General Certificate of Education
Advanced Level Examination
June 2011

Chemistry CHM6X/TN

Unit 6X A2 Externally Marked Practical Assignment

Teachers' Notes Confidential

A copy should be given immediately to the teacher responsible for GCE Chemistry

Open on receipt

Teachers' Notes

Confidential

These notes must be read in conjunction with *Instructions for the Administration of the Externally Marked Practical Assignment: GCE Chemistry* published on the AQA Website.

It is the responsibility of the centre to ensure that the practical investigations work with the materials provided to the candidates. It is essential that the tasks are trialled **before** the candidates attempt them.

The investigation of a weed killer

This practical assessment is in two parts.

Task 1 involves a series of observation exercises.

Task 2 involves a titration of a solution of an iron(II) salt with potassium manganate(VII) solution.

Task 1

Materials

Each candidate should be provided with the following reagents in suitable closed containers.

Reagent solution	Approximate concentration / mol dm^{-3}	Volume / cm^3	Note
Chromium(III) sulfate solution	0.3	10	Labelled '**Chromium(III) sulfate**'
Ammonium iron(II) sulfate	0.2	10	Labelled '**Iron(II) sulfate**'
Ammonium iron(III) sulfate	0.2	10	Labelled '**Iron(III) sulfate**'

These solutions should be made up in water, no more than one day before the examination. If any solution forms a precipitate, just sufficient drops of dilute sulfuric acid should be added to produce a clear solution.

Candidates will also require access to the following reagents. An individual supply is not required.

Reagent solution	Approximate concentration / mol dm^{-3}	Volume / cm^3	Note
Ammonia	0.5	25	Labelled '**Ammonia**'
Sodium carbonate	0.5	5	Labelled '**Sodium carbonate**'
Potassium thiocyanate	0.2	5	Labelled '**Potassium thiocyanate**'
Potassium hexacyanoferrate(II)	0.2	5	Labelled '**Potassium hexacyanoferrate(II)**'

Apparatus

In addition to access to general laboratory equipment, each candidate needs

Number	Apparatus
12	test tube
7	dropping pipette
1	test tube rack
	a plentiful supply of purified water (either distilled or deionised)
	eye protection

Task 2

Materials

Each candidate should be provided with the following reagents in suitable closed containers.

Reagent	Concentration / mol dm^{-3}	Volume / cm^3	Note
Ammonium iron(II) sulfate	between 0.100 and 0.110	175	Labelled '**Weed killer solution for Task 2**' *See note below
Potassium manganate(VII)	between 0.0195 and 0.0205	200	Labelled '**Potassium manganate(VII)**'
Sulfuric acid	between 0.95 and 1.05 The concentration of this solution does not need to be accurately known.	75	Labelled '**Sulfuric acid**' Individual supply not required

* For maximum resistance to oxidation the centre should make up this solution of ammonium iron(II) sulfate for Task 2 in sulfuric acid, of approximate concentration 1 mol dm^{-3}.

Apparatus

In addition to access to general laboratory equipment, each candidate needs

Number	Apparatus
1	50 cm^3 burette and stand
1	funnel suitable for filling a burette
1	25 cm^3 pipette
1	pipette filler
1	250 cm^3 conical flask
1	measuring cylinder (25 cm^3 or 50 cm^3)
1	dropping pipette
	a plentiful supply of purified water (either distilled or deionised)
	eye protection

Turn over ▶

Reading the burette

In part 5 of Task 2 candidates are instructed to ask their teacher to check one of their final burette readings. If a candidate does not read the burette correctly the teacher must tell the candidate the correct reading. There is no penalty for an incorrect reading. The centre is not required to inform AQA of an incorrect reading.

Teacher Results

A teacher must carry out the tasks, using similar apparatus and samples of the same stock solutions/chemicals as the candidates, in order to obtain Teacher Results. This must **not** be done in the presence of candidates.

Teacher Results

- are required for both tasks
- are required for each group of candidates
- must be recorded on the Teacher Results Sheets
- are used to assess the accuracy of candidates' results
- must be included with the scripts sent to the examiner.

