

AQA A-Level Chemistry

Thermodynamics

Questions only

The newest questions, about an hour. All 14 are in the exam generator.

Questions

6

Total marks

45

Time allowed

59 min

Name

Class or teacher

Date

Instructions

- Answer all questions in the spaces provided.
- Use black ink. Show your working for every calculation.
- You may use a scientific calculator and the AQA Data Sheet.
- Print the separate mark scheme when you are ready to mark your answers.

For marking

Q	Source	Marks	Score
1	2017 A-level P3 Q32	1	
2	2018 A-level P3 Q14	1	
3	2018 A-level P3 Q33	1	
4	2025 A-level P1 Q4	12	
5	2024 A-level P1 Q8	14	
6	2023 A-level P1 Q5	16	

Total _____ / 45 **Percentage** _____ %

Questions from AQA past papers, 2017–2025, reproduced for revision. Practise these topics online, with instant marking:

whiteboardchemistry.com/revision/aqa-a-level-chemistry/exam-questions?topics=thermodynamics&len=0

Questions

Thermodynamics · 6 questions · 45 marks · time allowed 59 min

Q1 · June 2017 · Paper 3 · Q32 · [1 mark]

A reaction is exothermic and has a negative entropy change.

Which statement is correct?

Tick (✓) one box.

- ☐ **A** The reaction is always feasible
 - ☐ **B** The reaction is feasible above a certain temperature
 - ☐ **C** The reaction is feasible below a certain temperature
 - ☐ **D** The reaction is never feasible
-

Q2 · June 2018 · Paper 3 · Q14 · [1 mark]

Which equation represents the process that occurs when the standard enthalpy of atomisation of iodine is measured?

Tick (✓) one box.

- ☐ **A** $1 \text{ I}_2(\text{s}) \rightarrow \text{I}(\text{g}) \times 2$
 - ☐ **B** $\text{I}_2(\text{s}) \rightarrow 2\text{I}(\text{g})$
 - ☐ **C** $1 \text{ I}_2(\text{g}) \rightarrow \text{I}(\text{g}) \times 2$
 - ☐ **D** $\text{I}_2(\text{g}) \rightarrow 2\text{I}(\text{g})$
-

Q3 · June 2018 · Paper 3 · Q33 · [1 mark]

Lattice enthalpy values can be obtained from Born–Haber cycles and by calculations based on a perfect ionic model.

Which compound shows the greatest percentage difference between these two values?

Tick (✓) one box.

- ☐ **A** CsF
- ☐ **B** CsI
- ☐ **C** LiF
- ☐ **D** LiI

Q4 · June 2025 · Paper 1 · Q4 · [12 marks]

This question also needs Chemical equilibria and Energetics.

Nitrogen dioxide gas is formed when magnesium nitrate is heated.

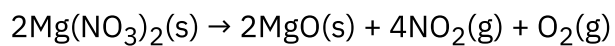


Table 4 shows some thermodynamic data.

Table 4

Substance	$\text{Mg}(\text{NO}_3)_2(\text{s})$	$\text{MgO}(\text{s})$	$\text{NO}_2(\text{g})$	$\text{O}_2(\text{g})$
$\Delta_f H^\ominus / \text{kJ mol}^{-1}$	-790	-602	+34	0
$S^\ominus / \text{J K}^{-1} \text{mol}^{-1}$	+164	+27	+240	+205

04.1 Give the standard conditions indicated by the symbol $\ominus$ in $\Delta_f H^\ominus$ and $S^\ominus$

[1 mark]

04.2 Use the equation and the data in Table 4 to calculate the temperature at which this reaction becomes feasible.

Temperature K

Nitrogen dioxide can also be produced in a reaction between ammonia and oxygen.

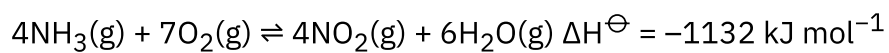


Table 5 shows some bond enthalpy values.

Table 5

	N-H	O=O	O-H
Mean bond enthalpy / kJ mol^{-1}	388	496	463

[5 marks]

04.3 Assume that the bonds between N and O in NO_2 are the same.

Calculate the mean bond enthalpy, in kJ mol^{-1} , for a bond between N and O in NO_2

Bond enthalpy kJ mol^{-1}

[3 marks]

04.4 An alloy of platinum and rhodium is used as a catalyst in the reaction.

What type of catalyst is this?

Tick () one box.

[1 mark]

Autocatalyst

Heterogeneous catalyst

Homogeneous catalyst

04.5 Some ammonia and oxygen are reacted and the mixture is left to reach equilibrium at a fixed temperature.

Explain why increasing the temperature of this equilibrium mixture decreases the mole fraction of NO_2 in the equilibrium mixture.

