

Titration and Solution Practice Problems

1. How much 18.0 M sulfuric acid is needed to make 500.0 mL of 0.10 M H₂SO₄(aq)?

$$M_1V_1 = M_2V_2 \quad V_1 = 2.8 \text{ mL}$$

$$(18.0 \text{ M})V_1 = (0.10 \text{ M})(500.0 \text{ mL})$$

2. How much solid KOH (mw = 56.11) is needed to make 250.0 mL of ~~10.10~~ M KOH(aq)?

$$250.0 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{1.010 \text{ mol KOH}}{\text{L}} \times \frac{56.11 \text{ g}}{1 \text{ mol KOH}} = 14.17 \text{ g KOH}$$

3. If it takes 25.27 mL of NaOH to titrate 0.4321 g of KHP dissolved in 150 mL water, what is the concentration of the NaOH? NaOH + KHP → NaKP + H₂O

$$0.4321 \text{ g KHP} \times \frac{1 \text{ mol KHP}}{204.22 \text{ g}} \times \frac{1 \text{ mol NaOH}}{1 \text{ mol KHP}} = \frac{2.116 \times 10^{-3} \text{ mol}}{0.02527 \text{ L}} = 0.08373 \text{ M NaOH(aq)}$$

4. A 1.3171 g sample containing sodium carbonate was titrated with 21.11 mL of 0.1007 M HCl(aq), what is the percent Na₂CO₃ in the sample? 2HCl + Na₂CO₃ → 2NaCl + CO₂ + H₂O

$$21.11 \text{ mL HCl} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{0.1007 \text{ mol HCl}}{\text{L}} \times \frac{1 \text{ mol Na}_2\text{CO}_3}{2 \text{ mol HCl}} \times \frac{105.99 \text{ g}}{1 \text{ mol Na}_2\text{CO}_3} = \frac{0.1127 \text{ g Na}_2\text{CO}_3}{1.3171 \text{ g sample}} \times 100$$

5. If 37.21 mL of 0.1178 M HCl(aq), is needed to neutralize 25.00 mL of barium hydroxide, what is the percent barium hydroxide in the sample? 2HCl + Ba(OH)₂ → 2H₂O + BaCl₂

$$37.21 \text{ mL HCl} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{0.1178 \text{ mol HCl}}{\text{L}} \times \frac{1 \text{ mol Ba(OH)}_2}{2 \text{ mol HCl}} = 2.191 \times 10^{-3} \text{ mol BaOH}$$

6. How much KHP is needed to standardize an aqueous solution of 0.1 M NaOH?

$$25 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{0.1 \text{ mol NaOH}}{\text{L}} \times \frac{1 \text{ mol KHP}}{1 \text{ mol NaOH}} \times \frac{204.22 \text{ g}}{1 \text{ mol KHP}} \approx 0.5 \text{ g}$$

7. If 10.00 mL of 1.71 M HNO₃(aq) was diluted to a total volume of 250.0 mL, what is the concentration of the resulting solution?

$$M_1V_1 = M_2V_2 \quad M_2 = 0.0684 \text{ M}$$

$$(1.71 \text{ M})(10.00 \text{ mL}) = M_2(250.0 \text{ mL})$$

8. A 5.00 g sample containing barium hydroxide was dissolved in 50.00 mL of 0.2000 M HCl(aq). The remaining HCl was titrated with 5.82 mL of 0.1002 M NaOH. What is the %Ba(OH)₂ in the sample?

$$(50.00 \text{ mL})(0.2000 \text{ M}) = 10.00 \text{ mmol HCl}$$

$$(5.82 \text{ mL OH})(0.1002 \text{ M}) = 0.583 \text{ mmol OH} = 0.583 \text{ mmol HCl rx}$$

$$10.00 - 0.583 = 9.42 \text{ mmol HCl rxd}$$

$$9.42 \text{ mmol HCl} \times \frac{1 \text{ mol}}{1000 \text{ mmol}} \times \frac{1 \text{ mol Ba(OH)}_2}{2 \text{ mol HCl}} \times \frac{171.35 \text{ g}}{1 \text{ mol Ba(OH)}_2}$$

- MW H₂SO₄ = 98.03
- KOH = 56.11
- KHP = 204.22
- Na₂CO₃ = 105.99
- HNO₃ = 63.02

$$\text{Ba(OH)}_2 = 171.35$$

5. continued

$$[\text{Ba(OH)}_2] = \frac{2.191 \times 10^{-3} \text{ mol}}{0.02500 \text{ L}} = 0.08767 \text{ M}$$

$$= \frac{0.807 \text{ g Ba(OH)}_2}{5.00 \text{ g sample}} \times 100$$

$$2.191 \times 10^{-3} \text{ mol} \times \frac{171.35 \text{ g}}{1 \text{ mol}} = 0.3755 \text{ g}$$

$$= 16.1\% \text{ Ba(OH)}_2$$

$$\% \text{ Ba(OH)}_2 = \frac{0.3755 \text{ g}}{25 \text{ mL}} \times 100 = 1.502\% (\text{g/mL})$$

11.8.553% Na₂CO₃