In order to ensure that each candidate can be matched to the appropriate Teacher Results, teachers must

- complete all details on each Teacher Results Sheet
- ensure that all candidates complete all details on the Candidate Results Sheets, clearly identifying their teaching group and/or teacher.

Managing the investigation

Centres with more than one teaching set

Centres may wish to divide their candidates into manageable groups and to conduct assessments at different times. This is acceptable provided that candidates in a later session are given an ammonium iron(II) sulfate solution for Task 2 whose concentration is slightly different from that given to candidates in the earlier sessions.

Candidates with unsatisfactory results or no results from the task

Candidates who have attempted the tasks must use their own results. A candidate absent for Task 1 or Task 2 should be given an opportunity to carry out the practical work before they sit the EMPA test. This may be with another group or at a different time. In exceptional circumstances, when such arrangements are not possible, the teacher may supply a candidate with data, such as the teacher's data. In this case candidates cannot be awarded marks for Task 1 and/or Task 2, but can still be awarded marks for the Written Test. The teacher must record the teacher's data on the Candidate Results Sheets for Task 1 and for Task 2, which must be given to the candidate at the start of the Written Test.

Candidates **must not** be given information about an EMPA assessment until one week before **Task 1**.

One week before **Task 1**, candidates should be given the following information.

The aim of **Task 1** is to complete a series of observation exercises. The results of these exercises will be used in the Written Test to confirm the identity of the cation present in a weed killer.

The aim of **Task 2** is to determine the concentration of iron(II) sulfate in a weed killer by titration of a solution of the weed killer with potassium manganate(VII).

The main areas of the specification in the Written Test include Section 3.4.3 (Acids and Bases), Section 3.5.3 (Redox Equilibria) and Section 3.5.4 (Transition metals).

There **must** be no further discussion and candidates **must not** be given any further resources to prepare for the assessment.

Teacher Results Sheet for Task 1 Centre Number | | | | | |

Teacher Name ..... Teacher Group.....

Results Record your observations in the table below.

Use a separate sample in each of the following tests.	**Observations with chromium(III) sulfate solution**	**Observations with iron(II) sulfate solution**	**Observations with iron(III) sulfate solution**
Test 1 Ammonia solution Place about 10 drops of the sample in a test tube. Add ammonia solution, dropwise with shaking, until in excess.			
Test 2 Sodium carbonate solution Place about 10 drops of the sample in a test tube. Add 10 drops of sodium carbonate solution and shake the mixture.			
Test 3 Potassium thiocyanate solution Place about 10 drops of the sample in a test tube. Add 10 drops of potassium thiocyanate solution and shake the mixture.			
Test 4 Potassium hexacyanoferrate(II) solution Place about 10 drops of the sample in a test tube. Add 10 drops of potassium hexacyanoferrate(II) solution and shake the mixture.			

This sheet may be photocopied

Teacher Results Sheet for Task 2

Centre Number | | | | | |

Teacher Name ..... Teacher Group .....

Results

Record your titration results in the table below.

Final burette reading / cm^3				
Initial burette reading / cm^3				
Volume of potassium manganate(VII) used / cm^3				
Tick the titres to be used in calculating the average titre				

Average titre / cm^3	

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use
Total Task 1

General Certificate of Education
Advanced Level Examination
June 2011

Chemistry CHM6X/PM1

Unit 6X A2 Externally Marked Practical Assignment

Task Sheet 1

To be completed before Task Sheet 2

For submission by 15 May 2011

For this paper you must have:
- a ruler
- a calculator.

The investigation of a weed killer

Some transition metal compounds are used to kill weeds in garden lawns. These transition metal compounds make the soil slightly acidic. Some weeds cannot tolerate the acidic conditions and therefore die. The grass is unaffected.

This practical assessment is in two parts.

The aim of Task 1 is to confirm that iron(II) ions are present in a weed killer by a series of observation exercises on solutions of some transition metal compounds. The results of these exercises, along with results for a solution of a weed killer published by the manufacturer, will be used in **Section A** of the Written Test.

