General Certificate of Education (Advanced Level) Examination

Chemistry

Neutralization enthalpy

(Worksheet)

Amila Senadeera

BSc Engineering (1st Class Hons)

Define "standard enthalpy change of neutralization"

Define "standard enthalpy change of neutralization of an acid"

Define "standard enthalpy change of neutralization of a base"

Define "standard dissociation enthalpy change of CH_3COOH"

Experiment : Determination of the Enthalpy Change of Neutralization of Sulfuric Acid

Objective:

To determine the enthalpy change of neutralization (ΔH) when sulfuric acid (H_2SO_4) reacts with sodium hydroxide (NaOH) solution.

Materials:

1.0 mol dm^{-3} sulfuric acid (H_2SO_4), 50.0 cm^3

1.0 mol dm^{-3} sodium hydroxide (NaOH), 100.0 cm^3

Polystyrene (insulated) cup with lid

Thermometer (±0.1 °C)

Measuring cylinders or pipettes

Beaker

Stirring rod

Stopwatch

Balance (if needed to verify mass)

Method:

1. Use a measuring cylinder or pipette to measure 50.0 cm^3 of 1.0 mol dm^{-3} sulfuric acid and pour it into the polystyrene cup. Record the initial temperature of the acid solution.
2. Measure 100.0 cm^3 of 1.0 mol dm^{-3} sodium hydroxide into a separate beaker. Record the initial temperature of the solutions.
3. Quickly add the sodium hydroxide to the sulfuric acid in the polystyrene cup. Stir gently with a thermometer and record the maximum temperature reached.

Observation:

1. A rise in temperature is observed upon mixing the acid and base.
2. Initial temperature of both solutions: 25.0 °C
   Final (maximum) temperature after mixing: 31.5 °C

Calculation:

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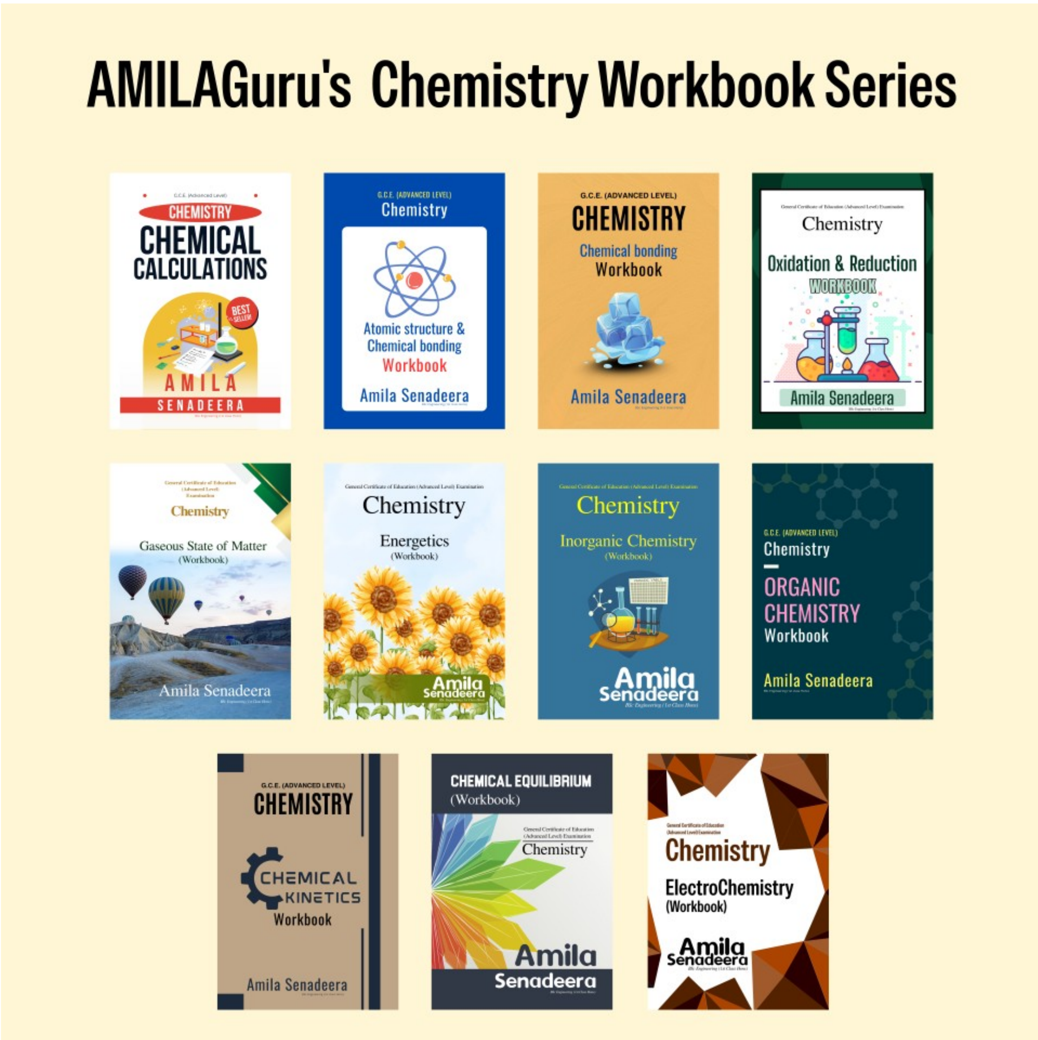
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Answers:

