

REVIEW QUESTIONS

## Chapter 9

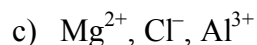
1. For each set shown below, select the atoms or ions that are isoelectronic with each other, and write their electron configuration:



**$\text{K}^+$  and  $\text{Ca}^{2+}$  are isoelectronic [Ne]  $3s^2 3p^6$**

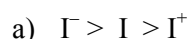


**$\text{S}^{2-}$  and Ar are isoelectronic [Ne]  $3s^2 3p^6$**



**$\text{Mg}^{2+}$  and  $\text{Al}^{3+}$  are isoelectronic  $1s^2 2s^2 2p^6$**

2. Explain each of the following trends in ionic radii:

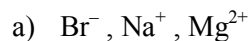


**All species have 5 energy levels.  $\Gamma^-$  has the largest number of electrons (54) and has the largest inter-electron repulsion, making it the largest.  $\text{I}^+$  has the lowest number of electrons (52) and has the lowest inter-electron repulsion, making it the smallest.**

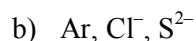


**$\text{Ca}^{2+}$  has 3 energy levels,  $\text{Mg}^{2+}$  has 2 energy levels, while  $\text{Be}^{2+}$  has only one energy level. Therefore  $\text{Ca}^{2+}$  is the largest and  $\text{Be}^{2+}$  is the smallest.**

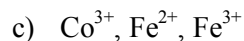
3. Arrange the atoms or ions in each of the following sets in order of increasing radius:



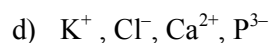
**$\text{Mg}^{2+} < \text{Na}^+ < \text{Br}^-$**



**$\text{Ar} < \text{Cl}^- < \text{S}^{2-}$**



**$\text{Co}^{3+} < \text{Fe}^{3+} < \text{Fe}^{2+}$**

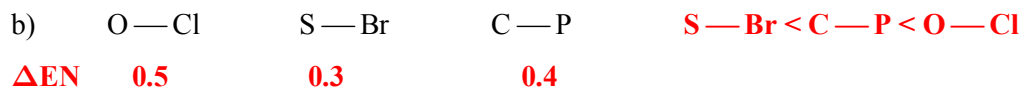
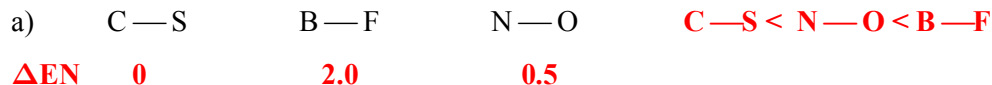


**$\text{Ca}^{2+} < \text{K}^+ < \text{Cl}^- < \text{P}^{3-}$**

**In an isoelectronic series size increases as the  $Z_{\text{eff}}$  decrease (charge becomes less positive)**



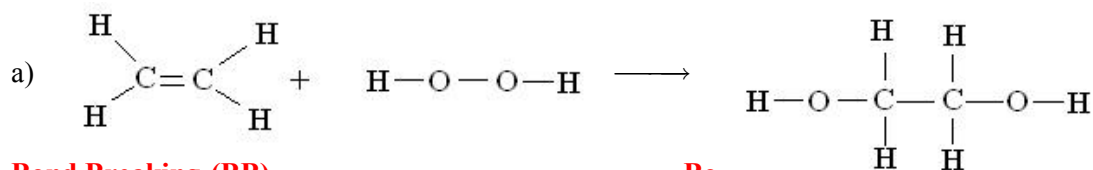
6. Arrange the bonds in each of the following sets in order of increasing polarity:



7. Classify each of the following bonds as ionic, polar covalent or non-polar covalent:



8. Use bond energies listed in Table 9.5 in your textbook to find  $\Delta H$  for the reactions shown below:



Bond Breaking (BB)

**C=C    1 x 602 = 602 kJ**

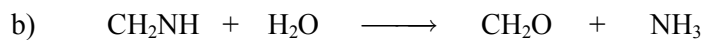
**O—O    1 x 142 = 142 kJ**

Bond Forming (BF)

**C—C    1 x 346 = 346 kJ**

**C—O    2 x 358 = 716 kJ**

**$\Delta H = \Sigma BB - \Sigma BF = (602+142) - (346+716) = -318 \text{ kJ}$**



Bond Breaking (BB)

**C=N    1 x 615 = 615 kJ**

**O—H    2 x 459 = 918 kJ**

Bond Forming (BF)

**C=O    1 x 745 = 745 kJ**

**N—H    2 x 386 = 772 kJ**

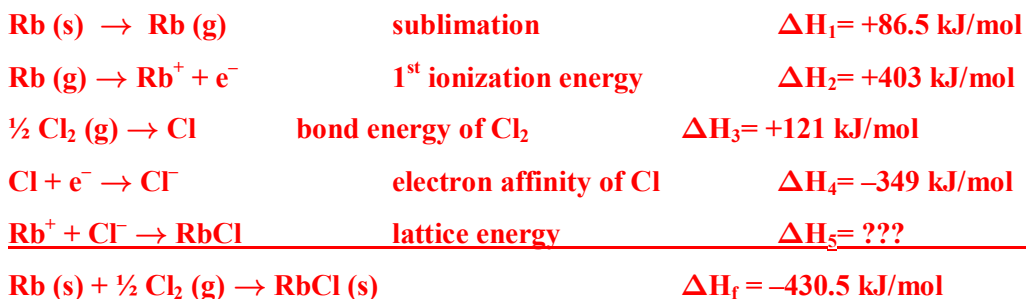
**$\Delta H = \Sigma BB - \Sigma BF = (615+918) - (745+772) = +16 \text{ kJ}$**

9. Use the data provided below to calculate the lattice energy of RbCl. Is this value greater or less than the lattice energy of NaCl? Explain.

Electron affinity of Cl = -349 kJ/mol  
 1<sup>st</sup> ionization energy of Rb = 403 kJ/mol  
 Bond energy of Cl<sub>2</sub> = 242 kJ/mol  
 Sublimation energy of Rb = 86.5 kJ/mol  
 $\Delta H_f [\text{RbCl (s)}] = -430.5 \text{ kJ/mol}$



This equation can be written as the sum of the following:



$$\Delta H_f = \Delta H_1 + \Delta H_2 + \Delta H_3 + \Delta H_4 + \Delta H_5$$

$$\begin{aligned} \text{Lattice energy} = \Delta H_5 &= \Delta H_f - (\Delta H_1 + \Delta H_2 + \Delta H_3 + \Delta H_4) \\ &= -430.5 - (86.5 + 403 + 121 - 349) \\ &= -692 \text{ kJ} \end{aligned}$$

This value would be expected to be smaller than NaCl (-786 from notes 9A). This is because Rb is a larger ion than Na and would be further apart from the anion. Lattice energy is inversely proportional to the distance between the ions.

10. Arrange the following compounds in order of increasing lattice energy:

NaF      CaO      CsI



Calcium has a +2 ion and oxygen has -2 ion, while both NaF and CsI possess +1 and -1 charges. Since lattice energy is directly proportional to the charges, CaO would have the largest value.

Sodium ion and fluoride ions are smaller than cesium and iodide ions. Since lattice energy is inversely proportional to the size of the ions, CsI would have the lowest value.