G621: Analysis at Work – Sample Assignment E

Unit Name: Analysis at Work	**Unit Number:** G621
Assignment Title: Power Station Emissions	**Assignment:** G621 Sample Assignment E
Date Set:	**Due Date:**
Assessment Objective(s): AO3	

Vocational Brief:

One the problems with coal-burning power stations is that coal contains sulfur and, as a result, sulfur dioxide gas is one of the flue gas products. This gas causes acidic rain. It is important to remove as much sulfur dioxide as possible to prevent this and flue gases are constantly monitored for their sulfur dioxide content.

One method of removing sulfur dioxide is to treat a known volume of flue gas with a hydrogen peroxide solution, which converts the sulfur dioxide into sulfuric acid.

The sulfuric acid is then reacted with a standard solution of sodium carbonate in an acid-base titration. Your task is to perform a practical exercise to find the percentage of sulfur dioxide in a given sample.

Task:

Finding the percentage of sulfur dioxide in flue gas from power stations

The aim of this task is to safely complete the volumetric analysis to find the percentage of sulfur dioxide in the sample of flue gas and complete a report.

Analyse the flue gas:

- identify hazards and carry out a risk assessment
- follow the Practical Instructions given - *Finding the Percentage of Sulfur Dioxide in Flue Gas from Power Stations Using an Acid-Base Titration*.

Produce a report that shows:

- an introduction to your analysis - to include some research which shows the vocational context
- the risk assessment you have used
- a record of your results
- a calculation of the concentration of sulfur dioxide in the flue gas
- an evaluation of the method used and results.

[Max marks possible for this task: 7]

Resources / Notes:

- Class notes on quantitative inorganic analysis using acid-base titrations.

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Practical Instructions

Finding the Percentage of Sulfur Dioxide in Flue Gas from Power Stations Using an Acid-Base Titration

Chemical Equations

$SO_2 + H_2O_2 \rightarrow H_2SO_4$

$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$

Practical Instructions

Complete an appropriate risk assessment before starting your work.

You should assume that all the sulfur dioxide gas has been absorbed and reacted with dilute hydrogen peroxide solution.

5.0 m^3 of flue gas has been bubbled through 250 cm^3 of dilute hydrogen peroxide solution. You are provided with this solution.

1. Fill your burette with the sodium carbonate solution of concentration 0.20 mol dm^{-3} provided.
2. Pipette 25 cm^3 of the 'flue gas' solution into a 250 cm^3 conical flask and add a few drops of methyl orange indicator solution.
3. Titrate with the sodium carbonate solution in the usual way until the indicator just turns from pink to orange.
4. Record the volume used in a suitable way and repeat as normal.

Calculations

5. Use the equations above to work out the mole ratio of sulfur dioxide to sodium carbonate.
6. Use the mean volume of the sodium carbonate solution used to calculate the number of moles of sodium carbonate used in the titration.
7. State the number of moles of sulfur dioxide present in 25 cm^3 of the 'flue gas' solution and hence the number of moles of sulfur dioxide present in the total volume of 'flue gas' solution provided.
8. Find the number of moles of sulfur dioxide present in 1 m^3 of the flue gas.
9. Calculate the concentration of sulfur dioxide in the flue gas in g m^{-3} and then in mg m^{-3}.

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Technicians' Guidance

Finding the Percentage of Sulfur Dioxide in Flue Gas from Power Stations Using an Acid-Base Titration

Technicians' Guidance:

- The flue gas solution is just a solution of sulfuric acid of a suitable concentration to fit the concentration of sodium carbonate.
- If 0.20 mol dm^{-3} sodium carbonate solution is used then 0.20 mol dm^{-3} sulfuric acid for a 1:1 ratio titre / aliquot.
- If 0.60 mol dm^{-3} sodium carbonate solution is used: 0.50 mol dm^{-3} H_2SO_4 gives a titre of approx 30 cm^3 for a 25 cm^3 aliquot of Na_2CO_3.
- Methyl orange indicator can be used.