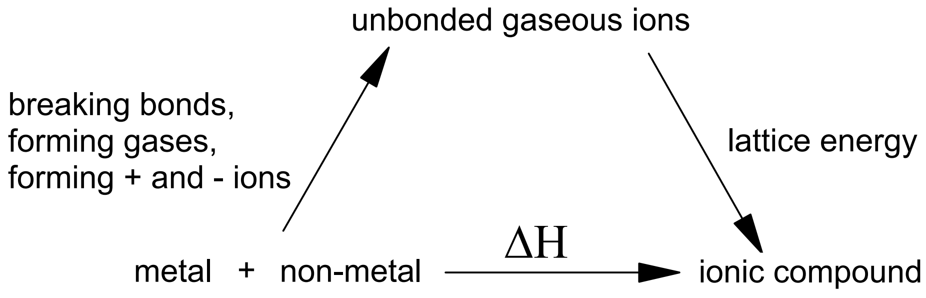
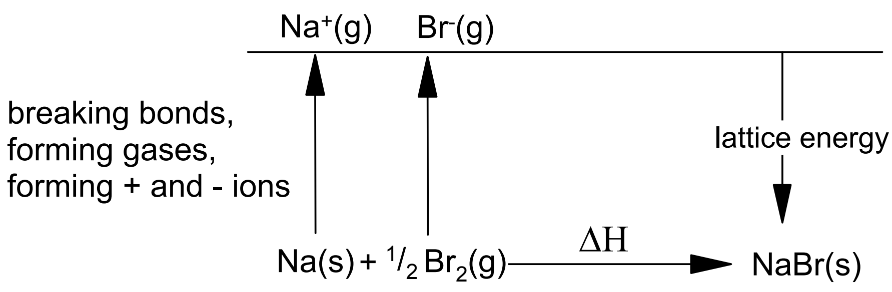
Watch a video tutorial on this at:

www.chemistry.jamesmungall.co.uk

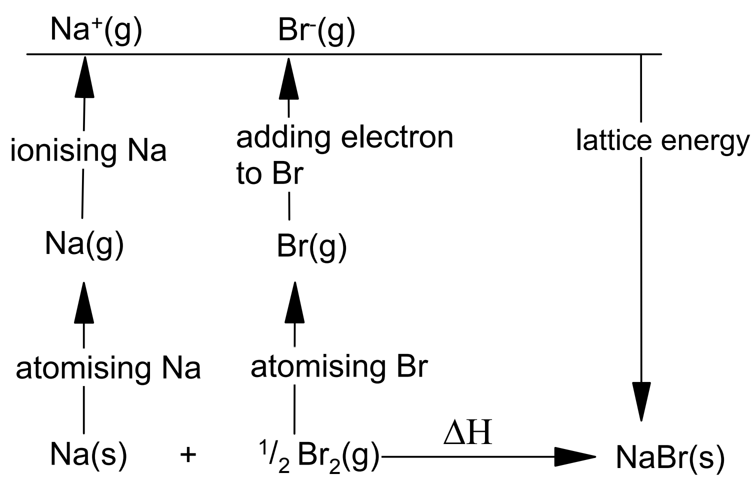
Born Haber Cycles



Example: Sodium Bromide



breaking down each of the stages



Example 1

Calculate the enthalpy change of the reaction $Na(s) + \frac{1}{2}Br_2(g) \longrightarrow NaBr(s)$

