

Born-Haber cycle: NaCl

The Born-Haber cycle can be divided into stages like the ones in the table below. Start by filling in the table using:

$\text{Na(g)} \rightarrow \text{Na}^{\text{+}}(\text{g}) + \text{e}^{-}$	$\text{Cl(g)} + \text{e}^{-} \rightarrow \text{Cl}^{-}(\text{g})$	$\text{Na}^{\text{+}}(\text{g}) + \text{Cl}^{-}(\text{g}) \rightarrow \text{NaCl(s)}$
stage	standard enthalpy change(s)	equation(s)
elements to gaseous atoms	$\Delta H^{\ominus}_{\text{at Na}} \text{ \& \ } \Delta H^{\ominus}_{\text{at Cl}}$	$\text{Na(s)} \rightarrow \text{Na(g)}$ $\frac{1}{2}\text{Cl}_2(\text{g}) \rightarrow \text{Cl(g)}$
atoms to positive ions	1 st IE of Na	
atoms to negative ions	1 st EA of Cl	
gaseous ions to solid lattice	lattice enthalpy (formation)	
elements to compound	$\Delta H^{\ominus}_{\text{f NaCl}}$	$\text{Na(s)} + \frac{1}{2}\text{Cl}_2(\text{g}) \rightarrow \text{NaCl(s)}$

Gridlock 1

Each row, column and 2 x 2 box contains information about the first four stages listed. Use your problem solving skills and the answers in the table above to fill in the blank boxes.

stage		standard enthalpy change(s)	
elements to gaseous atoms		1 st EA of Cl	lattice enthalpy (formation)
	gaseous ions to solid lattice		
			elements to gaseous atoms
		atoms to positive ions	
standard enthalpy change(s)		stage	

gridlocks – can you unlock the grid?

Gridlock 2

Each row, column and 2 x 2 box contains information about each of the last four stages listed.

stage		equations	
atoms to positive ions			
		$\text{Na}^+(\text{g}) + \text{Cl}^-(\text{g}) \rightarrow \text{NaCl}(\text{s})$	
		$\Delta H_f^\ominus \text{NaCl}$	
	$\text{Cl}(\text{g}) + \text{e}^- \rightarrow \text{Cl}^-(\text{g})$		
equations		standard enthalpy change(s)	

Gridlock 3

You will need to work out which stages are in this gridlock.

stage		equations	
	elements to gaseous atoms		$\text{Na}^+(\text{g}) + \text{Cl}^-(\text{g}) \rightarrow \text{NaCl}(\text{s})$
			$\text{Na}(\text{s}) \rightarrow \text{Na}(\text{g})$ $\frac{1}{2}\text{Cl}_2(\text{g}) \rightarrow \text{Cl}(\text{g})$
$\text{Na}(\text{s}) + \frac{1}{2}\text{Cl}_2(\text{g}) \rightarrow \text{NaCl}(\text{s})$			1 st EA of Cl
equations		standard enthalpy change(s)	

Born-Haber cycle: NaCl – answers

The Born-Haber cycle can be divided into stages like the ones in the table below. Start by filling in the table using:

$\text{Na(g)} \rightarrow \text{Na}^{\text{+}}(\text{g}) + \text{e}^{-}$	$\text{Cl(g)} + \text{e}^{-} \rightarrow \text{Cl}^{-}(\text{g})$	$\text{Na}^{\text{+}}(\text{g}) + \text{Cl}^{-}(\text{g}) \rightarrow \text{NaCl(s)}$
stage	standard enthalpy change(s)	equation(s)
elements to gaseous atoms	$\Delta H^{\ominus}_{\text{at Na}} \text{ \& \ } \Delta H^{\ominus}_{\text{at Cl}}$	$\text{Na(s)} \rightarrow \text{Na(g)}$ $\frac{1}{2}\text{Cl}_2(\text{g}) \rightarrow \text{Cl(g)}$
atoms to positive ions	1 st IE of Na	$\text{Na(g)} \rightarrow \text{Na}^{\text{+}}(\text{g}) + \text{e}^{-}$
atoms to negative ions	1 st EA of Cl	$\text{Cl(g)} + \text{e}^{-} \rightarrow \text{Cl}^{-}(\text{g})$
gaseous ions to solid lattice	lattice enthalpy (formation)	$\text{Na}^{\text{+}}(\text{g}) + \text{Cl}^{-}(\text{g}) \rightarrow \text{NaCl(s)}$
elements to compound	$\Delta H^{\ominus}_{\text{f NaCl}}$	$\text{Na(s)} + \frac{1}{2}\text{Cl}_2(\text{g}) \rightarrow \text{NaCl(s)}$

