Our ref: AS/NQ/MAR06

27 March 2006

Directors of Education
Head of Centre
SQA Co-ordinator
Principal Teacher of Chemistry
Teacher with responsibility for Chemistry
Chemistry Lecturers

For the attention of all staff responsible for the delivery of National Qualifications in Chemistry

Action by Recipient	
	Response required
✓	Note and pass on
	None — update/information only

Contact Name: Andrew Shield at Glasgow
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Dear Colleague,

National Qualifications Update — Chemistry

This letter is intended to provide centres with information on developments in National Qualifications in Chemistry.

Introduction

I would like to take this opportunity to introduce myself and make contact with you as Qualifications Manager for Chemistry. As you may be aware Mary Hoey joined HMIE last year and the portfolios within National Qualifications were reshuffled, and Chemistry was added to my existing remit of Physics and Engineering. I would also like to take this opportunity to welcome Lynn McMillan, Qualifications Officer, who joined me before Christmas.

Communication between SQA and practitioners is a high priority and in addition to these update letters I can be contacted in a number of ways: through e-mail using the address above, via the direct phone number above and also via the e-mail link on the Chemistry or Physics pages of SQA's website (**www.sqa.org.uk**).

Principal Assessor reports

The Principal Assessor (PA) reports for the 2005 diet of examinations are available on the NQ Chemistry subject-specific page of SQA's website.

The PA reports contain statistical information on candidate entries, grade boundaries and comments on candidate performance, highlighting areas where candidates performed well and areas in which candidates had difficulty.

It is recommended that centres download these as they contain a wealth of information that can be used to inform learning and teaching.

Senior Moderator reports

The Senior Moderator reports for 2005 will be posted on SQA's website early in 2006. The Senior Moderator reports include general information on the moderation events and specific issues identified for the following areas:

- Standard Grade Chemistry Practical Assessment
- NQ Access 3 — Advanced Higher Unit Assessment
- Advanced Higher Chemistry Investigation Unit Assessment

It is recommended that centres download these as they contain a wealth of information on internal assessment issues.

Marking instructions

The detailed marking instructions for Chemistry (Standard Grade, Intermediate 1, Intermediate 2, Higher and Advanced Higher) for the 2005 examinations are available on SQA's website.

Electronic marking of objective tests

SQA adopted electronic marking of objective test sections of examinations in 2005 and this practice will continue in 2006. Candidates will be issued with an answer sheet that contains their pre-printed personalised details. **However, as from 2006, candidates will be required to complete the answer sheet using an HB pencil**. If a candidate wishes to make a change to an answer they must do so by using an eraser. Posters will be distributed to centres informing them of this change so that, prior to sitting the examination, candidates will be familiar with the new procedure for completion of their answer sheet.

Moderation

Retrospective moderation of the Advanced Higher Chemistry Investigation took place in August 2005. A number of centres were selected and required to submit evidence for the Unit assessment of the Chemistry Investigation.

There were improvements in the standard of evidence provided by centres this year, however the issues highlighted last year continue to be issues for a number of centres this year.

In the 'daybooks' from some centres, very little evidence of planning was identified. One purpose of the investigation is to help promote good scientific practice and as such the 'daybook' should form a proper, working scientific document of all the work undertaken by the student.

Centres are reminded that this **must** include the relevant planning, such as:

- the aim/purpose of the investigation
- the rationale behind why particular methods have been chosen or why ideas have been rejected
- notes on the design/selection of experimental methods
- notes on research undertaken
- contributions made by others

For Outcome 2 the record of work **must** include both the results taken **and** the analysis of these results.

Centres are reminded that 'evidence submitted for moderation must include all of the evidence that you use to determine that each candidate included in the moderation sample has achieved this Unit. For each candidate the evidence must cover both outcomes of the Unit.'

There still appears to be a misunderstanding in some centres about the function that the 'daybook' or record of work forms the assessment for the Unit and that the Unit requirements are not simply a continuation of the function of the 'daybook' for CSYS Chemistry. The evidence for the NAB **must** be marked by the responsible teacher/lecturer and internal moderation is desirable, if resources permit. Successful centres adopted a strategy of either marking on the 'daybook' when Performance Criterion had been passed or using the pro forma provided in the NAB.

