

NATIONAL QUALIFICATIONS CURRICULUM SUPPORT

Chemistry

Researching Chemistry: Preparing a Scientific Communication

Student's Notes

[HIGHER]



The Scottish Qualifications Authority regularly reviews the arrangements for National Qualifications. Users of all NQ support materials, whether published by Learning and Teaching Scotland or others, are reminded that it is their responsibility to check that the support materials correspond to the requirements of the current arrangements.

Acknowledgement

Learning and Teaching Scotland gratefully acknowledges this contribution to the National Qualifications support programme for Chemistry.

© Learning and Teaching Scotland 2011

This resource may be reproduced in whole or in part for educational purposes by educational establishments in Scotland provided that no profit accrues at any stage.

Contents

Introduction	4
The golden rules of scientific writing	5
Activity: Improve the lab report!	8
Activity: Make a scientific report from a list of instructions	9
Which formats are used for science communication?	11
Activity: Evaluating different scientific communication formats	12
Activity: What have they got in common?	15
Activity: Which format is best?	16
Solutions	18
Appendix: Sample poster	22

Introduction

It is very important that scientists effectively communicate their work and results. There's no point in having a great scientific discovery and not telling anyone about it!

As part of the Researching Chemistry unit of Higher Chemistry you will be required to prepare a scientific communication about a practical investigation that you have carried out on a topical issue in chemistry.

The scientific communication can take any of the formats in which the results of scientific research are commonly reported, including:

- PowerPoint presentation
- conference poster
- video presentation/podcasts
- web page
- scientific paper
- traditional lab report, etc.

However, regardless of the format chosen, your scientific communication must contain the following essential features:

- a clear statement of the aim of your work
- an analysis of your results
- a valid evaluation of the procedures and results
- a valid conclusion based on the evidence in your results.

It can also be helpful (although not essential to pass the unit) to set the scene by including a summary of the background chemistry as part of an introduction, and a brief explanation of the procedure(s) used. These additional sections would usually appear between the aim and the results.

Aim of this resource

The aim of this resource is to help you to develop the skills required to prepare a scientific communication.

The golden rules of scientific writing

Good scientific writing includes all the normal conventions of good writing practice. However, there are some additional ‘golden rules’ that should be observed in scientific writing;

Write in the past tense and passive voice

‘Sodium chloride was added to the solution’ is correct whereas ‘Add sodium chloride to the solution’ or ‘I added the sodium chloride to the solution’ are both incorrect.

Try putting the following sentences into the past tense and passive voice:

- (i) I poured 5 ml of concentrated sulphuric acid into the flask.

- (ii) Record the volume of sodium hydroxide solution required to neutralise 25 ml acid.

- (iii) We then heated the reaction mixture gently using a water bath at 37°C.

THE GOLDEN RULES OF SCIENTIFIC WRITING

The name of an element or compound should not have a capital letter, except at the start of a sentence

Circle the correct word in the sentences below.

- (i) 5.1 g of powdered **Lead/lead** was added to **hydrochloric acid/Hydrochloric Acid**.
- (ii) **Tin/tin** has the symbol Sn.

Chemical symbols should be written exactly as they appear in the periodic table

For example, use 'Au' and not 'au'

The name of a technique should not have a capital letter, except at the start of a sentence

eg 'The distillation was set up to...' or 'An acid–base titration was carried out...'

Appropriate use of abbreviations

The expression should be written in full the first time it is used in the text, immediately followed by the abbreviation in brackets. The abbreviation should be used from then onwards, eg International Union for Pure and Applied Chemistry (IUPAC) should thereafter be referred to as IUPAC.

Use the correct scientific spellings for chemical words

For example IUPAC and the Royal Society of Chemistry (RSC) both adopted the spellings 'sulfur' and 'sulfuric acid' (instead of 'sulphur' and 'sulphuric acid') in the early 1990s.

Always use formal language

Colloquial (slang) language is never appropriate in scientific writing! Think of an appropriate formal phrase to replace each colloquial term in the table below.

Colloquial phrase	Formal phrase
A spatula of carbon was chucked into the beaker.	
Loads of tiny bubbles were given off.	
The solid looked kind of like a silver mirror.	
The rest of the stuff needed for the reaction was added to the conical flask.	

Scientific writing should be both concise and precise

Scientific writing should contain sufficient accurate, detailed information to allow the experiment to be repeated but without using redundant words or information.

Be consistent with units and names

Do not change between different units or names, eg use either ml *or* cm³. Do not use both in the same report.

