Tailored Tutors

Lattice Enthalpy Web Class

MCQ's

Q1. Which process describes the following equation?

$$Mg^{+}_{(g)} \rightarrow Mg^{2+}_{(g)} + e^{-}$$

☐ A The first ionisation energy of magnesium

☐ B The atomisation of magnesium

☐ C The electron affinity of magnesium

☑ D The second ionisation energy of magnesium

Q2. Which is the correct definition for Lattice Enthalpy?
The enthalpy change when……

☐ A 1 mole of a substance is formed from it's constituent elements in their standard states

☑ B 1 mole of an ionic substance is formed from it's gaseous ions under standard conditions

☐ C 1 mole of an ionic substance is formed from it's constituent elements under standard conditions

☐ D 1 mole of a substance is broken down into it's constituent elements under standard conditions

Q3. For which of the following changes is ΔH negative?

☐ A $Na_{(g)} \rightarrow Na^{+}_{(g)} + e^{-}$

☐ B $Na_{(s)} \rightarrow Na_{(g)}$

☑ C $Cl_{(g)} + e^{-} \rightarrow Cl^{-}_{(g)}$

☐ D $O^{-}_{(g)} + e^{-} \rightarrow O^{2-}_{(g)}$

Q4. Which of the following statements is false?

☐ A Enthalpy of Atomisation is always a positive value

☐ B Enthalpy of Hydration is always a negative value

☐ C Enthalpy of Solution is calculated using enthalpy of hydration and lattice enthalpy

☑ D Enthalpy of electron affinity is always an exothermic process 2nd is Endo!

Q5. Which of the following ions would you expect to have the most negative enthalpy of hydration?

☐ A Ca^{2+}

☐ B Na^{+}

☑ C Mg^{2+} Greatest charge density

☐ D K^{+}

Classic Exam Questions

Q6. Explain how lattice energy values, together with other data, can be used to predict the solubility of ionic compounds. [3]

Enthalpy of Solution ΔH_{sol} is a measure of Solubility.
Substances are more soluble if they have a NEGATIVE ΔH_{sol}

$\Delta H_{sol} = \Delta H_{LATT\ DISS} + \Delta H_{HYD}$

$\Delta H_{LATT\ DISS}$ is a POSITIVE value as it is a measure of how much energy is needed to break the ionic lattice. ΔH_{HYD} is a NEGATIVE value as it is a measure of how much energy is released as H_2O associates with ions.

Q7. The table contains some values of lattice dissociation enthalpies.

Compound	$MgCl_2$	$CaCl_2$	MgO
Lattice dissociation enthalpy / kJ mol^{-1}	2493	2237	3889

a) Write an equation, including state symbols, for the reaction that has an enthalpy change equal to the lattice dissociation enthalpy of magnesium chloride. [1]

$MgCl_{2(s)} \longrightarrow Mg^{2+}_{(g)} + 2Cl^-_{(g)}$

b) Explain why the lattice dissociation enthalpy of magnesium chloride is greater than that of calcium chloride. [2]

Magnesium has a greater charge density as it is a smaller ion. This means that the attraction to Cl^- ions is greater and ∴ more energy is needed to overcome these attraction. ie. ΔH_{latt} is greater.

c) Explain why the lattice dissociation enthalpy of magnesium oxide is greater than that of magnesium chloride. [2]

Oxygen ions have a greater charge (O^{2-}) than Chloride ions (Cl^-). They are also smaller so have a greater charge density. This means the attraction to Mg^{2+} ions is greater and ∴ ΔH_{latt} is greater.

d) When magnesium chloride dissolves in water, the enthalpy of solution is −155 kJ mol^{-1}. The enthalpy of hydration of chloride ions is −364 kJ mol^{-1}.
Calculate the enthalpy of hydration of magnesium ions.

[3]

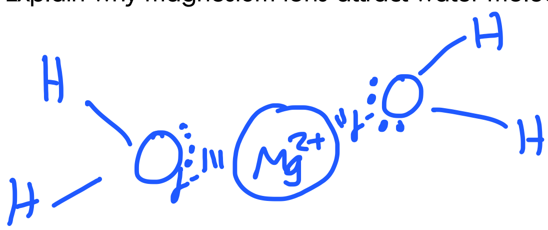
$\Delta H_{sol} = \Delta H_{latt\ diss} + \Delta H_{HYD}$

$-155 = +2493 + \Delta H_{HYD}\,Mg^{2+} + 2(-364)$

$-155 - 2493 + 2(364) = \Delta H_{HYD}\,Mg^{2+} = -1920\ kJ.mol^{-1}$

e) Energy is released when a magnesium ion is hydrated because magnesium ions attract water molecules.
Explain why magnesium ions attract water molecules. You may use a labelled diagram to illustrate your answer.

