Station 1 – Reading the Periodic Table Define the following terms, then label the periodic table with each of them.

1. Period Row
2. Group/family column
3. S-block group 1-2, s orbital valence
4. P-block 13-18
5. D-block 3-12
6. F-block lanthanide/actinide metals
7. Transition metals Metals w/ incomplete d sublevel as atom/ion
8. Alkali metals group 1 reactive metals
9. Alkaline-earth metals group 2 reactive metals
10. Halogens group 17 reactive nonmetals
11. Noble Gases inert gases group 18

s

Periodic Table of the Elements

d

	1 IA	2 IIA	3 IIIV	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VII	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA	
1	1																	2 S	1
2	3	4											5	6	7	8	9	10	2
3	11	12											13	14	15	16	17	18	3
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	4
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	5
6	55	56	57-71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	6
7	87	88	89-103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	7

p

6	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	6
7	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	7

f

☐ Alkali Metals ☐ Alkali Earth Metals ☐ Transition Metals ☐ Other Metals ☐ Metalloids

☐ Other Non Metals ☐ Halogens ☐ Noble Gases ☐ Lanthanides & Actinides

~~Station 2 – Periodicity – Trends on the Table~~ Write the full ground state electron configurations and orbital ~~notations~~

C. Electronegativity and Electron Affinity

1.Arrange the following elements in order of increasing electronegativity.

increasing

a. gallium, aluminum, indium Al, In, Ga

b. calcium 1, selenium 2.6, arsenic 2.2 Ca, As, Se

c. oxygen 3.4, fluorine 4, sulfur 2.6 S, O, F

d. phosphorus 2.2, oxygen 3.4, germanium 2.0 Ge, P, O

2.Will the electronegativity of barium (Ba) be larger or smaller than that of strontium (Sr)? Explain.

Ba ↓ EN; decreases generally as you go down

3.Compare the electronegativity of tellurium (Te) to that of antimony (Sb). Explain your reasoning.

Te ↑ EN slightly because increases across a period due to higher Zeff

4.The family within any period with the greatest negative electron affinity is usually the ______.

a. alkali metals b. transition metal c. halogens (group 17) d. noble gases

5.Contrast ionization energy and electron affinity. In general, what can you say about these values for metals and non metals?

energy for 1 mol gaseous atoms to lose e⁻ 1 mol

energy for 1 mol of gaseous atoms to gain 1 mol e⁻

metals: ↓IE ↓EA

nonmetals: ↑IE ↑EA

6.What is the difference between electron affinity and electronegativity?

electron affinity: gain e⁻

electronegativity: sharing e⁻ pull more tightly in covalent bond

7.If an element has a "large negative" electron affinity number where would it be located on the periodic table?

Nonmetal, right side group 16 or 17

F. Atomic Radius

~~1. Circle the atom in each pair with the larger atomic radius?~~

Li or K   Ca or Ni   Ga or B   O or C

Cl or Br   Be or Ba   Si or S   Fe or Au

Cl   Se   Br

2. Chlorine, selenium, and bromine are located near each other on the periodic table. Which of these elements is the smallest atom and which has the highest ionization energy?

Chlorine smallest & the highest IE — harder to lose e^-, nucleus closer to valence

3. Which of the following atoms is smallest: nitrogen, phosphorus, or arsenic? Which of these atoms has the most negative electron affinity?

