CH 101 - Practice problems – 2/24/2014

The Periodic Table of Elements, Ions and the Ionic Bond.

1. Periodic table and periodic properties of elements
   a. Rank the following species according to their properties. (1 = highest, 4 lowest)

	Se^{2-}	H	Se	C
Radius	1	4	2	3
Ionization Energy	3	1	4	2
Electron Affinity	4	2	1	3
Electonegativity	4	3	1 *	1 *

* Same exact values.

2. Assign to every atom of the following ionic compounds its formal charge.

Ca^{2+} C^{4-} **Ca_2C**

Am^{4+} I^- **AmI_4**

Mn^{7+} P^{3-} **Mn_3P_7**

3. Write two possible compounds for the following pairs of elements.

Sn; O Sn_2O SnO

W; F WF_6 WF_5 WF_4 WF_3 WF_2

4. Calculate the lattice energy of the following crystals:

   i. 2.5g of Cesium Chloride (CsCl) -1.0×10^4 J $= -10.$ KJ

   ii. 14.6g of rutile (TiO_2) -2.34×10^6 J $= -2340$ KJ

5. Fill the table below in, with the missing electron configurations and give an explanation for the trends in the first Ionization Energy; possible trends are :

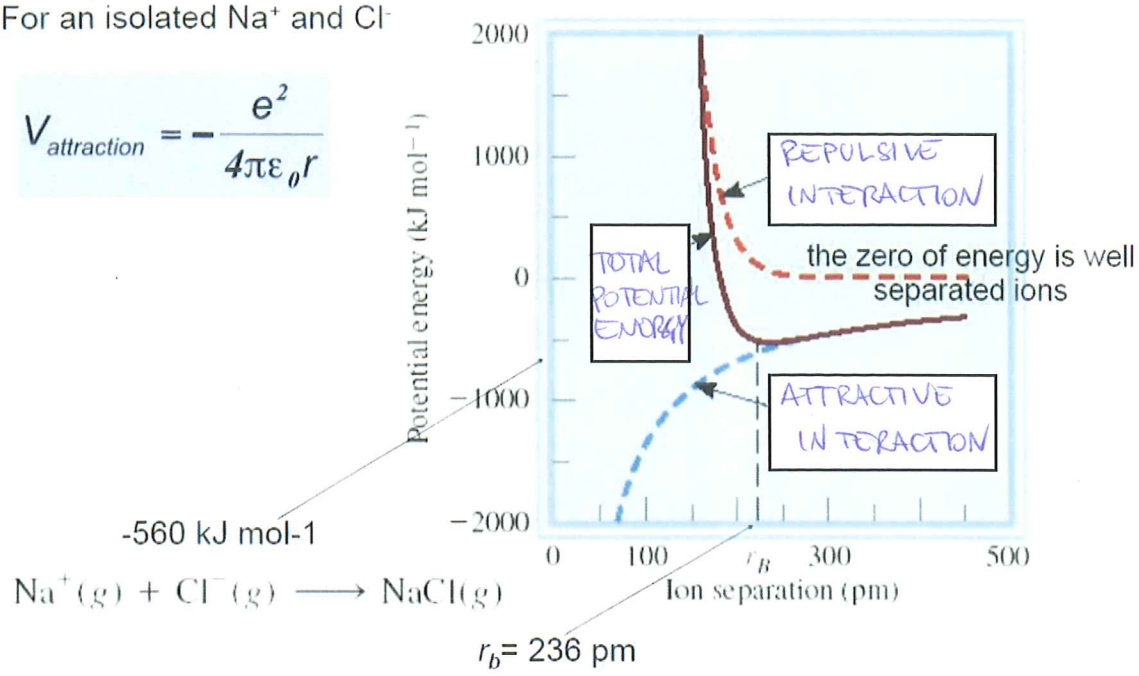
a. Z increases
b. Electron –electron repulsion
c. New shell
d. *l* increases or Z_{eff} decreases (shielding)

