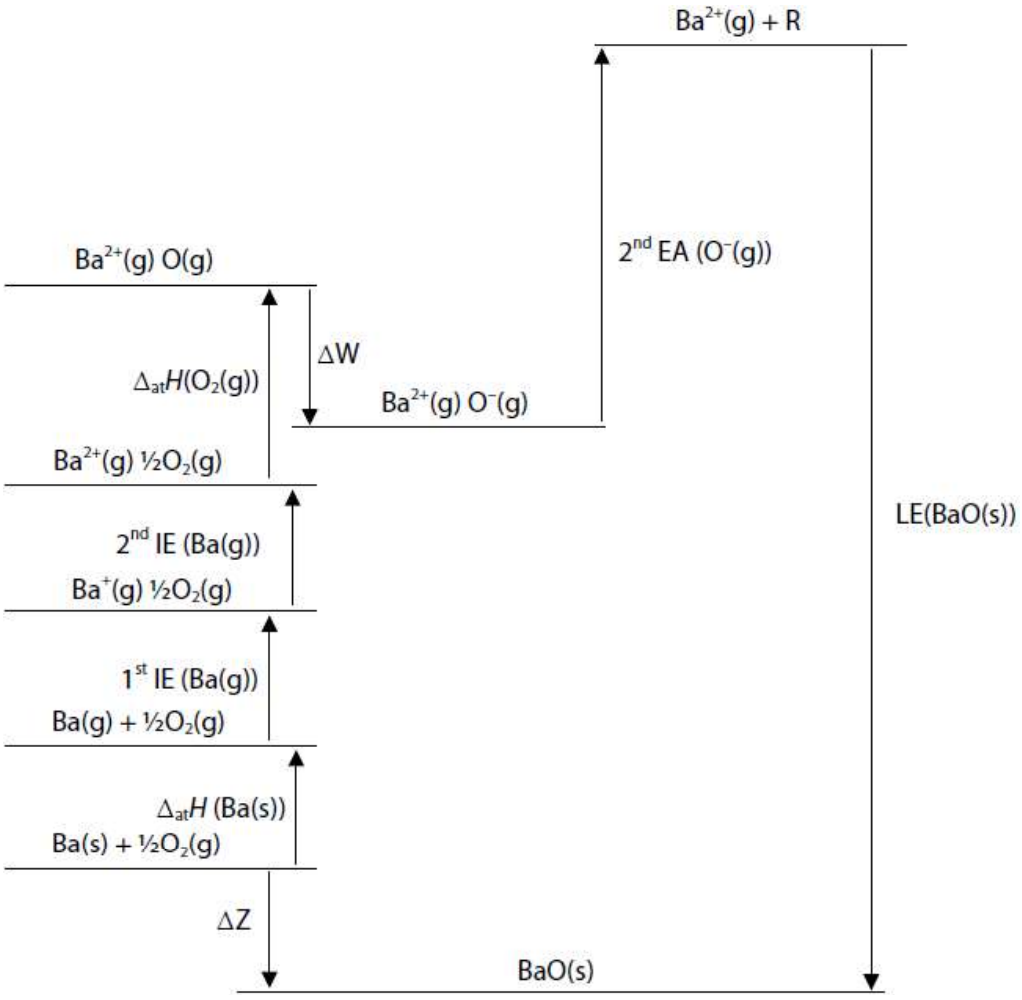
Q1.

Barium oxide is an ionic compound that reacts with water to form barium hydroxide.

(a) A Born-Haber cycle for barium oxide, BaO, is shown.

Some of the detail is missing. The letters **R**, **W** and **Z** represent some missing information.



(i) Identify the missing detail represented by the following letters.

(2)

R .....

W .....

(ii) Use the following data to calculate a value for the quantity ΔZ shown on the Born-Haber cycle.

Include a sign and units in your answer.

(3)

Energy quantity	Enthalpy change / kJ mol^{-1}
Enthalpy change of atomisation of barium, $\Delta_{at}H$(Ba(s))	+180.0
Enthalpy change of atomisation of oxygen, $\Delta_{at}H$ (½O_2(g))	+249.2
First ionisation energy of barium, lst IE (Ba(g))	+503.0
Second ionisation energy of barium, 2nd IE (Ba(g))	+965.0
ΔW	−141.1
Second electron affinity of oxygen, 2nd EA (O^-(g))	+798.0
Lattice energy barium oxide, $\Delta_{LE}H$(BaO(s))	−3054.0

(iii) The table gives some information about the lattice energies of barium oxide and magnesium iodide and shows the % difference between the theoretical and experimental values.

	Lattice energy / kJ mol^{-1}		
	Experimental	Theoretical	% difference
BaO(s)	−3054	−3029	0.8
MgI_2(s)	−2327	−1944	16.5

Explain why there is closer agreement for barium oxide than for magnesium iodide.

(3)

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(b) The table gives some information about Group 2 ions, M^{2+}, and their hydroxides.

Formula of hydroxide	Lattice energy / kJ mol^{-1}	$\Delta_{sol}H$ / kJ mol^{-1}	Solubility / mol per 100 g	Ion	$\Delta_{hyd}HN^{2+}$ / kJ mol^{-1}
$Mg(OH)_2$	−3000	+150	2.0×10^{-5}	Mg^{2+}	−1930
$Ca(OH)_2$	−2640	+140	1.6×10^{-4}	Ca^{2+}	−1580
$Sr(OH)_2$	−2475	+105	3.3×10^{-4}	Sr^{2+}	−1450
$Ba(OH)_2$	−2230		2.4×10^{-4}	Ba^{2+}	−1360

(i) Calculate the enthalpy change of solution, $\Delta_{sol}H$, of $Ba(OH)_2$ using a fully-labelled Hess's cycle.

[The hydration enthalpy of the hydroxide ion, OH^- = –460 kJ mol^{-1}.]

(4)

(ii) Explain why strontium hydroxide is slightly soluble in water, even though the enthalpy change of solution is endothermic.

(2)

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(Total for question = 14 marks)