15.1 Energy Cycles

Question Paper

Course	DP IB Chemistry
Section	15. Energetics/Thermochemistry (HL only)
Topic	15.1 Energy Cycles
Difficulty	Easy

Time allowed: 60

Score: /42

Percentage: /100

Question 1a

a)
Write one equation to represent each the following changes:

Atomisation of sodium ……..

First ionisation energy of magnesium ……..

First electron affinity of chlorine ……..

[3]

[3 marks]

Question 1b

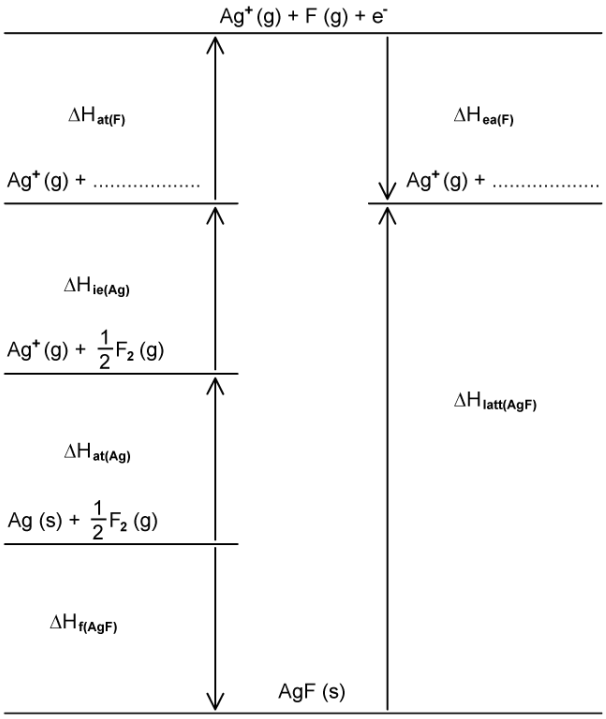
b)
Give the definition of the term *enthalpy of lattice formation.*

[2]

[2 marks]

Question 1c

c)
Study the following Born-Haber cycle.



State the enthalpy changes for the following steps:

Step 1 ……..

Step 3 ……..

Step 4 ……..

[3]

[3 marks]

Question 1d

d)
The enthalpy of lattice formation of potassium fluoride and caesium fluoride is -829 kJ mol^{-1} and -759 kJ mol^{-1} respectively.

With reference to the ions in the structure, explain why the enthalpy of lattice formation is more exothermic for potassium fluoride.

[3]

[3 marks]

Question 2a

a)
State the equation to determine the standard enthalpy change of solution, ΔH_{sol}.

[1 mark]

Question 2b

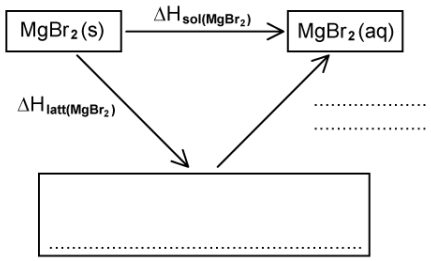
b)
Use sections 18 and 20 in the data booklet to determine the enthalpy change of solution, ΔH_{sol}, in kJ mol^{-1}, of sodium chloride, NaCl.

[2]

[2 marks]

Question 2c

c)
Part of the dissolution cycle for magnesium bromide is shown below. Complete the cycle.



[3]

[3 marks]

Question 2d

d)
The lattice enthalpy ΔH_{latt}, of magnesium bromide is 2421 kJ mol^{-1}. Using section 20 of the data booklet and your answer to part c), determine the enthalpy of solution, ΔH_{sol}, in kJ mol^{-1} of magnesium bromide.

[2]

[2 marks]

Question 2e

e)
The enthalpy of hydration for the calcium ion, $\Delta H_{hyd(Ca^{2+})}$, is 1616 kJ mol^{-1}. Explain why this value is less exothermic than the value for the enthalpy of hydration for the magnesium ion, $\Delta H_{hyd(Mg^{2+})}$.

[2]

[2 marks]

Question 3a

a)
State the definition of electron affinity, ΔH_{ea}.

[3]

[3 marks]

Question 3b

b)
Electron affinities can be represented using equations.

i)
State the equation which represents the first electron affinity of oxygen.

[1]

ii)
State the equation which represents the second electron affinity of oxygen.

[1]

[2 marks]

Question 3c

c)
The first and second electron affinities of oxygen are shown in the table below.

