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Office Hour: Tu 5-6pm Location: Bixby Common

Chem 4A Scholars Worksheet 2 Solution

Ionic Bonding and Electronegativity

Equations and useful constants:

$$F = -k\frac{q_1 q_2}{r^2} = -\frac{q_1 q_2}{4\pi\varepsilon_0 r^2} \qquad U = k\frac{q_1 q_2}{r} = \frac{q_1 q_2}{4\pi\varepsilon_0 r} \qquad e = 1.609 \times 10^{-19}\ C$$

$$k = 8.988 \times 10^9\ C^{-2}N\,m^2 \quad \varepsilon_0 = 8.854 \times 10^{-12}\ C^2N^{-1}m^{-2}$$

Ionic Bonding:

Questions:

1. *Warm up: Calculate the energy of a pair of Ca^{2+} and O^{2-} separated by 10.0 Å.*

$$U = k\frac{q_1 q_2}{r} = k\frac{2e \times (-2e)}{r} = k\frac{4e^2}{r}$$

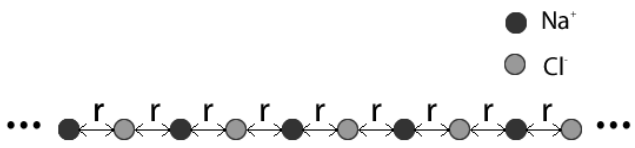
$$= -(8.988 \times 10^9)\frac{4 \times (1.608 \times 10^{-19})^2}{10.0 \times 10^{-10}} = -9.31 \times 10^{-19}\ J$$

2. *If the above two ions are brought together to 5.00 Å, will energy be released or absorbed. Find the energy.*

$$U = k\frac{q_1 q_2}{r} = k\frac{2e \times (-2e)}{r} = -k\frac{4e^2}{r}$$

$$= -(8.988 \times 10^9)\frac{4 \times (1.608 \times 10^{-19})^2}{5.00 \times 10^{-10}} = -1.86 \times 10^{-18}\ J$$

3. *Infinitely long NaCl chain. Imagine there are an infinitely long chain of alternating Na^+ and Cl^-, each separated by distance r, (i)write an expression for the potential energy felt by a Na^+ atom in the chain in r and necessary constant. Try use summation symbol to have a clear representation. (Extra Credit: If you have learned Taylor expansion in AP Calculus, try to write an analytical expression for the series) (ii) if r=2.80 Å, calculate the potential in J.*



$$-2k\frac{e^2}{r}\sum_n (-1)^n\frac{1}{n} = -2\,ln(2)k\frac{e^2}{r} = -2(8.988 \times 10^9) \times 0.6931 \times \frac{(1.608 \times 10^{-19})^2}{2.80 \times 10^{-10}} =$$

$$= -1.15 \times 10^{-18}\ J$$

Electronegativity:

4. *Rank the following elements by their electronegativity from lowest to highest: Na, Br, Fe, C, O, F, K, Cs.*

Cs<K<Na<Fe<C<Br<O<F

5. *Rank the the above elements in Ionization energy.*

Cs<K<Na<Fe<C<Br<O<F

6. *Is EA positive or negative?*

Positive, EA is the energy released by an atom when it takes an electron. Gaining electrons will release energy.