CONCEPT: LATTICE ENERGY

● **Lattice Formation Energy**: change in energy when separated gaseous ions combine to form an ionic _____.

$$Na^+ (g) + Cl^- (g) \longrightarrow \_\_\_\_\_ \quad \Delta H^\circ_{latt} = -787.3$$

□ **Exothermic Reaction**: Reaction *releases* energy in order to create a bond.

- More _____ lattice energy value = more exothermic reaction.

EXAMPLE: The lattice formation of $MgBr_2$ is the energy change for which one of the following processes?

I. $Mg (s) + Br_2 (g) \longrightarrow MgBr_2 (s)$

II. $Mg (g) + 2\ Br (g) \longrightarrow MgBr_2 (s)$

III. $Mg^{2+} (g) + 2\ Br^- (g) \longrightarrow MgBr_2 (s)$

IV. $Mg^{2+} (g) + 2\ Br^- (g) \longrightarrow MgBr_2 (g)$

V. $MgBr_2 (aq) \longrightarrow MgBr_2 (s)$

a) I b) II c) III d) IV e) V

● **Lattice Dissociation Energy**: change in energy of _____ mole of solid crystal as it is scattered into gaseous ions.

$$\_\_\_\_\_ \longrightarrow Na^+ (g) + Cl^- (g) \quad \Delta H^\circ = +787.3$$

□ **Endothermic Reaction** : Reaction *absorbs* energy in order to create a bond.

- More _____ lattice energy value = more endothermic reaction.

EXAMPLE: Which of the following reactions is associated with the lattice dissociation of Li_2O?

I. $2\ Li^+ (g) + O^{2-} (g) \longrightarrow Li_2O (s)$

II. $2\ Li (s) + O_2 (g) \longrightarrow Li_2O (s)$

III. $2\ Li^+ (g) + O^{2-} (aq) \longrightarrow Li_2O (s)$

IV. $Li_2O (s) \longrightarrow 2\ Li^+ (g) + O^{2-} (g)$

V. $Li_2O (s) \longrightarrow Li (g) + O_2 (g)$

a) I b) II c) III d) IV e) V

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Lattice Energy Formula

● By simplifying Coulomb's Law, a general formula for lattice energy can be used to determine ionic bond strength.

□ The ⇧ the lattice energy then the _____ the ionic bond.

Lattice Energy

Lattice Energy Formula

$$\text{Lattice Energy} = \frac{Q_1 Q_2}{r} \mu \frac{|\text{Cation Charge} \bullet \text{Anion Charge}|}{\text{Cation Radius} + \text{Anion Radius}}$$

□ Radius of the ion = _____ or Row on the Periodic Table

EXAMPLE: Which compound possesses the strongest ionic bond: $MgBr_2$ or KCl?

PRACTICE: The lattice energy for ionic crystals decreases as the charge of the ions _____ and the size of the ions _____.

a) Increases, increases b) Increases, decreases c) Decreases, increases d) Decreases, decreases

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Physical Properties

● The lattice energy of an ionic solid has a direct impact on its physical properties.

□ Recall, an ⇧ in the lattice energy causes an ____ in the strength of an ionic bond.

- An ⇧ in the lattice energy ____ the boiling point, ____ the melting point, and ____ the solubility.

EXAMPLE: Choose the compound below that should have the highest melting point according to the ionic bonding model.

a) AlN b) NaF c) MgO d) NaCl

PRACTICE: Which of the following compounds would you expect to have the highest boiling point?

a) $MgCl_2$ b) SrO c) $SrCl_2$ d) CsI e) LiBr

PRACTICE: The solubilities of $CaCrO_4$ and $PbCrO_4$ in water at 25 ºC are approximately 0.111 g/L and 0.0905 g/L in H_2O respectively. Based on this information, which compound do you think has the smaller lattice energy?