



Name _____ Class: _____

Start Time _____ End Time _____ Time Taken _____

Time allowed: 62 minutes**INSTRUCTIONS TO CANDIDATES**

- This document is designed to be used as a practice test.
- Complete the test under exam conditions in one sitting.
- Optional: Before marking it, go through the paper with a set of notes and improve your answers.
- Mark the test using the mark scheme make corrections on the paper.
- Complete the table on the front page.
- Improve your notes so that they better reflect your weaknesses.
- Make a note of your strengths and weaknesses for future revision.

| Success Criteria | Questions In Paper | Mark | Out of | % | Rank Order |
|---|-------------------------|------|--------|---|---------------|
| Hess's law | 4ai part 1 | | 3 | | |
| Calorimetry | 3cii | | 5 | | |
| Bond enthalpy | 1a-b | | 4 | | |
| Electron affinity | 1c | | 1 | | |
| Born Haber Cycles – Drawing them | 1di | | 3 | | |
| Born Haber Cycles – Calculations | 1bii | | 2 | | |
| Perfect Ionic Model Vs Covalent Character | 1e | | 6 | | |
| General Enthalpy Understanding | 2a-b, 2d | | 4 | | |
| Enthalpy of Hydration – Theory | 3a | | 3 | | |
| Enthalpy of Hydration – Calculations | 3b | | 2 | | |
| Entropy Changes – Theory | 3ci | | 3 | | |
| Entropy Calculations | 4ai Part 2 | | 3 | | |
| Gibbs Free Energy Calculations | 2c, 4aii, 4b, 4c, 5a | | 13 | | |
| Gibbs Free Energy Graphs | 5b, 5c, 5d | | 6 | | |
| General Chemistry | 2e | | 2 | | |
| Total | | | 60 | | |

**Q1.**

The table below gives some values of standard enthalpy changes. Use these values to answer the questions.

| Name of enthalpy change | $\Delta H^\ominus / \text{kJ mol}^{-1}$ |
|--|---|
| Enthalpy of atomisation of chlorine | +121 |
| Electron affinity of chlorine | -364 |
| Enthalpy of atomisation of silver | +289 |
| First ionisation enthalpy of silver | +732 |
| Enthalpy of formation of silver chloride | -127 |

- (a) Calculate the bond enthalpy of a Cl–Cl bond.

(1)

- (b) Explain why the bond enthalpy of a Cl–Cl bond is greater than that of a Br–Br bond.

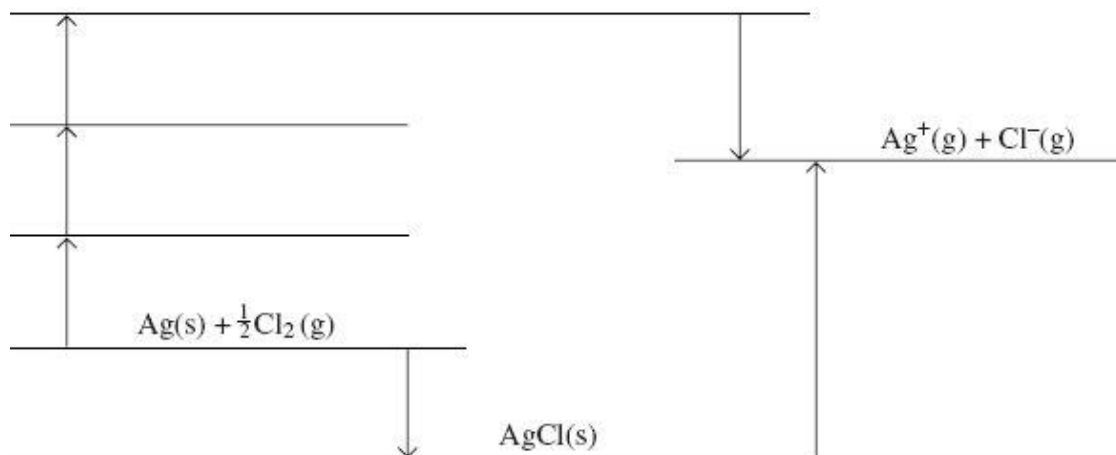
(2)

- (c) Suggest why the electron affinity of chlorine is an exothermic change.

(1)



- (d) The diagram below is an incomplete Born–Haber cycle for the formation of silver chloride. The diagram is not to scale.



- (i) Complete the diagram by writing the appropriate chemical symbols, with state symbols, on each of the three blank lines.

(3)

- (ii) Calculate a value for the enthalpy of lattice dissociation for silver chloride.

(2)

- (e) The enthalpy of lattice dissociation for silver chloride can also be calculated theoretically assuming a perfect ionic model.

- (i) Explain the meaning of the term *perfect ionic model*.

(1)

- (ii) State whether you would expect the value of the theoretical enthalpy of lattice dissociation for silver chloride to be greater than, equal to or less than that for silver bromide. Explain your answer.

Theoretical lattice enthalpy for silver chloride _____

Explanation _____

(3)



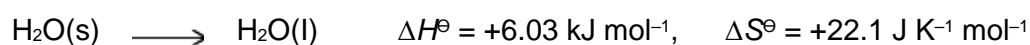
- (iii) Suggest why your answer to part (d) (ii) is greater than the theoretical value for the enthalpy of lattice dissociation for silver chloride.

(2)

(Total 15 marks)

Q2.

Consider the following process that represents the melting of ice.



- (a) State the meaning of the symbol \ominus in ΔH^\ominus .

(1)

- (b) Use your knowledge of bonding to explain why ΔH^\ominus is positive for this process.

(2)

- (c) Calculate the temperature at which $\Delta G^\ominus = 0$ 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 $0\text{ }^{\circ}\text{C}$ when it freezes.