N   P   Ar

N smallest, but O is most negative EA, because of electron configuration & Zeff

4. Which of the following is the largest: a potassium atom, a potassium ion with a charge of 1+ or a rubidium atom?

K (200) K^+ (138)

Rb (215)

Rubidium atom

5. Which of the following is the largest: a chlorine atom, a chlorine ion with a charge of 1- or a bromine atom?

(100)   (181)

(117)

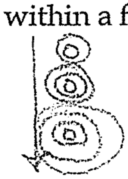
Chlorine ion

6. Which of the following is the smallest: a lithium atom, a lithium ion with a charge of 1+ or a sodium atom?

(130)   (76)   (160)

Li^{+1}

7. Explain why within a family such as the halogens, the ionic radius increases as the atomic number increases.



halogens gain e^- when becoming ions, therefore e^- are added to valence, increasing repulsion & radius

8. In terms of electron configuration and shielding, why is the atomic radius of sodium smaller than that of potassium?

another energy level added, held less tightly due to shielding although valence configuration is same

9. In terms of electron configurations and shielding, why do atoms get smaller as you move across a period?

Moving across, ↑ Zeff, so valence shells are held more tightly, but shielding does not increase

Station 3 – Reactivity of Metals

Practice Using the Activity Series

~~Using the Activity Series Handout, circle the element that is more likely to replace the other in a compound.~~

Sr or Ba Ni or Al F or I Cr or Bi Zn or Cu

Predicting Single Displacement Reactions

Part 1: Write the chemical name for each compound below

Part 2: Use the Activity Series to determine if a reaction will occur.

For those reactions that do occur, predict the products and balance the equation.

If no reaction occurs, write "NR" (No Reaction).

1. Mn + $Cr(NO_3)_2 \rightarrow$ NR (I know Mn isn't on your series) assume manganese (II)

2. Cu + $ZnSO_4 \rightarrow$ NR assume copper (II)

3. H_2 + BiCl $\rightarrow$ Bi + HCl

4. F_2 + KCl $\rightarrow$ KF + Cl_2

5. Fe + $CaSO_4 \rightarrow$ NR assume iron (III)

6. Pb + $Zn(NO_3)_2 \rightarrow$ NR assume lead (II)

7. Co + $H_2O \rightarrow$ H_2 + CoO assume cobalt (II)

8. Zn + $KNO_3 \rightarrow$ NR

9. Ca + $Cd(NO_3)_2 \rightarrow$ Cd + $Ca(NO_3)_2$

10. Sn + $Pb(NO_3)_2 \rightarrow$ $Sn(NO_3)_2$ + Pb assume tin (II)

11. Mg + $HNO_3 \rightarrow$ $Mg(NO_3)_2$ + H_2

Station 4 –Assigning oxidation numbers

1. Assemble a list of rules for assigning oxidation numbers.

(see handout)

2. Determine the oxidation number of each element in the following compounds.

		Oxidation Numbers for each Element					
a.	$SnCl_4$	Sn	+4	Cl	-1		
b.	Ca_3P_2	Ca	+2	P	-3		
c.	SnO	Sn	+2	O	-2		
d.	Ag_2S	Ag	+1	S	-2		
e.	HI	H	+1	I	-1		
f.	N_2H_4	N	-2	H	+1		
g.	Al_2O_3	Al	+3	O	-2		
h.	S_8	S	0				
i.	$\overset{+1}{H}(NO_2)^{-1}$	H	+1	N	+3	O	-2

j. O_2 O 0

k. H_3O^{+1} H +1 O -2

l. ClO_3^- Cl +5 O -2

m. $S_2O_3^{2-}$ S +2 O -2

n. $KMnO_4$ K +1 Mn +7 O -2

o. $(NH_4)_2SO_4$ N -3 H +1 S +6 O -2

3. Determine the oxidation number of carbon in each of the following compounds:

a. methane, CH_4

-4

b. formaldehyde, CH_2O +1 -2

0

c. carbon monoxide, CO -2

+2

d. carbon dioxide, CO_2 -2

+4

4. What is an oxidation number? How is this different than the archaic definition that calls it "the gaining of hydrogen in a reaction involving oxygen"?

prediction of way e⁻ is transferred in compound/ reaction as a charge

doesn't involve e⁻ transfer

Station 5 -Naming Compounds Use the spectra at the station to answer the following questions.