First electron affinity of O	-141 kJ mol^{-1}	Exothermic
Second electron affinity of O	+844 kJ mol^{-1}	Endothermic

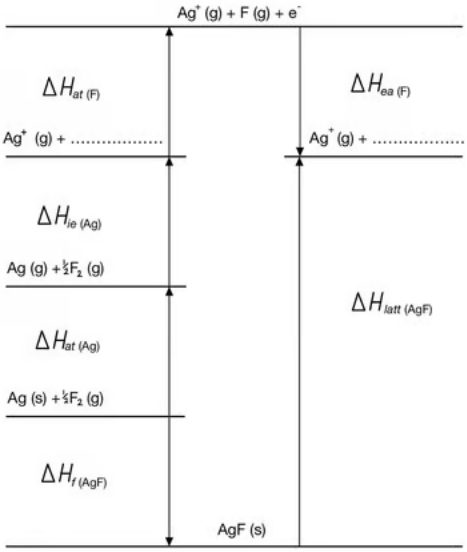
State why the second electron affinity of oxygen is an endothermic process.

[2]

[2 marks]

Question 4a

a)
The incomplete Born-Haber cycle for silver fluoride, AgF, is shown below.



Complete the Born Haber cycle.

[2]

[2 marks]

Question 4b

b)
Use the Born-Haber cycle in part a) and sections 8 and 11 in the data booklet to determine the enthalpy changes, in kJ mol^{-1}, of the following.

The enthalpy of atomisation of silver, $\Delta H_{at(Ag)}$, is +289 kJ mol^{-1}
The enthalpy of atomisation of fluorine, $\Delta H_{at(F)}$, is +79 kJ mol^{-1}

$\Delta H_{at(Ag)} + \Delta H_{ie(Ag)}$ .....

$\Delta H_{at(F)} + \Delta H_{ea(F)}$ .....

[2]

[2 marks]

Question 4c

c)
Use your answer to part b) and the lattice enthalpy of silver fluoride, $\Delta H_{latt(AgF)}$, in section 18 in the data booklet to determine the enthalpy of formation of silver fluoride, $\Delta H_{f(AgF)}$, in kJ mol^{-1}.

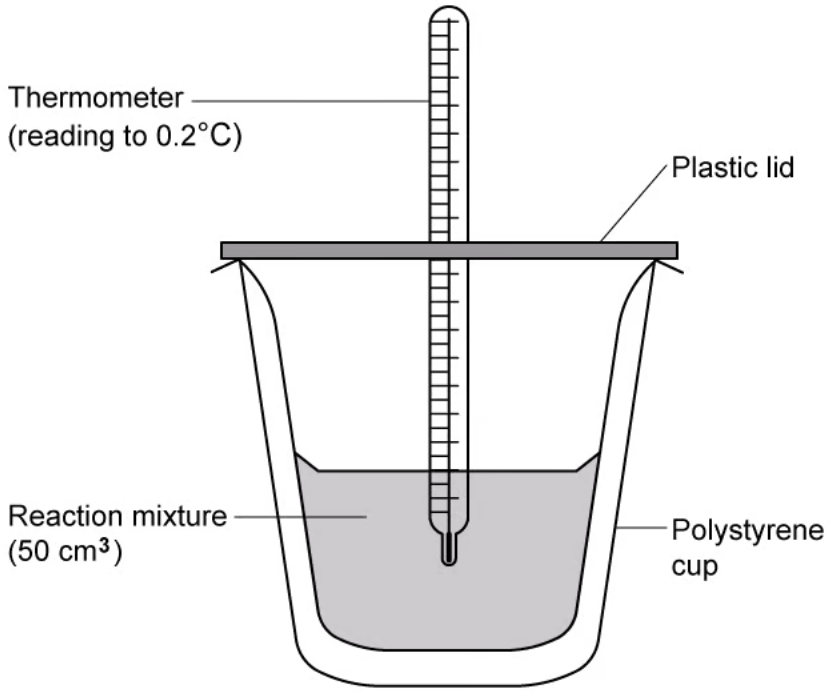
[3]

[3 marks]

Question 5a

a)

The equipment set up below is used to measure the enthalpy change for a reaction.



Suggest why a polystyrene cup is used for this experiment.

[1 mark]

Question 5b

b)
A student added 50.00 cm^3 of 1.50 mol dm^{-3} copper sulfate solution, $CuSO_4$ (aq), to the polystyrene cup. They recorded the temperature every minute for 3 minutes. On the fourth minute, 6.00 g of powdered zinc was added. They then recorded the temperature of the reaction mixture every minute for a further 7 minutes. The maximum temperature change was estimated to be 29.0 °C.

Use section 6 of the data booklet to answer the following questions.

i)
Determine the amount, in moles, of copper sulfate used in the reaction.

[1]

ii)
Determine the amount, in moles, of powdered zinc used in the reaction.

[1]

iii)
Determine the limiting reagent in the reaction.

[1]

[3 marks]

Question 5c

c)
Use the information in part b) and sections 1 and 2 in the data booklet to determine the following.

i)
The energy change, in J, for the reaction.

[1]

ii)
The enthalpy change, in kJ mol^{-1}, for the reaction between copper sulfate and zinc.

[2]

[3 marks]