Section 13.4
Bonding in Solids

Bonding in Ionic and Metallic Solids

In these sections…

a. Control of ionic bond strength
b. Determining lattice energy: Born-Haber Cycles
c. Band Theory: Metallic bonding
d. Band Theory: Semicondictors

Ionic Bonding Lattice Energy: Trends

Table 12.4.1: Lattice Energies and Melting Points for Some Common Ionic Solids

Compound	*U* (kJ/mol)	Melting Point (°C)
LiF	1037	870
LiCl	852	605
LiBr	815	552
NaF	926	993
NaCl	786	801
NaBr	752	747
MgO	3850	2852

Determining Lattice Energy: Born-Haber Cycles

Conceptualize Ionic Compound Formation:

$Na(s) + \frac{1}{2} Cl_2(g) \rightarrow NaCl(s)$ ΔH = -lattice energy

Step 1. Vaporize Na(s)
$Na(s) \rightarrow Na(g)$ $\Delta H^o_{sublimation} = 107$ kJ

Step 2. Ionize Na(g)
$Na(g) \rightarrow Na^+(g) + e^-$ Ionization Energy = 496 kJ

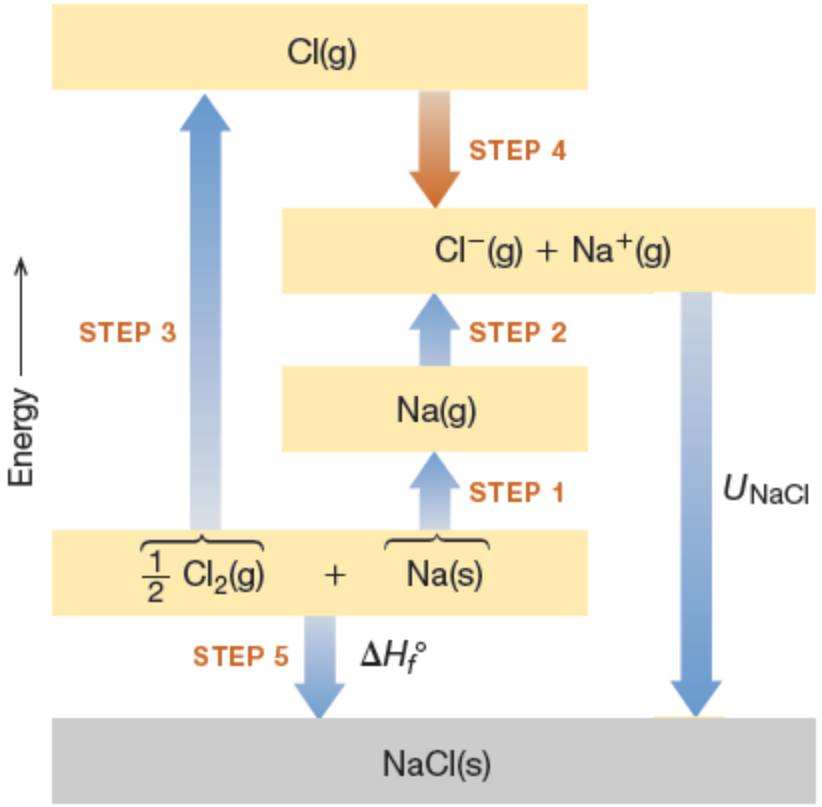
Step 3. Break Cl-Cl bond (need only 1 Cl)
$\frac{1}{2}$ Cl-Cl(g) → Cl(g) $\frac{1}{2}$ Cl-Cl Bond = $\frac{1}{2}$ 242 kJ = 121kJ

Step 4. Ionize Cl(g)
$Cl(g) + e^- \rightarrow Cl^-(g)$ Electron Affinity = -349 kJ

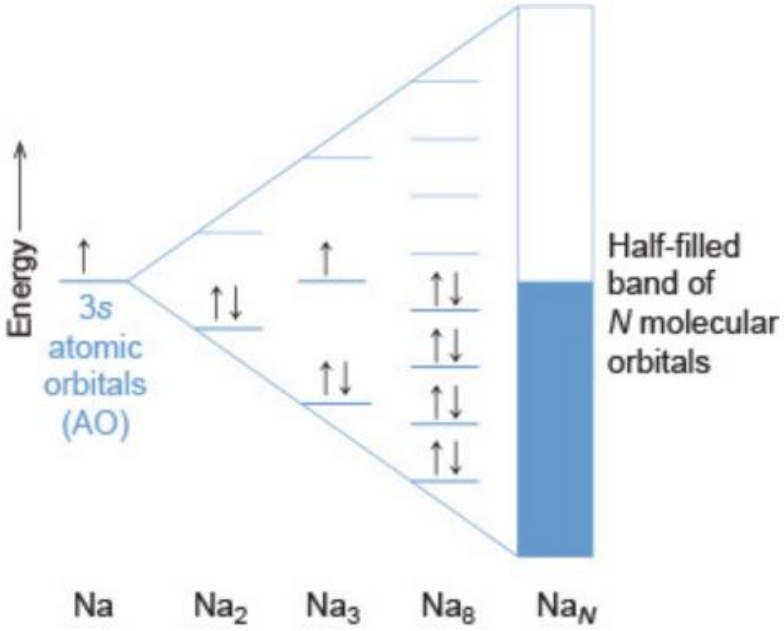
Step 5. Lattice Formation
$Na^+(g) + Cl^-(g) \rightarrow NaCl(s)$ Energy = U, Lattice Energy

