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CHEMISTRY
PHYSICAL CHEMISTRY II

Level & Board

AQA (A-LEVEL)

TOPIC:

THERMODYNAMICS

PAPER TYPE:

QUESTION PAPER - 1

TOTAL QUESTIONS

10

TOTAL MARKS

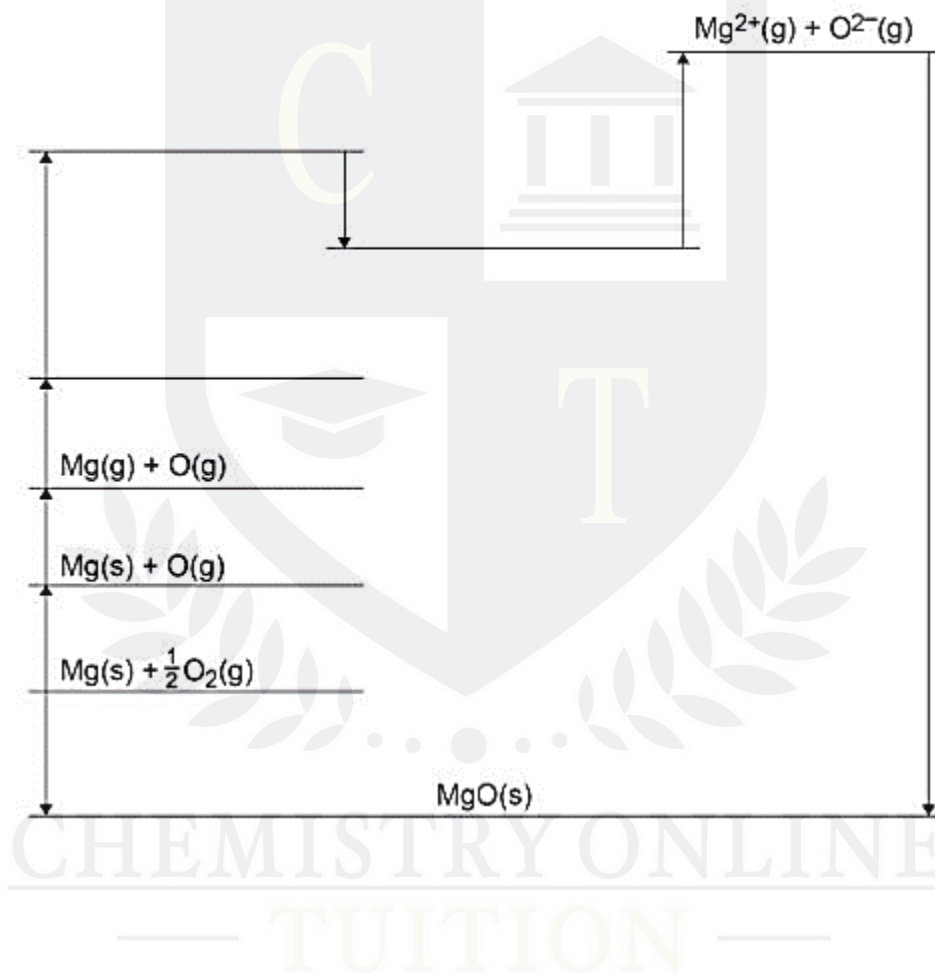
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Thermodynamics - 1

1. This question is about lattice enthalpies.

(a) The diagram shows a Born–Haber cycle for the formation of magnesium oxide.

Complete the diagram by writing the missing symbols on the appropriate energy levels.



(3)

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(b) The table contains some thermodynamic data

	Enthalpy change / kJ mol^{-1}
Enthalpy of formation for magnesium oxide	-602
Enthalpy of atomisation for magnesium	+150
First ionisation energy for magnesium	+736
Second ionisation energy for magnesium	+1450
Bond dissociation enthalpy for oxygen	+496
First electron affinity for oxygen	-142
Second electron affinity for oxygen	+844

Calculate a value for the enthalpy of lattice formation for magnesium oxide.

(3)

2. A reaction is exothermic and has a negative entropy change.

Which statement is correct?