The aim of Task 2 is to determine the concentration of iron(II) ions in the weed killer by titration of a solution of the weed killer with a 0.0200 mol dm^{-3} solution of potassium manganate(VII).

Task 1 Observation exercise

You are provided with solutions of chromium(III) sulfate, iron(II) sulfate and iron(III) sulfate.

Record your observations in a table of your own design on the Candidate Results Sheet for Task 1.

Where no visible change is observed, write 'no visible change'.

You are **not** required to identify any of the reaction products in this part of the task.

Wear eye protection at all times.
Assume that all of the solutions are toxic and corrosive.

Procedure

Test 1 Test with ammonia solution

Place about 10 drops of chromium(III) sulfate solution in a test tube.
Add ammonia solution, dropwise with shaking, until in excess.

Repeat this test replacing chromium(III) sulfate solution with
- iron(II) sulfate solution
- iron(III) sulfate solution.

Test 2 Test with sodium carbonate solution

Place about 10 drops of chromium(III) sulfate solution in a test tube.
Add 10 drops of sodium carbonate solution and shake the mixture.

Repeat this test replacing chromium(III) sulfate solution with
- iron(II) sulfate solution
- iron(III) sulfate solution.

Test 3 Test with potassium thiocyanate solution

Place about 10 drops of chromium(III) sulfate solution in a test tube.
Add 10 drops of potassium thiocyanate solution and shake the mixture.

Repeat this test replacing chromium(III) sulfate solution with
- iron(II) sulfate solution
- iron(III) sulfate solution.

Test 4 Test with potassium hexacyanoferrate(II) solution

Place about 10 drops of chromium(III) sulfate solution in a test tube.
Add 10 drops of potassium hexacyanoferrate(II) solution and shake the mixture.

Repeat this test replacing chromium(III) sulfate solution with
- iron(II) sulfate solution
- iron(III) sulfate solution.

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use
Total Task 2

General Certificate of Education
Advanced Level Examination
June 2011

Chemistry CHM6X/PM2

Unit 6X A2 Externally Marked Practical Assignment

Task Sheet 2

To be completed before the EMPA Written Test

For submission by 15 May 2011

For this paper you must have:
- a ruler
- a calculator.

The investigation of a weed killer

The aim of Task 2 is to determine the concentration of iron(II) ions in the weed killer by titration of a solution of the weed killer with a 0.0200 mol dm^{-3} solution of potassium manganate(VII).

Task 2 Titration

Wear eye protection at all times.
Assume that all of the solutions are toxic and corrosive.

Procedure

1 Rinse the burette with the potassium manganate(VII) solution provided. Set up the burette and use a funnel to fill it with the potassium manganate(VII) solution. Record the initial burette reading in a table of your own design on the Candidate Results Sheet for Task 2.

2 Use a pipette filler to rinse the pipette with the weed killer solution provided. Use this pipette to transfer 25.0 cm^3 of the weed killer solution to a 250 cm^3 conical flask.

3 Use a measuring cylinder to transfer approximately 10 cm^3 of dilute sulfuric acid to the conical flask.

4 Add the potassium manganate(VII) solution from the burette until the mixture in the conical flask just turns pink. Record your final burette reading in your table.

5 Rinse the conical flask with distilled or deionised water and repeat the titration until you obtain **two** concordant titres. You should do no more than five titrations.

Have one of your final burette readings checked by your teacher.

6 Calculate and record the average titre on the Candidate Results Sheet for Task 2. Indicate clearly the titres that you used in calculating this average titre.

You are not required to carry out any further calculations on the Candidate Results Sheet for Task 2. You will use your results to determine the concentration of iron(II) ions in the weed killer in **Section A** of the Written Test.

Centre Number						Candidate Number				
Surname						Other Names				

Notice to Candidate. The work you submit for assessment must be your own. If you copy from someone else or allow another candidate to copy from you, or if you cheat in any other way, you may be disqualified.

Candidate Declaration. I have read and understood the Notice to Candidate and can confirm that I have produced the attached work without assistance other than that which is acceptable under the scheme of assessment.

