Unit 17 Chemical Analysis and Detection: Contents

Assignment 17.4: Analysing unknown compounds

Help Sheet 1: Chromatography of food colours
Task Sheet 1: Chemical analyst's report: Section 1
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Checklist

Worksheets

1 Risk Assessment
2 Evaporating seawater
3 Preparing and testing gases
4 Preparing fertilisers
5 Chromatography of ink
6 Calculating Rf values
7 Extracting plant pigments
8 Column chromatography of plant pigments

Technician Sheets 1 – 15

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Scheme of Work

Functional Skills and PLTS

Overview

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

P1 Identify the reagents needed to analyse inorganic chemicals	**M1** Describe the hazards associated with the reagents needed to analyse inorganic chemicals	**D1** Explain how to avoid the risks associated with analysing inorganic chemicals	Lessons 1 to 10
P2 Describe the techniques needed to analyse inorganic chemicals	**M2** Explain the results of using these techniques by providing the formula of an unidentified compound	**D2** Evaluate the accuracy of techniques used to analyse inorganic chemicals and explain how they could be improved	
P3 Carry out experiments to classify compounds according to their pH	**M3** Explain the uses of the classified compounds in the laboratory and home	**D3** Explain, with examples, the difference between an acid, a base and an alkali	Lessons 11 to 15
P4 Carry out experiments to show how chromatography is used to analyse materials	**M4** Demonstrate how chromatography works to separate materials	**D4** Evaluate the advantages and disadvantages of using chromatography to analyse materials	Lessons 16 to 23
P5 Carry out experiments to identify chemicals in unknown compounds	**M5** Explain the scientific principles behind the tests used to identify the chemicals in unknown compounds	**D5** Evaluate the results of the analysis, considering how to improve subsequent experiments	Lessons 24 to 26

Introduction to this unit

Assignment 17.1: Lessons 1 to 10 (approximately 24 hours)

This assignment is in two parts. In part A, for criteria P1, P2, and M2 and D2, students will produce a Laboratory Manual on the analysis of inorganic chemicals in samples, for use by new technicians. The Manual will describe how the tests for anions and cations can be carried out, explain the science behind the tests, and evaluate the techniques used and explain how they could be improved.

In part B, for criteria M1 and D1, students will produce a set of Hazard Cards for use by technicians when they are testing for inorganic chemicals.

Assignment 17.2: Lessons 11 to 15 (approximately 11 hours)

As chemists working for a consumer group, students produce a Consumer Guide on the use of acids, bases and alkalis. The Guide will identify the acids, bases and alkalis widely used in laboratories and in the home, and describe how to measure their pH, for criterion P3.

In the Guide, they will also explain how scientists use acids, bases and alkalis in their laboratories, and why certain consumer products contain acids, bases or alkalis. This will cover M3.

For D3, students will produce a technical section to the Consumer Guide, in which they will explain the chemistry of acids, bases and alkalis, using the correct scientific terms and equations.

Assignment 17.3: Lessons 16 to 23 (approximately 15 hours)

Following practice in the technique of paper chromatography by analysing inks, students make use of this and improved techniques as chemical analysts employed by a chain of juice bars. The bars make and sell different types of fruit juice, vegetable juice and other 'exotic' juices. To show evidence for criterion P4, students use chromatography techniques to analyse the content and quality of the juices and write accounts of their methods. They will prepare a report to the company on three of its products. The presentation of their results and explanation of how chromatography has worked to separate the components of the juices covers criterion M4.

For D4, students will produce a section of their report in which they evaluate the chromatographic techniques used, and suggest how improvements can be made to their analyses.

Assignment 17.4: Lessons 24 to 26 (approximately 9 hours)

Students are working as independent chemical analysts who provide information for legal cases. Their job is to analyse and identify unknown chemical substances in samples, in the area of forensic science, food science or environmental science.

For P5, students will select and use appropriate techniques, from all of those used in previous Assignments, to carry out the analyses. They will write an account of their techniques in a Chemical Analyst's Report. The presentation of their findings, together with an explanation of how they used the appropriate science to draw their conclusions, covers M5.

In the final section of their Report, for D5, they will evaluate the results of their analyses and suggest how these could be improved.

1 Analysing inorganic compounds

Learning outcome

LO1 Know the reagents and techniques used to analyse a variety of chemical compounds

Assessment criteria

P1 Identify the reagents needed to analyse inorganic chemicals

P2 Describe the techniques needed to analyse inorganic chemicals

Planning and resources

This lesson will take one hour.

