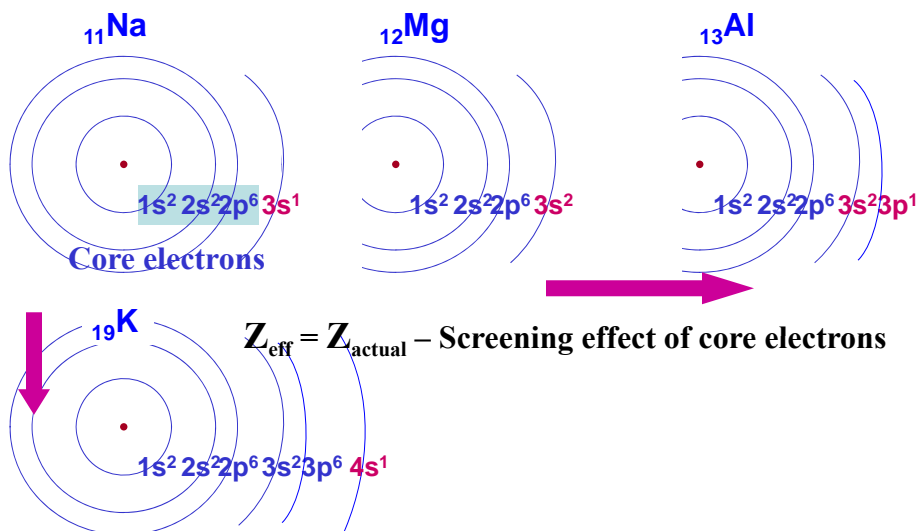
Malleable and shiny  
Good conductor of electricity and heat  
High melting points  
**Low electronegativity**

**Non-metallic Behavior**

Brittle and dull  
Poor conductor of electricity and heat  
Have a wide range of melting points and boiling points  
**High electronegativity**

**Electronegativity** is a measure of the ability of an atom to attract electrons to itself in a molecule.

**Effective Nuclear Charge,  $Z_{\text{eff}}$**  The effective nuclear attraction experienced by an outermost electron in an atom.



**Periodic Trend of Effective Nuclear Charge,  $Z_{\text{eff}}$**

1	1																	2
	H																	He
2	3	4											5	6	7	8	9	10
	Li	Be											B	C	N	O	F	Ne
3	11	2											13	14	15	16	17	18
	N	Mg											Al	Si	P	S	Cl	Ar
4	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
5	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
6	55	56	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
	Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
7	87	88	103	104	105	106	107	108	109	110	111	112	113	114		116		118
	Fr	Ra	Lr	Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub	Uut	Uuq		Uuh		Uuo

57	58	59	60	61	62	63	64	65	66	67	68	69	70
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb
89	90	91	92	93	94	95	96	97	98	99	100	101	102
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No

**Periodic Trend of Atomic Radii (size of atom)**

1	1	H																	2	He																
2	3	Li	4	Be											5	6	7	8	9	10	B	C	N	O	F	Ne										
3	11	Na	12	Mg											13	14	15	16	17	18	Al	Si	P	S	Cl	Ar										
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	32	33	34	35	36	Ga	Ge	As	Se	Br	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	50	51	52	53	54	In	Sn	Sb	Te	I	Xe
6	55	Cs	56	Ba	71	Lu	72	Hf	73	Ta	74	W	75	Re	76	Os	77	Ir	78	Pt	79	Au	80	Hg	81	82	83	84	85	86	Tl	Pb	Bi	Po	At	Rn
7	87	Fr	88	Ra	103	Lr	104	Rf	105	Db	106	Sg	107	Bh	108	Hs	109	Mt	110	Uun	111	Uuu	112	Uub	113	114		116		118	Uut	Uuq	Uuh	Uuo		



57	58	59	60	61	62	63	64	65	66	67	68	69	70
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb
89	90	91	92	93	94	95	96	97	98	99	100	101	102
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No

**Which species is bigger?**

**A tin atom or a bismuth atom**

**Br<sup>-</sup> or Br      NO<sub>2</sub> or SO<sub>2</sub>**

**SO<sub>3</sub> or SO<sub>3</sub><sup>2-</sup>**

1	H																	2	He																
3	Li	4	Be											6	7	8	9	10	B	C	N	O	F	Ne											
11	Na	12	Mg											13	14	15	16	17	18	Al	Si	P	S	Cl	Ar										
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	32	33	34	35	36	Ga	Ge	As	Se	Br	Kr
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	50	51	52	53	54	In	Sn	Sb	Te	I	Xe
55	Cs	56	Ba	71	Lu	72	Hf	73	Ta	74	W	75	Re	76	Os	77	Ir	78	Pt	79	Au	80	Hg	81	82	83	84	85	86	Tl	Pb	Bi	Po	At	Rn
87	Fr	88	Ra	103	Lr	104	Rf	105	Db	106	Sg	107	Bh	108	Hs	109	Mt	110	Uun	111	Uuu	112	Uub	113	114		116		118	Uut	Uuq	Uuh	Uuo		

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La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb
89	90	91	92	93	94	95	96	97	98	99	100	101	102
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No

### Periodic Trend of Electronegativity, $\chi$

A measure of the ability of an atom to attract electrons to itself in a molecule.