Candidate Signature		Date	

For Examiner's Use Total EMPA mark	
Examiner's Initials	
Section	Mark
Task 1	
Task 2	
Section A	
Section B	
Section C	
TOTAL EMPA MARK	

General Certificate of Education
Advanced Level Examination
June 2011

Chemistry CHM6X

Unit 6X A2 Externally Marked Practical Assignment

For submission by 15 May 2011

For this paper you must have:	**Time allowed**
• the Periodic Table/Data Sheet provided as an insert (enclosed) • your Task Sheets 1 and 2, including your own Candidate Results Sheets • a ruler with millimetre measurements • a calculator.	• 1 hour 20 minutes
Instructions • Use black ink or black ball-point pen. • Fill in the boxes at the top of this page. • Answer **all** questions. • You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages. • Do all rough work in this book. Cross through any work you do not want to be marked.	**Information** • The marks for questions are shown in brackets. • The maximum mark for this paper is 36. • You will be marked on your ability to: – organise information clearly – use scientific terminology accurately.

Details of additional assistance (if any). Did the candidate receive any help or information in the production of this work? If you answer yes give the details below or on a separate page.

Yes ☐ No ☐

Teacher Declaration:

I confirm that the candidate has met the requirements of the practical skills verification (PSV) in accordance with the instructions and criteria in section 3.8 of the specification.

Practical Skills Verification	**Yes** ☐

Signature of teacher ..... Date .....

Section A

These questions are about the task, the investigation of a weed killer.

You should use your Task Sheets 1 and 2, including your own Candidate Results Sheets, to answer them.

Answer **all** questions in the spaces provided.

1 The manufacturer of the weed killer published the following results when the tests used in Task 1 were repeated using a solution of the weed killer.

Test	Observations
Test 1 Ammonia solution Place about 10 drops of the sample in a test tube. Add ammonia solution, dropwise with shaking, until in excess.	Green precipitate formed. The precipitate was insoluble in excess ammonia solution.
Test 2 Sodium carbonate solution Place about 10 drops of the sample in a test tube. Add 10 drops of sodium carbonate solution and shake the mixture.	Green precipitate formed.
Test 3 Potassium thiocyanate solution Place about 10 drops of the sample in a test tube. Add 10 drops of potassium thiocyanate solution and shake the mixture.	Orange solution formed that turns red on standing.
Test 4 Potassium hexacyanoferrate(II) solution Place about 10 drops of the sample in a test tube. Add 10 drops of potassium hexacyanoferrate(II) solution and shake the mixture.	Pale blue precipitate formed.

Explain whether or not your observations from Task 1, and the manufacturer's results, allow you to confirm that iron(II) ions are present in the solution of the weed killer.

2 Describe a simple test to confirm that there are sulfate ions in the solution of the weed killer. State what you would observe.

3 Record the average titre from your Candidate Results Sheet for Task 2.

4 Half-equations for the redox reactions occurring in the reaction between iron(II) and potassium manganate(VII) in acidic solution are shown below.

$$Fe^{2+} \longrightarrow Fe^{3+} + e^-$$

$$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$$

Deduce an overall equation for the reaction between iron(II) and manganate(VII) ions in acidic solution.

5 The concentration of the potassium manganate(VII) used was 0.0200 mol dm^{-3}. Use your answers from Questions **3** and **4** to calculate the amount, in moles, of iron(II) ions in 25.0 cm^3 of the weed killer solution.

6 Use your answer from Question **5** to calculate the concentration, in mol dm^{-3}, of iron(II) ions in the weed killer solution.
Give your answer to the appropriate precision.

7 The weed killer solution was prepared by dissolving hydrated iron(II) sulfate, $FeSO_4.7H_2O$, in water.

7 (a) Use data from the Periodic Table to calculate the M_r of $FeSO_4.7H_2O$
Give your answer to one decimal place.

7 (b) Use your answers from Questions **6** and **7 (a)** to calculate the concentration, in g dm^{-3}, of hydrated iron(II) sulfate in the weed killer solution.

8 When iron(II) sulfate is used for killing weeds in lawns, it is often mixed with the fertiliser ammonium sulfate. Ammonium sulfate also makes the soil acidic.

