Q1 **(a) (i)** What is meant by the term *lattice energy*?

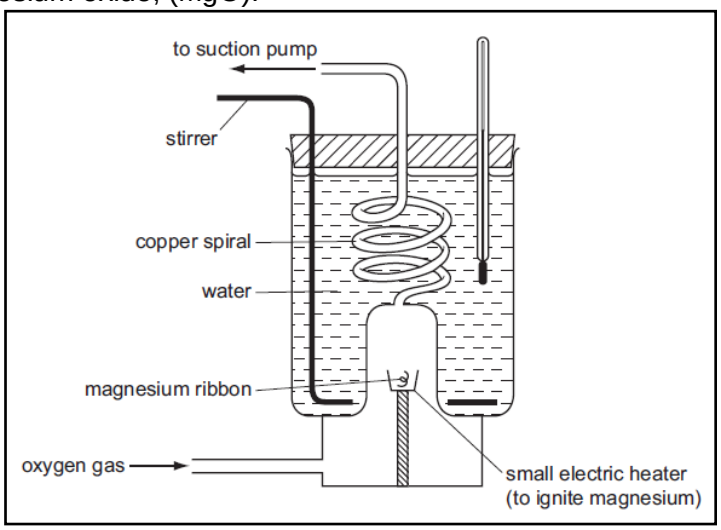
.....

.....

(ii) Write an equation to represent the lattice energy of MgO.

.....

(b) The apparatus shown in the diagram can be used to measure the enthalpy change of formation of magnesium oxide, (MgO).



List the measurements you would need to make using this apparatus in order to calculate enthalpy change of formation of magnesium oxide (MgO).

.....

.....

.....

(c) Use the following data, together with appropriate data from the *Data Booklet*, to calculate a value of enthalpy change of formation of (MgO).
lattice energy of MgO(s) = –3791 kJ mol^{-1}
enthalpy change of atomisation of Mg = +148 kJ mol^{-1}
electron affinity of the oxygen atom = –141 kJ mol^{-1}
electron affinity of the oxygen anion, O^- = +798 kJ mol^{-1}

(June 2012 P41)

Q2 The following table lists some enthalpy changes for magnesium and strontium compounds.

enthalpy change	value for magnesium / kJ mol^{-1}	value for strontium / kJ mol^{-1}
lattice enthalpy of $\boldsymbol{M}(OH)_2$	–2993	–2467
enthalpy change of hydration of $\boldsymbol{M}^{2+}(g)$	–1890	–1414
enthalpy change of hydration of $OH^-(g)$	–550	–550

(i) Use the above data to calculate values of $\Delta H_{solution}$ for $Mg(OH)_2$ and for $Sr(OH)_2$.

$Mg(OH)_2$ .....

.....

$Sr(OH)_2$ .....

.....

(ii) Use your results in **(i)** to suggest whether $Sr(OH)_2$ is more or less soluble in water than is $Mg(OH)_2$. State any assumptions you make.

.....

.....

(iii) Suggest whether $Sr(OH)_2$ would be more or less soluble in hot water than in cold. Explain your reasoning.

.....

.....

(June 2010 P42)

Q3 The major ore of barium is barytes, $BaSO_4$. This is very unreactive, and so other barium compounds are usually made from the sulfide, BaS. This is obtained by heating the crushed ore with carbon, and extracting the BaS with water.

$$BaSO_4(s) + 4C(s) \longrightarrow BaS(s) + 4CO(g)$$

When 250 g of ore was heated in the absence of air with an excess of carbon, it was found that the CO produced took up a volume of 140 dm^3 at 450 K and 1 atm.

(i) Calculate the number of moles of CO produced.

.....

.....

(ii) Calculate the number of moles of $BaSO_4$ in the 250 g sample of the ore.

.....

.....

(iii) Calculate the percentage by mass of $BaSO_4$ in the ore.

.....

.....

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}

(Nov 2009 P42)

Q4 One of the reasons the melting point of magnesium chloride is quite high is because it has a fairly high lattice energy.
(a) (i) Explain the term *lattice energy*.