- 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

(1)

3. The following table shows some enthalpy change and entropy change data.

	$\Delta H / \text{kJ mol}^{-1}$	$\Delta S / \text{J K}^{-1} \text{mol}^{-1}$
$\text{AgCl(s)} \rightarrow \text{Ag}^{\text{+}}(\text{g}) + \text{Cl}^{-}(\text{g})$	+905	
$\text{AgCl(s)} \rightarrow \text{Ag}^{\text{+}}(\text{aq}) + \text{Cl}^{-}(\text{aq})$	+77	+33
$\text{AgF(s)} \rightarrow \text{Ag}^{\text{+}}(\text{aq}) + \text{F}^{-}(\text{aq})$	-15	to be calculated
$\text{Ag}^{\text{+}}(\text{g}) \rightarrow \text{Ag}^{\text{+}}(\text{aq})$	-464	

(a) Define the term enthalpy of hydration of an ion.

(2)

(b) Use data from the table to calculate a value for the enthalpy of hydration of the chloride ion.

(2)

(c) Suggest why hydration of the chloride ion is an exothermic process.

(2)

(d) Silver chloride is insoluble in water at room temperature.

Use data from the table to calculate the temperature at which the dissolving of silver chloride in water becomes feasible.

Comment on the significance of this temperature value.

(4)

(e) When silver fluoride dissolves in water at 25 °C, the free-energy change is -9 kJ mol^{-1} .

Use this information and data from the table to calculate a value, with units, for the entropy change when silver fluoride dissolves in water at 25 °C.

(3)

4. 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?

- A. CsF
- B. CsI
- C. LiF
- D. LiI

(1)

5. The feasibility of a physical or a chemical change depends on the balance between the thermodynamic quantities of enthalpy change (ΔH), entropy change (ΔS) and temperature (T).

(a) Suggest how these quantities can be used to predict whether a change is feasible.

(2)

(b) Explain why the evaporation of water is spontaneous even though this change is endothermic.

In your answer, refer to the change in the arrangement of water molecules and the entropy change.

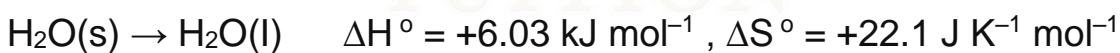
(4)

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

- A. $\frac{1}{2} \text{I}_2(\text{s}) \rightarrow \text{I}(\text{g})$
- B. $\text{I}_2(\text{s}) \rightarrow 2\text{I}(\text{g})$
- C. $\frac{1}{2} \text{I}_2(\text{g}) \rightarrow \text{I}(\text{g})$
- D. $\text{I}_2(\text{g}) \rightarrow 2\text{I}(\text{g})$

(1)

7. Consider the following process that represents the melting of ice.



(a) State the meaning of the symbol $^\circ$ in ΔH° .

(1)

(b) Use your knowledge of bonding to explain why ΔH° is positive for this process.

(2)

(c) Calculate the temperature at which $\Delta G^\circ = 0$ for this process. Show your working.

(3)

(d) The freezing of water is an exothermic process.

Give one reason why the temperature of a sample of water can stay at a constant value of 0°C when it freezes.

(1)

(e) Pure ice can look pale blue when illuminated by white light.

Suggest an explanation for this observation.

(2)

8. Which one of the following has the most covalent character?

- A. MgF_2
- B. MgBr_2
- C. AlF_3
- D. AlBr_3

(1)

9. When potassium nitrate (KNO_3) dissolves in water the value of the enthalpy change $\Delta H = +34.9 \text{ kJ mol}^{-1}$ and the value of the entropy change $\Delta S = +117 \text{ J K}^{-1} \text{ mol}^{-1}$.

(a) Write an equation, including state symbols, for the process that occurs when potassium nitrate dissolves in water.

(1)

(b) Suggest why the entropy change for this process is positive.

(1)

(c) Calculate the temperature at which the free-energy change, ΔG , for this process is zero.

(3)

10. Refer to the following reaction



Which one of the following statements is correct?

- A. This is a redox reaction.
- B. The reaction is not feasible below 298 K
- C. At equilibrium, the yield of hydrogen iodide is changed by increasing the pressure.
- D. At equilibrium, the yield of hydrogen iodide increases as the temperature is increased.

(1)



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