

- What amount of NaOH (in mol) needs to be added to 250 mL of 0.10 M acetic acid to give a solution with a pH of 5.00? The  $pK_a$  of acetic acid is 4.76.

**Marks**  
**3**

**If the concentration of  $\text{OH}^-$  which is added is  $x$  M then this will react with acetic acid to produce its conjugate base, acetate, so that:**

$$\begin{aligned}[\text{acid}] &= (0.10 - x) \text{ M and} \\ [\text{base}] &= x \text{ M}\end{aligned}$$

**The Henderson-Hasselbalch equation can be used to work out the ratio of these needed for a pH of 5.00:**

$$\text{pH} = \text{p}K_a + \log \frac{[\text{base}]}{[\text{acid}]}$$

$$5.00 = 4.76 + \log \frac{x}{0.10 - x}$$

**Hence:**

$$\frac{x}{0.10 - x} = 10^{0.24} \quad \text{so } x = 0.0634$$

**To achieve  $[\text{OH}^-(\text{aq})] = 0.0634 \text{ mol L}^{-1}$  in 250 mL, the number of moles of NaOH that must be added is:**

$$\begin{aligned}\text{number of moles} &= \text{concentration} \times \text{volume} \\ &= 0.0634 \text{ mol L}^{-1} \times 0.250 \text{ L} = 0.016 \text{ mol}\end{aligned}$$

**Answer: 0.016 mol**