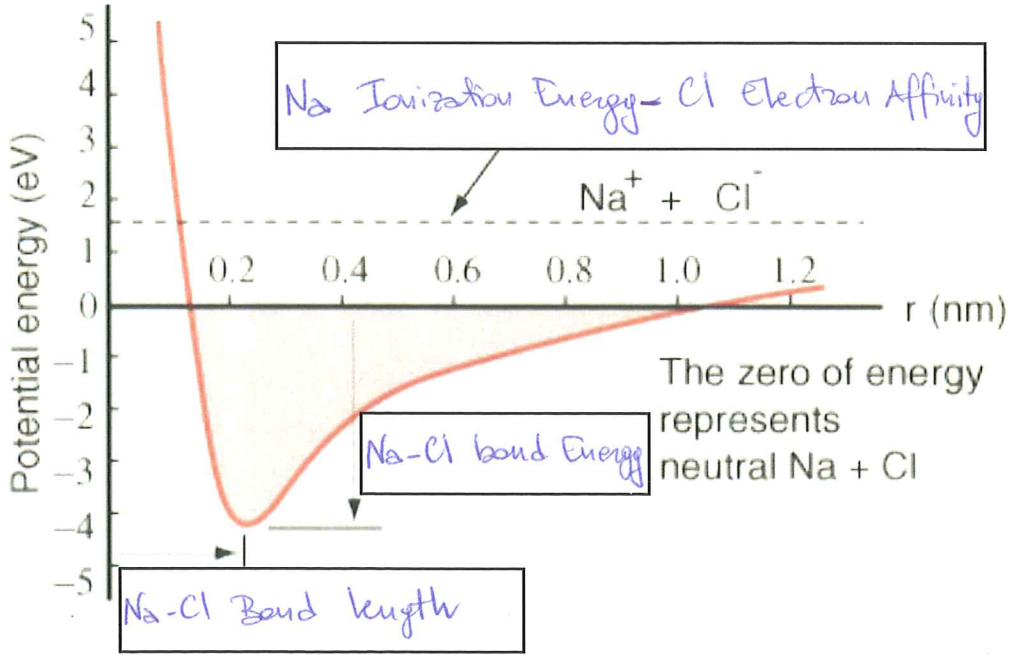
Atom	Z	**Electron configuration**	**IE_1** $\frac{kJ}{mol}$	**Trends in IE_1 Explanation**	**Ions**	**IE_2** $\frac{kJ}{mol}$
He	2	$1s^2$	2373	a.	He^+ $1s^1$	**5248**
Li	3	$1s^2 2s^1$	520	c. d.	Li^+ $1s^2$	**7300**
Be	4	$1s^2 2s^2$	**899**	a.	Be^+ $1s^2 2s^1$	**1757**
B	5	$1s^2 2s^2 2p_x^1$	**801**	d.	B^+ $1s^2 2s^2$	2430
C	6	$1s^2 2s^2 2p_x^1 2p_y^1$	1086	a.	C^+ $1s^2 2s^2 2p_x^1$	**2350**
N	7	$1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$	**1400**	a.	N^+ $1s^2 2s^2 2p_x^1 2p_y^1$	2860
O	8	$1s^2 2s^2 2p_x^2 2p_y^1 2p_z^1$	**1314**	b.	O^+ $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$	**3390**
F	9	$1s^2 2s^2 2p_x^2 2p_y^2 2p_z^1$	1680	a.	F^+ $1s^2 2s^2 2p_x^2 2p_y^1 2p_z^1$	**3370**
Ne	10	$1s^2 2s^2 2p_x^2 2p_y^2 2p_z^2$	2080	a.	Ne^+ $1s^2 2s^2 2p_x^2 2p_y^2 2p_z^1$	3950
Na	11	$[Ne]3s^1$	**496**	c. d.	Na^+ $1s^2 2s^2 2p_x^2 2p_y^2 2p_z^2$	**4560**
Mg	12	$[Ne]3s^2$	738	a.	Mg^+ $[Ne]3s^1$	1450
Al	13	$[Ne]3s^2 3p_x^1$	**578**	d.	Al^+ $[Ne]3s^2$	1820

6. Fill the blank boxes of the pictures below with the appropriate descriptor for the relative curve:

For an isolated Na^+ and Cl^-

$$V_{attraction} = -\frac{e^2}{4\pi\varepsilon_0 r}$$





7. The percent ionic character of a bond can be approximated by the formula $16\Delta\chi + 3.5\Delta\chi^2$, where $\Delta\chi$ is the difference between the Pauling electronegativity values of the two elements. Calculate the % ionic character of the following molecules and give a qualitative explanation (in words) of why that makes sense according to the electron configuration of the atoms/ions.

HF ~ 40 %

HCl ~ 19 %

HBr ~ 14 %

HI ~ 8 %

CsF ~ 87 %

8. Given the following information:

Energy of sublimation of Li(*s*) = 166 kJ/mol

Bond energy of HCl = 427 kJ/mol

Ionization energy of Li(*g*) = 520. kJ/mol

Electron affinity of Cl (*g*) = -349 kJ/mol

Lattice Energy of LiCl(*s*) = -829 kJ/mol

Bond Energy of H_2 = 432 kJ/mol

Energy needed to go from Li(s) to Li(g)