You will need the following resources:

- If you are a member, consult CLEAPSS Hazcards, or Laboratory Handbook, or similar materials safety data
- For teacher demonstration:
  - acidified silver nitrate solution, 0.1 mol dm^{-3} (IRRITANT)
  - potassium chloride solution, potassium bromide solution, potassium iodide solution, each 0.1 mol dm^{-3}
  - test tubes, test tube rack
  - Pasteur pipette
  - dilute ammonia solution, 0.1 mol dm^{-3}
  - concentrated ammonia solution, ~8 mol dm^{-3} (CORROSIVE)
  - fume cupboard
  - eye protection
- Student Book pages 114−115, 330−331
- Help sheet A17.1 HS1.1
- Technician sheet 1
- (optional) *Collins BTEC First Applied Science Interactive Book* Interactive presentation 'Water quality'

Real-life links

It may be possible to engage a chemical analyst to talk to students about the work he or she carries out. Depending on your location, it may be possible to liaise with a company that extracts salt from seawater.

Setting the scene

In the first Assignment, students will take the role of lab technicians working for a chemical analytical company. They are going to prepare part of a Lab Manual for use by technicians new to the laboratory, which will explain how to test for particular ions in a chemical sample.

Students will need to apply scientific knowledge and understanding of cations and anions, along with practical skills in carrying out chemical analyses.

In this lesson students will learn how to carry out tests for halide anions.

Class activity

P1 P2

In this lesson students are working towards Task 1 of Part A of Assignment 17.1.

- First of all initiate a 'thought shower' about the need for chemical analysis and the types of analyses carried out. The discussion should cover applications in forensic, environmental and pathology laboratories and in the food and pharmaceutical industries, but could also focus on local contexts.
- Then discuss and distinguish between inorganic and organic chemical compounds; students should appreciate that different methods will be required to analyse these. In Lessons 1−9, students will look at the analysis of ions. The Student Book introduces these through those in salt and in seawater. Talk through the chemistry of ionic bonding if students have not done Unit 4, or recap on it if they have (pages 114−115 and 330).
- Use the Student Book page 331 to point out that seawater contains many different chemical ions dissolved in water. When seawater is evaporated, a series of inorganic compounds crystallises out. As salt is a food product, it is important that organisations such as the Cornish Sea Salt Company (see the context paragraph, page 330) know the chemical composition of the salt that is left when seawater is evaporated. Students should also be made aware that the halogens chlorine, bromine and iodine can be extracted from seawater (though other methods may be preferable for iodine).
- Demonstrate the technique of testing for halides using silver nitrate (page 331, and **Help sheet A17.1 HS1.1**). This will be the first technique that students use in their Assignment work. Discuss safety precautions when using these chemicals. Silver nitrate is hazardous. If you are a member, refer to CLEAPSS Hazcards/Laboratory Manual, or other sources of materials safety data – see the list of websites below.

Teacher guidance

This lesson develops previous knowledge, from Units 1 and 4, of the periodic table, atomic structure and bonding. It also complements work in Unit 13, Investigation of a crime scene.

Delivering PLTS and functional skills

PLTS Reflective learners − communicating learning in relevant ways for different audiences

Effective participators − analysing and evaluating information, judging its relevance and value

Self-managers − working towards goals, showing initiative, commitment and perseverance; organising time and resources, prioritising actions

Functional skills Speaking and listening − participating in group discussions

Useful websites

http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa/atomic/ionicrev4.shtml – an animation of ionic bonding

Materials safety data (note that these safety data sheets need careful interpretation for school and college work)

http://www.fisher.co.uk/techzone/msds_material_safety_data_sheets.php – Fisher Scientific Material Safety Data Sheets

http://msds.chem.ox.ac.uk/ – information from the University of Oxford

Companies in the UK that extract salt from seawater:

http://www.cornishseasalt.co.uk/ – The Cornish Sea Salt Company

http://www.seasalt.co.uk/ – The Anglesey Sea Salt Company Limited (Halen Môn)

http://www.maldonsalt.co.uk/ – The Maldon Crystal Salt Company

Other related organisations:

http://www.saltsense.co.uk/ – The Salt Association

http://www.saltinstitute.org/ – The Salt Institute

http://www.eusalt.com/ – The European Salt Producers' Association

2 Testing for halides I

Learning outcome

LO1 Know the reagents and techniques used to analyse a variety of chemical compounds

Assessment criteria

P1 Identify the reagents needed to analyse inorganic chemicals

P2 Describe the techniques needed to analyse inorganic chemicals

M1 Describe the hazards associated with the reagents needed to analyse inorganic chemicals

D1 Explain how to avoid the risks associated with analysing inorganic chemicals

Planning and resources

This lesson will take at least two hours.