Activity: Improve the lab report!

In a scientific communication, it is important that enough accurate, detailed information to allow the experiment to be repeated is presented. The style of the language used should be both formal and consistent.

Look at the following sentences taken from a third year student's lab report:

Pour 10 ml acidified Sodium Dichromate into a boiling tube. To this was added, some Ethanol and then the mixture was shaken gently. The mixture was then cooled by placing the boiling in a small beaker of cold water. Once the reaction had calmed down a bit, the mixture is gently warmed lending to formation of Ethanoic Acid.

Rewrite the student's lab report in the space below to bring it up to the standard required for a real scientific report. Check the golden rules of scientific writing to help you!

Activity: Make a scientific report from a list of instructions

Change the list of instructions below into scientific report format by converting to the past tense (as the experiment was carried out in the past by the time of writing) and passive voice, and joining the sentences up into a paragraph.

1. Using a measuring cylinder add 20 cm³ of dilute sulfuric acid to a beaker.
2. Add a spatulaful of magnesium or magnesium carbonate to the acid and stir the reaction mixture with a glass rod.
3. If all the solid reacts add another spatulaful of magnesium or magnesium carbonate and stir the mixture.
4. Continue adding the magnesium or magnesium carbonate until no more bubbles of gas are produced and some of the solid remains unreacted.
5. Place the filter funnel in the neck of the conical flask. Fold the filter paper and insert it in the funnel.
6. Carefully pour the reaction mixture into the filter paper.
7. When the filtration is complete, transfer the salt solution from the conical flask into the evaporating basin.
8. Place the evaporating basin on the tripod and carefully heat the salt solution until about half the water has boiled off.
9. Let the basin cool before transferring it to a safe place. Leave it until your next lesson to allow the solution to crystallise slowly.
10. Transfer the crystals onto a piece of filter paper to dry.

Which formats are used for science communication?

Scientists can use a number of different methods to communicate about their work. The most appropriate method will depend on the target audience and in how much detail the information needs to be shared. Commonly used scientific communication formats include:

- (a) Traditional lab report
 - a formal account of an experiment
 - contains enough detail to be used to repeat the experiment
 - can be used to evaluate the procedure and results of an experiment
 - written using the notes recorded in a lab book

- (b) Scientific report
 - summarises the contents of many lab reports
 - reviews some of the scientific literature in the topic
 - makes recommendations based on both the research results and the literature
 - related lab reports, diagrams and raw data may be attached as appendices

- (c) Scientific paper
 - a scientific report which is submitted to be an article in a scientific journal
 - 'peer-reviewed' by a respected scientist to evaluate the experiments, the results and the writing
 - the more high-quality scientific papers a scientist produces, the more respected the scientist!

- (d) Scientific poster
 - a large poster used to communicate research results at scientific conferences
 - a highly visual method of presentation
 - summarises key points briefly on a single page

WHICH FORMATS ARE USED FOR SCIENCE COMMUNICATION

(e) PowerPoint presentation

- used to share results at meetings and conferences
- visual, interactive form of communication
- slides contain minimal information
- information on slides is expanded upon orally

(f) Video presentation

- modern form of scientific communication
- visual and engaging
- means of interaction with wide audiences over the internet

(g) Podcasts

- short soundbites of information on websites
- modern form of scientific communication
- means of interacting with wide audiences over the internet

(h) Blogs

- short, regular 'diary'-like posts on a website
- allow scientists to 'drip-feed' information to a wide audience
- another modern form of scientific communication

Activity: Evaluating different scientific communication formats

In the past, scientists would almost always have produced a written report to communicate their research findings. Nowadays, they can choose to communicate in any one of a diverse range of communication media.

In pairs, examine and compare the four different resources listed below.

Note: It is not necessary to understand all of the chemistry content in the resources to undertake this activity. These resources can be evaluated with your current level of chemistry knowledge.

1. A video clip from the TV programme 'Brainiac', in which scientists investigate the reaction of thermite with liquid nitrogen.
See http://www.youtube.com/watch?v=Yex063_Fblk.

WHICH FORMATS ARE USED FOR SCIENCE COMMUNICATION

2. A scientific paper from an on-line chemistry journal which looks at the effect of antioxidants on heavy smokers.
See <http://www.journal.chemistrycentral.com/content/3/1/13>.
3. An article from *Highlights in Chemical Science* on recent advances in the Periodic Table.
http://www.rsc.org/Publishing/ChemScience/Volume/2010/11/Extended_elements.asp
4. A conference poster entitled 'Making Esters' (Appendix).

