Experiment 3

Aim

To measure the change in temperature during chemical reactions and to conclude whether the reaction is exothermic or endothermic.

Theory

Most of the chemical reactions are accompanied by energy changes. In some reactions, energy is absorbed while in some energy is released in the form of heat. The chemical reactions in which energy is absorbed are called endothermic reactions and those in which energy is released are known as exothermic reactions. The reaction can be identified as exothermic or endothermic by measuring the change in temperature of the reaction mixture.

In this experiment the following chemical reactions can be carried out:

(i) $NaOH\ (aq) + HCl\ (g) \longrightarrow NaCl\ (g) + H_2O\ (l)$; and

(ii) $Ba(OH)_2.8H_2O\ (s) + 2NH_4Cl\ (s) \longrightarrow BaCl_2\ (aq) + 10H_2O\ (l) + 2NH_3\ (aq)$

Materials Required

Sodium hydroxide solution, hydrochloric acid, ammonium chloride (solid) and barium hydroxide (solid), weighing balance, watch glass, four beakers (100 mL), a thermometer (–10 ºC to 110 ºC), and a glass rod.

Procedure

1. Mark all the four clean beakers as 1, 2, 3, and 4.
2. Take 20 mL of sodium hydroxide solution in beaker no. 1; 20 mL of hydrochloric acid in beaker no. 2; 15.75 g of barium hydroxide in beaker no. 3, and 5.35 g of ammonium chloride in beaker no. 4.
3. Successively insert a thermometer in each beaker for some time and record their temperatures. Also record the room temperature.
4. To see the reaction of sodium hydroxide solution with hydrochloric acid, pour the contents of beaker no. 1 in beaker no. 2. Quickly insert the thermometer in the reaction mixture. Note and record its initial temperature reading. Stir well the reaction mixture gently using a glass rod. Note and record the final temperature reading of the thermometer. Wash the thermometer and glass rod after noting the readings.
5. Similarly, to see the reaction of barium hydroxide solution with ammonium chloride, pour the contents of beaker no. 3 in beaker no. 4. Quickly insert the thermometer in this reaction mixture. Note and record the initial temperature. Stir well the reaction mixture gently using the glass rod. Note and record the final temperature readings of the thermometer.

Observations and Calculations

(i) Temperature of the sodium hydroxide solution = ___ °C =___ K

(ii) Temperature of the hydrochloric acid = ___ °C =___ K

(iii) Temperature of the barium hydroxide solution = ___ °C =___ K

(iv) Temperature of the ammonium chloride = ___ °C =___ K

(v) Room temperature = ___ °C =___ K

Sl. No.	Reactants of the reaction	Inital temperature of the reaction mixture	Final temperature of the reaction mixture	Change in temperature
		θ_1 (°C)	θ_2 (°C)	$\theta_2 \sim \theta_1$ (°C)
1.	$NaOH + HCl$			
2.	$Ba(OH)_2.8H_2O + 2NH_4Cl$			

Results and Discussion

Based on your observations for the change in tempearture in two reactions, infer about the nature of the two chemical reactions (exothermic or endothermic).

The reaction between sodium hydroxide solution and hydrochloride acid is _____ ; and the reaction between barium hydroxide solution and ammonium chloride is _____ (exothermic or endothermic).

Precautions

- Stir the reaction mixture very gently so that there is no heat loss during stirring.
- Wash the thermometer and glass rod with water before inserting it in another reactant or reaction mixture.

Questions

- The reaction between HCl and NaOH in its simplified version is

  H^+ (aq) + OH^- (aq) $\longrightarrow$ H_2O (l)

  (from acid) (from base)

  Can you assign a plausible explanation as to why the reaction should be exothermic?
- Consider the changes;

  $2HCl\ (g) \longrightarrow H_2\ (g) + Cl_2\ (g)$;

  $2Mg\ (s) + O_2\ (g) \longrightarrow 2MgO\ (s)$.

  Which according to you is exothermic change?
- What precautions did you take while measuring the temperature of a reaction mixture?