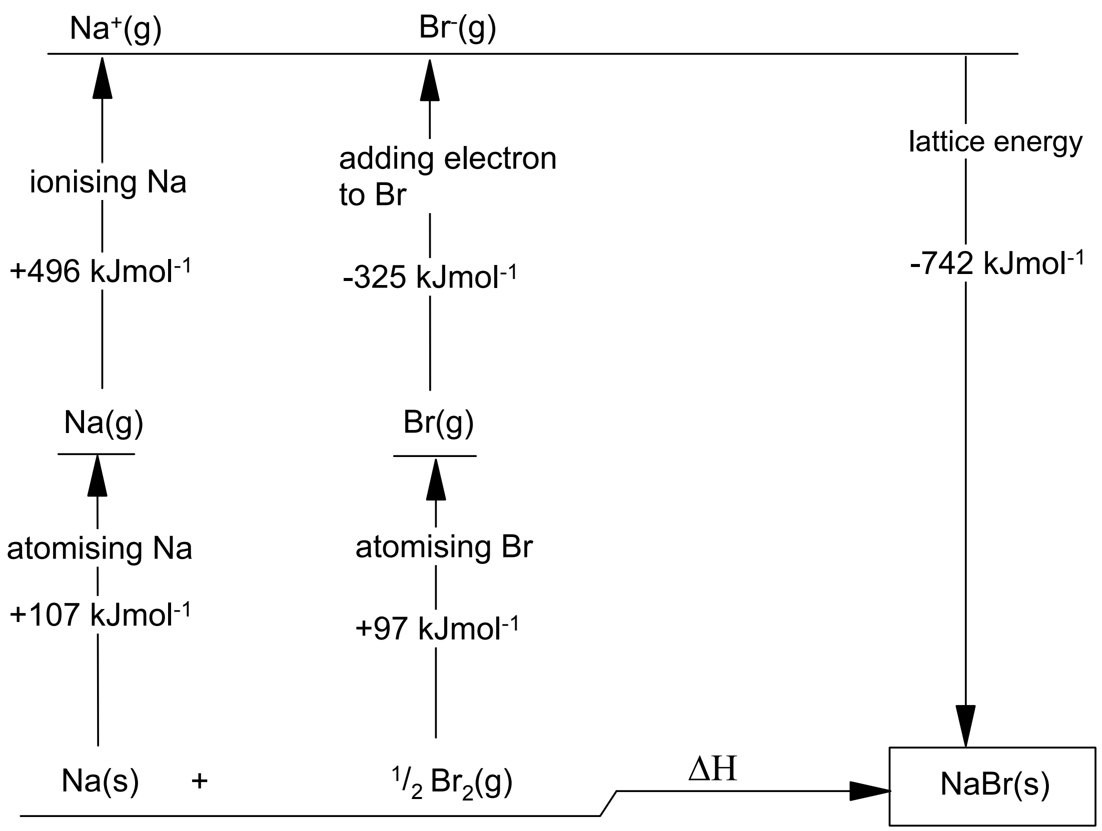
ΔH atomisation(Na) = +107 $kJmol^{-1}$

ΔH atomisation(Br) = +97 $kJmol^{-1}$

ΔH first ionisation energy(Na) = +496 $kJmol^{-1}$

ΔH first electron affinity(Br) = -325 $kJmol^{-1}$

ΔH lattice energy(NaBr) = -742 $kJmol^{-1}$



ΔH = 107 + 496 +97 -325 -742

= $\underline{\underline{-367\ kJmol^{-1}}}$

Example 2

Which ions are present in MgO(s)? *Mg^{2+} O^{2-}*

Calculate the enthalpy change for the reaction $Mg(s) + \frac{1}{2}O_2(g) \longrightarrow MgO(s)$

What kind of enthalpy change is this? *standard enthalpy of formation of MgO*

$\Delta H_{atm(O)}$ = +249 kJmol^{-1}

$\Delta H_{atm(Mg)}$ = +148 kJmol^{-1}

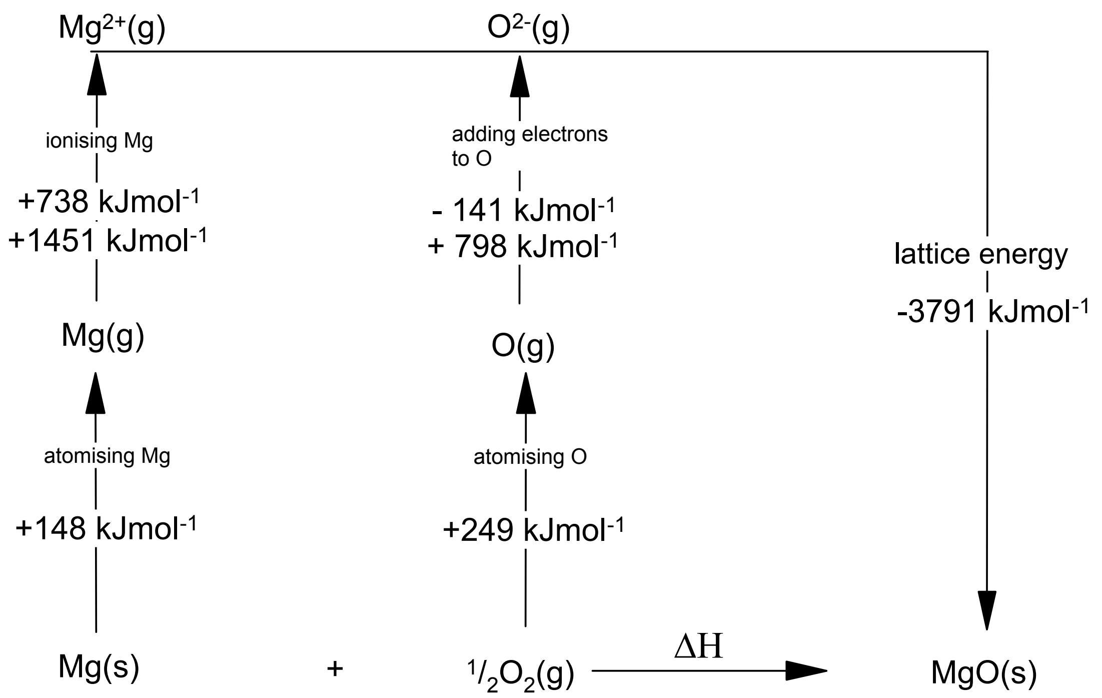
$\Delta H_{1st\ ionisation\ energy(Mg)}$ = +738 kJmol^{-1}

