Born–Haber cycles

Page 1: Enthalpy changes for NaCl

Print on stiff paper or card and then laminate to make them more durable.
Cut out the cards.

Na$^+$(g)

+496 KJ mol^{-1}

$\Delta H^{\ominus}_{ie}$ First ionisation enthalpy of sodium

Na(g)

Cl$^-$

− 349 KJ mol^{-1}

$\Delta H^{\ominus}_{ea}$ First electron affinity of chlorine

Cl$^-$(g)

− 790 KJ mol^{-1}

$\Delta H^{\ominus}_{le}$ Lattice enthalpy of sodium chloride

Na(s) + ½Cl$_2$(g)

$\Delta H^{\ominus}_{at}$ Atomisation enthalpy of chlorine
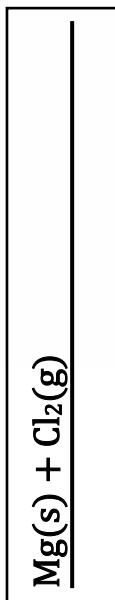
+ 121 KJ mol^{-1}

− 415 KJ mol^{-1}

$\Delta H^{\ominus}_f$ Enthalpy of formation of sodium chloride

NaCl(s)

$\Delta H^{\ominus}_{at}$ Atomisation enthalpy of sodium

107 KJ mol^{-1}
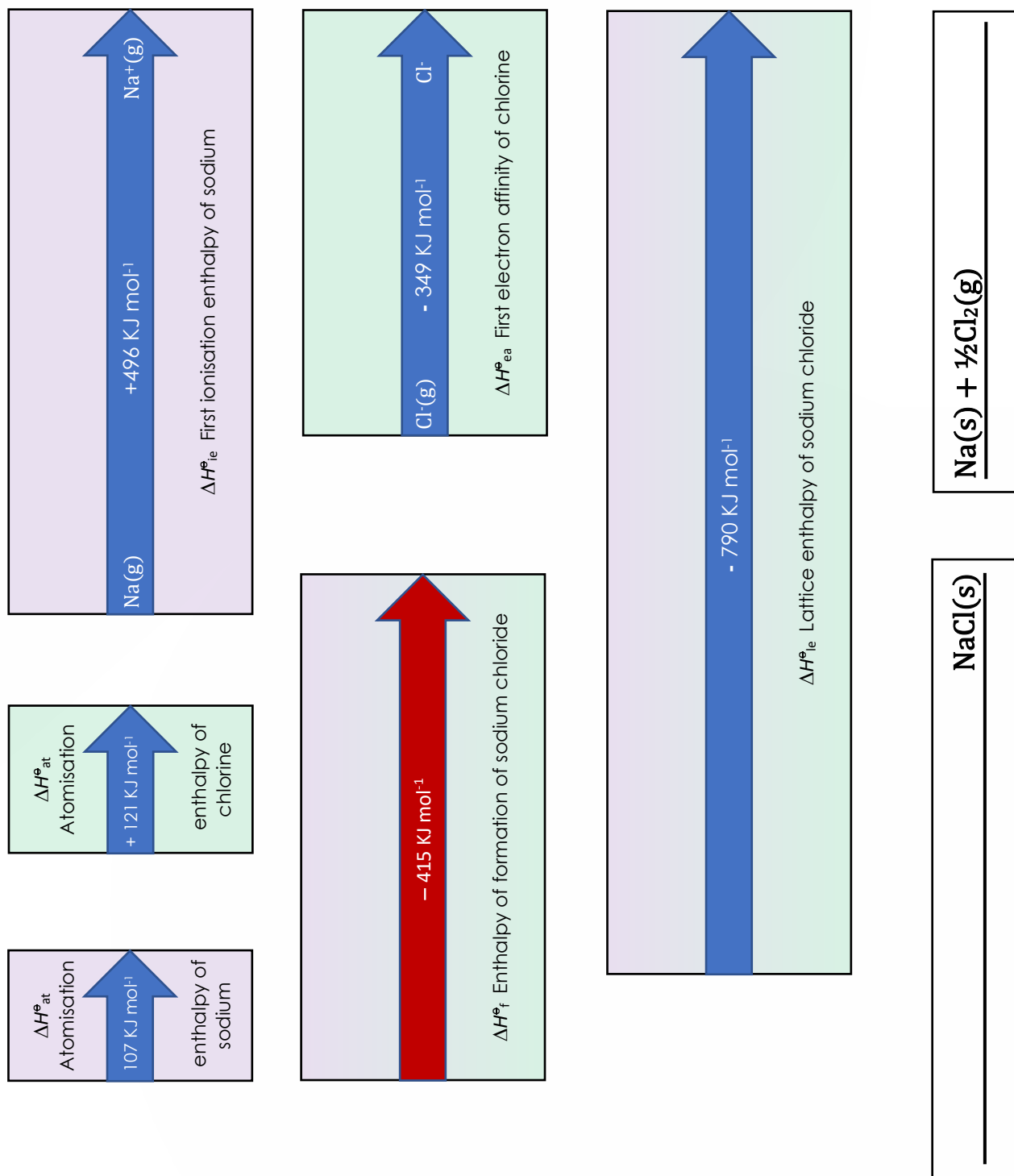
Page 2: Additional enthalpy changes for $MgCl_2$

You will also need to use the enthalpy of atomisation and first electron affinity for chlorine from page 1 and the lattice enthalpy for $MgCl_2$ from the A3 sheet to complete the cycle.
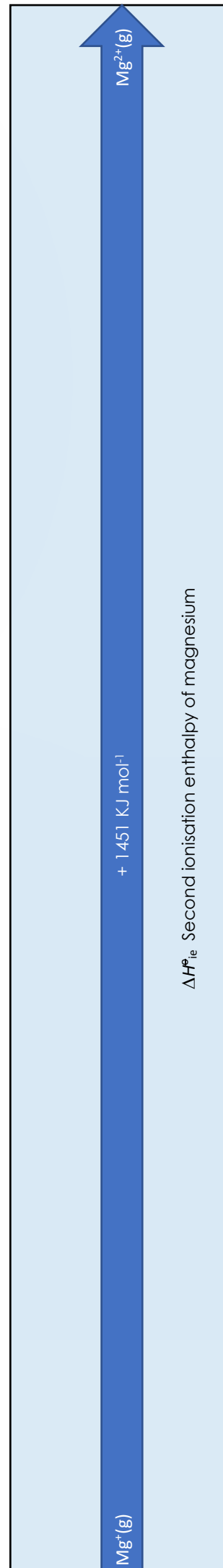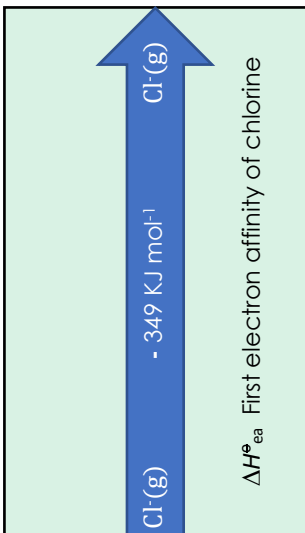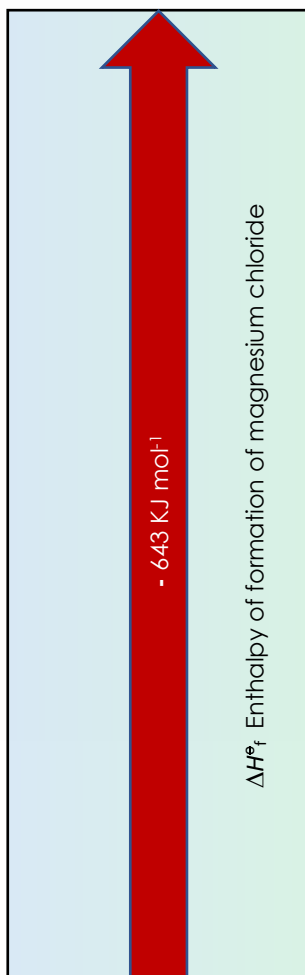