Sample answer – Mod 8 ions

Stage 6 Chemistry - Guided by 2019 NSW Department of Education question and responses

Our excursion at Penrith Water Recycling Plant applies some content from Module 8 in the NSW Stage 6 Chemistry syllabus. References to excursion experiences can help answer the following HSC exam questions.

Question 31 (9 marks)

An investigation was carried out to determine the barium ion concentration in a water sample using gravimetric analysis.
Sodium sulfate solution was added to a water sample in a flask and heated until no more precipitate was formed. The water sample was then filtered.
The filtration apparatus consisted of a sintered glass filter set into the top of a sidearm flask which was connected to a vacuum pump. The precipitate was then dried and weighed, and the amount of chloride ion calculated.
Explain how the procedure and equipment were used to accurately, validly and reliably determine the barium ion concentration.

Marking Criteria and Sample answer

Marking Guidelines	Marks
• explains how the barium ion concentration in a water sample can be determined • includes evaluation of accuracy, validity and reliability of data	9
• describes how the barium ion concentration in a water sample can be determined • describes how the accuracy, validity or reliability of data was ensured	7-8
• outlines relevant steps for the determination of barium ion concentration in a water sample • shows some understanding of accuracy, validity or reliability of data	5-6
• outlines relevant steps for the determination of barium ion concentration in a water sample AND/OR • shows some understanding of accuracy and/or validity and/or reliability of data	3-4
• outlines a step to determine barium ion concentration OR • shows some understanding of accuracy or validity or reliability of data	2
• any relevant information	1

Source: NSW DoE Chemistry Year 12 modules problem set _30Oct2019 p.56

Content revision

Refresh your knowledge of the Penrith Water Recycling Plant.

Try some of the supporting High School resources, content and activities.

Haven't been on excursion with us? Make a free excursion request online.

Please note: information provided in this document is from Sydney Water, STANSW information and NSW DoE accredited sites.

Sample answer context - Stage 6 Chemistry Wastewater excursion at Penrith Water Recycling Plant

Explain both the **procedure** and **equipment**, make the relationships between things evident. Provide why and how barium ion can be separated.

2 marks

Explain how barium ion **concentration** can be determined.

1 mark

Evaluation of **validity**, **accuracy** and **reliability**, make a judgement based on criteria. Determine the value of, not just describe.

2 marks each

The procedure outline applies the addition of sodium sulfate leads to the precipitation of Barium Sulfate ($K_{sp} = 1.08 \times 10^{-10}$). The mass of precipatate can then be used to calculated the barium ion concentration in the water sample. By stoichiometry: $Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightleftharpoons BaSO_{4(s)}$ with 1:1 ratio. The concentration of barium ions = [mass Ba^{2+} ions / (mass of water)] $\times 100\%$.

For a valid method, it need to have an experiment control. For this procedure, carry out the method with just distilled or de-ionised water as a control. No precipitate should be formed in the control sample. If other ions may be present, other separation techniques may be required to remove them (such as adding HCl to remove carbonate ions). Also add the sodium sulfate solution in excess amounts to cause complete precipitation of the barium ion being determined quantitatively.

For an accurate method, provide sufficient time for the complete precipitation of the barium ions and the water sample is constantly stired and mixed. In the filtration process, wash the precipitate carefully with sufficient water to ensure that no soluble components are collected in it. Dry the precipitate completely and repeatly until its mass is constant (in a desiccator), this ensures that all water has been removed, thus also improve the validity, use Analytical balance to 2 or more decimal places to improve the accuracy.

For a reliable method, repeat the procedure three times or more with controlled condition (such as same temperature, same sample and same amount) to ensure the results are reliable and consistent