[2 marks]

Q5 • June 2024 • Paper 1 • Q8 • [14 marks]

This question is about enthalpy changes.

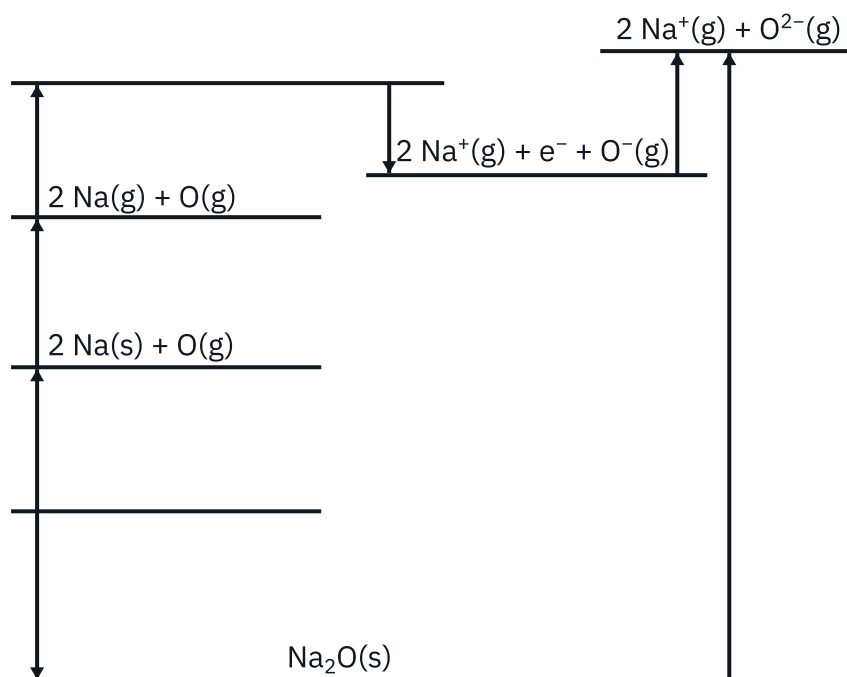
(a) Theoretical values for enthalpies of lattice dissociation can be calculated using a perfect ionic model.

State the meaning of the term perfect ionic model.

[1 mark]

(b) Enthalpies of lattice dissociation can also be obtained from Born–Haber cycles.

The figure below shows an incomplete Born–Haber cycle for the formation of sodium oxide.



Complete above figure by writing formulas, including state symbols, of the appropriate species on each of the two blank lines.

[2 marks]

Draw your answer on the figure above.

(c) Table 1 shows some enthalpy changes.

Table 1

Enthalpy change	$\Delta H / \text{kJ mol}^{-1}$
Enthalpy of atomisation of oxygen	+248
Enthalpy of atomisation of sodium	+109
Enthalpy of formation of sodium oxide	-416
First ionisation energy of sodium	+494
First electron affinity of oxygen	-142
Second electron affinity of oxygen	+844

Use the data in Table 1 to calculate the enthalpy of lattice dissociation of sodium oxide.

Enthalpy of lattice dissociation kJ mol^{-1}

[2 marks]

(d) Explain why the second electron affinity of oxygen has a positive value.

[1 mark]

(e) Explain why the enthalpy of lattice dissociation for sodium oxide is greater than the enthalpy of lattice dissociation for sodium chloride.

[2 marks]

(f) Sodium chloride dissolves in water.

Table 2 shows some more enthalpy changes.

Table 2

Enthalpy change	$\Delta H / \text{kJ mol}^{-1}$
Enthalpy of hydration for Cl^- ions	-364
Enthalpy of hydration for Na^+ ions	-406
Enthalpy of lattice dissociation for NaCl	+771

Use the data in Table 2 to calculate the enthalpy of solution for sodium chloride.

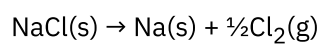
Enthalpy of solution kJ mol^{-1}

[2 marks]

(g) Give a reason why data books do not contain a value for the enthalpy of solution of sodium oxide.

[1 mark]

(h) Calculate the temperature, in °C, at which this reaction becomes feasible.



$$\Delta H = +411 \text{ kJ mol}^{-1}$$

$$\Delta S = +90.1 \text{ J K}^{-1} \text{ mol}^{-1}$$

Temperature °C

[3 marks]

Q6 · June 2023 · Paper 1 · Q5 · [16 marks]

This question is about metal chlorides.

(a) Table 1 shows some enthalpy change data.

