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CHEMISTRY

PHYSICAL CHEMISTRY II

Level & Board	AQA (A-LEVEL)
TOPIC:	THERMODYNAMICS
PAPER TYPE:	QUESTION PAPER - 3
TOTAL QUESTIONS	10
TOTAL MARKS	/48

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Thermodynamics - 3

1. Some thermodynamic data for fluorine and chlorine are shown in the table. In the table, X represents the halogen F or Cl.

	Fluorine	Chlorine
Electronegativity	4.0	3.0
Electron affinity / kJ mol^{-1}	-348	-364
Enthalpy of atomisation / kJ mol^{-1}	+79	+121
Enthalpy of hydration of $\text{X}^- (\text{g})$ / kJ mol^{-1}	-506	-364

(a) Explain the meaning of the term electron affinity.

(2)

(b) Explain why the electronegativity of fluorine is greater than the electronegativity of chlorine.

(2)

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

(2)

2. The enthalpy of solution for potassium chloride is $+17.2 \text{ kJ mol}^{-1}$.

(a) Explain why the free-energy change for the dissolving of potassium chloride in water is negative, even though the enthalpy change is positive.

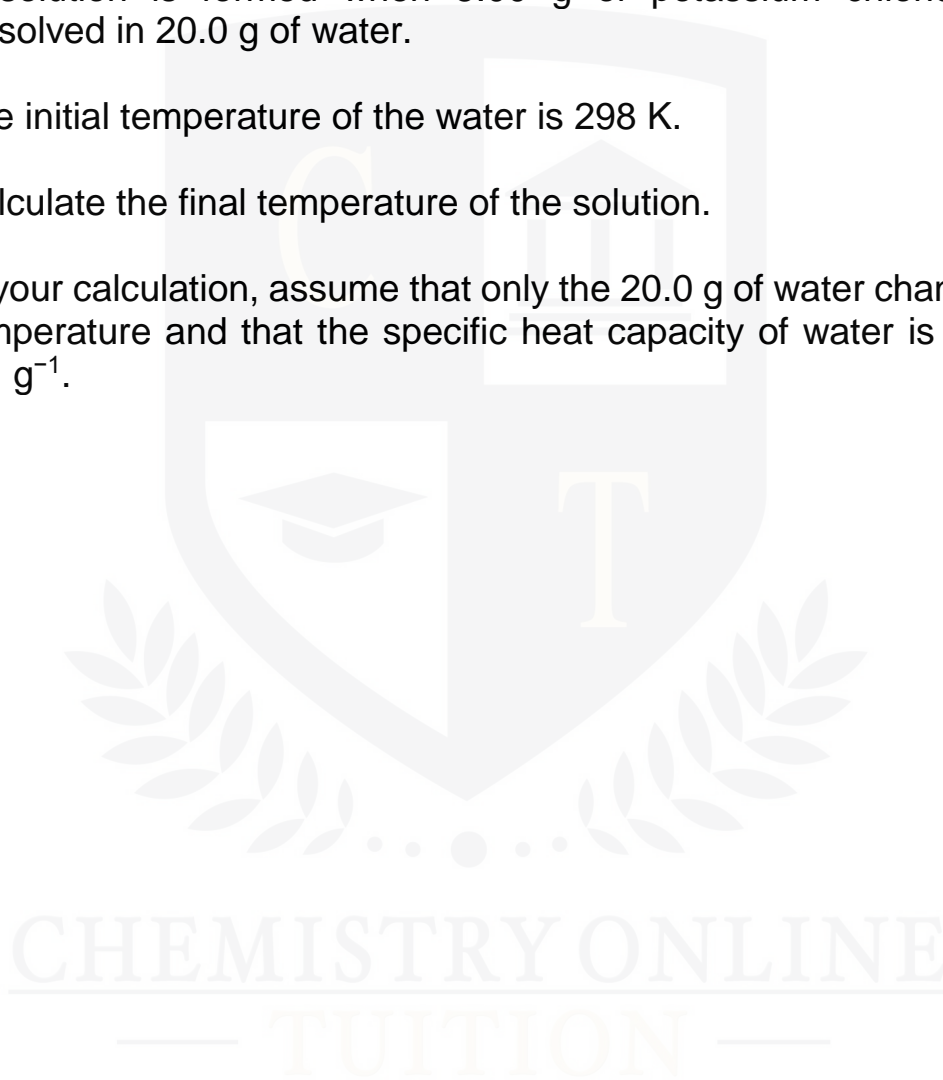
(3)

(b) A solution is formed when 5.00 g of potassium chloride are dissolved in 20.0 g of water.