A large number of the issues identified could easily have been avoided if candidates had been issued with, or made use of the Candidate's Guide on pages 22–24 of the NAB.

When starting Investigations candidates **must** be issued with the appropriate documentation:

- Advice to Candidates (pages 22–24, Chemistry Investigation D075 13/NAB001)
- Advanced Higher Chemistry Investigation Guidance (**www.sqa.org.uk**)

Centres should note that if they have candidates who have passed the Unit assessment for the Investigation but have not submitted an Investigation report for the external assessment, then the centre is likely to be selected for retrospective moderation.

Preparations are currently underway for central moderation at Easter.

If selected for NQ moderation, centres are reminded that they must submit both a NAB test and a complete Outcome 3 report, and that this report should be marked, either by annotating the actual report or by using the pro forma provided in NAB001 of each Unit. A summary of the Outcome 3 requirements for each level is contained in the appendices to this letter.

Professional Development Workshops

At the beginning of November 2005 the SQA ran a workshop detailing how Intermediate 1 and 2 Chemistry are marked and common issues and misconceptions that candidates display. This was aimed at helping practitioners understand the procedures and standards applied at this level. Approximately 60 Chemistry teachers from across Scotland attended the event and the workshops were very well received by the delegates.

A big vote of thanks goes to the Intermediate Chemistry team for their hard work and dedication in preparing and running the workshops and making the event such a success.

Planning is underway for a similar event in November of this year looking at Advanced Higher Chemistry, including the Investigations.

Access 3/Intermediate 1

I have received a number of enquiries relating to entries for Access 3/Intermediate 1 Chemistry. In particular what to do about pupils who have a number of Units passed at Intermediate 1 and a number of Units at Access 3, or what to do about a pupil who passes all Units at Intermediate 1 but then fails the exam.

Firstly queries regarding entries should normally be made through your SQA Co-ordinator to the Customer Accounts Manager (CAM).

If a candidate has been entered for the Intermediate 1 Course and Units and subsequently passes at least one of the Units at Access 3 level, the Course entry should be amended to Access 3 along with those Units achieved at Access 3. The entries for those Units they pass at Intermediate 1 should be left at that level, so that the candidate is credited with an Intermediate 1 pass for the Unit. The Outcome 3 reports for Intermediate 1 will cover the assessment requirements for Outcome 3 at Access 3. Deadlines for submissions of entries can be found in the Operational Guide, which can be accessed on SQA's website or from your SQA Co-ordinator.

In cases where a candidate passes all Units at Intermediate 1 and then fails the examination, the candidate will have the Unit passes on their certificate, but they are not automatically credited with an Access 3 Course award. In order for candidates to be automatically credited with a pass for the Access 3 cluster a dual entry should be made, on paper, for the Access 3 Course code only (C069 09).

Appeals

A number of issues continue to arise with appeals. The most common reason for appeals not being granted continues to be that the evidence submitted has incomplete course coverage, eg a prelim only covering two Units. For all Chemistry Courses, Standard Grade and Intermediate 1 through to Advanced Higher, there should be evidence from all the Course Units.

Centres are reminded that for an appeal for a grade C a **high scoring** NAB may be submitted as additional evidence, but this is not valid evidence to support an appeal at A or B.

Centres should also note that only the current years' commercial papers can be used in their entirety and there is an important caveat that centres must check the standard of these before using them. SQA does not validate commercially produced papers in any way. Unfortunately, once again, a significant number of centres did not follow the advice on use of commercial papers this year.

The specimen question papers on SQA's website and the appeals exemplification material are not suitable sources of evidence. Centres are referred to the SQA publication *Estimates, Absentees and External Assessment Appeals: guidance on evidence requirements April 2004*, which contains clear guidance on generating evidence.

