

[AQA A2 Specimen Paper 1 (set 2)]

At 298K, 25.0 cm³ of a solution of a strong monoprotic acid contained 1.45 x 10⁻³ mol of hydrogen ions.

- a) Calculate a value for the pH of this solution. Give your answer to 2 decimal places.

① Find the concentration of the solution:

$$\text{conc.} = \frac{1.45 \times 10^{-3} \times 1000}{25.0}$$
$$= 0.058 \text{ mol dm}^{-3}$$

② Use this to find [H⁺] ions:

↑ since the acid is strong and monoprotic, it completely dissociates to ions.

$$\Rightarrow [\text{H}^+] = 0.058 \text{ mol dm}^{-3}$$

③ Calculate the pH of the acid:

$$\text{pH} = -\log_{10}(0.058)$$

$$= 1.236\dots$$

$$\Rightarrow \underline{1.24}_{//} \text{ (2dp)}$$

$$\text{pH} = -\log_{10}[\text{H}^+]$$

↑ a strong acid
≈ 0 - 2.



- b) Calculate the pH of the solution formed after the addition of 35.0 cm³ of 0.150 mol dm⁻³ NaOH to the original 25.0 cm³ of monoprotic acid. The ionic product of water, $K_w = 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$ at 298K

① Calculate the moles of acid:

$$\text{moles} = 1.45 \times 10^{-3} \quad \leftarrow \text{from part (a).}$$

② Calculate the moles of base:

$$\begin{aligned} \text{moles} &= \frac{35.0 \times 0.150}{1000} \\ &= 5.25 \times 10^{-3} \end{aligned}$$

$$\text{moles} = \frac{\text{conc.} \times \text{vol.}}{1000}$$

③ Find which is in excess:

$$\begin{aligned} &5.25 \times 10^{-3} - 1.45 \times 10^{-3} \\ &\Rightarrow \text{base in excess by } 3.8 \times 10^{-3} \text{ moles.} \end{aligned}$$

④ Find [OH⁻] ions in the mixture:

$$\begin{aligned} [\text{OH}^-] &= \frac{3.8 \times 10^{-3} \times 1000}{60} \quad \leftarrow \text{use the total mixture volume.} \\ &= 0.0633 \text{ mol dm}^{-3} \end{aligned}$$

⑤ Use K_w to find [H⁺] ions:

$$\begin{aligned} [\text{H}^+] &= \frac{K_w}{[\text{OH}^-]} = \frac{1 \times 10^{-14}}{0.0633} \\ &= 1.578 \dots \times 10^{-13} \text{ mol dm}^{-3} \end{aligned}$$

$$K_w = [\text{H}^+][\text{OH}^-]$$

⑥ Hence find the pH of the mixture:

$$\begin{aligned} \text{pH} &= -\log_{10} (1.578 \dots \times 10^{-13}) \\ &= 12.801 \dots \\ &\Rightarrow \underline{12.80} \quad \leftarrow \text{basic pH} \approx 10-14 \end{aligned}$$