.....

.....
(ii) Write a balanced equation including state symbols to represent the lattice energy of magnesium chloride.

.....

.....
(b) Suggest, with an explanation in each case, how the lattice energy of magnesium chloride might compare with that of
(i) sodium chloride, NaC*l*,

.....

.....
(ii) calcium chloride, $CaCl_2$.

.....

.....

(c) Use the following data to calculate a value for the lattice energy of sodium chloride.

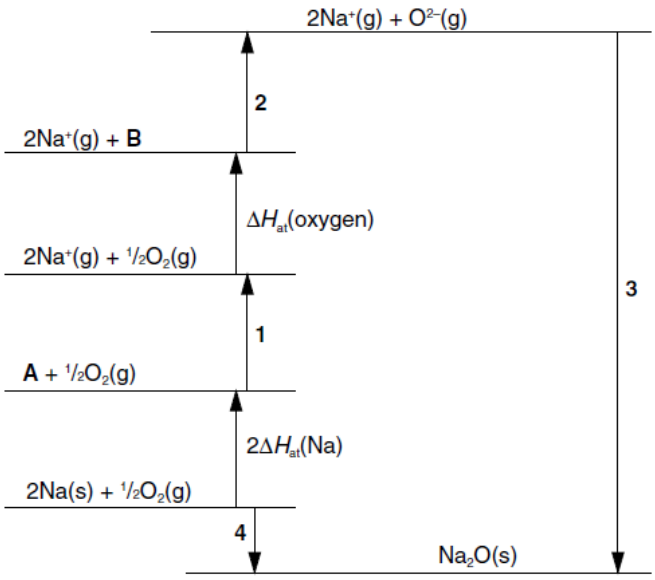
ΔH_f (NaCl)	=	$-411\ kJ\ mol^{-1}$
ΔH_{at} (Na)	=	$107\ kJ\ mol^{-1}$
ΔH_{at} (Cl)	=	$122\ kJ\ mol^{-1}$
first ionisation energy of Na	=	$494\ kJ\ mol^{-1}$
electron affinity of Cl	=	$-349\ kJ\ mol^{-1}$

(June 2004)

Q5 **(a)** Write an equation to represent the lattice energy of sodium oxide, Na_2O.

.....

(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 .....

(Nov 2002)

Q6 **(i)** Write a chemical equation representing the lattice energy of AgBr.

.....

(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}

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

.....

.....

.....

Q6 **(a) (i)** What is meant by the term *enthalpy change of hydration*,?

.....

.....

(ii) Write an equation that represents the of the hydration Mg^{2+} ion.

.....

(iii) Suggest a reason why *enthalpy change of hydration* of the Mg^{2+} ion is greater than *enthalpy change of hydration* of the Ca^{2+} ion.

.....

.....

(iv) Suggest why it is impossible to determine the enthalpy change of hydration of the oxide ion, O^{2-}.

.....

.....

The enthalpy change of solution for $MgCl_2$, enthalpy change of solution ($MgCl_2(s)$), is represented by the following equation.

$$MgCl_2(s) + aq \rightarrow Mg^{2+}(aq) + 2Cl^-(aq)$$

Describe the simple apparatus you could use, and the measurements you would make, in order to determine a value for enthalpy change of solution of ($MgCl_2(s)$) in the laboratory.

.....

.....

.....

.....

.....

.....

(c) The table below lists data relevant to the formation of $MgCl_2(aq)$.

enthalpy change	value / kJ mol^{-1}
$\Delta H_f^{\ominus}(MgCl_2(s))$	–641
$\Delta H_f^{\ominus}(MgCl_2(aq))$	–801
lattice energy of $MgCl_2(s)$	–2526
$\Delta H_{hyd}^{\ominus}(Mg^{2+}(g))$	–1890

By constructing relevant thermochemical cycles, use the above data to calculate a value for

(i) $\Delta H_{sol}^{\ominus}(MgCl_2(s))$,

(ii) $\Delta H_{hyd}^{\ominus}(Cl^-(g))$.

(June 2012 P42)