

Topic 2: Analytical Techniques

Chemists perform a wide variety of monitoring roles, including analysing for drug residues and measuring the concentrations of pollutants such as pesticides in the environment. Chemists are also employed to analyse materials used in or produced by many branches of industry, including pharmaceuticals, polymers, metal production, and food preparation. In this topic students consider some of the more common means of analysis and undertake practical activities in measurement.

WEEK 6-8

2.1 Volumetric Analysis

- Concentrations of solutes in solutions can be described by using a number of standard conventions.
- Knowledge of the mole ratios of reactants can be used in quantitative calculations.
- A titration can be used to determine the reacting volumes of two solutions.
- Analysis of a variety of chemicals depends on an understanding of quantitative aspects of chemical reactions, including acid–base and redox reactions.
- A titration can be used to determine the concentration of a solution of a reactant in a chemical reaction.

TOPIC CHECKLIST

- Convert concentrations from one unit to another (e.g. mol L⁻¹, g L⁻¹, %w/v, ppm, and ppb).
- Perform stoichiometric calculations when given the reaction equation and the necessary data.
- Describe the correct use of a volumetric flask, a pipette, and a burette.
- Describe and explain the procedure involved in carrying out a titration, particularly rinsing glassware and determining the end-point.
- Determine the concentration of a solution of a reactant in a chemical reaction by using the results of a titration.

Volumetric Analysis Assignment

QUESTION 1

a) 0.0245 mole of sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) was weighed out and used to prepare a solution.

i) Determine the mass of sodium thiosulfate weighed out.

.....
.....
.....
(3 marks)

ii) Calculate the concentration in moles per litre if 0.0245 mole were dissolved to make 250.0 mL of solution.

.....
.....
.....
(2 marks)

b) In a sample of orange juice the concentration of iron was found to be 0.64 mg per litre.

i) Determine the concentration in moles per litre.

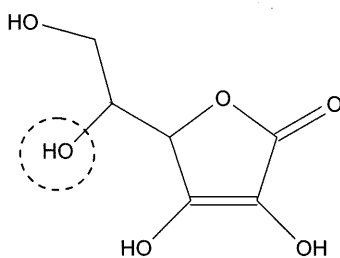
.....
.....
.....
(3 marks)

ii) Determine the concentration in parts per million.

.....
.....
.....
(2 marks)

QUESTION 2

a) Ascorbic acid is a water-soluble vitamin that has the structural formula shown below:



ascorbic acid

i) State whether the hydroxyl group circled is primary, secondary, or tertiary.

.....
 (1 mark)

ii) Explain why ascorbic acid is soluble in water.

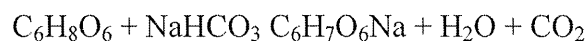
.....

 (3 marks)

b) Ascorbic acid tablets may be analysed by the following procedure:

Step 1: Two ascorbic acid tablets are dissolved in water and made up to 100.0 mL.

Step 2: 25.0 mL of this solution is then titrated against 0.0500 molL⁻¹ sodium hydrogen carbonate solution, as shown in the following equation:



In one such procedure, a titre of 28.2 mL was recorded.

i) Calculate the number of moles of hydrogen carbonate anion in 28.2 mL of 0.0500 molL⁻¹ sodium hydrogen carbonate solution.

.....

 (3 marks)

ii) Determine the number of moles of ascorbic acid in the 25.0 mL aliquot.

.....
.....
(1 mark)

iii) Calculate the number of moles of ascorbic acid in the two tablets.

.....
.....
(1 mark)

iv) Calculate the mass of ascorbic acid in each tablet. The molar mass of ascorbic acid is 176.1 g mol^{-1} .

.....
.....
(2 marks)

QUESTION 3

a) Solutions of bromide ions are used as a raw material for the production of bromine.

i) In sea water the concentration of bromide ions is 65 ppm. Convert this concentration to g L^{-1} .

.....
.....
.....
(2 marks)

ii) The Dead Sea contains bromide ions in a concentration of $1.25 \times 10^{-2} \text{ mol L}^{-1}$. Convert this concentration to g L^{-1} .

.....
.....
.....
(2 marks)

QUESTION 4

A 2.80 g sample of anhydrous sodium carbonate was dissolved in distilled water and made up to 250.0 mL in a volumetric flask. 20.00 mL aliquots of the solution were pipetted into conical flasks and titrated against a hydrochloric acid solution.

Final Reading (mL)	24.20	49.70	24.40
Initial Reading (mL)	0.00	24.20	0.20
Titre (mL)			

a) What should the following items have been rinsed with:

i) Volumetric flask.....

ii) Burette.....

iii) Pipette.....

iv) Conical flask.....

(4 marks)

b) Calculate:

i) The average volume of HCl solution

.....
(1 mark)

ii) The concentration of the HCl solution

.....
.....
.....
(3 marks)

c) When the HCl was titrated against an ammonia solution, 16.20 mL of HCl was required to neutralise a 20.00 mL aliquot of ammonia solution.

i) Calculate the molarity of the ammonia solution.

.....
.....
.....
.....
(2 marks)

QUESTION 5

An oxide of vanadium, V_2O_5 , is used in pellet form as a catalyst in industry. V_2O_5 can be analysed by a reaction with excess hydroxide ions, OH^- . The unreacted OH^- ions are then titrated with hydrochloric acid solution, HCl .

Credit will be given for answers to part (a) which show clear well-expressed ideas, and which present accurate and relevant information in a well-organised, logical manner. Your answer should be confined to the space provided and should take approximately 10 minutes.

A standard solution of hydrochloric acid was prepared for titration by dilution, using a volumetric pipette and a volumetric flask. Describe three steps in the correct use of the volumetric pipette, and explain why these steps are necessary to ensure that the concentration of the diluted solution is accurate.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(8 marks)