Table 1

	Enthalpy change / kJ mol^{-1}
$\text{Ca}^{2+}(\text{g}) \rightarrow \text{Ca}^{2+}(\text{aq})$	-1650
$\text{Cl}^{-}(\text{g}) \rightarrow \text{Cl}^{-}(\text{aq})$	-364
$\text{Ca}^{2+}(\text{g}) + 2 \text{Cl}^{-}(\text{g}) \rightarrow \text{CaCl}_2(\text{s})$	-2237

Use the data in Table 1 to calculate the molar enthalpy change when calcium chloride dissolves in water.

Molar enthalpy change kJ mol^{-1}

[2 marks]

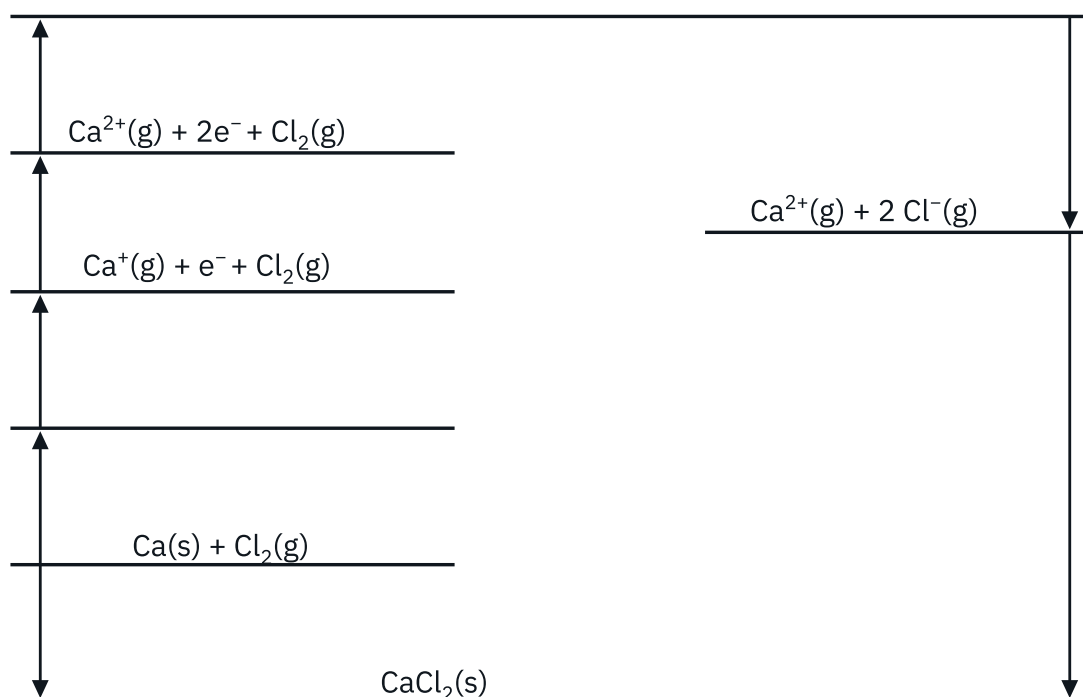
(b) Use your answer to part (a) to deduce how the temperature changes when calcium chloride dissolves in water.

[1 mark]

(c) Explain why the enthalpy of hydration of fluoride ions is more negative than the enthalpy of hydration of chloride ions.

[2 marks]

(d) The figure below shows an incomplete Born–Haber cycle for calcium chloride.



Complete the Born–Haber cycle by writing the formulas of the missing species on each of the two blank lines.

[2 marks]

Draw your answer on the figure above.

(e) Table 2 shows some enthalpy change data.

Table 2

	Enthalpy change / kJ mol^{-1}
Enthalpy of atomisation of calcium	+193
First ionisation energy of calcium	+590
Enthalpy of atomisation of chlorine	+121
Electron affinity of chlorine	-364
Enthalpy of formation of calcium chloride	-795
Enthalpy of lattice formation of calcium chloride	-2237

Use the figure in (d) and data from Table 2 to calculate the second ionisation energy of calcium.

Second ionisation energy kJ mol^{-1}

[2 marks]

(f) Explain why the second ionisation energy of calcium is greater than the first ionisation energy of calcium.

[1 mark]

(g) Table 3 shows lattice enthalpies based on a perfect ionic model and lattice enthalpies from Born–Haber cycles for three metal chlorides.

Table 3

Lattice enthalpy of dissociation / kJ mol^{-1}		
	Perfect ionic model	Born–Haber cycle
Calcium chloride	2223	2237
Potassium chloride	690	701
Silver chloride	770	905

Discuss the values in Table 3.

In your answer you should

- compare the three values based on a perfect ionic model
- compare the values based on a perfect ionic model to the values from a Born–Haber cycle for each compound.

[6 marks]

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Mark scheme:

whiteboardchemistry.com/revision/aqa-a-level-chemistry/exam-questions/pdf/thermodynamics-mark-scheme.pdf