Gridlock 1 – answers

Each row, column and 2 x 2 box contains information about the first four stages listed. Use your problem solving skills and the answers in the table above to fill in the blank boxes.

stage		standard enthalpy change(s)	
elements to gaseous atoms	atoms to positive ions	1 st EA of Cl	lattice enthalpy (formation)
atoms to negative ions	gaseous ions to solid lattice	$\Delta H^{\ominus}_{\text{at Na}} \text{ \& \ } \Delta H^{\ominus}_{\text{at Cl}}$	1 st IE of Na
1 st IE of Na	1 st EA of Cl	gaseous ions to solid lattice	elements to gaseous atoms
lattice enthalpy (formation)	$\Delta H^{\ominus}_{\text{at Na}} \text{ \& \ } \Delta H^{\ominus}_{\text{at Cl}}$	atoms to positive ions	atoms to negative ions
standard enthalpy change(s)		stage	

gridlocks – can you unlock the grid?

Gridlock 2 – answers

Each row, column and 2 x 2 box contains information about each of the last four stages listed.

stage		equations	
atoms to positive ions	gaseous ions to solid lattice	$\text{Cl(g)} + \text{e}^- \rightarrow \text{Cl}^-\text{(g)}$	$\text{Na(s)} + \frac{1}{2}\text{Cl}_2\text{(g)} \rightarrow \text{NaCl(s)}$
atoms to negative ions	elements to compound	$\text{Na}^+\text{(g)} + \text{Cl}^-\text{(g)} \rightarrow \text{NaCl(s)}$	$\text{Na(g)} \rightarrow \text{Na}^+\text{(g)} + \text{e}^-$
$\text{Na}^+\text{(g)} + \text{Cl}^-\text{(g)} \rightarrow \text{NaCl(s)}$	$\text{Na(g)} \rightarrow \text{Na}^+\text{(g)} + \text{e}^-$	$\Delta H_f^\ominus \text{NaCl}$	1 st EA of Cl
$\text{Na(s)} + \frac{1}{2}\text{Cl}_2\text{(g)} \rightarrow \text{NaCl(s)}$	$\text{Cl(g)} + \text{e}^- \rightarrow \text{Cl}^-\text{(g)}$	1 st IE of Na	lattice enthalpy (formation)
equations		standard enthalpy change(s)	

Gridlock 3 – answers

You will need to work out which stages are in this gridlock.

stage		equations	
atoms to negative ions	elements to gaseous atoms	$\text{Na(s)} + \frac{1}{2}\text{Cl}_2\text{(g)} \rightarrow \text{NaCl(s)}$	$\text{Na}^+\text{(g)} + \text{Cl}^-\text{(g)} \rightarrow \text{NaCl(s)}$
gaseous ions to solid lattice	elements to compound	$\text{Cl(g)} + \text{e}^- \rightarrow \text{Cl}^-\text{(g)}$	$\text{Na(s)} \rightarrow \text{Na(g)}$ $\frac{1}{2}\text{Cl}_2\text{(g)} \rightarrow \text{Cl(g)}$
$\text{Na(s)} \rightarrow \text{Na(g)}$ $\frac{1}{2}\text{Cl}_2\text{(g)} \rightarrow \text{Cl(g)}$	$\text{Cl(g)} + \text{e}^- \rightarrow \text{Cl}^-\text{(g)}$	lattice enthalpy (formation)	$\Delta H_f^\ominus \text{NaCl}$
$\text{Na(s)} + \frac{1}{2}\text{Cl}_2\text{(g)} \rightarrow \text{NaCl(s)}$	$\text{Na}^+\text{(g)} + \text{Cl}^-\text{(g)} \rightarrow \text{NaCl(s)}$	$\Delta H_{\text{at}}^\ominus \text{Na}$ & $\Delta H_{\text{at}}^\ominus \text{Cl}$	1 st EA of Cl
equations		standard enthalpy change(s)	