You will need the following resources:

- If a member, consult CLEAPSS Hazcards, Laboratory Handbook or similar materials safety data
- for class practical (per group): acidified silver nitrate solution, 0.1 mol dm^{-3} (IRRITANT); potassium chloride solution, potassium bromide solution, potassium iodide solution, each 0.1 mol dm^{-3}; three test tubes; test tube rack; Pasteur pipette
- eye protection for all
- Student Book pages 330−331
- Worksheet WS1 Risk assessment
- Help sheet A17.1 HS1.1
- Task sheet A17.1 TS1.1
- Task sheet A17.1 TS1.2
- Technician sheet 2

Setting the scene

Students will now carry out their own analyses of samples of halides, following a risk assessment. They will then begin to prepare their Lab Manuals for new technicians at the chemical analysis company.

Class activity

P1 P2 M1 D1

Before students begin to carry out their own testing of halides, discuss with them the importance of first producing a risk assessment. Remind them of the demonstration in the last lesson and work through the risk assessment procedure with them, identifying the specific hazards and the necessary precautions. Silver nitrate is hazardous. If you are a member, you could provide the students with a copy of the CLEAPSS Hazcard for silver nitrate (number 87) which will give details of its hazards. Note that students should not be given free access to CLEAPSS resources.

Students can fill in the first row of the table on **Worksheet WS1 Risk assessment**. This is in preparation not only for their practical work, but also for Part B of the Assignment, which will involve producing Hazard Cards for the new technicians at the chemical analysis company. (These will be started in the next lesson.)

Assignment activity

P1 P2

In this lesson students work on Tasks 1a and 1b of Part A of Assignment 17.1.

Students work in groups to carry out practical work, testing for halide ions. **Help sheet A17.1 HS1.1** gives the procedure. At this stage students should do **steps 1 to 6**. The precautions they have outlined on **Worksheet WS1 Risk assessment** should be taken.

Following the completion of steps 1 to 6, students should not discard the precipitates. They should be encouraged to discuss the reliability of conclusions that can be drawn. They may say, for example, that it is difficult to distinguish between the colour of the precipitates obtained from the bromide and iodide. They may mention difficulties when testing samples that are not colourless, or not completely colourless. They should note the points down for later reference.

- For Task 1a (P1), students need to identify the reagent needed to test for halides. They record this on **Task sheet A17.1 TS1.1**.
- For Task 1b (P2), students need to describe the technique used, in the form of a set of instructions for their Lab Manual, and provide their results as predicted outcomes of the tests. They can use **Task sheet A17.1 TS1.2**. The method can be simply written instructions (using **Help sheet A17.1 HS1.1** as a guide) or a combination of text and diagrams or photographs.

This work will comprise the first part of their Lab Manual, to be continued in Lessons 3–8.

Teacher guidance

Students should work independently on their Task sheets.

If there is time, students can continue with **steps 7 and 8** of the procedure, testing the precipitates with ammonia solution (see **Help sheet A17.1 HS1.1**). Otherwise, this can be done in the next lesson.

Delivering PLTS and functional skills

PLTS Reflective learners − communicating learning in relevant ways for different audiences

Effective participators − proposing practical ways forward, breaking these down into manageable steps

Self-managers − working towards goals, showing initiative, commitment and perseverance; organising time and resources, prioritising actions

Functional skills Writing − writing Lab Manual and Hazard Cards

Useful websites

http://www.fisher.co.uk/techzone/msds_material_safety_data_sheets.php – Fisher Scientific Material Safety Data Sheets

http://msds.chem.ox.ac.uk/ – chemical safety information from the University of Oxford

http://www.chemguide.co.uk/inorganic/group7/testing.html − the Chemguide webpage on testing for halides

P1
P2
(part)

Help Sheet 1.1

Testing for halides

You are going to carry out some tests on chemicals called halides – negative ions formed by Group 7 elements.

Read the procedure below carefully.