8 (a) Write an equation to show how the ammonium ion behaves as a Brønsted–Lowry acid in water.

8 (b) Compounds such as ammonium sulfate react on warming with sodium hydroxide solution as shown in the equation below.

$$(NH_4)_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2NH_3 + 2H_2O$$

Use this information to describe a simple test, other than smell, to show that ammonia is evolved. State what you would observe.

9 The table below shows some standard electrode potentials.

	$E^{\ominus}$/V
$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$	+1.51
$Cl_2(g) + 2e^- \longrightarrow 2Cl^-(aq)$	+1.36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$	+1.33

A student determined the concentration of iron(II) ions in a solution of iron(II) chloride by titration with acidified potassium dichromate(VI) solution. A second student titrated the same solution of iron(II) chloride with acidified potassium manganate(VII) solution. By reference to the table, explain why the second student obtained a greater value for the concentration of iron(II) ions.

Section B

Answer **all** questions in the spaces provided.

Introduction

Iron(II) sulfate is used to kill weeds in garden lawns. It is a by-product of the manufacture of steel. When a lawn is treated with iron(II) sulfate, the iron(II) ions are oxidised to form iron(III) ions.

10 Iron(III) ions are acidic in aqueous solution as shown by the following equation.

$$[Fe(H_2O)_6]^{3+}(aq) \rightleftharpoons [Fe(H_2O)_5(OH)]^{2+}(aq) + H^+(aq)$$

In an experiment, a calibrated pH meter was used to measure the pH of an iron(III) salt in solution. At 20 °C the pH of a 0.100 mol dm^{-3} solution of iron(III) sulfate was found to be 1.62

10 (a) Explain briefly why a pH meter should be calibrated before use.

10 (b) Write an expression for the equilibrium constant, K_a, for the dissociation of iron(III) ions in aqueous solution.

10 (c) Use your answer from Question **10 (b)** to calculate the value of K_a for this reaction at 20 °C.
Give your answer to the appropriate precision. Show your working.

10 (d) Name the substance that is most likely to oxidise the iron(II) ions when iron(II) sulfate is used as a weed killer.

10 (e) Suggest a value for the pH of a 0.100 mol dm^{-3} solution of iron(II) sulfate.

11 Steel rods are cleaned before they are painted. The rods are cleaned by passing them through a bath of dilute sulfuric acid. This process produces large quantities of iron(II) sulfate.