[2]



Electrostatic attractions occur between the Mg^{2+} ions and the δ^- Oxygen atoms in H_2O molecules. The δ^- is created by the two sets of lone pairs on the O atom and a large difference in electronegativity between O + H.

f) Suggest why a value for the enthalpy of solution of magnesium oxide is **not** found in any data books.

[1]

- MgO is not soluble in water.

OR

- MgO reacts with water to form $Mg(OH)_2$

Q11. This question is about magnesium oxide. Use data from the table below, where appropriate, to answer the following questions.

	$\Delta H^{\ominus}$/kJ mol^{-1}
First electron affinity of oxygen (formation of O^-(g) from O(g))	–142
Second electron affinity of oxygen (formation of O^{2-}(g) from O^-(g))	+844
Atomisation enthalpy of oxygen	+248

a) Define the term enthalpy of lattice dissociation. [3]

The enthalpy change when 1 mole of an ionic lattice is dissociated into its separate ions. The ions are released in the gaseous state.

b) In terms of the forces acting on particles, suggest **one** reason why the first electron affinity of oxygen is an exothermic process. [1]

There is an overall attractive force between the nucleus of the O atom and the electron.

c) Write equations to represent the three enthalpy changes in the table above. [3]

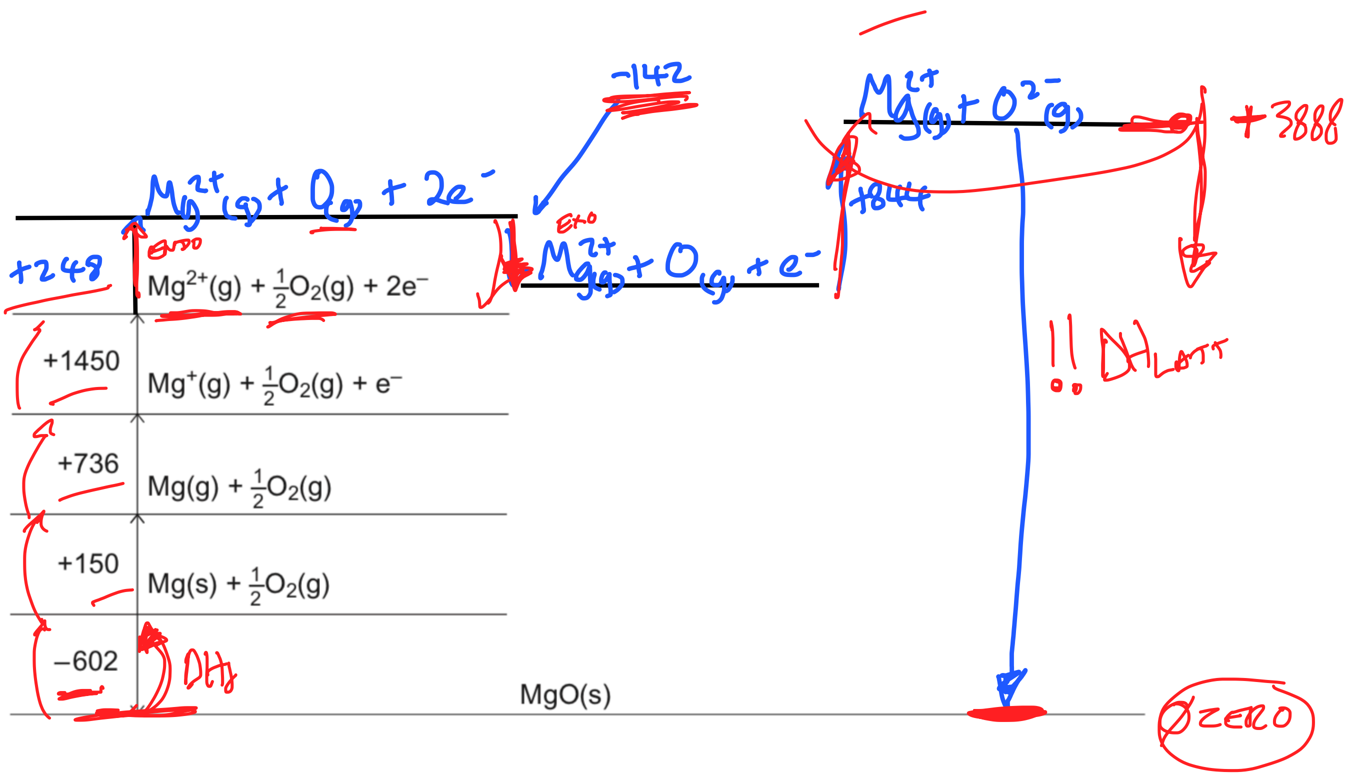
First electron affinity of oxygen $O_{(g)} + e^- \rightarrow O^-_{(g)}$

