# Answer on Question #43895 - Chemistry - Other

**Question:**

Calculate the heat when 150 ml of .500 M HCI is mixed with450 ml of .100 M barium hydroxide. Assuming the temperature of both solutions was initially 25℃ and that the final mixture has a mass of 600 g and specific heat if water, calculate the final temperature of the mixture?

$c_i(\mathrm{Ba(OH)_2})$ = 0.100 $\frac{mol}{L}$

$V(\mathrm{Ba(OH)_2})$ = 450.0 *mL*

$c_i(\mathrm{HCl})$ = 0.500 $\frac{mol}{L}$

$V(\mathrm{HCl})$ = 150.0 *mL*

$m$(solution) = 600.0 *g*

$t_1(\mathrm{HCl}) = t_1(\mathrm{Ba(OH)_2})$ = 25°C

$c_{\mathrm{P}}(\mathrm{H_2O})$ = 4.1813 $\frac{J}{g \cdot K}$

$t_2$(solution) – ?

**Solution:**

1. Write the reaction as a molecular equation:

$$\mathrm{Ba(OH)_{2\,(aq)} + 2HCl_{(aq)} \rightarrow BaCl_{2\,(aq)} + 2H_2O_{(l)}}$$

2. Then the overall ionic equation for the reaction:

$$\mathrm{Ba^{2+}_{(aq)} + 2OH^-_{(aq)} + 2H^+_{(aq)} + 2Cl^-_{(aq)} \rightarrow Ba^{2+}_{(aq)} + 2Cl^-_{(aq)} + 2H_2O_{(l)}}$$

3. The net ionic equation for the reaction:

$$\mathrm{2H^+_{(aq)} + 2OH^-_{(aq)} \rightarrow 2H_2O_{(l)}}$$

4. When we mix strong acid with strong base, we obtain the heat from the reaction of water synthesis. The standard enthalpy of neutralization for such reaction is constant $\Delta H^{\ominus}_{\mathrm{N}} = -56000\ \frac{J}{mol}$. This value shows us the change of enthalpy during water synthesis. We can calculate the heat released from such reaction by the equation:

$$Q = -\frac{\Delta H_{\mathrm{N}}^{\ominus}}{n_i(\mathrm{H_2O})}$$

5. The amount of water can be find from the equation:

$$n_i(\mathrm{H_2O}) = n_i(\mathrm{HCl}) = \frac{n_i(\mathrm{Ba(OH)_2})}{2}$$

6. We compare the amount of acid and base and find that the base is in excess:

$$n_i(\mathrm{Ba(OH)_2}) = c_i(\mathrm{Ba(OH)_2}) \cdot V(\mathrm{Ba(OH)_2}) = 0.100\ \frac{mol}{L} \cdot \frac{450.0\ mL}{1000} = 0.045\ mol$$

$$n_i(\mathrm{HCl}) = c_i(\mathrm{HCl}) \cdot V(\mathrm{HCl}) = 0.500\ \frac{mol}{L} \cdot \frac{150.0\ mL}{1000} = 0.075\ mol$$

The stoichiometric ratio $\frac{n_i(\mathrm{Ba(OH)_2})}{n_i(\mathrm{HCl})}$ is 1 : 2, so for full acid neutralization we need to have

$$n_i(\mathrm{Ba(OH)_2}) = \frac{n_i(\mathrm{HCl})}{2} = \frac{0.075\ mol}{2} = 0.0375\ mol$$

The stoichiometric ratio $\frac{n_i(\mathrm{HCl})}{n_i(\mathrm{H_2O})}$ is 1 : 1, so

$$n_i(\mathrm{H_2O}) = n_i(\mathrm{HCl}) = 0.075\ mol$$

7. Find heat released after reaction:

$$Q = -\Delta H_{\mathrm{N}}^{\ominus} \cdot n_i(\mathrm{H_2O}) = -(-56000)\frac{J}{mol} \cdot 0.075\ mol = 4200.0\ J$$

8. Then we can calculate the temperature difference after the reaction:

$$Q = c_{\mathrm{P}}(\mathrm{H_2O}) \cdot m(\mathrm{H_2O}) \cdot \Delta T$$

$$\Delta T = \frac{Q}{c_{\mathrm{P}}(\mathrm{H_2O}) \cdot m(\mathrm{H_2O})} = \frac{4200.0\ J}{600\ g \cdot 4.1813\ \frac{J}{g \cdot K}} = 1.67\ K$$

$$\Delta T = \Delta t = 1.67°\mathrm{C}$$

9. Find the final temperature of the mixture:

$$\Delta t = t_2(solution) - t_1(\mathrm{HCl})$$

$$t_2(solution) = \Delta t + t_1(\mathrm{HCl}) = 25°\mathrm{C} + 1.67°\mathrm{C} = 26.67°\mathrm{C}$$

**Answer:** The final temperature of the mixture is 26.67°C.