Advanced Higher Chemistry Investigation Guidance

A revised Guide for Candidates has been produced and is included in the appendices to this letter. **The requirements for the Investigation report have not changed**, but it is hoped that candidates will find the new document easier to use. The revised guide will also be placed alongside the existing one, which will revert to being the Guide for Teachers/Lecturers, on SQA's website.

I hope you find the information in this letter helpful. If you require any clarification please do not hesitate to contact me.

Yours faithfully

Andy Shield
Qualifications Manager
Maths, Science & Languages Unit
Qualifications Directorate

Appendices

Appendix A: Chemistry Moderation Guidance for Centres
Appendix B: Advanced Higher Chemistry Investigation Guidance: Candidate Information

Appendix A

Chemistry Moderation: Guidance for Centres

If you have been selected for central moderation, you must include evidence of each of the
Outcomes for the unit selected for moderation for each candidate in the sample.

For units at Access 3, Int. 1, Int. 2, Higher and Advanced Higher you must include:

- a unit test for Outcomes 1 and 2, and
- one Outcome 3 report.

The evidence for each candidate should be clearly marked and annotated to support the decision made for that candidate. Where a candidate has taken more than one attempt at each test or report it is only necessary to submit the final version.

Centres should include a copy of the NAB test used together with a copy of the marking scheme used for each test, which may include additional acceptable answers agreed by centre staff as the result of internal moderation.

Outcome 3 Reports

For Access 3 to Higher level the Outcome 3 report **must be from a Unit 1 PPA** (prescribed practical activity) irrespective of the unit selected for moderation.

Completion Dates and Processing Results

Care should be taken in deciding on the completion date for each unit as a candidate cannot be resulted for a unit until all of the evidence for that unit has been assessed. Centres are reminded that they are required to have a completion date of the 31 March for at least one unit in each course. This means that the Outcome 3 report **must** be completed before this date.

Access 3 Chemistry

For Access 3 one of the following PPAs from Unit 1 (Chemistry in Action) must be submitted:

- The Effect of Temperature Changes on Dissolving Speed
- The Effect of Concentration Changes on Reaction Speed
- Testing the pH of Solutions.

These PPAs for Access 3 Chemistry are identical to those for Intermediate 1 Chemistry Unit 1 (Chemistry in Action).

Intermediate 1 Chemistry

For Intermediate 1 one of the following PPAs from Unit 1 (Chemistry in Action) must be submitted:

- The Effect of Temperature Changes on Dissolving Speed
- The Effect of Concentration Changes on Reaction Speed

- Testing the pH of Solutions.

Candidates may transfer evidence of Outcome 3 from Intermediate 2 Chemistry Unit 1 (Building Blocks) to Intermediate 1 Chemistry in respect of the PPAs:

- The Effect of Concentration Changes on Reaction Rate
- The Effect of Temperature Changes on Reaction Rate.

Intermediate 2 Chemistry

For Intermediate 2 Chemistry one of the following PPAs from Unit 1 (Building Blocks) must be submitted:

- The Effect of Concentration Changes on Reaction Rate
- The Effect of Temperature Changes on Reaction Rate
- Electrolysis.

Candidates may transfer evidence of Outcome 3 from Higher Chemistry Unit 1 (Energy Matters) to Intermediate 2 Chemistry in respect of PPAs:

- The Effect of Concentration Changes on Reaction Rate
- The Effect of Temperature Changes on Reaction Rate.

Higher Chemistry

For Higher Chemistry one of the following PPAs from Unit 1 (Energy Matters) must be submitted:

- The Effect of Concentration Changes on Reaction Rate
- The Effect of Temperature Changes on Reaction Rate
- Enthalpy of Combustion.

Advanced Higher Chemistry

The Outcome 3 report submitted for evidence can be on any one of the following PPAs:

Unit 1 (Electronic Structure and the Periodic Table)
- Preparation of Potassium Trioxalatoferrate(III)
- Colorimetric Determination of Manganese in Steel

Unit 2 (Principles of Chemical Reactions)
- Complexometric Determination of Nickel using EDTA
- Gravimetric Determination of Water in Hydrated Barium Chloride
- Determination of a Partition Coefficient
- Verification of a Thermodynamic Prediction
- Kinetics of the Acid-Catalysed Propanone/Iodine Reaction

Unit 3 (Organic Chemistry)
- Preparation of Cyclohexene
- Identification by Derivative Formation
- Preparation of Benzoic Acid by Hydrolysis of Ethyl Benzoate
- Preparation of Aspirin
- Aspirin Determination.