Second electron affinity of oxygen $O^-_{(g)} + e^- \rightarrow O^{2-}_{(g)}$

Atomisation enthalpy of oxygen $\frac{1}{2}O_{2(g)} \rightarrow O_{(g)}$

d) Complete the Born–Haber cycle for magnesium oxide by drawing the missing energy levels, symbols and arrows. The standard enthalpy change values are given in kJ.mol-1.

[4]



e) Use your Born–Haber cycle from part **(d)** to calculate a value for the enthalpy of lattice dissociation for magnesium oxide.

lattice dis

[2]

+602 + 150 + 736 + 1450 + 248 − 142 + 844 = + 3888 kJ.mol⁻¹

−3888

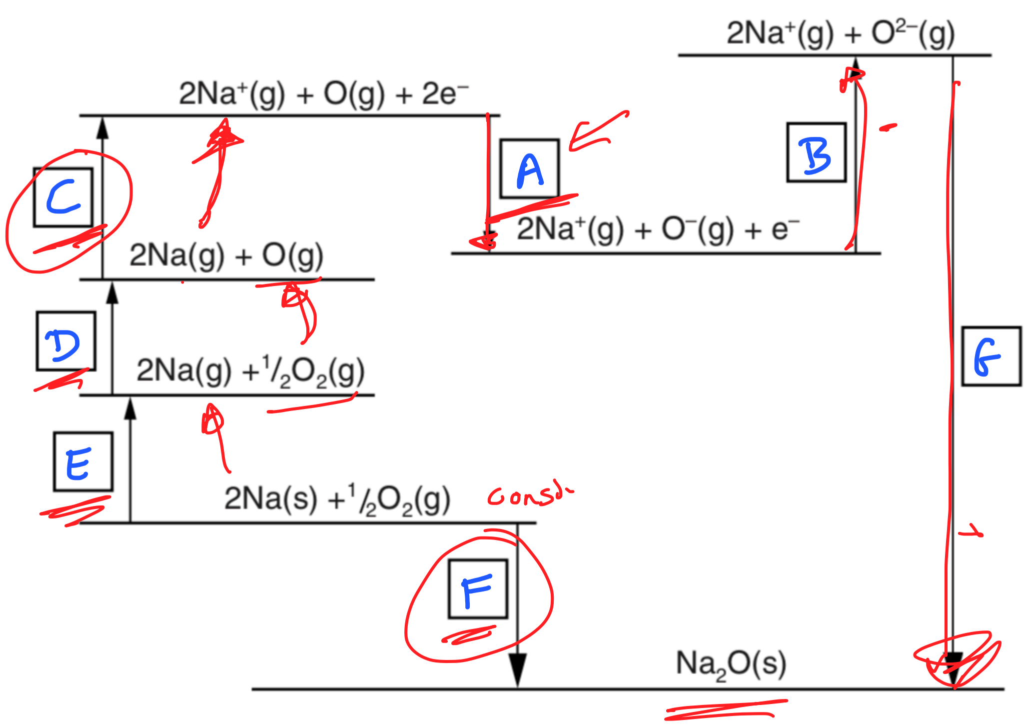
Q12. Lattice enthalpies can be calculated indirectly using Born–Haber cycles.
The table below shows enthalpy changes needed to calculate the lattice enthalpy of sodium oxide, Na_2O.

letter	enthalpy change	energy /kJ mol^{-1}
A	1st electron affinity of oxygen	–141
B	2nd electron affinity of oxygen	+790
C	1st ionisation energy of sodium	+496
D	atomisation of oxygen	+249
E	atomisation of sodium	+108
F	formation of sodium oxide	–414
G	lattice enthalpy of sodium oxide	

Eq!

a) The Born–Haber cycle below links the lattice enthalpy of sodium oxide with its enthalpy change of formation.
(i) On the Born–Haber cycle, write the correct letter from the table above in each box.