Standard enthalpy change of neutralization:

Standard enthalpy change of neutralization, is the enthalpy change that occurs when one mole of an aqueous H^+ ions and one mole of an aqueous OH^- ions in the standard state react to form a mole of liquid water in the standard states.

Standard enthalpy change of neutralization of an acid:

Standard enthalpy change of neutralization of an acid is the enthalpy change that occurs when one mole of acid in the standard states completely neutralized by an excess amount of a strong aqueous base in the standard state to form products (salt and water) in the standard states.

Standard enthalpy change of neutralization of a base:

Standard enthalpy change of neutralization of a base is the enthalpy change that occurs when one mole of base in the standard states completely neutralized by an excess amount of a strong aqueous acid in the standard state to form products (salt and water) in the standard states.

Standard dissociation enthalpy change of CH_3COOH

The standard dissociation enthalpy change of CH_3COOH is the enthalpy that occurs when one mole of aqueous CH_3COOH in standard conditions dissociates completely to result aqueous H^+ ions and aqueous CH_3COO^- ions.

Calculation:

Let us assume that the density of the resulting solution is the same as the density of water.

Let us assume that the volume change during mixing of the solutions is negligible.

Mass of the resulting solution $= 1000 \text{ kg m}^{-3} \times 150 \times 10^{-6} \text{ m}^3$

$= 150 \times 10^{-3} \text{ kg}$

Let us assume that the specific heat capacity of the resulting solution is equal to the specific heat capacity of water.

The amount of heat absorbed by the resulting solution

$= 150\times10^{-3} \text{ kg} \times 4200 \text{ J kg}^{-1} {}^{o}\text{C}^{-1} \times [31.5 - 25.0]^{0}\text{C}$

$= 4.095 \text{ kJ}$

Let us assume that the heat loss to the surroundings and the heat gained by the container containing the solution are negligible.

Therefore, the amount of heat released by the reaction $= 4.095 \text{ kJ}$

Number of moles of H_2SO_4 used for the reaction = $1.0 \text{ mol dm}^{-3} \times 0.05 \text{ dm}^3$

= 0.05 mol

Number of moles of NaOH used for the reaction = $1.0 \text{ mol dm}^{-3} \times 0.10 \text{ dm}^3$

= 0.10 mol

$$H_2SO_4(aq) + 2NaOH(aq) \longrightarrow Na_2SO_4(aq) + 2H_2O(l)$$

Number of moles of H_2SO_4 reacted = 0.05 mol

The amount of heat released during neutralization of 0.05 mol of H_2SO_4 = 4.095 kJ

The enthalpy change of neutralization of H_2SO_4 = $-\dfrac{4.095\,kJ}{0.05\,mol}$

= $-81.90 \text{ kJ mol}^{-1}$