1 These questions are from different areas of chemistry.

This question is about two salts of rubidium (atomic number 37): $RbClO_3$ and $RbClO_4$.

i. The oxidation number of chlorine is different in the two rubidium salts, $RbClO_3$ and $RbClO_4$.

What is the name of $RbClO_4$?

[1]

ii. A student carries out an experiment to determine the enthalpy change of solution of $RbClO_3$ using the method below.

- A 2.00 g sample of solid $RbClO_3$ is added to water in a well-insulated container.
  The initial temperature is 23.0 °C.
- The mixture is stirred until all the $RbClO_3$ has dissolved.
  The final temperature is 21.5 °C.
  The final solution has a mass of 102 g.

Determine the enthalpy change of solution, $\Delta_{sol} H$, of $RbClO_3$ in kJ mol^{-1}.

Assume that the specific heat capacity of the solution is the same as that of pure water.

$\Delta_{sol} H (RbClO_3)$ = ... kJ mol^{-1} **[3]**

2 This question is about energy changes.

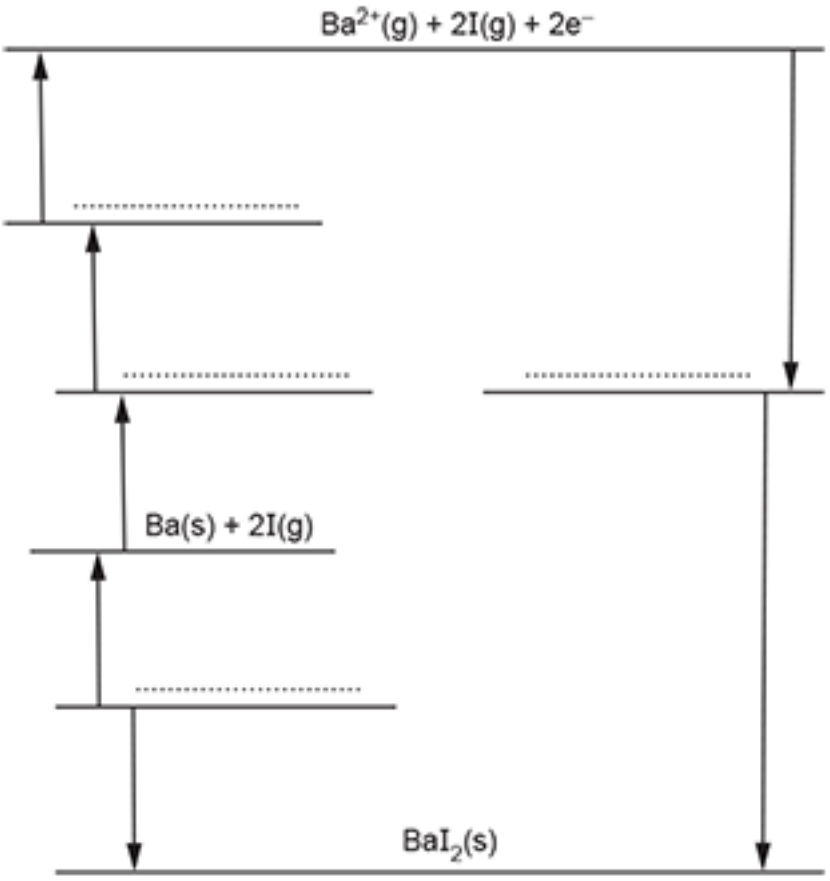
Lattice enthalpies can be determined indirectly using Born-Haber cycles.

The table below shows the energy changes that are needed to determine the lattice enthalpy of barium iodide, BaI_2.

Energy term	Energy change / kJ mol^{-1}
formation of barium iodide	–602
1st electron affinity of iodine	–296
1st ionisation energy of barium	+503
2nd ionisation energy of barium	+965
atomisation of iodine	+107
atomisation of barium	+180

i. The diagram below shows an incomplete Born-Haber cycle that can be used to calculate the lattice enthalpy of barium iodide.

On the dotted lines, add the species present, including state symbols.



[4]

ii. Calculate the lattice enthalpy of barium iodide.

lattice enthalpy = ... kJ mol^{-1} **[2]**

3 Which compound requires the most energy to convert one mole into its gaseous ions?

A NaF
B Na_2O
C MgF_2
D MgO

Your answer ☐ **[1]**

4 Which equation represents the change that accompanies the standard enthalpy change of atomisation of bromine?

A ½ $Br_2(l) \rightarrow Br(g)$
B $Br_2(l) \rightarrow 2Br(g)$
C ½ $Br_2(g) \rightarrow Br(g)$
D $Br_2(g) \rightarrow 2Br(g)$

Your answer ☐ **[1]**

5 This question is about energy changes.

***** A student plans to determine the enthalpy change of hydration of calcium ions.

The student finds the information below from data tables.

Enthalpy change	ΔH / kJ mol^{-1}
Lattice enthalpy of calcium chloride	-2223
Enthalpy change of hydration of chloride ions	-378

The student carries out an experiment to find the enthalpy change of solution of calcium chloride.

Student's method:

- Weigh a bottle containing calcium chloride and weigh a polystyrene cup.
- Add water from a measuring cylinder to the polystyrene cup and measure its temperature.
- Add the calcium chloride, stir the mixture, and measure the maximum temperature of the final solution.
- Weigh the empty bottle and weigh the polystyrene cup with the final solution.

Mass readings

Mass of bottle + calcium chloride / g	27.45
Mass of empty bottle / g	18.17
Mass of polystyrene cup / g	21.24
Mass of polystyrene cup + final solution / g	127.84

Temperature readings

Initial temperature of water / °C	21.0
Maximum temperature of final solution / °C	39.5

Calculate the enthalpy change of solution of calcium chloride and determine the enthalpy change of hydration of calcium ions.

Show your working, including an energy cycle linking the energy changes.

Assume that the density and specific heat capacity, *c,* of the solution are the same as for water.

[6]

END OF QUESTION PAPER