(1)

- (e) Pure ice can look pale blue when illuminated by white light. Suggest an explanation for this observation.

(2)

(Total 9 marks)

**Q3.**

The enthalpy of hydration for the chloride ion is -364 kJ mol^{-1} and that for the bromide ion is -335 kJ mol^{-1} .

- (a) By describing the nature of the attractive forces involved, explain why the value for the enthalpy of hydration for the chloride ion is more negative than that for the bromide ion.

(3)

- (b) The enthalpy of hydration for the potassium ion is -322 kJ mol^{-1} . The lattice enthalpy of dissociation for potassium bromide is $+670 \text{ kJ mol}^{-1}$.

Calculate the enthalpy of solution for potassium bromide.

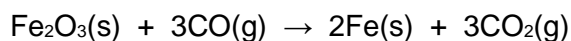
(2)

**Q4.**

Use the data in the table below to answer the questions which follow.

| Substance | Fe ₂ O ₃ (s) | Fe(s) | C(s) | CO(g) | CO ₂ (g) |
|--|------------------------------------|-------|------|--------|---------------------|
| $\Delta H_f^\ominus / \text{kJ mol}^{-1}$ | -824.2 | 0 | 0 | -110.5 | -393.5 |
| $S^\ominus / \text{J K}^{-1} \text{ mol}^{-1}$ | 87.4 | 27.3 | 5.7 | 197.6 | 213.6 |

- (a) The following equation shows one of the reactions which can occur in the extraction of iron.



- (i) Calculate the standard enthalpy change and the standard entropy change for this reaction.

Standard enthalpy change _____

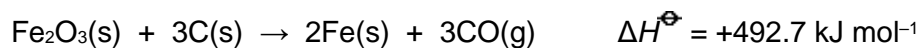
Standard entropy change _____

- (ii) Explain why this reaction is feasible at all temperatures.

(9)



- (b) The reaction shown by the following equation can also occur in the extraction of iron.



The standard entropy change, ΔS^\ominus , for this reaction is $+542.6 \text{ J K}^{-1} \text{ mol}^{-1}$

Use this information to calculate the temperature at which this reaction becomes feasible.

(3)

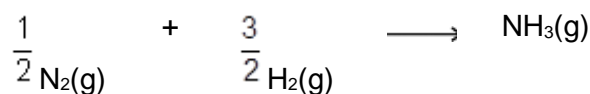
- (c) Calculate the temperature at which the standard free-energy change, ΔG^\ominus has the same value for the reactions in parts (a) and (b).

(3)

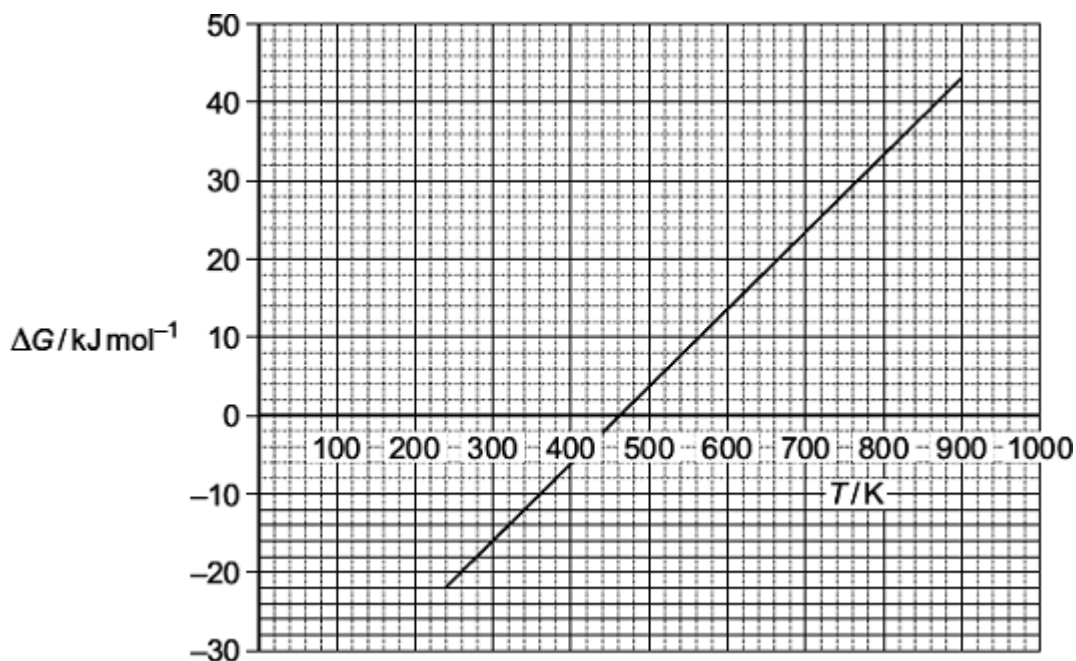
(Total 15 marks)

**Q5.**

The following equation shows the formation of ammonia.



The graph shows how the free-energy change for this reaction varies with temperature above 240 K.



- (a) Write an equation to show the relationship between ΔG , ΔH and ΔS .

(1)

- (b) Use the graph to calculate a value for the slope (gradient) of the line. Give the units of this slope and the symbol for the thermodynamic quantity that this slope represents.

Value of the slope _____

Units _____

Symbol _____

(3)



- (c) Explain the significance, for this reaction, of temperatures below the temperature value where the line crosses the temperature axis.

(2)

- (d) The line is not drawn below a temperature of 240 K because its slope (gradient) changes at this point.

Suggest what happens to the ammonia at 240 K that causes the slope of the line to change.

(1)

(Total 7 marks)