Practice Question Set For A-Level
Subject : Chemistry
Paper-1 Topic: Physical 1_Thermodynamics

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Name of the Student:____

Max. Marks : 18 Marks **Time : 18 Minutes**

Q1.

A value for enthalpy of solution can be determined in two ways:

- from a cycle, using lattice enthalpy and enthalpies of hydration
- from the results of a calorimetry experiment.

(a) Define the term enthalpy of lattice dissociation.

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(2)

(b) The enthalpy of solution for ammonium nitrate is the enthalpy change for the reaction shown.

$$NH_4NO_3(s) + aq \rightarrow NH_4^+(aq) + NO_3^-(aq) \qquad \Delta H = +26 \text{ kJ mol}^{-1}$$

Table 1

	$NH_4^+(g)$	$NO_3^-(g)$
Enthalpy of hydration $\Delta_{hyd}H$ / kJ mol^{-1}	−307	−314

Draw a suitably labelled cycle and use it, with data from **Table 1**, to calculate the enthalpy of lattice dissociation for ammonium nitrate.

Enthalpy of lattice dissociation _______________ kJ mol^{-1}

(3)

(c) A student does an experiment to determine a value for the enthalpy of solution for ammonium nitrate.

The student uses this method.

- Measure 25.0 cm^3 of distilled water in a measuring cylinder.
- Pour the water into a beaker.
- Record the temperature of the water in the beaker.
- Add 4.00 g of solid NH_4NO_3 to the water in the beaker.
- Stir the solution and record the lowest temperature reached.

Table 2 shows the student's results.

Table 2

Initial temperature / °C	20.2
Lowest temperature / °C	12.2

Calculate the enthalpy of solution, in kJ mol^{-1}, for ammonium nitrate in this experiment.

Assume that the specific heat capacity of the solution, c = 4.18 J K^{-1} g^{-1}

Assume that the density of the solution = 1.00 g cm^{-3}

Enthalpy of solution _______________ kJ mol^{-1}

(3)

(d) The uncertainty in each of the temperature readings from the thermometer used in this experiment is ±0.1°C

Calculate the percentage uncertainty in the temperature change in this experiment.

Percentage uncertainty ____________________

(1)

(e) Suggest a change to the student's method, using the same apparatus, that would reduce the percentage uncertainty in the temperature change.

Give a reason for your answer.

Change ____

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Reason ____

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(2)

(f) Another student obtained a value of +15 kJ mol^{-1} using the same method.

Suggest the main reason for the difference between this experimental value for the enthalpy of solution and the correct value of +26 kJ mol^{-1}

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(1)

(g) **Table 3** shows some entropy data at 298 K

Table 3

	Entropy *S* / J K^{-1} mol^{-1}
$NH_4NO_3(s)$	151
$NH_4^+(aq)$	113
$NO_3^-(aq)$	146

Calculate a value for the Gibbs free-energy change (ΔG), at 298 K, for the reaction when ammonium nitrate dissolves in water.

$$NH_4NO_3(s) + aq \rightarrow NH_4^+(aq) + NO_3^-(aq) \qquad \Delta H = +26 \text{ kJ mol}^{-1}$$

Use data from **Table 3** and the value of ΔH from the equation.
Assume for the solvent, water, that the entropy change, $\Delta S = 0$

Explain what the calculated value of ΔG indicates about the feasibility of this reaction at 298 K

ΔG ________________ kJ mol^{-1}

Explanation ____

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(4)

(h) Ammonium nitrate decomposes as shown.

$$NH_4NO_3(s) \rightarrow N_2(g) + \frac{1}{2} O_2(g) + 2\ H_2O(g) \qquad \Delta H = +123 \text{ kJ mol}^{-1}$$

The entropy change (ΔS) for this reaction is +144 J K^{-1} mol^{-1}

Calculate the temperature at which this reaction becomes feasible.

Temperature _______________ K

(2)

(Total 18 marks)