[3]



b) Calculate the lattice enthalpy of sodium oxide

[2]

$+414 + 2(108) + 249 + 2(496) - 141 + 790$

$x = +2520\ kJ.mol^{-1}$ / Arrow down ≥ $-2520\ kJ.mol^{-1}$

c) Explain why it is difficult to predict whether the lattice enthalpy of magnesium sulfide would be more or less exothermic than the lattice enthalpy of sodium oxide.

(A) MgS (B) Na_2O

[3]

Not comparable. Mg^{2+} has a greater charge density than Na^+.
S^{2-} has a lower charge density than O^{2-}.
∴ Mg^{2+} has a greater attraction than Na^+ and S^{2-} has a weaker attraction than O^{2-}.

d) A student wanted to determine the lattice enthalpy of sodium carbonate, Na_2CO_3. Unfortunately this is very difficult to do using a similar Born–Haber cycle to that used for sodium oxide in (b). (i) Suggest why this is very difficult.

[1]

Carbonate ion contains two elements, C and O. [1]
Need to include the formation of CO_3^{2-} ion.

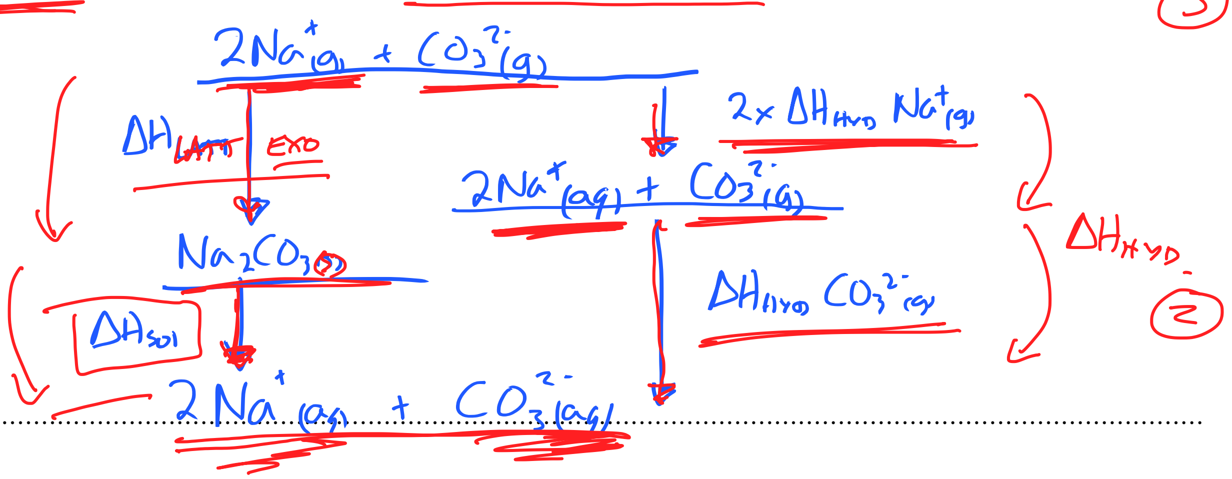
$\boxed{\Delta H_{SOL} = \Delta H_{LATT\ DISS} + \Delta H_{HYD}}$

e) The student thought that he could determine the lattice enthalpy of Na2CO3 using a Born–Haber cycle that links lattice enthalpy with enthalpy change of solution.

-ve

The enthalpy change of solution of Na_2CO_3 is exothermic. Sketch this Born–Haber cycle. Explain how the lattice enthalpy of Na_2CO_3 could be calculated from the enthalpy changes in the cycle.

3



$\Delta H_{LATT} = 2 \times \Delta H_{HYD} Na^+ + \Delta H_{HYD} CO_3^{2-} \longrightarrow \Delta H_{SOL}$ 1