Name_____ H. Chem, Period_____

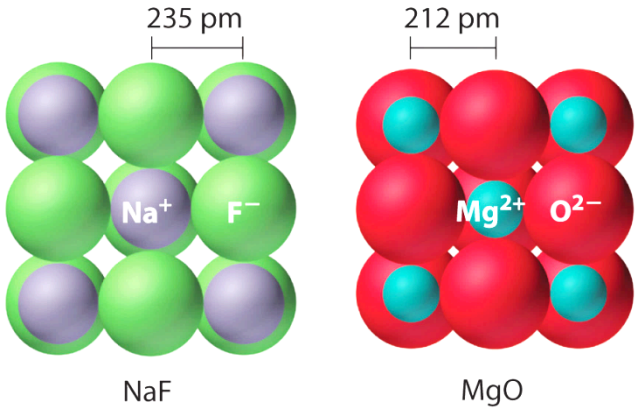
Lattice Energy in Ionic Compounds

Lattice energy is the energy contained in an ionic crystal. Energy is released (-) when the crystal comes together, and energy is absorbed (+) when the crystal dissociates. The equation for lattice energy is below:

$$Lattice\ Energy = \frac{kQ_1Q_2}{r}$$

- Q_1 and Q_2 stand for the charges on the ions in the compound
- R stands for the distance between the ions in the compound

Lattice energy is greater when the ions have larger charges and a smaller distance between the ions.



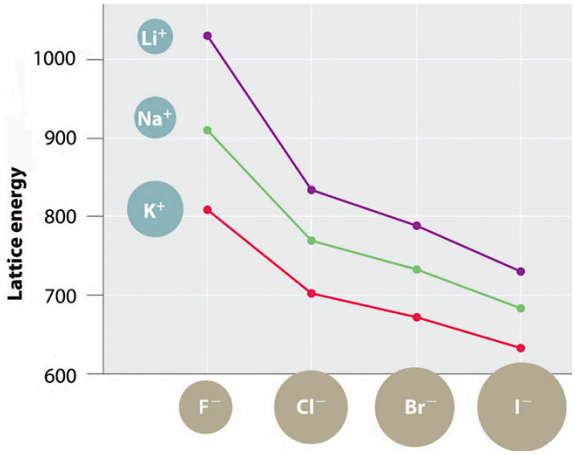
Use the information above to answer the following questions about lattice energy.

1. What two things affect lattice energy? Which of the figures above would have greater lattice energy?
Lattice energy is dependent upon the charge of the ions and the distance between ions. The greater the charge, the greater the lattice energy required for the salt to dissociate (or released when the lattice forms). The shorter the distance between ions, the greater the lattice energy. MgO would have the greatest lattice energy as it has a higher charge and a shorter distance between ions.

2. If a crystal structure is to be more stable and have a stronger bond, what type of charges do the ions have to have? What does the distance between the ions need to be?

A crystal lattice structure is more stable and has a stronger bond if it has higher lattice energy. Thus, the charges are typically greater than +/- 1 and/or the distance between the ions should be shorter.

Use the graph below to answer questions 3-4.



3. What is the lattice energy for KCl? Use your notes to determine the units. What does it mean that the lattice energy is positive? Is the lattice energy of KCl greater or less than LiCl? Explain?

The lattice energy for KCl is 700 kJ/mol. Since lattice energy is positive, it indicated the energy required for 1 mole of the salt to dissociate. The lattice energy for KCl is less than that of LiCl because even though the Cl^- is the same, the cation of Li^+ is much smaller than potassium shortening the bond length in the lattice structure. The closer the ions are to each other, the greater the lattice energy.

4. What happens to lattice energy as the size of the ion increases? Explain.

As the lattice energy is inversely related to size, the smaller radii nuclei more strongly attracted to opposite electrons and the bond length is smaller. The smaller radii and bond length increase the lattice energy making the bond more stable.

5. The radius of the Ca atom is 197 pm; the radius of the Ca^{2+} ion is 99 pm. Account for the difference.
When two electrons are removed from the valence shell, the Ca radius loses the outermost energy level and reverts to the lower $n = 3$ level, which is much smaller in radius. There are more protons than electrons and the remaining electrons can be attracted to the nucleus.

6. The lattice energy of CaO(*s*) is –3460 kJ/mol; the lattice energy of K_2O is –2240 kJ/mol. Account for the difference.

The +2 charge on calcium pulls the oxygen much closer compared with K, thereby increasing the lattice energy relative to a less charged ion