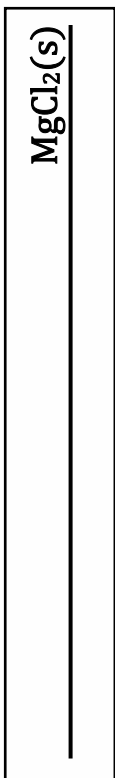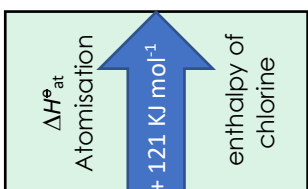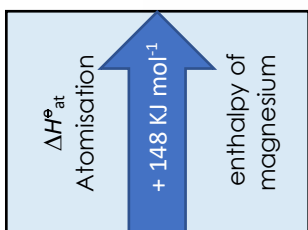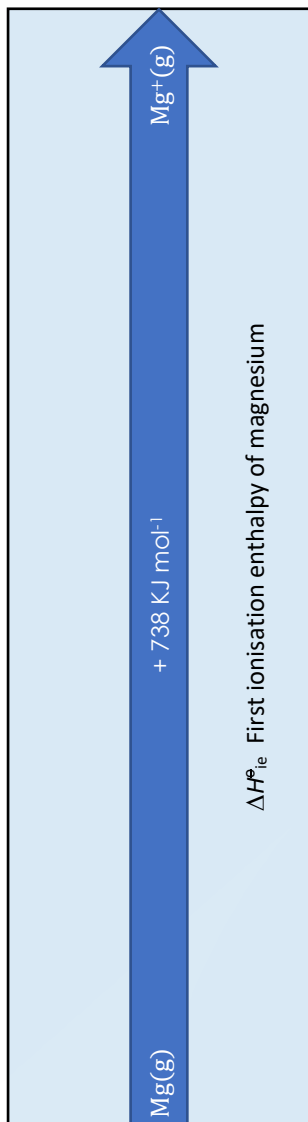
Page 3: Additional enthalpy changes for Na_2O and MgO
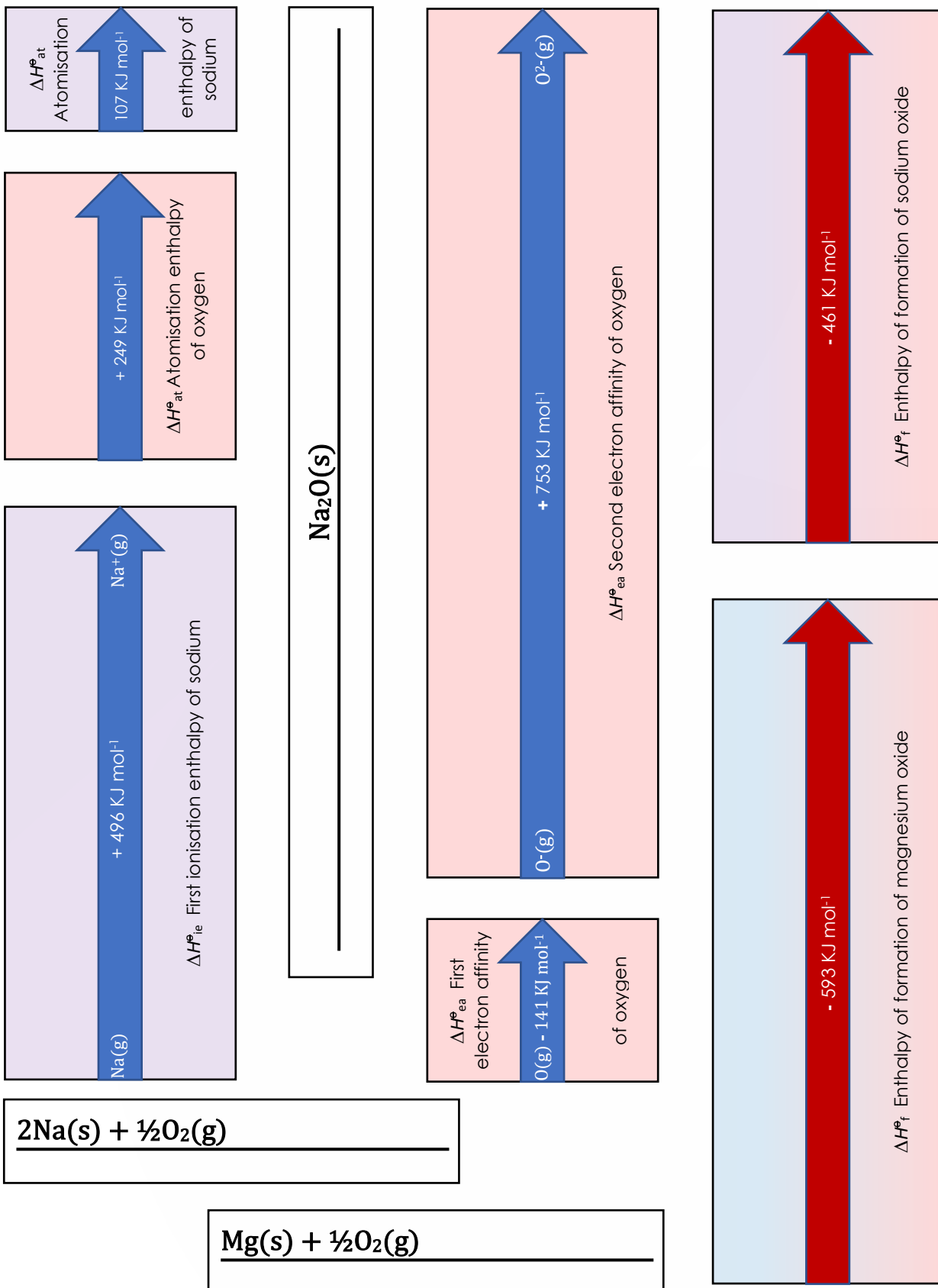
You will also need to use the enthalpy of atomisation and ionisation energies for sodium and magnesium from pages 1 and 2, as well as the lattice enthalpies for Na_2O and MgO from the A3 sheet to complete the cycles.
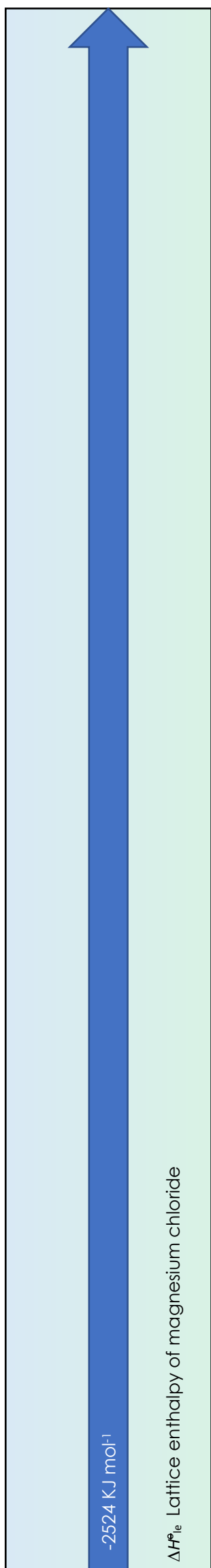
$\Delta H^{\ominus}_{at}$ Atomisation — 107 KJ mol^{-1} — enthalpy of sodium