Name these compounds. They may be either ionic or covalent – indicate which are ionic and which are covalent compounds

1) $LiOH$ Lithium hydroxide Bond: I

2) PBr_3 Phosphorus tribromide Bond: C

3) Na_2SO_4 Sodium sulfate Bond: I

4) $(NH_4)_2S$ ammonium sulfide Bond: I

5) $CaCO_3$ Calcium carbonate Bond: I

6) CF_4 carbon tetrafluoride Bond: C

7) $NaNO_3$ sodium nitrate Bond: I

8) P_2S_3 diphosphorus trisulfide Bond: C

9) $Al(NO_3)_3$ aluminum nitrate Bond: I

10) $Mg(OH)_2$ magnesium hydroxide Bond: I

Write the formulas for the following compounds. Remember, they may be either ionic or covalent compounds, so make sure you use the right method!

11) potassium oxide K_2O Bond: I

12) phosphorus tribromide PBr_3 Bond: C

13) calcium hydroxide $Ca(OH)_2$ Bond: I

14) dinitrogen mono sulfide N_2S Bond: C

15) carbon monoxide CO Bond: C

16) diboron tetrahydride B_2H_4 Bond: C

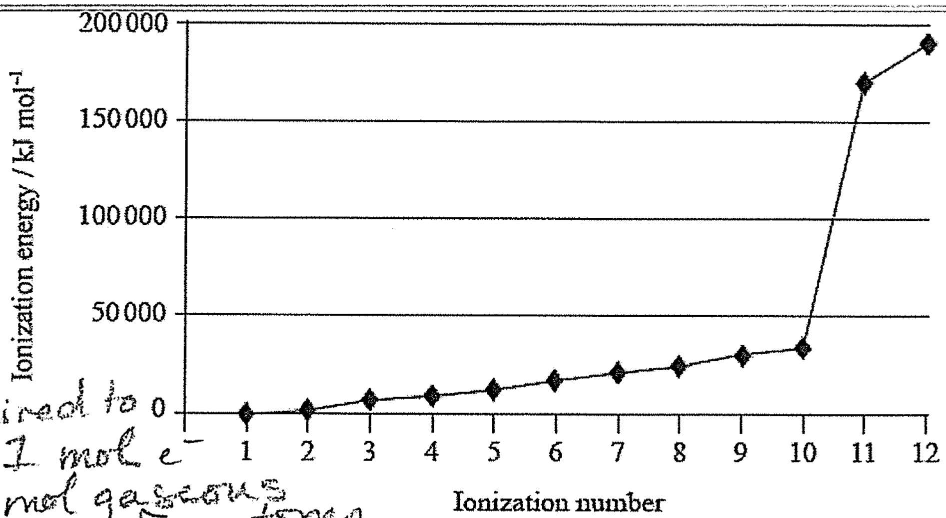
17) phosphorus pentabromide PBr_5 Bond: C

18) sulfur dichloride SCl_2 Bond: C

19) sodium carbonate Na_2CO_3 Bond: I

20) aluminum acetate $Al(CH_3COO)_3$ Bond: I

10. Magnesium is the eighth most abundant element in the earth's crust. The successive ionization energies of the element are shown below.



E required to lose 1 mol e^- from 1 mol gaseous atoms

(i) Define the term *first ionization energy* and state the equation for the first ionization of magnesium.