Advanced Higher Chemistry Investigation Guidance

Candidate Information

(a) Introduction

The Investigation is a piece of individual research undertaken to prove that you can

- research a chemistry topic by looking up textbooks, journals and using the worldwide web
- design and plan experiments
- carry out experiments safely and accurately
- evaluate procedures and results
- write a scientific report.

(b) Assessment

Your Investigation will be assessed both **externally** and **internally**.

- **External assessment**
  For external assessment purposes, you are required to write and submit to the SQA, a Report on your Investigation. A total of 25 marks (20% of the total marks) are allocated to the Investigation Report. Following the guidelines in this document should allow you to score a high mark in this part of the course.

- **Internal assessment**
  The Investigation is also treated as a Unit of the course and as such, is internally assessed using a NAB. The NAB has two Outcomes:
  Outcome 1: "Develop a plan for an Investigation"
  Outcome 2: "Collect and analyse information obtained from the Investigation".
  In order to provide satisfactory evidence of your achieving these Outcomes, you may be asked to submit a record of your Investigation and this will be in the form of a Daybook. Guidance on how to maintain your Daybook is provided in this document and in a separate candidate's guide for the NAB. Your daybook should be regularly checked by your teacher during the Investigation and collected from you, once you have completed the Investigation Report. Like any other NAB, you can either pass or fail and if you fail, you cannot receive the course award.

(c) Timescale

Right at the start of your Investigation, it is advisable to set up a **timescale** with start dates and deadlines for each phase of your Investigation, e.g.

Phase	Start Date	Tasks	Deadlines
Planning		Read this guide	
		Decide on which Investigation you are to carry out.	
		Show teacher daybook with aims and outline of experiments	
		Prepare a risk assessment for the experiments you intend to do and show your teacher the completed Risk Assessment form.	
		Check and organise that the apparatus and chemicals will be available for you to start your experimental work.	
Experimental		Complete the experimental work in the time allocated. Allow time to carry out duplicates.	
Report		Hand in First Draft	
		Hand in Final Report	

The three important stages in the Investigation are "Planning", "Experimental phase" and "Writing the Report".

(d) Planning your Investigation

The key to success in the Investigation is undoubtedly forward planning. There are two reasons for this:

- if sufficient time is invested and you follow the guidelines, then you will be able to perform the practical part of the Investigation in the recommended time allocated and writing the Report will be straightforward
- if you maintain your Daybook on a regular basis, then it should provide the necessary evidence to allow you to pass the Unit assessment, i.e. the NAB.

The steps in the planning stage of the Investigation are outlined below:

- Select an Investigation topic in consultation with your teacher.

- Start thinking about the background to the Investigation. You should make a list of questions in your daybook. You can find answers by; looking in books, searching on the web, or by speaking to teachers or other scientists. Take notes of any discussions etc in your daybook.

- In your daybook write down everything you have found out. Remember to include full references. References and bibliography entries must be written in standard form as follows. This will help you later when you are writing your report.

Books

Author(s), (surname followed by initials) (Year of publication) *Title*, Publisher, Place of publication, Page number(s).

eg Aldridge, S (1998) Magic Molecules: how drugs work, Cambridge University Press, Cambridge, p134.

Journals/Periodicals

Author(s), (surname followed by initials) (Year of publication) Title of article, *Name of Journal*, **Volume number** (Part number if appropriate), Page number(s).

eg Brown, TM, Cooksey, CJ and Dronsfield, AT (2001) Indigo – forever in blue jeans, *Education in Chemistry*, **38**(3), pp69-71.