1	1 H																	2 He						
2	3 Li	4 Be																	5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg																	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
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	71 Lu	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	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Uub	113 Uut	114 Uuq	116 Uuh	118 Uuo								

57 La	58 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
89 Ac	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

### Electronegativities of Elements on Pauling Scale

Reference:  $\chi_{\text{H}} = 2.2$

H 2.20																	He ---						
Li 0.98	Be 1.57																	B 2.04	C 2.55	N 3.04	O 3.44	F 3.98	Ne ---
Na 0.93	Mg 1.31																	Al 1.61	Si 1.90	P 2.19	S 2.58	Cl 3.16	Ar ---
K 0.82	Ca 1.00	Sc 1.36	Ti 1.54	V 1.63	Cr 1.66	Mn 1.55	Fe 1.8	Co 1.88	Ni 1.91	Cu 1.90	Zn 1.65	Ga 1.81	Ge 2.01	As 2.18	Se 2.55	Br 2.96	Kr ---						
Rb 0.82	Sr 0.95	Y 1.22	Zr 1.33	Nb 1.6	Mo 2.16	Tc 1.9	Ru 2.28	Rh 2.2	Pd 2.2	Ag 1.93	Cd 1.69	In 1.78	Sn 1.96	Sb 2.05	Te 2.1	I 2.66	Xe ---						
Cs 0.79	Ba 0.89	La 1.10	Hf 1.3	Ta 1.5	W 2.36	Re 1.9	Os 2.2	Ir 2.2	Pt 2.28	Au 2.54	Hg 2.00	Tl 2.04	Pb 2.10	Bi 2.02	Po 2.0	At 2.2	Rn ---						
Fr ---	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt															

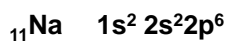
$\chi_{\text{metals}} < 2.0$

$\chi_{\text{semimetals}} \sim 2.0$

$\chi_{\text{nonmetals}} > 2.0$

There are some exceptions

## Simplified Model of Chemical Bonding

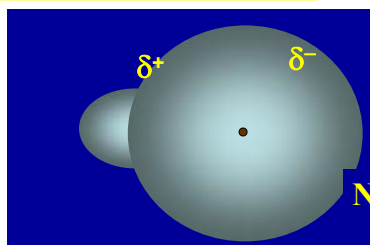


**Ionic bond(s)** --- Attraction between a cation and an anion resulting from the transfer (or partially transfer) of one or more electrons from one atom to the other. Atoms of very different electronegativity form ionic bonds. The greater the difference in electronegativity, the higher ionic character of the bond.

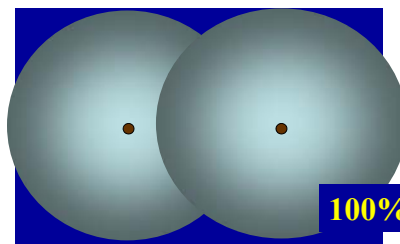
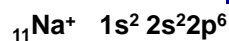
**Covalent bond(s)** --- An interatomic attraction resulting from the sharing of electrons between the atoms. Atoms of similar electronegativities form covalent bonds.

**Metal combines with non-metal to form “ionic compounds”.**  
**Non-metal combines with non-metal to form “covalent compounds”.**

## Simplified Model of Chemical Bonding



No bond is 100% ionic.



100% covalent is possible.

## Electrical Conductivity

**Electricity is conducted by mobile charged particles!**

### For Elements:

- Metals hold valence  $e^-$  loosely (low electronegativity)
- Nonmetals hold valence  $e^-$  tightly (high electronegativity)

### For Solutions:

- Ionic compounds dissociate to form cations and anions in water (mobile charges). Ionic compounds are usually **strong electrolytes**.
- Covalent compounds usually have little or no ionization in water. They are **weak electrolytes** or **non-electrolytes**.

Can ions in solids conduct electricity?

## Electrical Conductivity Demonstration

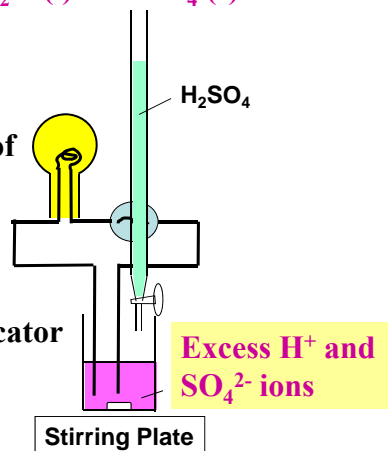


Use a light bulb to indicate the end point of an acid-base titration

Phenolphthalein is an Acid/Base indicator

pink in basic solution

colorless in neutral/acidic solution



### In Experiment 1, you will

1. Check-in your lab drawer (TA presentation will be longer)
2. Measure and compare the relative conductivity of elements
3. Prepare solutions of: ammonium sulfate  $(\text{NH}_4)_2\text{SO}_4$   
sucrose  $\text{C}_{12}\text{H}_{22}\text{O}_{11}$   
acetic acid  $\text{CH}_3\text{COOH}$
4. Compare relative conductivity of solutions and predict types of bonding in solid
5. Molarity calculations

### Tips

Do not bent or twist the legs of the LED circuit boards

When compare the LED brightness, look straight into the LED, not from the side. **Do not compare the brightness of your LED to other students.**

When measure conductivity, be sure to press the solid particles together