Once you have looked over the resources, answer the following questions:

- (a) Which one was most eye-catching?

- (b) Which one looks like it will be the easiest to read and understand?

- (c) Which one looks most credible and reliable?

- (d) Which one was most interesting?

WHICH FORMATS ARE USED FOR SCIENCE COMMUNICATION

(e) Which one was presented best?

(f) Which one gave the most information?

(g) Did you need to understand everything in the resource to gain a general understanding of the experiment?

Which format(s) would you prefer for your Researching Chemistry investigation?

WHICH FORMATS ARE USED FOR SCIENCE COMMUNICATION

Activity: What have they got in common?

Even though scientific communications can be presented in a variety of different ways, they all have a lot in common. Look over the four resources and complete the table below.

	Video clip	Scientific paper	Article	Conference poster
Is the objective of the experiment mentioned?				
Is there information on the procedures used in the experiment?				
Are the results data given?				
Is a conclusion given on the basis of the evidence of the experiment?				

All good scientific communications contain the same key sections:

- Title
- Aim/objective
- Background chemistry
- Experimental procedure
- Analysis of results and evaluation of procedures
- Conclusion

Make sure you include these key sections in *your* scientific communication.

WHICH FORMATS ARE USED FOR SCIENCE COMMUNICATION

Activity: Which format is best?

The format chosen for a scientific communication will depend largely on the target audience.

Choose the most appropriate form(s) of scientific communication for each of the situations in the table below.

Situation	Type of communication
You are a scientist working in the quality assurance lab of a pharmaceutical company. You are undertaking an experiment to analyse the purity of aspirin tablets and need to record the details so you don't forget what you did.	
You are a university professor who has just completed some highly significant, ground-breaking research that needs to be communicated to other experts in the scientific community.	
You are a scientific journalist working for a popular science magazine and want to provide your wide readership with short, regular news updates on the latest hot scientific topics.	
You are a scientist who is giving a one-off schools lecture called 'Fun Explosions in Chemistry'. You think that students who are not able to be in the live audience would also benefit from seeing these exciting experiments.	
You are a young researcher who needs an eye-catching visual method of communicating a summary of your results at an international conference.	
You are a scientist advising the government on global warming. You have reviewed a large number of articles on the subject and now need to collate and communicate your findings.	

WHICH FORMATS ARE USED FOR SCIENCE COMMUNICATION

<p>You are a product development scientist working for a large consumer goods company. You have been asked to present the results of your recent research work to the company director. You know he will want to ask lots of questions.</p>	
---	--

Solutions

The golden rules of scientific writing

Write in the past tense and passive voice

- (i) 5 ml concentrated sulphuric acid was poured into the flask.
- (ii) The volume of sodium hydroxide solution required to neutralise 25ml acid was recorded.
- (iii) The reaction mixture was heated gently using a water bath at 37°C.

The name of an element or compound should not have a capital letter, except at the start of a sentence

- (i) 5.1 g of powdered Lead/lead was added to hydrochloric acid/
Hydrochloric Acid.
- (ii) Tin/tin has the symbol Sn.

Always use formal language

Colloquial phrase	Formal phrase
A spatula of carbon was chucked into the beaker.	A spatula of carbon was added to/placed in the beaker.
Loads of tiny bubbles were given off.	A large number of tiny bubbles were given off. Vigorous effervescence was observed.
The solid formed on the side of the test-tube looked kind of like a silver mirror.	The solid formed on the side of the test tube resembled/had the appearance of a silver mirror.
The rest of the stuff needed for the reaction was added to the conical flask.	The remainder of the reactants/chemicals was added to the conical flask.

Activity: Improve the lab report!

Look at the following sentences taken from a third year student's lab report:

Pour 10 ml acidified Sodium Dichromate into a boiling tube. To this was added, 2 ml Ethanol and then the mixture was shaken gently. The mixture was then cooled by placing the boiling in a beaker of cold water. Once the reaction had calmed down a bit, the mixture is gently warmed leading to formation of Ethanoic Acid.

Rewrite the student's lab report in the space below to bring it up to the standard required for a real scientific report. Check the golden rules of scientific writing to help you!

10 ml acidified sodium dichromate was poured into a boiling tube. 2ml ethanol was added and the mixture was gently shaken. The mixture was then cooled by placing the boiling tube in a beaker of cold water. Once the reaction had subsided the mixture was gently warmed, leading to the formation of ethanoic acid.