Websites

You should give as many of the following items as **are available**: author, date, title, publisher, **date you accessed the material** (because the 'site' may be updated between the time you use it and the point at which a reader refers to it) and the URL.

eg PDR health Malic Acid. Visited: September 2005.
URL:
http://www.pdrhealth.com/drug_info/nmdrugprofiles/nutsupdrugs/mal_0292.shtml

- In your daybook you should write the broad aims of your investigation.

- Consider the direction you want the investigation to take. Always try to use more than one experimental method when carrying out your Investigation. For example, you should try to use two or more different methods such as volumetric analysis, gravimetric analysis, colorimetric analysis, electrolysis etc (not just two different types of volumetric analysis).

- Look carefully at the experimental details you have discovered in your research. Think about the purpose of each experiment and every piece of apparatus required. The methods you selected may not fit your proposed Investigation perfectly so think about any amendments you may wish to make.

- In your daybook write down theories behind the methods you have chosen as well as explanations of how these methods work. You need to consider how these meet the aims of your Investigation. You should include equations for any reactions as well as risk assessments for what you intend to do.

- It is advisable to write out a detailed day to day plan in your daybook. Your plan should list the chemicals and apparatus required each day (showing both the quantity and concentration of solutions) with step-by-step procedures written in enough detail so that another AH chemistry candidate could follow it.

- Don't be over ambitious. Remember some time will be lost assembling apparatus at the start and packing away at the end.

(e) Experimental phase

Practical work almost always takes longer than you anticipate. You should plan each day's work in advance and organise that all the equipment and chemicals you need are available for you.

Before each lab session

- You should have a clear plan written in your Daybook of exactly what you hope to achieve during the session.

During each lab session

- You should enter the date in your Daybook, followed by **all** measurements and observations you make. Your Daybook must contain a complete record of the work undertaken during each session in the lab.
- If you are uncertain about any procedure, ask a member of staff before continuing.
- The Daybook should be brought to every lab session.

After each lab session

In your Daybook

- you should analyse the results obtained during the lab session
- note down any conclusions or findings
- note down what you will do in your next practical session. This may be repeating what you have already done or making modifications as a result of what you have found out.

(f) Writing the Investigation Report

The Report on the Investigation must have a logical structure and must include the following sections:

- **Title page**
- **Contents page**
- **Summary**
- **Introduction**
- **Procedures**
- **Results**
- **Discussion**
- **References**

It may also include:

- **Acknowledgements**

The Report must be clear and concise and should be easy to read and understand.

The Report should be about 2000-2500 words in length excluding the title page, contents page, tables, graphs, diagrams, calculations, references, acknowledgements and any appendices.

The Report should be written in the past tense and the passive voice should be used.

While the Report may be word-processed, a handwritten Report is equally acceptable.

A total of 25 marks, representing 20% of the total marks for the course are awarded for the Investigation Report.

The Report is marked externally using the following categories:

1 Presentation (3 marks)
2 Introduction (4 marks)
3 Procedures (6 marks)
4 Results (5 marks)
5 Discussion (7 marks)

Title page

The title page must include an appropriate title for the Investigation, your name and candidate number and the name and number of the centre you attend.

Contents page

The contents page must list the sections within the Investigation along with their corresponding page numbers for the purposes of cross-referencing. It is essential that all pages throughout the Report are numbered.

Summary (or Abstract)

In the Summary, the main aims(s) **and** overall finding(s)/conclusion(s) of the Investigation must be stated. The Summary must be brief and although it is likely to be the final section you write, **it must immediately follow the contents page**.

Introduction

The purpose of the Introduction is to set the scene and to justify the chemical importance of the Investigation.

The Introduction must **also** include a clear statement of the aims of the Investigation despite the fact that you will have already stated these in the Summary.

This section must also include a concise account of the chemical theory underlying the procedures employed in the Investigation. Diagrams, structural formulae, balanced chemical equations, etc must be included as appropriate. This may include information covered at Higher or in the Advanced Higher course plus information from various references as appropriate.

To set the Investigation in context, background information must also be included and while the emphasis is on 'chemical' information, 'historical' information may also be given.

