TOPIC: 2.3 STRUCTURE OF IONIC SOLIDS

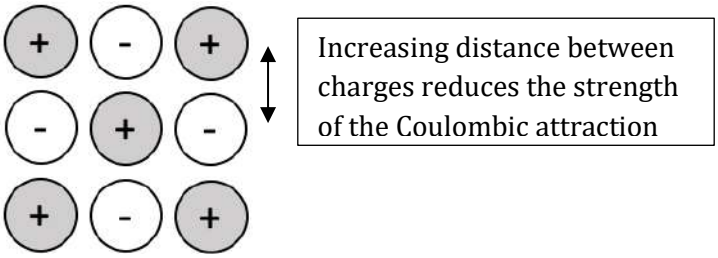
ENDURING UNDERSTANDING:	
SAP-3	Atoms or ions bond due to interactions between them, forming molecules
LEARNING OBJECTIVE:	
SAP-3.C	Represent an ionic solid with a particulate model that is consistent with Coulomb's law and the properties of the constituent ions
ESSENTIAL KNOWLEDGE:	
SAP-3.C.1	The cations and anions in an ionic crystal are arranged in a systematic, periodic 3-D array that maximizes the attractive forces among cations and anions while minimizing the repulsive forces. XX – Knowledge of specific types of crystal structures will not be assessed on the AP exam
EQUATION(S):	
Coulomb's Law	$F = \frac{k*q_1*q_2}{r^2}$

NOTES:

Ionic solids consist of cations (+ positive charge) and anions (- negative charge). Discrete ionic molecules do not exist. Instead, a repeating array of molecules are held together by strong Coulombic forces (ionic bonds) between oppositely charged ions adjacent to one another. The following properties are due to this arrangement:

1) Ionic solids are nonvolatile and have high melting points – ionic bonds must be broken to melt the solid, which separates oppositely charged particles. This requires very high temperature to give the particles enough kinetic energy.
2) Ionic solids do not conduct electricity – the charged ions are fixed in place. When melted or dissolved in solution, the ions become free to move about, enabling electrical conduction.
3) Many ionic compounds are soluble in polar solvents like water and insoluble in non-polar solvents like benzene.

Relative strength of different ionic bonds can be estimated from Coulomb's Law. Coulomb's Law states that the force is proportional to each of the charges and inversely proportional to the distance squared. Therefore, calcium oxide (CaO, +2 and -2) has a much stronger bond that sodium chloride, NaCl. This manifests in the melting points of each compound (2927 °C for CaO versus 801 °C for NaCl). Similar reasoning can be used to compare ionic compounds with varying internuclear distances. Because chloride is smaller than bromide, sodium chloride, NaCl, has a higher melting point (801 °C) than sodium bromide, NaBr (747 °C).



I DO:

Why does KBr (672 kJ/mol) have a higher lattice energy than KI (632 kJ/mol)?

Bromide ions (Br-) have a smaller ionic radius than iodide ions (I-). This results in a smaller distance between the potassium ion and the bromide ion. The smaller distance increases the coulombic attraction resulting in higher lattice energy.

WE DO:

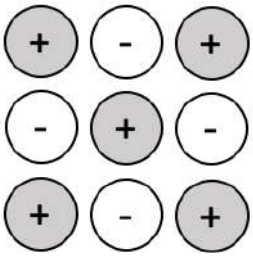
Draw a particle diagram of rubidium iodide. Be sure to include relative sizes.

SCAN ME

YOU DO:

1) An ionic solid does not conduct electricity, but does conduct electricity when dissolved in water. Which of the following explains why?
   a. Water is polar so it readily conducts electricity. The ionic solid does not play a role.
   b. The ionic solid has too small of spaces between particles for electricity to flow. Water moves the particles apart enough to conduct electricity.
   c. Ionic solids do not have free movement of ions. When dissolved, the ions are free moving. This allows electricity to flow.
   d. Ionic solids are too big to conduct electricity. When dissolved, the solid gets smaller and then can conduct electricity.

2) The following particle diagram represents KF. Construct a particle diagram that represents NaCl.



3) The energy required to dissociate an ionic solid into gaseous ions is known as the lattice energy. Sodium chloride, NaCl, has a lattice energy of 787.3 kJ/mol. Sodium oxide, Na_2O has a lattice energy of 2564 kJ/mol. Which explanation best accounts for this difference?
   a. Chloride has a smaller ionic radius than oxide, resulting in a lower lattice energy.
   b. Chloride cannot form hydrogen bonds.
   c. There are two sodium ions in the chemical formula, meaning there are more ions that need to become a gas.
   d. Oxygen has a -2 charge, whereas Cl has a -1 charge. This results in a stronger attraction for Na_2O.

4) Which of the following would represent an ionic solid? What is wrong with the others?