CHEMISTRY ONLINE
TUITION

Phone: +442081445350

www.chemistryonlinetuition.com

Email:asherrana@chemistryonlinetuition.com

CHEMISTRY

PHYSICAL CHEMISTRY II

Level & Board	AQA (A-LEVEL)
TOPIC:	THERMODYNAMICS
PAPER TYPE:	QUESTION PAPER - 4
TOTAL QUESTIONS	10
TOTAL MARKS	43

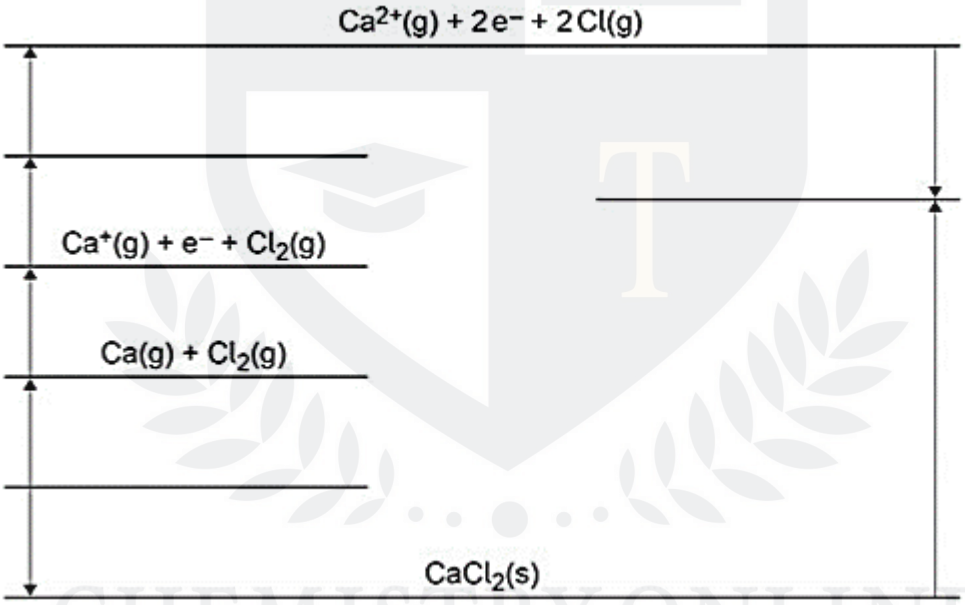
Thermodynamics - 4

1. This question is about enthalpy changes for calcium chloride and magnesium chloride.

(a) State the meaning of the term enthalpy change.

(1)

(b) The figure below shows an incomplete Born–Haber cycle for the formation of calcium chloride.

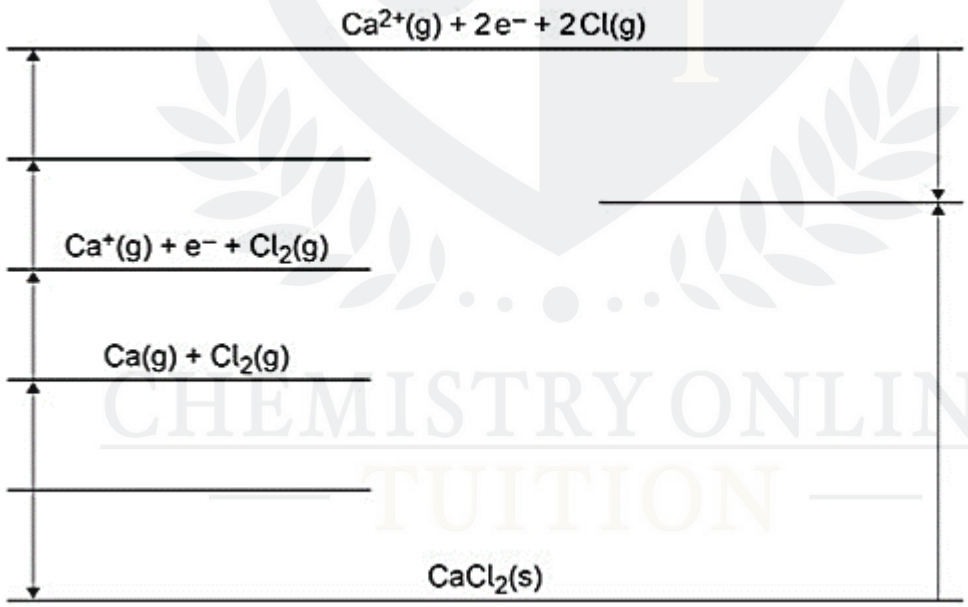


Complete the figure above by writing the formulas, including state symbols, of the appropriate species on each of the three blank lines.

(3)

(c) Table shows some enthalpy data.

	Enthalpy change / kJ mol^{-1}
Enthalpy of formation of calcium chloride	–795
Enthalpy of atomisation of calcium	+193
First ionisation energy of calcium	+590
Second ionisation energy of calcium	+1150
Enthalpy of atomisation of chlorine	+121
Electron affinity of chlorine	–364



Use the figure and the data in Table to calculate a value for the enthalpy of lattice dissociation of calcium chloride.

(2)

2. This question is about the reaction given below.

$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$

Enthalpy data for the reacting species are given in the table below.

Substance	CO(g)	$H_2O(g)$	$CO_2(g)$	$H_2(g)$
ΔH_f / kJ mol^{-1}	−110	−242	−394	0

Which one of the following statements is not correct?

