# Example: Melting Points of BeO through SrO

Which compound would you expect to have the highest melting point?

- [x] BeO
- [ ] MgO
- [ ] CaO
- [ ] SrO

BeO minimizes the sum of the ionic radii of the anion and cation.

Example: Relative melting points of compounds

~~Which of the following~~ Which compound would you expect to have the lowest melting point?

- MgO
- BeS
- NaCl
- X KCl

For this problem, we would like to maximize the sum of ionic radii. We see that BeS has a smaller atomic radius than MgO, thus we cross it out. Now compare it to the maximum of the chlorides; KCl.
KCl's radius sum is clearly larger, thus it has the lowest melting point.

# Example: Atomic Radii of atoms and ions

Which atom or ion would you expect to have the smallest radius?

- Ne
- $F^-$
- X $Na^+$
- $Ne^-$

$Ne^-$ is right out; it is the only one with an electron occupying an orbital with pqn = 3. Of the three remaining, all ~~have~~ have their highest energy electrons in the 2p orbital, $Na^+$ has the highest proton:electron ratio and thus pulls the cloud of probability in closest.

Example: Ionization energy of Li, Na, K, and Mg

Which atom would you expect to have the highest second ionization energy?

X | Li
  | Na
  | K
  | Mg

Lithium; its second ionizat is the ionization of Helium, the highest ionization on the periodic table.

## Example: Bond Energy of KI

What is the magnitude of the energy of a bond formed between a $K^+$ and an $I^-$? The ionic radii of $K^+$ and $I^-$ are 152 pm and 206 pm respectively. Assume the Born exponent $n = 10$.

Recall that $$E_{BE} = \frac{-Q_+ Q_- e^2}{4\pi \varepsilon_0 r_0}\left(1 - \frac{1}{n}\right)$$

Then insert

$$E_{BE} = \frac{e^2}{4\pi (8.854 \cdot 10^{-12})(152 + 206 \text{ pm}) \cdot 10^{-12}} \cdot 0.9$$

$$\cancel{= -1.44 \cdot 10^{-39}}$$

$$= 3.62 \cdot 10^{-19} \text{ J}$$

Example: Cohesive Energy

Calculate the magnitude of the cohesive energy of KI. The ionic radii of $K^+$ and $I^-$ are 152 pm and 206 pm respectively. Assume the Born exponent n is 10. Assume a madelung constant of 1.7.

Recall the formula

$$E_{tot} = \frac{-N_A Q_+ Q_- e^2 M}{4\pi \varepsilon_0 r_0}\left(1-\frac{1}{n}\right)$$

Insert,

$$E_{tot} = \frac{N_A e^2 \, 1.7}{4\pi \varepsilon_0 (358\cdot 10^{-12})} \cdot 0.9$$

$$= \cancel{32.074\ kJ/mol}$$

$$= \cancel{59.302}\ 594\ kJ/mol$$

# Example: Ionic radius of cesium

Estimate the radius of the cesium ion $Cs^+$. The lattice energy of cesium chloride, $CsCl$, is 633 kJ/mol. For $CsCl$, the Madelung constant $M$ is 1.763, and the Born exponent $n$ is 10.7. The radius of $Cl^-$ is known to be 1.81Å. Express your answer in angstroms.

We must solve

$$-633{,}000 = \frac{-N_a \cdot 1.763 \cdot e^2}{4\pi \varepsilon_0 (r_{Cs} + 1.81Å)} \left(1 - \frac{1}{10.7}\right)$$

$$\Longrightarrow$$

$$r_{Cs} + 1.81\,Å = 3.50\,Å$$

$$r_{Cs} = 1.69\,Å$$