ΣSteps 1 through 5 = $\Delta H^o_{formation}$ *(NaCl(s))= -411 kJ*

Solve for U = (-107 + -496 + -121 + 349 + -411) kJ = -786 kJ
Lattice energy = 786 kJ/mol



Metallic Bonding: Band Theory



Metallic Bonding: Trends
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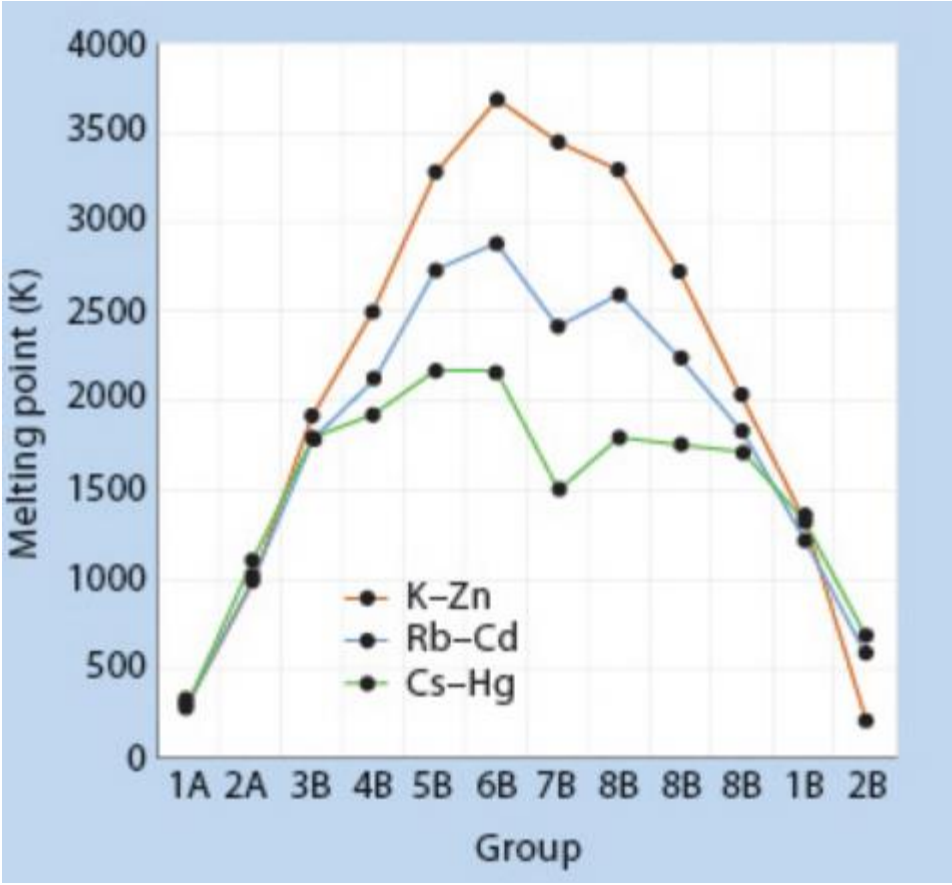

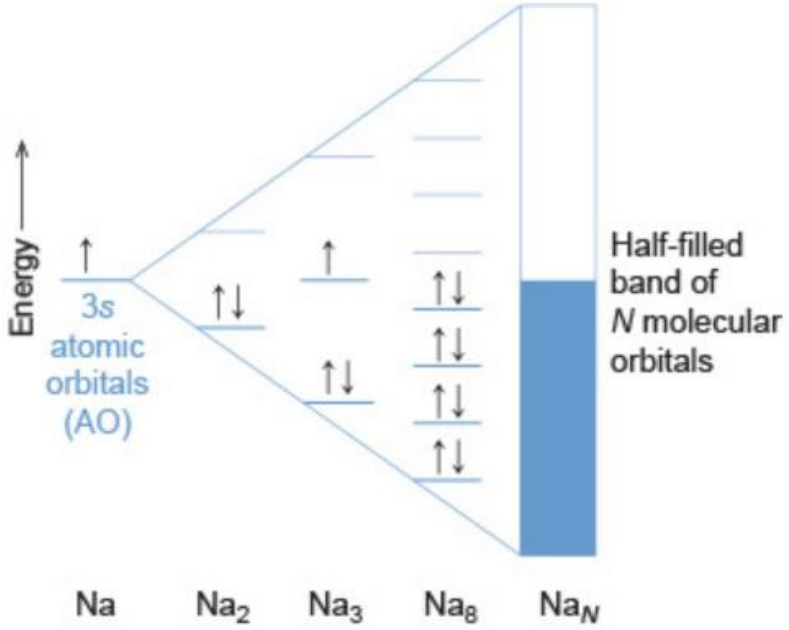

Semiconductors: Band Theory