Question #47871 – Chemistry – Other

Question:

Why does the titration of 50 mL of 0.1 M H_2SO_4 require a larger titrant than the titration of 50 mL of 0.1 M HCl? Assume that the titrant being used is 0.1 M NaOH.

Answer:

The titration of HCl is described with the equation:

$NaOH + HCl \rightarrow NaCl + H_2O$

The amount of moles of 0.1 M HCl in 50 ml is:

$$\nu(HCl) = C(HCl) \times V(HCl) = 0.1\,\mathrm{M} \times \frac{50\,\mathrm{ml}}{1000} = 5 \cdot 10^{-3}\,\mathrm{moles}$$

The amount of moles of NaOH required to neutralize $5 \cdot 10^{-3}$ moles of HCl according to the equation above is the same:

$$\nu_1(NaOH) = \nu(HCl) = 5 \cdot 10^{-3}\ \mathrm{moles}$$

The volume of 0.1 M NaOH required for the titration is

$$V_1(NaOH) = \frac{\nu_1(NaOH)}{C(NaOH)} = \frac{5 \cdot 10^{-3}\ \mathrm{moles}}{0.1\,\mathrm{M}} = 5 \cdot 10^{-2}\,\mathrm{L} = 50\,\mathrm{ml}$$

The equation reaction for H_2SO_4 is:

$2\,NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2\,H_2O$

The amount of moles of 0.1 H_2SO_4 in 50 ml of its solution is

$$\nu(H_2SO_4) = C(H_2SO_4) \times V(H_2SO_4) = 0.1\,\mathrm{M} \times \frac{50\,\mathrm{ml}}{1000} = 5 \cdot 10^{-3}\,\mathrm{moles}$$

According the above equation, two moles of NaOH are required to neutralize one mole of NaOH. Than the amount of NaOH that is required to neutralize $5 \cdot 10^{-3}$ moles is

$$\nu_2(NaOH) = 2 \times \nu(H_2SO_4) = 2 \times 5 \cdot 10^{-3}\ \mathrm{moles} = 10 \cdot 10^{-3}\ \mathrm{moles}$$

The volume of 0.1 M NaOH that contains $10 \cdot 10^{-3}$ moles is

$$V_2(NaOH) = \frac{\nu_2(NaOH)}{C(NaOH)} = \frac{10 \cdot 10^{-3}\ \mathrm{moles}}{0.1\,\mathrm{M}} = 10 \cdot 10^{-2}\,\mathrm{L} = 100\,\mathrm{ml}$$