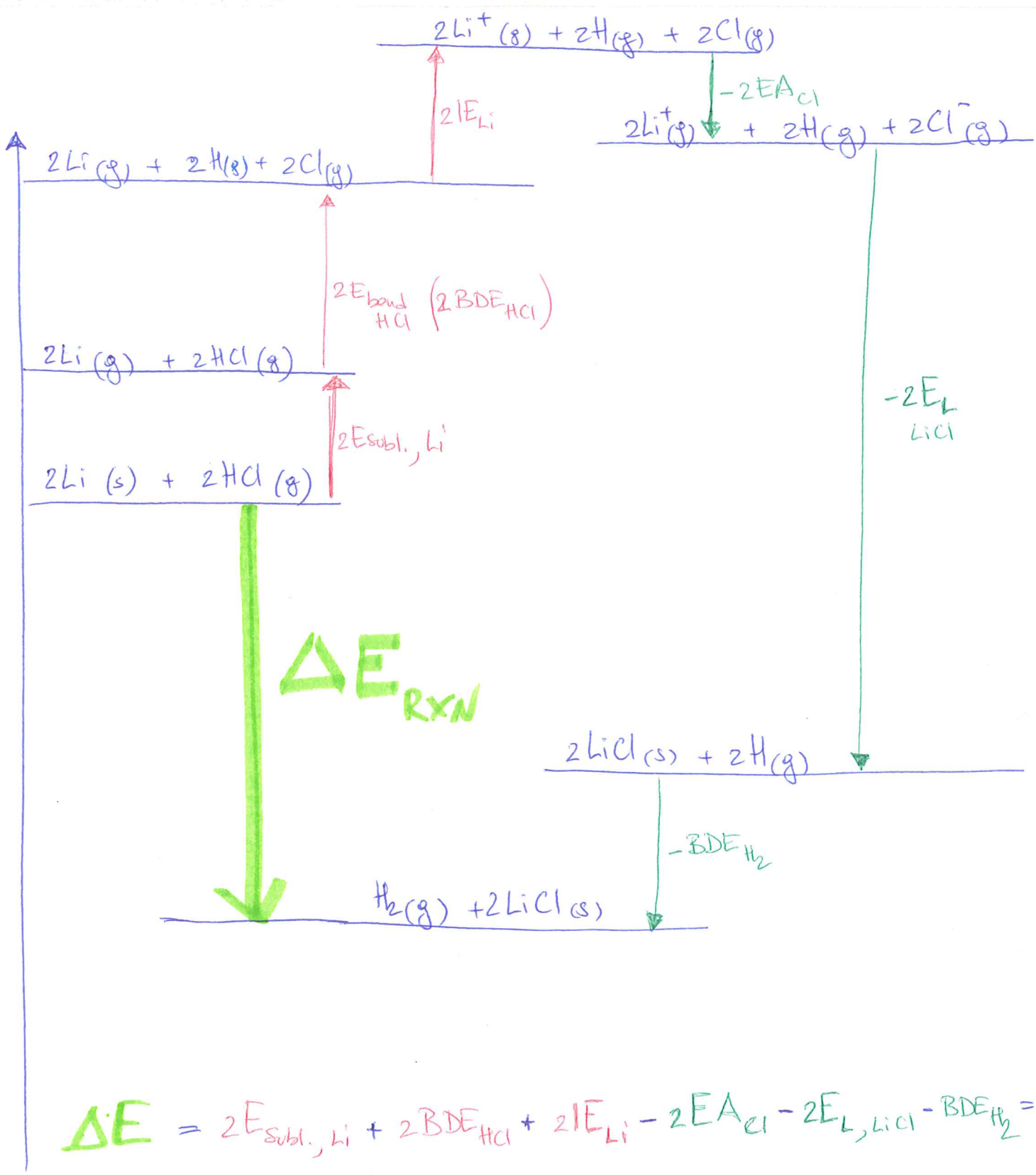
Calculate the net change in energy for the following reaction:

$$2Li\,(s) + 2HCl\,(g) \rightarrow 2LiCl\,(s) + H_2\,(g)$$

$\Delta E = 2E_{sub} + 2E_{bond\ HCl} + 2E_{lattice} + 2IE_{Li} - Energy_{bond\ H_2} + 2EA_{Cl} =$

$= (2\times 166) + (2\times 427) + (2\times 520) - (2\times 349) - 432 - (2\times 829) = -562\ \frac{KJ}{mol}$

See next page →



$$\Delta E = 2E_{subl.,Li} + 2BDE_{HCl} + 2IE_{Li} - 2EA_{Cl} - 2E_{L,LiCl} - BDE_{H_2} =$$

$$= \underline{2\times 166} + \underline{2\times 427} + \underline{2\times 520} - \underline{2\times 349} - \underline{2\times 829} - \underline{432} =$$

$$= \boxed{-562\ \frac{KJ}{mol}}$$