$Mg_{(g)} \longrightarrow Mg^{+1}_{(g)} + e^-$

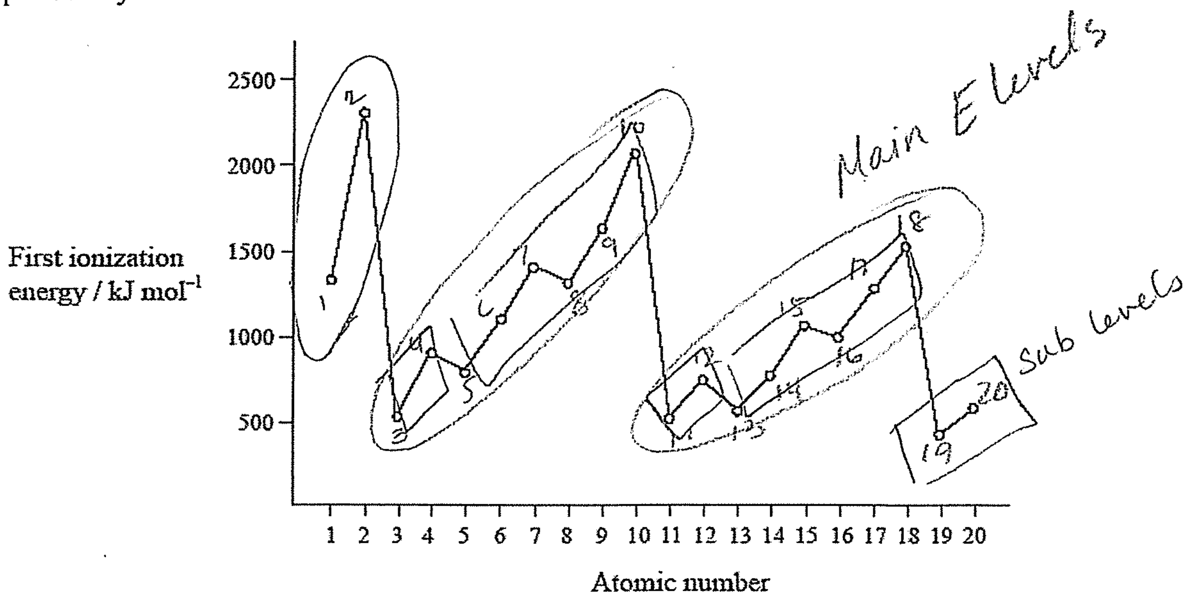
(ii) Explain the general increase in successive ionization energies of the element.

As more e^- are removed, e^- are held more tightly by positive nucleus

(iii) Explain the large increase between the tenth and eleventh ionization energies.

11^{th} e^- to be removed is in the E level closest to nucleus, most tightly held & requires more energy to lose e^-

11. The graph of the first ionization energy plotted against atomic number for the first twenty elements shows periodicity.



(ii) Explain how information from this graph provides evidence for the existence of main energy levels and sub-levels within atoms.

Station 6 – Writing Word Equations

~~1) When dissolved beryllium chloride reacts with dissolved silver nitrate in water, aqueous beryllium nitrate~~ and silver chloride powder are made.

$$BeCl_{2(aq)} + AgNO_{3(aq)} \rightarrow Be(NO_3)_{2(aq)} + AgCl_{(s)}$$

2) When isopropanol (C_3H_8O) burns in oxygen, carbon dioxide, water, and heat are produced.

$$C_3H_8O_{(l)} + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(g)}$$

3) When dissolved sodium hydroxide reacts with sulfuric acid, aqueous sodium sulfate, and water are formed.

$H + SO_4^{2-}$

$$NaOH_{(aq)} + H_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + H_2O_{(l)}$$

4) When fluorine gas is put into contact with calcium metal at high temperatures, calcium fluoride powder is created.

$$F_{2(g)} + Ca_{(s)} \rightarrow CaF_{2(s)}$$

5) When sodium metal reacts with iron (II) chloride, iron metal and sodium chloride are formed.

$$Na_{(s)} + FeCl_{2(aq)} \rightarrow NaCl_{(aq)} + Fe_{(s)}$$

6) Solid sodium oxide is added to water at room temperature and forms sodium hydroxide.

$$Na_2O_{(s)} + H_2O_{(l)} \rightarrow NaOH_{(aq)}$$

7) Solid aluminum metal reacts with aqueous zinc chloride to produce solid zinc metal and aqueous aluminum chloride.