+ 249 KJ mol^{-1} — $\Delta H^{\ominus}_{at}$ Atomisation enthalpy of oxygen

Na$^+$(g) — + 496 KJ mol^{-1} — Na(g) — $\Delta H^{\ominus}_{ie}$ First ionisation enthalpy of sodium

$Na_2O(s)$

O^{2-}(g) — + 753 KJ mol^{-1} — O$^-$(g) — $\Delta H^{\ominus}_{ea}$ Second electron affinity of oxygen

$\Delta H^{\ominus}_{ea}$ First electron affinity — O(g) - 141 KJ mol^{-1} — of oxygen

- 461 KJ mol^{-1} — $\Delta H^{\ominus}_{f}$ Enthalpy of formation of sodium oxide

- 593 KJ mol^{-1} — $\Delta H^{\ominus}_{f}$ Enthalpy of formation of magnesium oxide

2Na(s) + ½O$_2$(g)
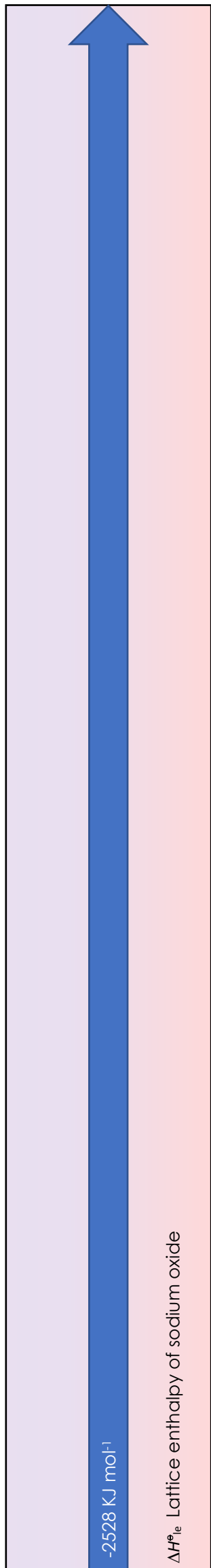
Mg(s) + ½O$_2$(g)

TOOLKIT

Page 4: Lattice enthalpies for $MgCl_2$, Na_2O and MgO.