You need: test tubes, test tube rack, halide solutions for testing (potassium chloride, potassium bromide, potassium iodide), the reagent acidified silver nitrate solution, dilute ammonia solution.

Carry out a risk assessment before you begin and take necessary precautions. Use **Worksheet 1 Risk assessment** and have this checked by your teacher. Wear eye protection.

Procedure

1 Put 1 cm^3 of potassium chloride solution into a test tube.

2 Add 1 cm^3 of silver nitrate solution.

3 Observe and record the changes that take place in the test tube. You can use Table 1 on the next page to help.

4 Put 1 cm^3 of potassium bromide solution into another test tube. Repeat steps 2 and 3.

5 Put 1 cm^3 of potassium iodide solution into a third test tube. Repeat steps 2 and 3.

6 Leave the test tubes to stand in the light for 30 minutes. Record what happens.

You can use the first table on **Task Sheet 1.2** for your results.

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7 Now prepare fresh samples of each of the precipitates in the same way, in three clean test tubes. To each, add 1 to 2 cm^3 of dilute ammonia solution. Shake carefully. Record what happens. You can use Table 2 on the next page to help.

8 If nothing happens, your teacher will add a small volume of *concentrated* ammonia solution, in a fume cupboard. Record what happens when the test tube is shaken.

You can use the second table on **Task Sheet 1.2** for your results.

Help Sheet 1.1

Testing for halide ions (continued)

P1
P2
(part)

Chemical tests for halides

Table 1 Precipitates obtained with silver nitrate solution

Ion	**Colour of precipitate with silver nitrate solution**
chloride	white precipitate
bromide	cream precipitate
iodide	pale yellow precipitate

Table 2 Confirming the identity of the ion using ammonia solution

Precipitate	**Observation on the addition of ammonia solution**
silver chloride	precipitate dissolves in dilute ammonia solution
silver bromide	precipitate almost unchanged in dilute ammonia solution; precipitate dissolves in concentrated ammonia solution
silver iodide	precipitate is insoluble in dilute and in concentrated ammonia solution

Preparing for Assignment 17.1

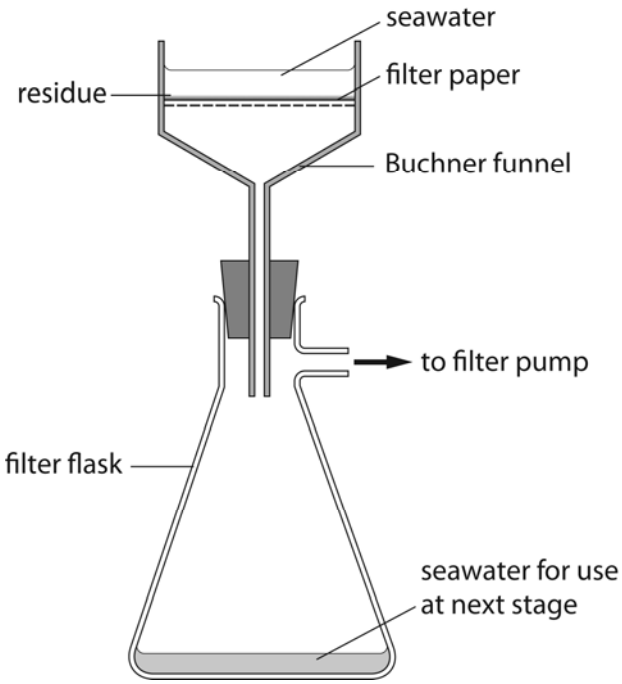
Worksheet 2

Evaporating seawater

Your teacher will take one litre (1 dm^3) of seawater and evaporate off the water in stages.

At each stage, as the water is reduced, chemicals may come out of solution as residue.

Your teacher will separate each residue from the remaining seawater by filtering the seawater using a Buchner funnel.



What you need to do

1 Using a spatula and a watch glass, collect a small amount of the chemical residue. Make sure to use a clean spatula and watch glass each time.

2 Redissolve about 0.5 cm^3 of each chemical residue in about 2 cm^3 of distilled water in a test tube.

3 Use the techniques that you have used in previous lessons (see **Help Sheets 1.1** to **1.4**) to analyse the samples. Try to identify the ions in each sample.

4 Place one drop of the sample solution on a clean microscope slide. Allow the water to evaporate. Observe the crystals produced, with the microscope on low power.