The initial temperature of the water is 298 K.

Calculate the final temperature of the solution.

In your calculation, assume that only the 20.0 g of water changes in temperature and that the specific heat capacity of water is $4.18 \text{ J K}^{-1} \text{ g}^{-1}$.



(5)

3. Define the term lattice enthalpy of dissociation.

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(2)

4. Lattice enthalpy can be calculated theoretically using a perfect ionic model.

Explain the meaning of the term perfect ionic model.

Suggest two properties of ions that influence the value of a lattice enthalpy calculated using a perfect ionic model.

(3)

5. 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.

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(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)

6. When magnesium chloride dissolves in water, the enthalpy of solution is -155 kJ mol^{-1} .

The enthalpy of hydration of chloride ions is -364 kJ mol^{-1} .

Lattice dissociation enthalpy of MgCl_2 is 2493 kJ mol^{-1}

Calculate the enthalpy of hydration of magnesium ions.

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(3)

7. This table contains some values of lattice dissociation enthalpies.

Compound	MgCl_2	CaCl_2	MgO
Lattice dissociation enthalpy / kJ mol^{-1}	2493	2237	3889

- (a) Write an equation, including state symbols, for the reaction that has an enthalpy change equal to the lattice dissociation enthalpy of magnesium chloride.

(1)

(b) Explain why the lattice dissociation enthalpy of magnesium chloride is greater than that of calcium chloride.

(2)

(c) Explain why the lattice dissociation enthalpy of magnesium oxide is greater than that of magnesium chloride.

(2)

(d) Energy is released when a magnesium ion is hydrated because magnesium ions attract water molecules.

Explain why magnesium ions attract water molecules.

(2)

8. Thermodynamics can be used to investigate the changes that occur when substances such as calcium fluoride dissolve in water.

(a) Give the meaning of each of the following terms.

i. Enthalpy of lattice formation for calcium fluoride

(1)

ii. Enthalpy of hydration for fluoride ions

(1)

(b) Explain the interactions between water molecules and fluoride ions when the fluoride ions become hydrated.

(2)

9. Enthalpy changes of reaction can be determined indirectly from average bond enthalpies and standard enthalpy changes.

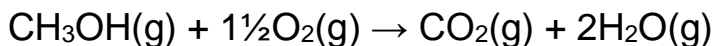
The table below shows the values of some average bond enthalpies.

bond	average bond enthalpy /kJ mol ⁻¹
C-H	+410
O-H	+465
O=O	+500
C=O	+805
C-O	+336

(a) Why do bond enthalpies have positive values?

(1)

(b) The equation below shows the combustion of methanol, CH₃OH, in the gaseous state.



Using the average bond enthalpies in the table above, calculate the enthalpy change of combustion, ΔH_c , of gaseous methanol.

(3)

10. The enthalpy of solution for silver fluoride in water is -20 kJ mol^{-1} .

The hydration enthalpy for silver ions is -464 kJ mol^{-1} .

	Fluorine	Chlorine
Electronegativity	4.0	3.0
Electron affinity / kJ mol^{-1}	-348	-364
Enthalpy of atomisation / kJ mol^{-1}	+79	+121
Enthalpy of hydration of $\text{X}^- (\text{g})$ / kJ mol^{-1}	-506	-364

(a) Use these data to calculate a value for the lattice enthalpy of dissociation of silver fluoride.

(3)

(b) Suggest why the entropy change for dissolving silver fluoride in water has a positive value.

(1)

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(c) Explain why the dissolving of silver fluoride in water is always a spontaneous process.

(2)



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