LATTICE ENERGY

1

(c) (i) Use the data in the table below, and relevant data from the *Data Booklet*, to calculate the lattice energy, $\Delta H^{\ominus}_{latt}$, of potassium oxide, $K_2O(s)$.

energy change	value / kJ mol^{-1}
enthalpy change of atomisation of potassium, $\Delta H^{\ominus}_{at}$ K(s)	+89
electron affinity of O(g)	–141
electron affinity of O^-(g)	+798
enthalpy change of formation of potassium oxide, $\Delta H^{\ominus}_{f}$ $K_2O(s)$	–361

$\Delta H^{\ominus}_{latt}$ = ... kJ mol^{-1} [3]

(ii) State whether the lattice energy of Na_2O would be more negative, less negative or the same as that of K_2O. Give reasons for your answer.

.....

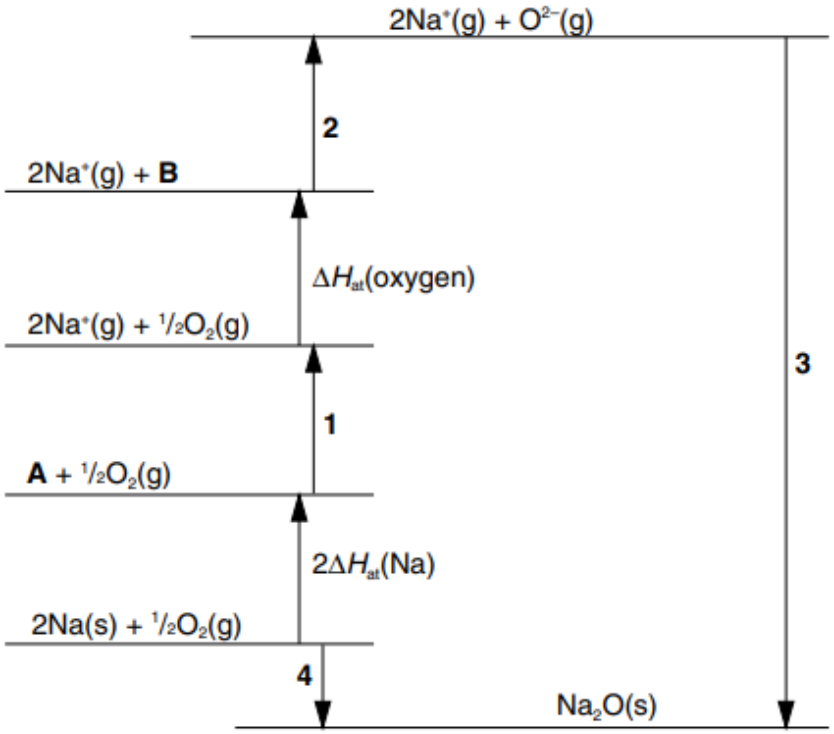
..... [1]

9701/42/M/J/17

2 **(a)** Write an equation to represent the lattice energy of sodium oxide, Na_2O.

.....[1]

(b) The Born-Haber cycle shown may be used to calculate the lattice energy of sodium oxide.



(i) In the spaces below, identify the species **A** and **B** in the cycle, including the appropriate state symbols.

species **A** ..... species **B** .....

(ii) Identify the enthalpy changes labelled by the numbers **1** to **4** in the cycle.

1 .....

2 .....

3 .....

4 .....

[3]

(c) Use your cycle, the following data, and further data from the *Data Booklet* to calculate a value for the lattice energy of sodium oxide.

Data:

enthalpy change of atomisation for Na(s)	$+107\ kJ\ mol^{-1}$
first electron affinity of oxygen	$-141\ kJ\ mol^{-1}$
second electron affinity of oxygen	$+798\ kJ\ mol^{-1}$
enthalpy change of formation of $Na_2O(s)$	$-414\ kJ\ mol^{-1}$

enthalpy change of atomisation for oxygen = half the bond energy for O_2.

[3]

(d) **(i)** How would you expect the magnitude of lattice energy of magnesium oxide to compare with that of sodium oxide? Explain your reasoning.

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(ii) State a use of magnesium oxide, and explain how the use relates to your answer in part **(d) (i)**.

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.....

[4]

[Total: 11]

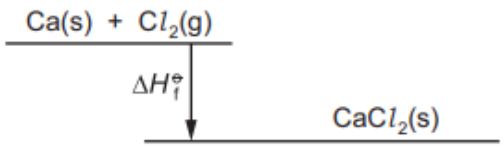
9701/4 O/N/02

2 **(a)** Calcium metal reacts with chlorine gas to form calcium chloride, $CaCl_2$.

(i) Write an equation, including state symbols, to represent the lattice energy of calcium chloride, $CaCl_2$.

