

SOLUTIONS

SOLUTION STOICHIOMETRY

1. Calculate the concentration in parts per million of the following solutions:

(a) 1.0 g of Zn dissolved in HCl and diluted to 500 mL with distilled water

$$\frac{1.0 \text{ g}}{500 \text{ mL}} = \frac{1000 \text{ mg}}{0.500 \text{ L}} = 2000 \text{ ppm}$$

(b) 0.001 g of Pb dissolved in HCl and diluted to 100 mL with distilled water.

$$\frac{0.001 \text{ g}}{100 \text{ mL}} = \frac{1 \text{ mg}}{0.10 \text{ L}} = 10 \text{ ppm}$$

(c) 0.5 g of Ag dissolved in 10mL HNO₃ and diluted to 250 mL.

$$\frac{0.05 \text{ g}}{250 \text{ mL}} = \frac{50 \text{ mg}}{0.250 \text{ L}} = 200 \text{ ppm}$$

2. What mass of CaCl₂·2H₂O is required to prepare 250 mL of a 500 ppm Ca solution?

$$500 \text{ ppm} = 500 \text{ mg per 1L}$$

$$= 0.5 \text{ g per 1000 mL}$$

$$= 0.125 \text{ g per 250 mL}$$

$$\% \text{ Ca in CaCl}_2 \cdot 2\text{H}_2\text{O} = \text{MM Ca} / \text{MM CaCl}_2 \cdot 2\text{H}_2\text{O} \times 100$$

$$= 40.08 \text{ g mol}^{-1} / 147.02 \text{ g mol}^{-1} \times 100$$

$$= 27.26 \%$$

$$0.125 \text{ g} = 27.26 \% \text{ by Ca}$$

$$(x) \text{ g} = 100 \% \text{ by Ca}$$

$$(x) \text{ g} = 0.4585 \text{ g.}$$

To prepare 250 mL of a 500 ppm, accurately weigh out 0.4585 g of CaCl₂·2H₂O salt, dissolve in water and make up to 250 mL with deionized water.

3. What is the concentration of Cr (in ppm) when 0.8 g of Cr₂O₃ was dissolved and made up to 750 mL?

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$$\% \text{ Cr in Cr}_2\text{O}_3 = 2x \text{ MM Cr} / \text{MM Cr}_2\text{O}_3 \times 100$$

$$= (52 \text{ g mol}^{-1} \times 2) / 152 \text{ g mol}^{-1} \times 100 = 68.45 \%$$

$$\text{Mass of Cr in Cr}_2\text{O}_3 = 0.6845 \times 0.8 \text{ g} = 0.5476 \text{ g}$$

$$0.5476 \text{ g per 750 mL} = 547.6 \text{ mg} / 0.750 \text{ L} = 730.13 \text{ ppm}$$

4. The label on a reagent bottle containing Manganese had the following information:

$$1.0 \text{ g Mn} / 100 \text{ mL}$$

$$1000 \text{ mg} / 100 \text{ mL} = 1000 \text{ mg} / 0.1 \text{ L} = 10\,000 \text{ ppm Mn solution}$$

$$\text{Purity of Mn } 99.99\%$$

$$\text{Vol of solution} = 500 \text{ mL}$$

What volume of this solution is required to prepare 100 mL of the following?

- (a) 1000 ppm Mn solution

$$10\,000 \text{ ppm Mn stock} \times (x) = 1000 \text{ ppm} \times 100 \text{ mL}$$

$$(x) = 0.10 \text{ mL}$$

- (b) 100 ppm Mn solution

$$10\,000 \text{ ppm Mn stock} \times (x) = 100 \text{ ppm} \times 100 \text{ mL}$$

$$(x) = 1 \text{ mL}$$

- (c) 10 ppm Mn solution

$$10\,000 \text{ ppm Mn stock} \times (x) = 10 \text{ ppm} \times 100 \text{ mL}$$

$$(x) = 10 \text{ mL}$$

5. A solution of copper sulphate is labeled $0.1000 \text{ mol dm}^{-3}$. How many milliliters of this solution contains 4.25 g of CuSO_4 ?

$$M = \frac{\text{mass of salt (g)}}{\text{MM of salt (g mol}^{-1})} \times \frac{1}{\text{vol (dm}^3\text{)}}$$

