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A2 CHEMISTRY

5.2.1 LATTICE ENTHALPY

5.2.2 ENTHALPY AND ENTROPY

BOOKLET OF PAST EXAMINATION QUESTIONS

TOTAL 37 MARKS

MARK: /37	**%**	**GRADE:**

For Examiner's Use

Answer **all** questions.

1 Enthalpy changes of formation can be calculated using Born-Haber cycles.

(a) Construct a labelled Born-Haber cycle for magnesium chloride, $MgCl_2$, using the information below.

enthalpy change	energy/kJ mol^{-1}
atomisation of magnesium	+148
atomisation of chlorine	+122
1st ionisation energy of magnesium	+738
2nd ionisation energy of magnesium	+1451
1st electron affinity of chlorine	–349
lattice enthalpy of magnesium chloride	–2526
formation of magnesium chloride	?

[5]

(b) Use the Born-Haber cycle to calculate a value for the enthalpy change of formation of magnesium chloride.

[2]

(c) State and explain which compound has the **most exothermic** lattice enthalpy; $MgCl_2$, $MgBr_2$ or MgI_2.

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.....[3]

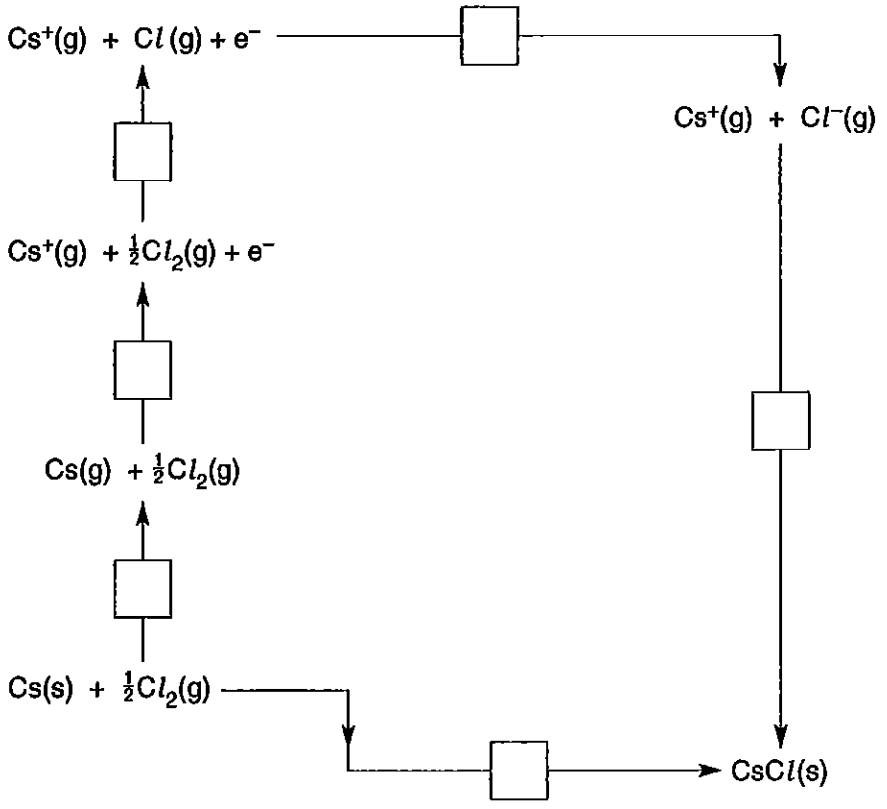
[Total : 10]

3 The lattice enthalpy of caesium chloride, CsC*l*, can be calculated using a Born-Haber cycle.

The table below shows the enthalpy changes and corresponding data for this cycle.

enthalpy change		energy/kJ mol^{-1}
lattice enthalpy of CsC*l*	**A**	?
atomisation of caesium	**B**	+76
atomisation of chlorine	**C**	+122
1st Ionisation energy of caesium	**D**	+376
1st electron affinity of chlorine	**E**	–349
formation of CsC*l*	**F**	–443

(a) On the cycle below, put the letter for each enthalpy change in the appropriate box.



[3]

(b) Calculate the lattice enthalpy of caesium chloride.

Answer .....kJ mol^{-1} [2]

(c) The lattice enthalpy of sodium chloride is **more exothermic** than the lattice enthalpy of caesium chlorlde.

State and explaln the relative strengths of the ionic bonding in sodium chlorlde and caesium chloride.

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.....[3]

(d) What would you expect to observe when solid caeslum chloride is added to water?

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.....[2]

(e) Describe how you would distinguish between aqueous caesium chloride and aqueous caesium iodide uslng a simple laboratory test. State the observations you would make.

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.....[3]

[Total : 13]

For Examiner's Use

Answer **all** the questions.

1 Calcium carbonate thermally decomposes into calcium oxide and carbon dioxide as shown in the equation.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

(a) Show that the thermal decomposition of calcium carbonate is **not** a redox reaction. Use oxidation states in your answer.

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..... [2]

(b) Magnesium carbonate also thermally decomposes. Describe and explain the difference in the ease of thermal decomposition between magnesium carbonate and calcium carbonate. Use ideas about charge density and polarisation in your answer.

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.....[3]

(c) Calculate the enthalpy change of reaction, ΔH_r, for the thermal decomposition of calcium carbonate using the enthalpy changes of formation given in the table.

compound	enthalpy change of formation, ΔH_f / kJ mol^{-1}
$CaCO_3(s)$	−1207
$CaO(s)$	−635
$CO_2(g)$	−393

answer ..... kJ mol^{-1} [2]

[Turn over

(d) The lattice enthalpy of magnesium oxide is $-3916\ kJ\ mol^{-1}$.

Explain, with the aid of a suitable equation, what is meant by the statement the 'lattice enthalpy of magnesium oxide is $-3916 kJ mol^{-1}$'.

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..... [3]

(e) The table below shows the enthalpy changes needed to calculate the lattice enthalpy of magnesium oxide.

process	equation	enthalpy change /kJ mol^{-1}
first ionisation energy of magnesium	$Mg(g) \rightarrow Mg^+(g) + e^-$	+735
second ionisation energy of magnesium	$Mg^+(g) \rightarrow Mg^{2+}(g) + e^-$	+1445
first electron affinity of oxygen	$O(g) + e^- \rightarrow O^-(g)$	−141
second electron affinity of oxygen	$O^-(g) + e^- \rightarrow O^{2-}(g)$	+878
enthalpy change of formation for magnesium oxide	$Mg(s) + \frac{1}{2}O_2(g) \rightarrow MgO(s)$	−602
enthalpy change of atomisation for magnesium	$Mg(s) \rightarrow Mg(g)$	+150
....	$\frac{1}{2}O_2(g) \rightarrow O(g)$	+247

(i) Complete the table by writing in the missing process. [1]

(ii) Explain why the second ionisation energy of magnesium is **more endothermic** than the first ionisation energy.

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.....[2]

For Examiner's Use

(iii) Draw a labelled Born-Haber cycle using the information in the table. Show, by calculation, that the lattice enthalpy of magnesium oxide is –3916 kJ mol^{-1}.

[4]

(f) State **one** use for magnesium oxide that relies on its high lattice enthalpy.

..... [1]

[Total: 18]

[Turn over