Chemistry 362 Mini-EXAM III
Chapters 4,5

Thursday October 17, 2019

Professor Kim R. Dunbar

NAME: _____
ID: _____

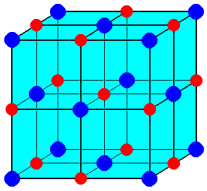
Total Points on Exam is 50 points

1. (12pts)

(a) From radius ratios, what is the expected crystal form or structure type of NaBr? (Na=0.95, Br=1.95) (2pts)

0.95/1.95 = 0.487
Rock salt structure, CN = 6

(b) Draw the unit cell for NaBr (2pts)



must draw entire unit cell, not 1/8 of it
blue = sodium
red = bromide

(c) Fill in the following chart (2pts)

	# corner atoms	#edge atoms	#face atoms	#internal atoms
Sodium	**8**	**0**	**6**	**0**
Bromide	**0**	**12**	**0**	**1**

(d) What is the contribution to a unit cell from a lattice point that is located (4pts)

i) in the corners of the unit cell?
1/8
ii) in the faces of the unit cell?
1/2
iii) in the edges of the unit cell?
1/4
iv) in the interior of the unit cell?
1

(e) How many atoms in total are contained inside the unit cell of NaBr? (2pts)
(8 x 1/8) + (12 x 1/4) + (6 x 1/2) + (1 x 1) = 8

2. (6 pts)

Name the six types of ionic solids described in the lectures? (Hint: 4 are of the AB type and 2 are of the AB_2 type)

Rock salt (NaCl), Cesium chloride (CsCl), Fluorite (CaF_2), Rutile (TiO_2), Zinc Blende (cubic ZnS), Wurtzite (hexagonal ZnS)

3. (4pts)

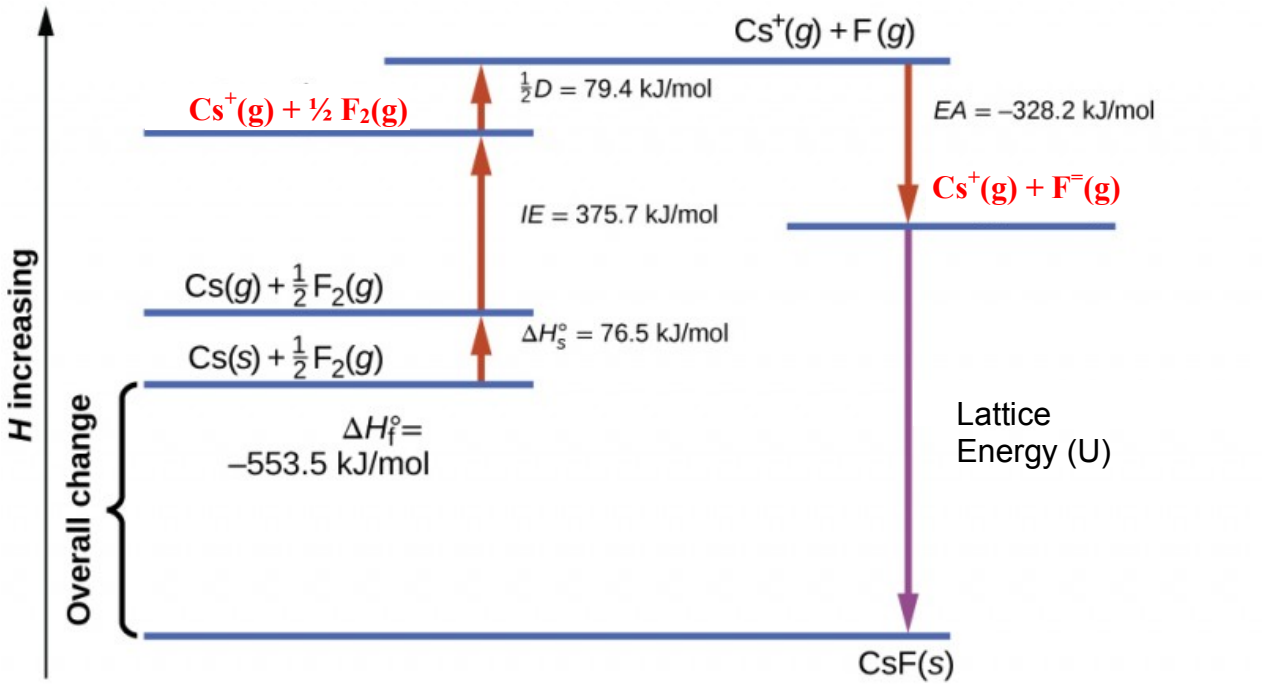
What are the two major consequences of having a very small cation and a large anion combinations?

1) The anhydrous salts are not stable – they prefer to have the cation surrounded by water. This means they are very water soluble compared to salts with bigger cations (consider Li+ vs Na+ solubilities)
2)They can be thermally unstable. The anion can decompose to a smaller one.

4. (14 pts)

Below is the Born-Haber cycle for CsF which is labeled with the types of reactions involved and their delta H values for each reaction.

(a) Write the **two missing chemical reactions** directly onto the diagram (4pts)



(b) Calculate the Lattice Energy (U) from the information provided. *Show all work (*4 pts)

U = -756.9 kJ/mol

(c) Define Lattice Energy. How do you determine it experimentally? (6 pts)

Enthalpy (ΔH) of forming a solid ionic compound from gaseous ions. The lattice formation enthalpy is the enthalpy change when 1 mile of solid crystal is formed from its gaseous ions.

Determine it experimentally using the Born-Haber cycle. Cannot measure U directly, but can calculate it from all the steps in the Born Haber cycle. All the other enthalpies have been experimentally determined.

5. (4 pts)

What are the four main **categories** of anions? Give an example of each (4 pts)

1. Oxides, Hydroxides, Alkoxides (Discrete, molecular species)
2. Polymeric Oxides (also includes larger polynuclear ones)
3. Halogen – Containing Anions
4. Sulfide and Hydrosulfide Anions

many correct answers for the examples.

6. (10 pts)

(a)What are the three main categories of oxides? Give an example of each (3pts)

Basic (alkali or alkali earth metal + O)
Acidic (most of p block + O)
Amphoteric (most transition metals and lower half of p-block)

Many correct answers for the examples.

Will accept that polymeric oxides are a category of oxides. However, note than an oxide is a binary compound of O^{2-} with some other element or group. Do not be confused between oxides and types of oxo anions.

(b) Are Group IA oxides of the elements acidic or basic? (1pt)

Basic

(c) Write the full, balanced chemical equation for the reaction of sodium oxide with water. (2pts)

Na_2O (s) + H_2O (l) → 2 NaOH (aq)

(d) How can you predict if a transition metal oxide will be acidic, basic or amphoteric? In other words, what is the trend? (4pts)

The higher the oxidation state of the metal, the more covalent (acidic) it will be.
The lower the oxidation state of the metal, the more ionic (basic) it will be.