KTT 111 : Inorganic Chemistry 1 : Model Answers
Sem 1 : 2005/2006 : Q5d : CHEMICAL BONDING
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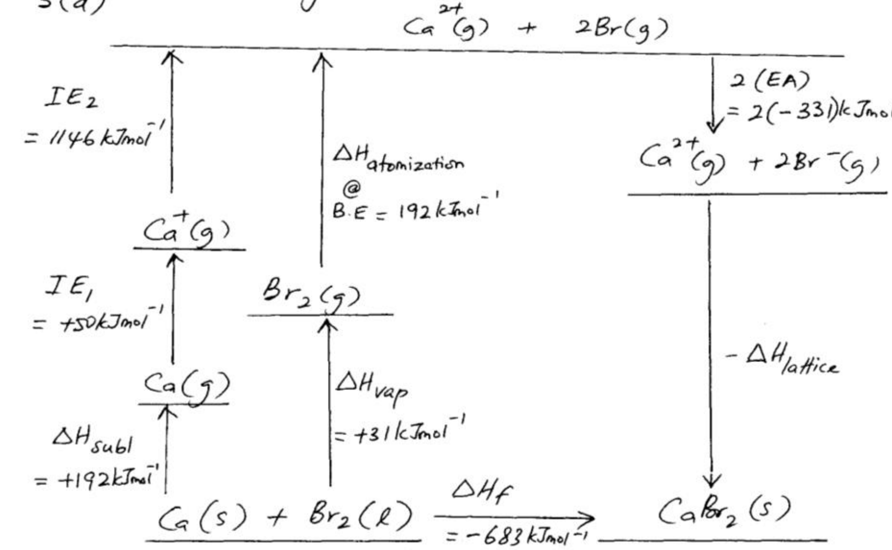
Sem 1 (2005/2006): Chemical Bonding

Q5(d) Born-Haber cycle.



$$\Delta H_f = \Delta H_{subl} + \Delta H_{vap} + IE_1 + IE_2 + \Delta H_{atom} + 2(EA) + (-\Delta H_{lattice})$$

$$-683 = (+192) + (+31) + (+50) + (+1146) + 192 + 2(-331) - \Delta H_{lattice}$$

$$-683 = 949 - \Delta H_{lattice}$$

$$\therefore \Delta H_{lattice} = 1632\ kJmol^{-1}$$

$$CaBr_2(s) \longrightarrow Ca^{2+}(g) + 2Br^-(g)\ ;\ \Delta H_{lattice} = +1632\ kJmol^{-1}\ (Ans)$$

Alternative Method:

$Ca(s) \longrightarrow Ca(g)$;	$\Delta H_{subl} = +192\ kJmol^{-1}$	
$Ca(g) \longrightarrow Ca^+(g) + e$;	$IE_1 = +50\ kJmol^{-1}$	
$Ca^+(g) \longrightarrow Ca^{2+}(g) + e^-$;	$IE_2 = +1146\ kJmol^{-1}$	
$Br_2(l) \longrightarrow Br_2(g)$;	$\Delta H_{vap} = +31\ kJmol^{-1}$	+
$Br_2(g) \longrightarrow 2Br(g)$;	$\Delta H_{atom} = B.E = 192\ kJmol^{-1}$	
$2Br + 2e^- \longrightarrow 2Br^-(g)$;	$\Delta H_{EA} = 2(-331)\ kJmol^{-1}$	
$Ca^{2+}(g) + 2Br^-(g) \longrightarrow CaBr_2(s)$	$-\Delta H_{lattice}$	

$$Ca(s) + Br_2(l) \longrightarrow CaBr_2(s)\ ;\ \Delta H_{formation}$$

$$(+192) + (50) + (1146) + (31) + (192) + (-662) + (-\Delta H_{lattice}) = \Delta H_{formation}$$

$$949 - \Delta H_{lattice} = \Delta H_{form} = -683\ kJmol^{-1}$$

$$\therefore \Delta H_{lattice} = +1632\ kJmol^{-1}.$$

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Sem 1 (2005/2006) : Chemical Bonding

Q5(d) cont.

$$CaBr_2(s) \longrightarrow Ca^{2+}(g) + 2Br^-(g) \; ; \Delta H_{lattice} = +1632\, kJmol^{-1}$$

$$CaCl_2(s) \longrightarrow Ca^{2+}(g) + 2Cl^-(g) \; ; \Delta H_{lattice} = +2269\, kJmol^{-1}$$

$$F_{\text{electrostatic force}} \propto \frac{\text{charge}(+) \times \text{charge}(-)}{(\text{distance})^2}$$

Electrostatic Energy = F × distance

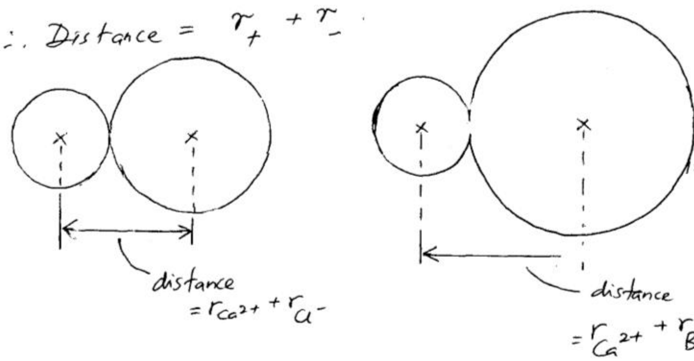
Lattice energy @ Electrostatic Energy $\propto \frac{\text{charge}(+) \times \text{charge}(-)}{(\text{distance})}$

$\therefore$ Lattice energy $\propto \frac{1}{\text{distance}}$ since

since in both case ($CaBr_2$ and $CaCl_2$) the charges on the cation and the anion are similar.

Distance = distance between their centers

$\therefore$ Distance = $r_+ + r_-$



Cl^- $1s^2 2s^2 2p^6 3s^2 3p^6$

Br^- $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$

Since $r_{Br^-} > r_{Cl^-}$

$\therefore (r_{Ca^{2+}} + r_{Br^-}) > (r_{Ca^{2+}} + r_{Cl^-})$

$\therefore$ Lattice energy for $CaCl_2$ > Lattice energy for $CaBr_2$

since Lattice energy $\propto \frac{1}{r_+ + r_-}$

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