$$Al_{(s)} + ZnCl_{2(aq)} \rightarrow Zn_{(s)} + AlCl_{3(aq)}$$

Station 7 – Ionization Energy

1.What is the definition for first ionization energy? And how is it different from second ionization energy?

energy for 1 mol gaseous atoms to lose 1 mol e^-

E to lose $2e^-$

2.Choose the element with the greatest first ionization energy:

Carbon or aluminum Calcium or strontium Helium or lithium

Chlorine or argon Chlorine or fluorine Sulfur or chlorine

3.Which has the larger first ionization energy: sodium or potassium? Why?

Smaller atom, less E levels, closer valence shell to nucleus, harder to lose outer e^-

4.Explain the difference in first ionization energy between lithium and beryllium.

Be has higher nuclear charge + smaller atomic radius due to ↑ Zeff, therefore ↑IE

5.The first and second ionization energies of magnesium are both relatively low, but the third ionization energy requirement jumps to five times the previous level. Explain.

first $2e^-$ of Mg are in valence, easier to lose than inner e^- held more tightly + closely to nucleus

6.What is the most likely ion for magnesium to become when it is ionized?

Mg^{2+}

7.Compare the first ionization energies for the noble gases.

They are all huge, He the greatest because smallest atom with nucleus closest to valence

8.Compare the first ionization energies for a noble gas with that of a halogen in the same period.

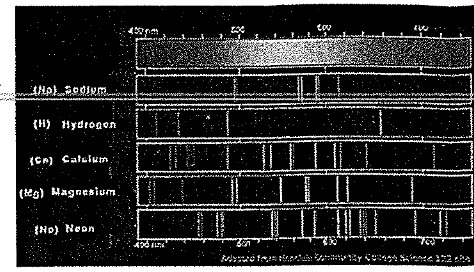
Noble gas is still much higher — greater Zeff

9.Where would the largest jump in ionization energies be for oxygen? (with the loss of how many electrons?)

6th to 7th —

10.How can you tell from a list of ionization energies for an element where a principal (non valence) electron has been removed?

Highest jump in IE



Station 8 – Extension: Relating Ionization Energy to Line Emission Spectra

1. What is the convergence on emission line spectra?

Lines appear very close together, representing the high E levels farther away from nucleus that are close together

2. What do you think is meant by *limit of convergence* on emission line spectra?

Limit = a point beyond which something cannot pass/extend

So must mean, Convergence can't extend pass this limit — the limit of the atom — final shell/E jump

3. Define ionization energy in simple terms.

Energy needed to pull an e^- off an atom

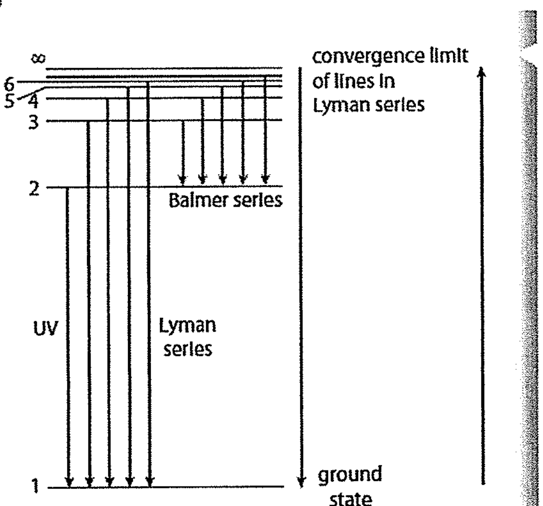


Figure 2.22 The transition from $n = 1$ to $n = \infty$ corresponds to ionization.

8

4. If you were told the "limit of convergence" is determined by the atom's first ionization energy, explain how this makes sense.

e^- can't jump past the "limit of convergence" or past the last E level, or it is pulled off/lost when that amount of energy is added, which must be the ionization energy.