**Homework One**

1. What is a standard solution? (1)
2. State three properties of a **PRIMARY STANDARD**. (1)

**3.** Name **three** primary standard chemicals. (1)

**4.** (i) Describe in detail how you would prepare 250 cm3 of a standard solution containing 1.26g of oxalic acid {(COOH)2.2H2O} (3)

 (ii) Calculate the concentration, in mol l-1, of this solution? (1)

**5.** Solutions which are not primary standards require standardisation before they are used. What does standardisation mean? (1)

**6.** Margaret carried out a titration to find the concentration of a solution of hydrochloric acid by reacting it with 0.001mol l-1 sodium hydroxide. Margaret’s results are shown below:

 1st titre = 23.1cm3 2nd titre = 23.4cm3

 3rd titre = 23.0cm3  4th titre = 22.8cm3

 Calculate the average titre from these results (1)

**7.** In an experiment to standardise dilute hydrochloric acid, 25.0 cm3 of 0.200 mol l-1 sodium carbonate solution was neutralised by 20.0 cm3 of the dilute hydrochloric acid. Calculate the concentration, in mol l-1, of the hydrochloric acid.

 Na2CO3 + 2HCl 2NaCl + CO2 + H2O

 (3)

8. In an experiment to determine the concentration of a hydrogen peroxide solution, H2O2, 25.0 cm3 of hydrogen peroxide solution was pipette into a conical flask. An excess of dilute sulfuric acid was added to the flask using a measuring cylinder. The solution in the flask was then titrated with 0.0200 mol l-1 potassium permanganate solution, KMnO4. 28.1 cm3 of potassium permanganate solution was required to reach the end-point.

 5H2O2 + 2MnO4- + 6H+ 2Mn2+ + 5O2 + 8H2O

 (i) Why was sulfuric acid added to the flask? (1)

 (ii) Explain why an indicator is not required for this titration. (1)

 (iii) Explain why the hydrogen peroxide was measured out with a pipette but the sulfuric acid was measured out with a measuring cylinder. (1)

 (iv) Calculate the concentration, in mol l-1 of the hydrogen peroxide solution (3)

9. Andy was asked to dilute 500 cm3 of a 2.0 mol l-1 solution of sulfuric acid with 250 cm3 of deionised water.

 Calculate the concentration of the diluted solution. (2)

 Total Marks (20)

**Homework Two**

**1.** Use the options (i) to (v) below to answer questions a,b,c, and d

 (i) Mg2+ (ii) S2O32- (iii) NaOH (iv) I- (v) MnO4-

a. Which substance can be estimated in an acid/base titration?

b. Which substance will reduce iodine, I2?

c. Which substance can be estimated in a complexometric titration?

d. Which substance is a powerful oxidising agent?

**2.** EDTA forms a 1:1 complex with Ni 2+(aq). What is the concentration, in mol l-1, of a nickel(II) solution, if 20 cm3 of it reacts with 2 x 10 -3 moles of EDTA?

 A 0.10 B 0.01 C 0.02 D 0.002

**3.** A 125 cm3 sample of a 3.0 mol l-1 HCl is diluted by adding 250 cm3 of water. The new concentration of the HCl solution is

 A 8.0 mol l-1 B 1.5 mol l-1 C 1.0 mol l-1 D 0.5 mol l-1

**4.** Which of the substances below would **not** be suitable as a primary standard?

 A Oxalic acid B Potassium iodate

 C Sodium hydroxide D Potassium hydrogenphthalate

 **5.** What is the concentration of a solution obtained by dissolving 8.40 g of sodium hydrogencarbonate (NaHCO3) in 500 cm3 of solution?

 A 0.1 mol l-1 B 0.2 mol l-1 C 0.5 mol l-1 D 1.0 mol l-1

 **6.** What volume of 1.50 mol l-1 calcium chloride is required to make, by dilution with water, one litre of a solution with a **chloride ion** concentration of 0.15 mol l-1?

 a 50 cm3 b 75 cm3 c 100 cm3 d 200 cm3

 **7.** What volume of 0.25 mol l-1 calcium nitrate is required to make, by dilution with water, 500 cm3 of a solution with a **nitrate ion** concentration of 0.10 mol l-1?

 A 50 cm3 B 100 cm3 C 200 cm3 D 400 cm3

**8.** A salt has the formula Pt(NH3)**x**Cl2

 0.02 moles of this salt required 40 cm3 of 2.0 mol l-1 hydrochloric acid for exact neutralisation of the NH3. The value of **X** is

 A 2 B 4 C 6 D 8.

