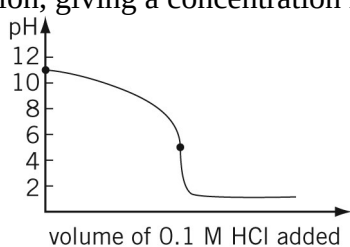


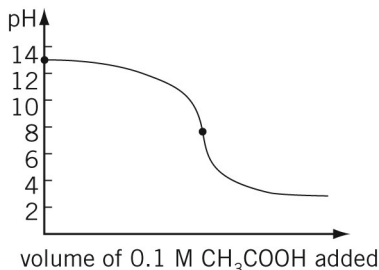
Worksheet 8.1: Solutions

Acid–base titrations

No.	Answer
1	$n(\text{Na}_2\text{CO}_3) = c \times V = 0.0500 \times 0.250 = 0.0125 \text{ mol}$ $m(\text{Na}_2\text{CO}_3) = n \times M = 0.0125 \times 105.99 = 1.325 \text{ g}$ 1 Accurately weigh approximately 1.3 g sample of the primary standard. 2 Transfer the sample to a 250.0 mL volumetric flask. 3 Ensure complete transfer by washing with water. 4 Dissolve the primary standard in water by swirling the flask. 5 Add water to make up the solution to the calibration mark, then mix thoroughly.
2	The sodium hydroxide is very concentrated. An exact concentration cannot be calculated from the data available.
3	The ratio of volumes is 20:5 or 1:4. This means the sodium hydroxide is four times more concentrated than the nitric acid. Therefore the concentration is 0.4 mol L^{-1} . This ratio only works if the molar ratio of acid and base in the balanced equation is 1:1.
4	a $2\text{HNO}_3(\text{aq}) + \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow 2\text{NaNO}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$ b $n(\text{HNO}_3) = c \times V = 0.10 \times 0.040 = 0.00400 \text{ mol}$ $n(\text{Na}_2\text{CO}_3) = \frac{1}{2} \times n(\text{HNO}_3) = 0.00200 \text{ mol}$ $V(\text{Na}_2\text{CO}_3) = \frac{n}{c} = \frac{0.00200}{0.20} = 10 \text{ mL}$
5	a $\text{HCl}(\text{aq}) + \text{NH}_3(\text{aq}) \rightarrow \text{NH}_4^+(\text{aq}) + \text{Cl}^-(\text{aq})$ b i At the equivalence point, some NH_4^+ exists. This is a weak acid; hence the pH will be about 5. ii After excess HCl is added, the pH is slightly greater than 1. (pH of the acid is 1. The acid will be diluted by the increased volume due to the neutralised ammonia solution, giving a concentration less than 0.1 M and so a pH greater than 1.) iii 
6	$\text{CH}_3\text{COOH}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{CH}_3\text{COONa}(\text{aq}) + \text{H}_2\text{O}(\text{l})$ $n(\text{NaOH}) = c \times V = 0.114 \times 0.01545 = 0.001761 \text{ mol}$ $n(\text{CH}_3\text{COOH}) = n(\text{NaOH})$ $n(\text{CH}_3\text{COOH}) \text{ in original } 25.0 \text{ mL} = n(\text{CH}_3\text{COOH}) \text{ in aliquot} \times \frac{100}{20.0} = 0.008810 \text{ mol}$ $c(\text{CH}_3\text{COOH}) = \frac{n}{V} = \frac{0.008810}{0.0250} = 0.352 \text{ mol L}^{-1}$

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7	<p>Back titrations are performed when the substance to be analysed is:</p> <ul style="list-style-type: none"> insoluble volatile (<i>so the titration method is not fast enough to carry out the analysis before the concentration of the solution changes as evaporation occurs</i>) a weak acid or a weak base (<i>it is sometimes difficult to obtain sharp endpoints in these titrations</i>).
8	<p>a</p>  <p>b CH_3COO^- is present at the equivalence point. This weak base will mean that the pH will be above 7 at the equivalence point.</p> <p>c An indicator such as methyl red would be a poor choice because it does not change colour until pH 3, long after the equivalence point has been reached.</p>
9	<p>a</p> <ul style="list-style-type: none"> i Water ii Solution going into it—hydrochloric acid iii Solution going into it—sodium carbonate iv Water <p><i>One method to try with this style of question is to picture a very exaggerated amount of water in the piece of glassware and to ask whether this will affect the experiment in any way.</i></p> <p>b $2\text{HCl}(\text{aq}) + \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow 2\text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$ $n(\text{Na}_2\text{CO}_3) = c \times V = 0.100 \times 0.0183 = 0.001\,830 \text{ mol}$ $n(\text{HCl}) = 2 \times n(\text{Na}_2\text{CO}_3) = 2 \times 0.001\,830 = 0.003\,660 \text{ mol}$ $n(\text{HCl}) \text{ in original } 10.0 \text{ mL} = n(\text{HCl}) \text{ in aliquot} \times \frac{250.0}{20.00}$ $= 0.003\,660 \times \frac{250.0}{20.00} = 0.045\,80 \text{ mol}$ $c(\text{HCl}) = \frac{n}{V} = \frac{0.04580}{0.0100} = 4.58 \text{ mol L}^{-1}$</p>
10	<p>$2\text{HNO}_3(\text{aq}) + \text{Mg}(\text{OH})_2(\text{aq}) \rightarrow \text{Mg}(\text{NO}_3)_2(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$ $n(\text{Mg}(\text{OH})_2) = c \times V = 0.10 \times 0.0250 = 0.002\,50 \text{ mol}$ $n(\text{HNO}_3) = 2 \times n(\text{Mg}(\text{OH})_2) = 2 \times 0.002\,50 = 0.005\,00 \text{ mol}$ $c(\text{HNO}_3) = \frac{n}{V} = \frac{0.00500}{0.0135} = 0.37 \text{ mol L}^{-1}$</p>