Activity: Make a scientific report from a list of instructions

Please note that this is not the only correct answer. There will be many other variations that would all be acceptable. This is only provided as a specimen answer.

20 cm³ of diluted sulfuric acid was added to a beaker. To this was added a spatulaful of magnesium and the reaction was stirred with a glass rod. Addition of magnesium continued a spatulaful at a time until no more bubbles of gas were produced and some magnesium remained unreacted. The mixture was filtered. The filtrate was then transferred to an evaporating dish and heated on a tripod with a Bunsen burner until half of the water had evaporated. The heat was removed and the evaporating basin left to cool overnight, allowing the solution to crystallise slowly. The crystals were then transferred onto filter paper to examine with a hand lens and a drawing of one of these crystals was made.

SOLUTIONS

Activity: Which format is best?


The format chosen for a scientific communication will depend largely on the target audience.

Choose the most appropriate form(s) of scientific communication for each of the situations in the table below.

Situation	Type of communication
You are a scientist working in the quality assurance lab of a pharmaceutical company. You are undertaking an experiment to analyse the purity of aspirin tablets and need to record the details so you don't forget what you did.	Lab report
You are a university professor who has just completed some highly significant, ground-breaking research that needs to be communicated to other experts in the scientific community.	Scientific paper
You are a scientific journalist working for a popular science magazine and want to provide your wide readership with short, regular news updates on the latest hot scientific topics.	Blog
You are a scientist who is giving a one-off schools lecture entitled 'Fun Explosions in Chemistry'. You think that students who are not able to be in the live audience would also benefit from seeing these exciting experiments.	Video (on website)
You are a young researcher who needs an eye-catching visual method of communicating a summary of your results at an international conference.	Scientific poster

<p>You are a scientist advising the government on global warming. You have reviewed a large number of articles on the subject and now need to collate and communicate your findings.</p>	<p>Scientific report</p>
<p>You are a product development scientist working for a large consumer goods company. You have been asked to present the results of your recent research work to the company director. You know he will want to ask lots of questions.</p>	<p>PowerPoint presentation</p>

Sample poster



This poster was prepared by **Joe Bloggs**, a Higher Chemistry student at Any School, Scotland. For further information contact joe.bloggs@any.school.sc.nhs.uk

Making Esters


Higher Chemistry

Aim of the Research


to prepare the ester ethyl ethanoate by a condensation reaction between ethanoic acid (a carboxylic acid) and ethanol (an alcohol)

Introduction

Esters are organic compounds which are widely used in fragrances and flavourings because of their strong, characteristic smells.



The ester methyl salicylate is responsible for the distinctive smell of 'Germolene' antiseptic cream.

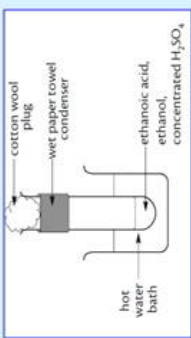


Background Chemistry

carboxylic acid + alcohol → *ester + water*

$$\begin{array}{c}
 \text{H} & & \text{H} & & \text{H} & & \text{H} \\
 | & & | & & | & & | \\
 \text{H}-\text{C}-\text{C}(=\text{O})-\text{O}-\text{H} & + & \text{H}-\text{C}-\text{H} & \xrightarrow{\text{concentrated H}_2\text{SO}_4} & \text{H}-\text{C}-\text{C}-\text{H} & + & \text{H}_2\text{O} \\
 | & & | & & | & & | \\
 \text{H} & & \text{H} & & \text{H} & & \text{H} \\
 \text{ethanoic acid} & & \text{ethanol} & & \text{ethyl ethanoate} & & \text{water}
 \end{array}$$

Procedure



- The reaction was catalysed with concentrated sulphuric acid.
- The wet paper towel condenser prevented chemicals boiling off.

Results

Two signs of a chemical reaction were observed during the procedure:

- (1) An oily layer formed on top of the mixture, as esters are immiscible in water.
- (2) A strong, distinctive smell was detected coming from the test-tube.

Conclusion

The ester ethyl ethanoate was successfully formed by the procedure described above.

Evaluation

- The procedure described above was effective in safely producing the ester ethyl ethanoate. The use of a hot water bath instead of a naked flame was essential, as several flammable chemicals are involved.
- The reaction occurred quickly because the rate was increased at the high temperature.