..... [1]

(ii) Complete a fully labelled Born-Haber cycle that could be used to calculate the lattice energy, $\Delta H^{\ominus}_{latt}$, for calcium chloride.



[2]

(iii) Use your answer to **(ii)** and the following data, together with relevant data from the *Data Booklet*, to calculate a value for $\Delta H^{\ominus}_{latt}$ for calcium chloride.

standard enthalpy change of formation of $CaCl_2$(s), $\Delta H^{\ominus}_f$	–796 kJ mol^{-1}
standard enthalpy change of atomisation of Ca(s), $\Delta H^{\ominus}_{at}$	+178 kJ mol^{-1}
electron affinity of chlorine atoms	–349 kJ mol^{-1}

$\Delta H^{\ominus}_{latt}$ = ... kJ mol^{-1} [3]

(c) (i) The equation for which ΔH is the lattice energy for MgCl is shown.

$$Mg^+(g) + Cl^-(g) \rightarrow MgCl(s)$$

Use the equation, the following data, and relevant data from the *Data Booklet* to calculate a value for the lattice energy of MgCl. You might find it helpful to construct an energy cycle.

electron affinity of Cl(g) = –349 kJ mol^{-1}
enthalpy change of atomisation of Mg(s) = +147 kJ mol^{-1}
enthalpy change of formation of MgCl(s) = –106 kJ mol^{-1}

lattice energy MgCl = ... kJ mol^{-1} [3]

(ii) Suggest how the lattice energies of $MgCl_2$ and NaCl will compare to that of MgCl. Explain your answers.

$MgCl_2$ and MgCl .....

.....

NaCl and MgCl.....

.....

[3]

9701/42/O/N/17

(d) Use the data below, and other suitable data from the *Data Booklet*, to calculate the lattice energy of sodium oxide, $\Delta H^{\ominus}_{latt}$ $Na_2O(s)$.

energy change	value / kJ mol^{-1}
standard enthalpy change of formation of sodium oxide, $\Delta H^{\ominus}_{f}$ $Na_2O(s)$	–416
standard enthalpy change of atomisation of sodium, $\Delta H^{\ominus}_{at}$ Na(s)	+109
electron affinity of O(g)	–142
electron affinity of O^-(g)	+844

$\Delta H^{\ominus}_{latt}$ $Na_2O(s)$ = ... kJ mol^{-1} [4]

(e) State how $\Delta H^{\ominus}_{latt}$ $Na_2S(s)$ differs from $\Delta H^{\ominus}_{latt}$ $Na_2O(s)$.
Indicate this by placing a tick (✓) in the appropriate box in the table.

$\Delta H^{\ominus}_{latt}$ $Na_2S(s)$ is more exothermic than $\Delta H^{\ominus}_{latt}$ $Na_2O(s)$	$\Delta H^{\ominus}_{latt}$ $Na_2S(s)$ is the same as $\Delta H^{\ominus}_{latt}$ $Na_2O(s)$	$\Delta H^{\ominus}_{latt}$ $Na_2S(s)$ is less exothermic than $\Delta H^{\ominus}_{latt}$ $Na_2O(s)$

Explain your answer.

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.....

[2]

9701/43/M/J/18

(c) **(i)** Write a chemical equation representing the lattice energy of AgBr.

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(ii) Use the following data to calculate a value for the lattice energy of AgBr(s).

first ionisation energy of silver	=	+731 kJ mol^{-1}
electron affinity of bromine	=	–325 kJ mol^{-1}
enthalpy change of atomisation of silver	=	+285 kJ mol^{-1}
enthalpy change of atomisation of bromine	=	+112 kJ mol^{-1}
enthalpy change of formation of AgBr(s)	=	–100 kJ mol^{-1}

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(iii) How might the lattice energy of AgC*l* compare to that of AgBr? Explain your answer.

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[4]

In photography a bromide ion absorbs a photon and releases an electron which reduces a silver ion to a silver atom.

$$Br^- \longrightarrow Br + e^-$$

$$Ag^+ + e^- \longrightarrow Ag$$

(d) Predict whether it would require **more** energy or **less** energy to initiate this process in a AgC*l* emulsion, compared to a AgBr emulsion. Explain your answer.

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..... [1]

(c) (i) Use the following data and data from the *Data Booklet* to construct a Born-Haber cycle and calculate the lattice energy of BaS.

standard enthalpy change of formation of BaS(s)	–460 kJ mol^{-1}
standard enthalpy change of atomisation of Ba(s)	+180 kJ mol^{-1}
standard enthalpy change of atomisation of S(s)	+279 kJ mol^{-1}
electron affinity of the sulfur atom	–200 kJ mol^{-1}
electron affinity of the S^- ion	+640 kJ mol^{-1}

lattice energy = ... kJ mol^{-1}

(ii) Explain whether the magnitude of the lattice energy of BaS is likely to be greater or less than that of BaO.

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[4]

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