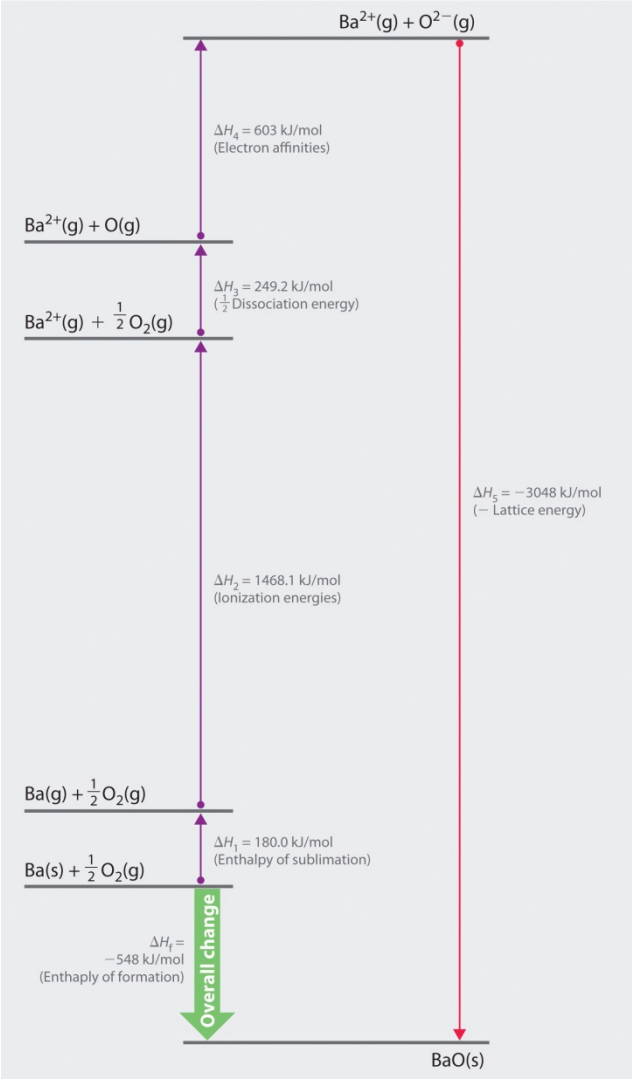
*Question#46435 – Chemistry – Other*

**Question:**

Write down Born-Haber cycle for the BaO crystal formation. Using it, obtain an equation useful in calculating lattice energy of BaO crystal.

**Answer:**

The scheme below represents Born-Haber cycle for BaO crystal.




Step 1.

Sublimation of solid Ba: $Ba_{(s)} \rightarrow Ba_{(g)}$ , $\Delta H_1 = 180.0$ kJ/mol

During this process, the change in enthalpy is positive, energy is required to change the state of barium from solid to gaseous (to break metal lattice).

Step 2.

The next step is ionization of atomized Ba gas: $Ba_{(g)} \rightarrow Ba^{2+}{}_{(g)} + 2e^-$, $\Delta H_2 = 1468.1$ kJ/mol

Again change in enthalpy is positive, energy is required to take away two electrons from barium atom.

Step 3.

Dissociation of $O_2$ molecule into atoms is presented with the following equation:

$½\ O_{2(g)} \rightarrow O_{(g)}$, $\Delta H_3 = 249.2$ kJ/mol

The change in enthalpy is ½ from dissociation energy.

Step 4.

Electron affinities of oxygen is the energy, required to maintain the process of electron accepting by oxygen atom: $O_{(g)} + 2e^- \rightarrow O^{2-}_{(g)}$, $\Delta H_4 = 603$ kJ/mol

Step 5.

Now when $Ba^{2+}$ ions and $O^{2-}$ ions are available, crystals of BaO are formed according to the scheme:

$Ba^{2+}_{(g)} + O^{2-}_{(g)} \rightarrow BaO_{(s)}$, $\Delta H_5 = -3048$ kJ/mol

The value of $\Delta H_5$ is negative lattice energy of BaO crystals, because during their formation energy is released.

The equation $Ba_{(s)} + ½\ O_{2(g)} \rightarrow BaO_{(s)}$, $\Delta H_f$ describes the overall process of BaO formation from solid Ba and gaseous oxygen molecules and is the sum of all above processes:

$\Delta H_f = \Delta H_1 + \Delta H_2 + \Delta H_3 + \Delta H_5 = -548$ kJ/mol