A. The value of Kp changes when the temperature changes.
B. The activation energy decreases when the temperature is increased.
C. The entropy change is more positive when the water is liquid rather than gaseous.
D. The enthalpy change is more positive when the water is liquid rather than gaseous

(1)

3. This question is about thermodynamics.

Consider the reaction shown.

$2Al_2O_3(s) + 3C(s) \rightarrow 4Al(s) + 3CO_2(g)$

The table below shows some thermodynamic data

Substance	$Al_2O_3(s)$	Al(s)	C(s)	$CO_2(g)$
$\Delta_f H^{\ominus}$/ kJ mol^{-1}	–1669	0	0	–394
$S^{\ominus}$/ J K^{-1} mol^{-1}	51	28	6	214

(a) Explain why the standard entropy value for carbon dioxide is greater than that for carbon.

(1)

(b) State the temperature at which the standard entropy of aluminium is 0 J K^{-1} mol^{-1}

(1)

(c) Use the equation and the data in the table above to calculate the minimum temperature, in K, at which this reaction becomes feasible.

(7)

4. Using the information below, answer this question.

$Fe_2O_3(s) + 3H_2(g) \rightarrow 2Fe(s) + 3H_2O(g)$

ΔH = +96 kJ mol^{-1} ΔS = +138 J K^{-1} mol^{-1}

	$Fe_2O_3(s)$	$H_2(g)$	Fe(s)
ΔH / kJ mol^{-1}	−822.0	0	0
ΔS / J K^{-1} mol^{-1}	90.0	131.0	27.0

The standard entropy value for steam is

A. +332 J K^{-1} mol^{-1}
B. +189 J K^{-1} mol^{-1}
C. +145 J K^{-1} mol^{-1}
D. +85 J K^{-1} mol^{-1}

(1)

5. Define the terms spontaneous and feasible.

(2)

6. The diagram shows an incomplete Born−Haber cycle for the formation of caesium iodide.

The diagram is not to scale.

Table gives values of some standard enthalpy changes

Name of enthalpy change	$\Delta H^{\ominus}$ / kJ mol^{-1}
Enthalpy of atomisation of caesium	+79
First ionisation energy of caesium	+376
Electron affinity of iodine	−314
Enthalpy of lattice formation of caesium iodide	−585
Enthalpy of formation of caesium iodide	−337

(a) Complete the diagram above by writing the formulas, including state symbols, of the appropriate species on each of the two blank lines.

(2)

(b) Use the diagram above and the data in Table to calculate the standard enthalpy of atomisation of iodine.

(2)

(c) The enthalpy of lattice formation for caesium iodide in Table is a value obtained by experiment.

The value obtained by calculation using the perfect ionic model is $-582\ kJ\ mol^{-1}$

Deduce what these values indicate about the bonding in caesium iodide.

(1)

7. Define Gibbs free energy using an equation.

I am Sorry !!!!!

(2)

8. Titanium(IV) chloride can be made from titanium(IV) oxide as shown in the equation.

$TiO_2(s) + 2C(s) + 2Cl_2(g) \rightarrow 2CO(g) + TiCl_4(l)$

$\Delta H^o = -60.0 \text{ kJ mol}^{-1}$

Some entropy data are shown in the table.

Substance	$TiO_2(s)$	$C(s)$	$Cl_2(g)$	$CO(g)$	$TiCl_4(l)$
S^o/J K^{-1} mol^{-1}	50.2	5.70	223	198	253

Use the equation and the data in the table to calculate the Gibbs free-energy change for this reaction at 989 °C

Give your answer to the appropriate number of significant figures.

Use your answer to explain whether this reaction is feasible.

(6)

9. What does Hess's Law state?

I am Sorry !!!!!

(2)

10. Anhydrous magnesium chloride, $MgCl_2$, can absorb water to form the hydrated salt $MgCl_2.4H_2O$

$MgCl_2(s) + 4H_2O(l) \longrightarrow MgCl_2.4H_2O(s)$

(a) Suggest one reason why the enthalpy change for this reaction cannot be determined directly by calorimetry.

(1)

(b) Some enthalpies of solution are shown in Table 1

Salt	$MgCl_2(s)$	$MgCl_2.4H_2O(s)$
Enthalpy of solution / kJ mol^{-1}	−155	−39

Calculate the enthalpy change for the absorption of water by $MgCl_2(s)$ to form $MgCl_2.4H_2O(s)$.

(2)

(c) Describe how you would carry out an experiment to determine the enthalpy of solution of anhydrous magnesium chloride.

I am Sorry !!!!!

You should use about 0.8 g of anhydrous magnesium chloride.

Explain how your results could be used to calculate the enthalpy of solution.

(6)

www.chemistryonlinetuition.com asherrana@chemistryonlinetuition.com

DR. ASHAR RANA

CHEMISTRY ONLINE TUITION
Phone: +442081445350
www.chemistryonlinetuition.com
Email: asherrana@chemistryonlinetuition.com

- Founder & CEO of Chemistry Online Tuition Ltd.
- Tutoring students in UK and worldwide since 2008
- CIE & EDEXCEL Examiner since 2015
- Chemistry, Physics, and Math's Tutor

CONTACT INFORMATION FOR
CHEMISTRY ONLINE TUITION

I am Sorry !!!!!

- UK Contact: 02081445350
- International Phone/WhatsApp: 00442081445350
- Website: www.chemistryonlinetuition.com
- Email: asherrana@chemistryonlinetuition.com
- Address: 210-Old Brompton Road, London SW5 OBS, UK