$\Delta H_{2nd\ ionisation\ energy(Mg)}$ = +1451 kJmol^{-1}

$\Delta H_{1st\ electron\ affinity(O)}$ = - 141 kJmol^{-1}

$\Delta H_{2nd\ electron\ affinity(O)}$ = + 798 kJmol^{-1}

$\Delta H_{lattice\ energy(MgO)}$ = -3791 kJmol^{-1}



ΔH = (148+1451+738) + (249+798-141) - 3791

= 2337 + 906 - 3791

= <u>-548 kJmol^{-1}</u>

The actual value for this reaction is -602 kJmol^{-1}

This is because there is a degree of covalent bonding in MgO. Therefore the bonds formed are slightly stronger than those predicted by a purely ionic model.

Example 3

Construct a Born-Haber cycle and use it to calculate the first electron affinity of chlorine.

$\Delta H_{atm(Cl)}$ = + 122 kJmol^{-1}

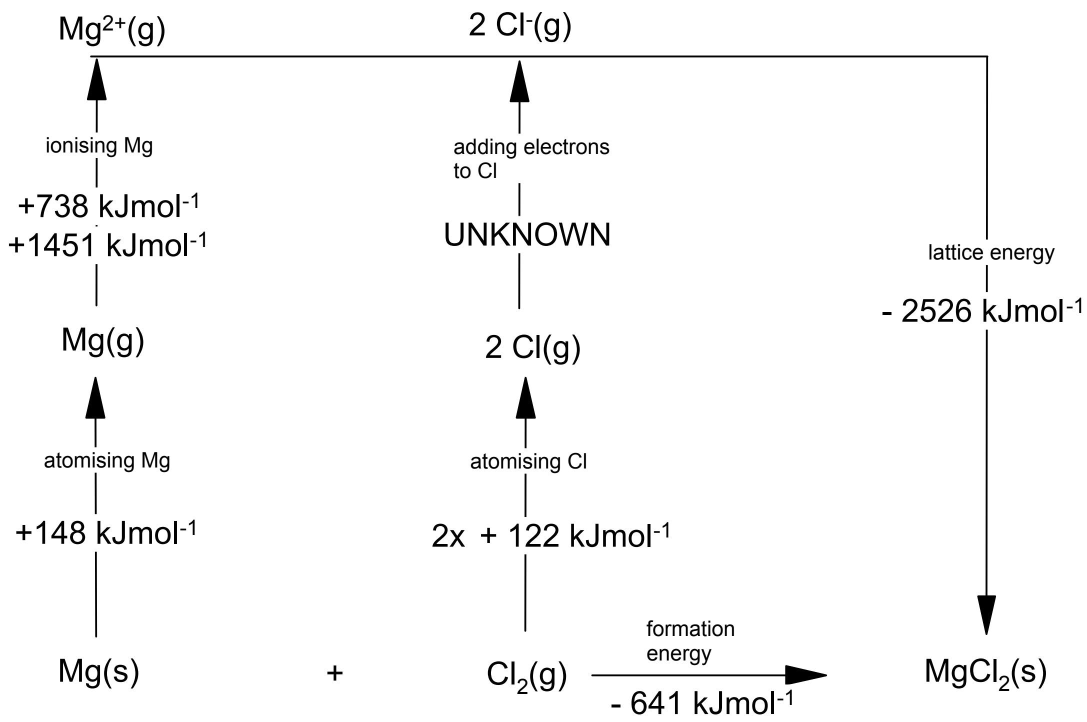
$\Delta H_{atm(Mg)}$ = +148 kJmol^{-1}

$\Delta H_{1st\ ionisation\ energy(Mg)}$ = +738 kJmol^{-1}

$\Delta H_{2nd\ ionisation\ energy(Mg)}$ = +1451 kJmol^{-1}

$\Delta H_{lattice\ energy(MgCl_2)}$ = - 2526 kJmol^{-1}

$\Delta H_{formation(MgCl_2)}$ = - 641 kJmol^{-1}



148 + 1451 + 738 + (2 x 122) + UNKNOWN - 2526 = - 641

2581 + UNKNOWN - 2526 = - 641

55 + UNKNOWN = -641

UNKNOWN = -641 - 55

= - 696

This is for 2 moles of Cl.
Therefore the 1st electron affinity of chlorine is
-696/2
= - 348 kJmol^{-1}