

Answer on Question #39529-Chemistry-Inorganic Chemistry

Question

In this experiment I will find out how the temperature rise changes when 25 cm³ portions of sodium hydroxide solution are mixed with different volumes of hydrochloric acid between 5 cm³ and 45 cm³.

I understand that the temperature of the solution will increase as the amount of hydrochloric acid increases and that the optimum temperature change will be at 25 cm³ of hydrochloric acid. However it will start decreasing when more hydrochloric acid is added.

Can you explain how this relates to neutralisation, collision theory, exothermic reactions and why the optimum is at 25 cm³ and why it decreases after 25 cm³?

*I will be using the same concentration of NaOH and HCl (1 mol).

*I will not be using an indicator.

Answer

When adding the hydrochloric acid solution to the sodium hydroxide solution neutralization reaction occurs: $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$

The neutralization reaction is exothermic. That is why the temperature rises when adding the acid to the base. The heat evolved is proportional to the amount of substances reacted: the greater the amount of the acid added the greater the amount of heat evolved.

If the acid and base concentrations are equal than to neutralize 25 cm³ of the base solution 25 cm³ of the acid solution are needed. In this case both reactants react completely. When the acid volume is less than 25 cm³ some amount of base remains unreacted, so the heat evolved is less, and consequently the temperature is less.

When more than 25 cm³ of the acid solution is added the amount of substances reacted does not increase because of the lack of base, and the heat evolved does not increase as well. That is why the temperature optimum (maximum) is at 25 cm³.

So, it is clear, why does the temperature stop rising when adding more than 25 cm³ of the acid solution, but why does it decrease?

Since no additional heat is evolved when adding more than 25 cm³ the temperature of resulting mixture would decrease even when doing nothing just because of cooling down (heat loss into the environment). Addition of extra portions of cool solution of the acid absorbs heat and contributes to the cooling down of the mixture.

Regarding the collision theory, it is clear that the greater the amount of the acid added the more frequent collisions are and the higher the reaction rate is. But it does not relate to the temperature change.