Print on stiff paper or card and then cut out the individual cards. Laminate the cards to make them more durable and join the extension pieces as shown using clear sticky tape.
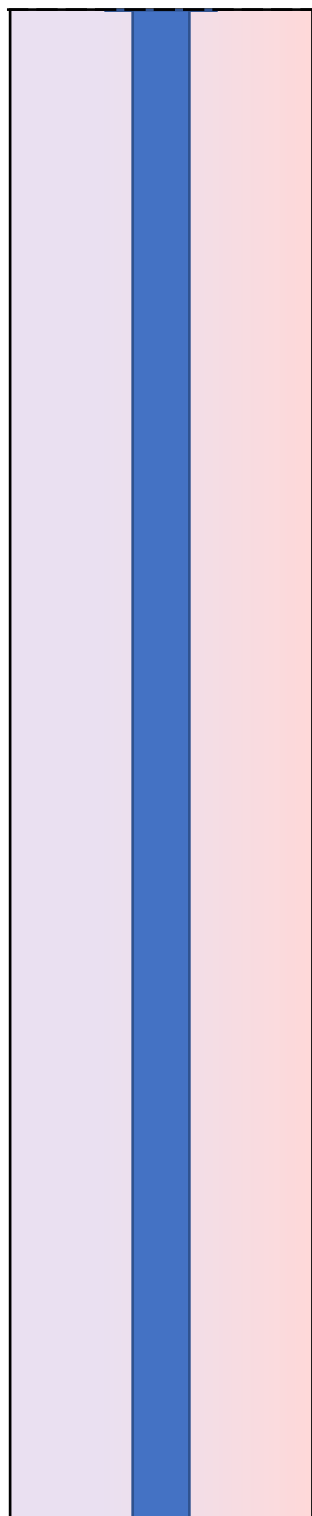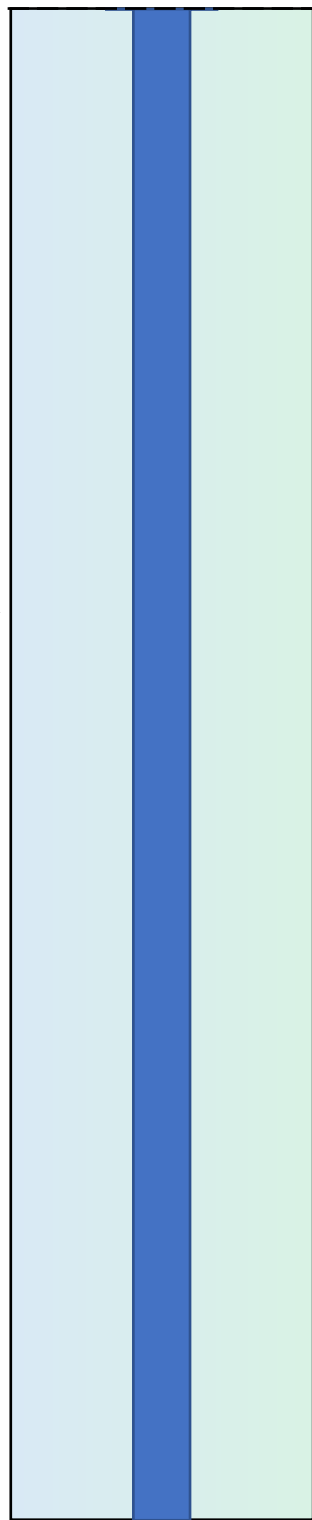
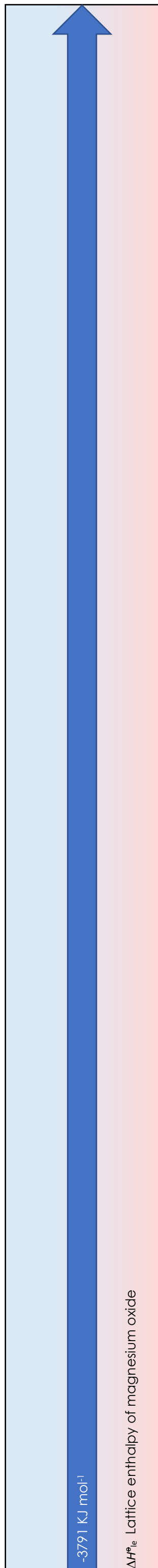Extension pieces for $MgCl_2$ and Na_2O. →

Extension piece for MgO. ↓

$MgO(s)$

-2524 KJ mol^{-1} $\Delta H^{\ominus}_{le}$ Lattice enthalpy of magnesium chloride

Attach extension piece here ↑

-2528 KJ mol^{-1} $\Delta H^{\ominus}_{le}$ Lattice enthalpy of sodium oxide

Attach extension piece here ↑

Attach extension piece here →

-3791 KJ mol^{-1} $\Delta H^{\ominus}_{le}$ Lattice enthalpy of magnesium oxide