 **9.** To determine the concentration of acetic acid (CH3COOH) ­in a sample of vinegar, 25.00 cm3 of vinegar was pipetted into a 250 cm3 volumetric flask. Deionised water was added to fill the flask up to the mark. 20.00 cm3 samples of this diluted vinegar were titrated with 0.105 mol l-1 sodium hydroxide solution.

 The equation for the reaction is:

 CH3COOH+ NaOH CH3COONa+ H2O

 The results of the titrations are shown in the table.

|  |  |
| --- | --- |
| **Burette readings (cm3)** | **Titrations** |
| **1** | **2** | **3** | **4** |
| Final  | 12.50 | 24.65 | 36.75 | 49.90 |
| Initial  | 0.00 | 12.50 | 24.65 | 36.75 |
| Titre volume | (i) | (ii) | (iii) | (iv) |

a. What are the values of the titre volumes (i) to (iv)? (1)

b. Calculate the average titre volume. (1)

c. Calculate the concentration of ethanoic acid in the undiluted vinegar. (1)

d. How would a control experiment be carried out for this analysis? (2)

**10.** Human teeth contain the element calcium. To determine the percentage mass of calcium in a tooth 1.40 g of a dried tooth was dissolved in a small quantity of hot conc. nitric acid. The solution was neutralised by the addition of sodium hydroxide and then made up to 250 cm3 in a volumetric flask.

10.0 cm3 of this solution was pipetted into a conical flask and 1 cm3 of a concentrated.ammonia/ammonium chloride pH 10 buffer was added. The solution was titrated with 0.02 mol l-1 EDTA using Eriochrome Black T indicator. The indicator turned blue after 22.5 cm3 of EDTA was added.

Calculate the percentage mass of calcium in the tooth. (3)

**11.** In an experiment to find the percentage of sodium chloride in a sample of rock salt, Catherine weighed 1.50 g of rock salt which was crushed and dissolved in deionised water in a beaker. The mixture was filtered to remove insoluble material and the filtrate was added to a 250 cm3 standard flask. Deionised water was used to make the volume up to 250 cm3. The flask was stoppered and shaken to ensure thorough mixing. 25.0 cm3 samples of this solution were titrated with 0.100 mol l-1 silver(I) nitrate. On average 23.5 cm3 of silver(I) nitrate was needed.

a. Catherine omitted two important steps when making up the solution in the standard flask. Suggest any one of these mistakes. (1)

b. The equation for the reaction is

 NaCl(aq) + AgNO3(aq) AgCl(s) + NaNO3(aq)

 Calculate the percentage by mass of sodium chloride in the rock salt. (3)

 Total Marks (20)

**Homework Three**

**1.** An experiment was carried out to find the purity of chalk, which contains mainly calcium carbonate, CaCO3. 3.63 g sample of impure chalk was added to 50.0 cm3 of 2.00 mol l-1 hydrochloric acid. The resulting solution was filtered into a volumetric flask and made up to 250.0 cm3. 25.00 cm3 samples of this solution were then titrated against 0.105 mol l-1 sodium hydroxide solution.

 The results of the titrations are shown in the table below.

|  |  |
| --- | --- |
| **Burette readings (cm3)** | **Titrations** |
| **1** | **2** | **3** |
| Final  | 32.50 | 37.25 | 43.15 |
| Initial  | 0.00 | 5.50 | 11.30 |
| Titre volume | 32.50 | 31.75 | 31.85 |

 The equations for the reactions taking place are:

 CaCO3 + 2HCl CaCl2  + CO2 + H2O

 NaOH + HCl NaCl + H2

a. This technique is a back titration. Why does calcium carbonate require to be analysed by back titration? (1)

b. What is the average titre volume? (1)

c. Calculate the number of moles of hydrochloric acid added to the chalk. (1)

d. Calculate the number of moles of hydrochloric acid in the standard flask. (1)

e. Calculate the number of moles of calcium carbonate in the chalk. (1)

f. Calculate the percentage mass of calcium carbonate in the chalk (1)

**2.** In an experiment to find the percentage of iron in iron ore, 2.650 g of ore was dissolved in hydrochloric acid. A powerful oxidising agent was then added to convert all the iron(II) ions to iron (III) ions and the solution diluted to 250 cm3 in a standard flask. 25.0 cm3 of this solution was then transferred to a conical flask and when a few drops of ammonium thiocyanate solution were added, a red colour appeared due to reaction with iron(III) ions. The solution was titrated with 0.10 mol l–1 titanium(III) solution until the red colour just disappeared. The titration results were as follows.