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$$\text{Volume}(\text{dm}^3) = \frac{\text{mass of salt}}{\text{Molarity} \times \text{MM of salt}} = \frac{4.25 \text{ g}}{0.1000 \text{ M} \times 161.61 \text{ g mol}^{-1}} = 0.263 \text{ dm}^3$$
$$= 0.263 \text{ dm}^3 \times 1000 = \mathbf{263 \text{ mL}}$$

6. (a) What is the molar concentration of concentrated H_2SO_4 that contains 96% (m/m) H_2SO_4 and has density of 1.84 g/mL?
- (b) What volume of the above solution is required to make 20 dm^3 of a 0.100 M H_2SO_4 solution?

7. Describe using a calculation how you would prepare 250 mL of a 1.5 M NaCl (molar mass 58.44 g mol^{-1}) using pure solid NaCl.

$$\text{Mass of NaCl} = \text{Molarity}(\text{mol dm}^{-3}) \times \text{MM} (\text{g mol}^{-1}) \times \text{vol} (\text{dm}^3)$$
$$= 1.5 \text{ mol dm}^{-3} \times 58.44 \text{ g mol}^{-1} \times 0.250 \text{ dm}^3$$
$$= 21.92 \text{ g}$$

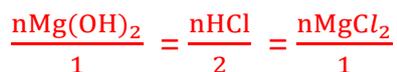
Accurate weight out 21.92 g of NaCl salt, dissolve in deionized water and make up to 250 mL with deionized water in a volumetric flask

8. A solution prepared by dissolving solid $\text{Mg}(\text{OH})_2$ was neutralized with 50 mL of 0.0950M HCl.
- (a) Give a balanced equation for the reaction.



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- (b) Give the stoichiometries for all species involved.



- (c) What mass of Mg(OH)_2 is required to neutralize the HCl?

$$\frac{n\text{Mg(OH)}_2}{1} = \frac{n\text{HCl}}{2} = \frac{0.0950 \text{ M} \times 50 \text{ mL}}{2}$$

$$= 2.375 \text{ millimoles (note vol in mL)}$$

No of millimols of $\text{Mg(OH)}_2 = 2.375 \text{ mmols} (= 0.002375 \text{ mols})$

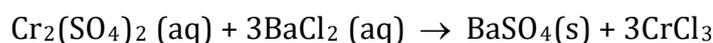
Mass of Mg(OH)_2 needed to neutralize HCl = $2.375 \text{ mmols} \times \text{MM Mg(OH)}_2$

$$= 2.375 \text{ mmols} \times 58.33 \text{ g mol}^{-1}$$

$$= 138.53 \text{ mg}$$

$$= 0.1385 \text{ g}$$

9. How many mL of 0.250M $\text{Cr}_2(\text{SO}_4)_2$ solution are needed to react completely with 300 mL of a 0.400 M BaCl_2 solution according to the given equation?



10. A sample of seashell (made up mainly of CaCO_3) of mass 0.1265 g was treated with 50.0 mL of 0.1002 M HCl solution. The excess unreacted HCl required 30.75 mL of a 0.09959M NaOH for complete neutralization, calculate the percentage (%) CaCO_3 in the sample.

BACK-TITRATION PROBLEM

1. Write a balanced equation

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2. Calculated no of mols of HCl that reacted with CaCO₃

No of mmols HCl added initially = 0.1002 M x 50 mL = 5.010 mmols

No of mmols NaOH added (= HCl remaining) = 0.09959 M x 30.75 mL = 3.062 mmols

No of mols of HCl that reacted with CaCO = 5.010 mmols - 3.062 mmols = **1.948 mmols**

3. From stoichiometry:

$$\frac{n\text{CaCO}_3}{1} = \frac{n\text{HCl}}{2}$$

$$n\text{CaCO}_3 = 1.948\text{mmols}/2 = 0.974 \text{ mmols}$$

$$\text{mass of CaCO}_3 = 0.974 \text{ mmols} \times 100 \text{ g mol}^{-1} = 97.40 \text{ mg} = 0.09740 \text{ g}$$

$$\% \text{ CaCO}_3 = \frac{0.09740 \text{ g}}{0.1265 \text{ g}} \times 100$$

$$= \mathbf{76.99 \%}$$