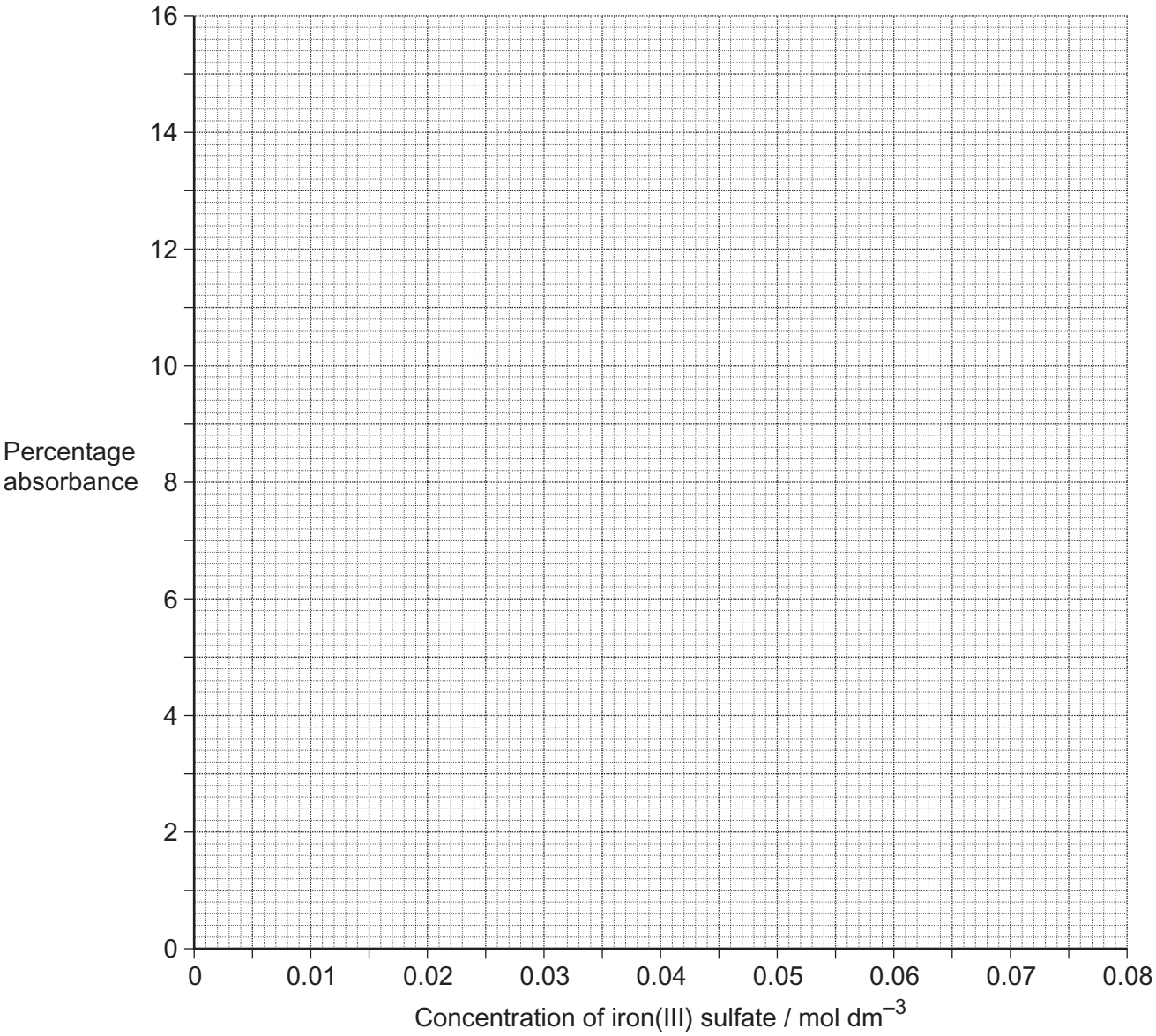
11 (a) Write an equation for the reaction between iron and dilute sulfuric acid.

11 (b) State **one** chemical hazard in this process and suggest an appropriate safety precaution for this hazard.

12 The concentration of iron(III) ions in a dilute solution can be determined by visible spectrometry. The absorption of light of a particular frequency by solutions of iron(III) sulfate of different concentrations was measured. The results are shown in the table below.

Percentage absorbance	Concentration of iron(III) sulfate / mol dm^{-3}
1.0	7.5×10^{-3}
2.5	14.0×10^{-3}
5.0	27.5×10^{-3}
7.0	37.5×10^{-3}
10.0	54.0×10^{-3}
12.0	65.0×10^{-3}

12 (a) Use these results to plot a graph of percentage absorbance (*y*-axis) against concentration of iron(III) sulfate on the grid opposite.
Draw a straight line of best fit.



12 (b) Use your graph to determine the concentration of an iron(III) sulfate solution that has a percentage absorbance of 14.0%.

12 (c) Use your observations from Task 1 to explain why it is an advantage to add thiocyanate ions to the iron(III) sulfate solution before measuring the percentage absorbance.

Section C

These questions test your understanding of the skills and techniques you have acquired during your A-level course.

Answer **all** questions in the spaces provided.

---

13 (a) State why it is necessary to maintain a constant temperature in an experiment to measure an equilibrium constant.

13 (b) Suggest **one** method for maintaining a constant temperature in an experiment.

14 Draw a diagram to show the apparatus you would use to filter a mixture under reduced pressure.
You are **not** required to show the pump that is used to reduce the pressure.

15 Samples of 1-chloropropane and ethanoyl chloride can be distinguished by the addition of an aqueous solution of silver nitrate.
State what you would observe with each sample.