 Note: titanium(III) is a powerful reducing agent, itself being oxidised to titanium(IV).

a. Write the ion–electron half-equations for the reactions that occur during the titration. (1)

b. Deduce the reacting mole ratio of iron(III) ions with titanium(III) ions from the ion-electron equations in a. (1)

c. (i) What volume of titanium(III) solution should be used for any calculation? (1)

 (ii) Calculate the percentage of iron in the ore. (3)

**3.** The chloride of an element **Z** reacts with water according to the following equation.

 ZCl4(l) + 2 H2O(l) ZO2(s) + 4 HCl(aq)

 1.304 g of ZCl4 was added to water. The solid ZO2 was removed by filtration and the resulting solution was made up to 250 cm3 in a volumetric flask. A 25.0 cm3 portion of this solution was titrated against a 0.112 mol l-1 solution of sodium hydroxide, of which 21.7 cm3 were required to reach the end point.

 NaOH + HCl NaCl + H2O

a. Assuming each reaction is 100% efficient. Calculate the number of moles of **ZCl4** that reacted with the water. (2)

b. Identify element **Z**. (2)

4. The mineral cerussite contains lead(II) carbonate, PbCO3 and some inert rocky material. 1.00g of cerussite was crushed and added to 25.0 cm3 of 1.00 mol l-1 nitric acid (an excess). When no more reaction was observed the mixture was filtered and the filtrate was made up to 250 cm3 in a standard flask.

 25.0 cm3 samples of this solution were titrated with 0.100 mol l-1 sodium hydroxide solution. The average titre value was 20.5 cm3.

 PbCO3 + 2HNO3 Pb(NO3)2  + CO2 + H2O

 NaOH + HNO3 NaNO3  + H2O

a. Why is it considered good practice to carry out titrations more than once? (1)

b. Calculate the percentage by mass of lead(II) carbonate in the cerussite. (3)

 {Hint: this is a back titration)

 Total marks (20)

**Homework Four**

1. A compound contains 4.6 g of sodium, 2.8 g of nitrogen and 9.6 g of oxygen. Use this information to calculate the formula of the compound (2)

2. Bryce took two equal volumes of calcium iodide solution. To one he added and excess of silver(I) nitrate which precipitated all the iodine out as silver(I) iodide, AgI. The precipitate was filtered, washed and dried and found to have a mass of 9.40 g To the second volume Bryce added an excess of sodium carbonate solution which precipitated all the calcium out as 2.00 g of calcium carbonate, CaCO3.

a. What type of quantitative analysis was carried out on the calcium iodide? (1)

b. Why was the silver(I) nitrate added in excess? (1)

c. The silver(I) iodide was dried in an oven. Suggest a piece of apparatus that should be used to store this compound as it cools. (1)

d. Use the results of the experiment to confirm that the formula of calcium iodide is CaI2. (2)

3. A 0.4500 g sample of impure potassium chloride, KCl, was dissolved in water and treated with an excess of silver nitrate. 0.8402 g of silver chloride, AgCl, was produced. Calculate the percentage of potassium chloride in the original sample. (2)

4. A 3.00 g sample of an alloy containing only Lead, Pb and tin, Sn, was dissolved in dilute nitric acid. Sulfuric acid was added to this solution, which precipitated 1.69 g of lead(II) sulfate, PbSO4. Assuming that all of the lead was precipitated, what is the percentage of **tin** in the sample? (3)

5. Aluminium can be determined gravimetrically by reaction with a solution of 8-hydroxyquinoline (C9H7NO).

 Al3+(aq) + 3C9H7NO(aq) Al(C9H6NO)3(s) + 3H+ (aq)

 18.571 g of a mineral containing aluminium was dissolved in acid and the solution was made up to 250 cm3 in a standard flask. An excess of 8-hydroxyquinoline was added to 25 cm3 of the aluminium solution. The precipitate formed was washed, dried and heated to constant mass. 0.1248 g was obtained.

a. Outline the process of heating the precipitate to constant mass. (1)

b. Calculate the percentage mass of aluminium in the mineral. (3)

6. A sample containing nickel was treated with dimethylglyoxime, resulting in the precipitation of nickel(II) dimethylglyoximate. The sample had a mass of 1.247 g and 3.761 g of precipitate was produced.



a. Find the percent purity of nickel in the sample. (3)

b. Suggest how nickel could be determined volumetrically. (1)

 Total marks (20)