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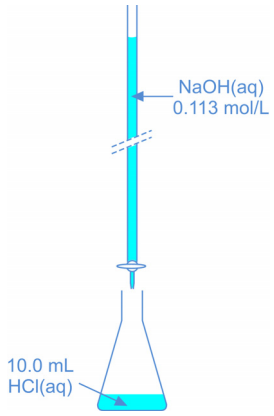
Titration of 10.0 mL HCl-solution (with unknown concentration) with 0.113 mol/L NaOH(aq). The equivalence point is reached after adding 11.2 mL NaOH.



1. Calculate the original HCl-concentration.
2. Calculate the pH at the start of the titration (0 mL added).
3. Calculate the pH after adding 5.0 mL NaOH.
4. Calculate the pH after adding 11.2 mL NaOH (EP).
5. Calculate the pH after adding 15.0 mL NaOH.

Solutions

Reaction: **1** HCl(aq) + **1** NaOH(aq) ⟶ H_2O + NaCl(aq)

1. At the EP the total amount of HCl has reacted.

   11.2 mL 0.113 mol/L NaOH(aq) contains $11.2\times10^{-3}\,\text{L}\times0.113\,\frac{\text{mol}}{\text{L}}=1.27\times10^{-3}\,\text{mol}$ of NaOH.

   So the original HCl-solution also contained 1.27×10^{-3} mol of HCl.

   The unknown HCl-concentration was $\frac{1.27\times10^{-3}\,\text{mol}}{10.0\times10^{-3}\,\text{L}}=0.127\,\frac{\text{mol}}{\text{L}}$.

2. At the start we have a HCl-solution 0.127 mol/L.

   As HCl is a strong acid (completely ionized), the H^+-concentration also is 0.127 mol/L.

   pH = −log 0.127 = 0.90.

3. After adding 5.0 mL NaOH, containing $5.0\times10^{-3}\,\text{L}\times0.113\,\frac{\text{mol}}{\text{L}}=5.65\times10^{-4}\,\text{mol}$ of NaOH:

mole	HCl	NaOH	NaCl
Before reaction	1.27×10^{-3}	5.65×10^{-4}	
Δ	-5.65×10^{-4}	-5.65×10^{-4}	$+5.65\times10^{-4}$
After reaction	7.05×10^{-4}	0	5.65×10^{-4}

   The NaCl (neutral salt) has no influence on the pH.

   So the pH is determined by the strong acid HCl. The HCl-concentration at this moment is $\frac{7.05\times10^{-4}\,\text{mol}}{15.0\times10^{-3}\,\text{L}}=0.0470\,\frac{\text{mol}}{\text{L}}$ and pH = −log 0.0470 = 1.33.

4. After adding 11.2 mL NaOH (EP), containing $11.2\times10^{-3}\text{L}\times0.113\ \frac{\text{mol}}{\text{L}}=1.27\times10^{-3}\ \text{mol}$ of NaOH:

mole	HCl	NaOH	NaCl
Before reaction	1.27×10^{-3}	1.27×10^{-3}	
Δ	-1.27×10^{-3}	-1.27×10^{-3}	$+1.27\times10^{-3}$
After reaction	0	0	1.27×10^{-3}

The NaCl (neutral salt) has no influence on the pH.
So the pH = 7.00.

5. After adding 15.0 mL NaOH, containing $15.0\times10^{-3}\text{L}\times0.113\ \frac{\text{mol}}{\text{L}}=1.70\times10^{-3}\ \text{mol}$ of NaOH:

mole	HCl	NaOH	NaCl
Before reaction	1.27×10^{-3}	1.70×10^{-3}	
Δ	-1.27×10^{-3}	-1.27×10^{-3}	$+1.27\times10^{-3}$
After reaction	0	4.30×10^{-4}	5.65×10^{-4}

The NaCl (neutral salt) has no influence on the pH.
So the pH is determined by the strong base NaOH.

The NaOH-concentration at this moment is $\frac{4.30\times10^{-4}\ \text{mol}}{25.0\times10^{-3}\ \text{L}}=0.0172\ \frac{\text{mol}}{\text{L}}$ and pOH = −log 0.0172 = 1.76 $\Rightarrow$ pH = 12.24.