Procedures

This section must contain an account of the procedures/experiments carried out in the Investigation. The procedures must be clearly described and in sufficient detail to allow someone else to repeat the Investigation without reference to any other source.

It would be appropriate in this section to include labelled diagrams or labelled photographs of assembled apparatus.

In this section, it is essential that you demonstrate some original thought and that you have been involved in the planning of the Investigation and not simply followed a given set of instructions. For example, in the light of experience, you may have modified the procedures and these modifications must be described here.

In this section, you must also address such aspects as

- the need for controls and control of variables
- replicates and sample size.

For example, procedures must be carried out in duplicate where practicable. It should be noted that repeating titrations to obtain concordancy does not meet this criterion.

In describing procedures, you must demonstrate that the correct equipment has been used to give measurements of appropriate accuracy. For example, in a quantitative dilution of a standard solution, a standard flask must be seen to have been used rather than say, a measuring cylinder. In giving quantitative data within the introduction, you must quote these data to the correct number of decimal places appropriate to the equipment used. For example, if you use a balance reading to two decimal places, then masses must be quoted to two decimal places, e.g. 5·00 g and not 5 g.

The procedures should be presented as paragraphs of prose rather than a numbered list of procedural points. The **procedures must be written in the past tense and the passive voice must be used**, e.g.

'25·0 cm^3 of 0.105 mol l^{-1} sodium hydroxide solution was pipetted into a conical flask'

and **not**

'Pipette 25·0 cm^3 of 0.105 mol l^{-1} sodium hydroxide solution into a conical flask'

nor

'I pipetted 25·0 cm^3 of 0.105 mol l^{-1} sodium hydroxide solution into a conical flask'.

Results

How you write up your results depends on the type of Investigation you have chosen to do.

There are two types of Investigation – **quantitative** and **qualitative**. A quantitative Investigation is one in which you measure things, e.g. 'The determination of the vitamin C content of citrus fruits'. A qualitative Investigation is one in which you make or extract something, e.g. 'The preparation of paracetamol' or 'The extraction of caffeine from beverages'. 'Identifying an unknown chemical' is also an example of a qualitative Investigation.

Quantitative

In the Results section, you must provide all raw data as well as processed or derived data. Raw data are the readings you actually record in the course of the Investigation. For example, in titrations, **the raw data are the initial and final burette readings not the titre volumes**. The titre volumes are processed data.

Raw and processed data must be presented in a clear and concise manner with appropriate use of tables, graphs, diagrams and calculations.
Tables must have appropriate headings and units must be specified.
Graphs must be supported with tables of raw and/or processed data, i.e. a graph on its own is not sufficient – the data from which it has been derived must also be presented. In drawing a graph, you must ensure that

- scales are chosen so that the plotted points are widely spread
- each axis is labelled with the name of the quantity and the unit
- data are plotted accurately
- a best-fit straight line or curve is drawn – not 'join the dots'.

Where Excel or other software packages are used to present graphs, it is important that axes are adapted to suit the data in order that the results are presented in the most appropriate way.

Calculations must be clearly structured. Where the same type of calculation is repeated for different raw data, then only one sample calculation need be set out in detail but raw data, intermediate and final results (including the sample) must, of course, be presented in a table.

You must also take care with significant figures in presenting and processing data. In calculations, for example, it is appropriate that intermediate results carry one or two extra digits beyond the last significant one, but the raw data and final results must be quoted with the correct number of significant figures. For example, an initial burette reading must be quoted as 0·0 cm^3 or 3·0 cm^3 rather than 0 cm^3 or 3 cm^3.

Observations, e.g. indicator colour changes, precipitates forming, gases forming, colours of solutions or precipitates etc, must be recorded.

Qualitative

In the Results section, you must provide all raw data, e.g. chromatograms, spectra, initial and final masses, melting point etc.

All raw and processed results must be presented in a clear and concise manner using an appropriate format. For example, in analysing

- a chromatogram, you should record the raw data used to calculate R_f values as well as the R_f values themselves
- a spectrum, you should record the main absorptions

All observations, e.g. colour changes, crystal shapes, precipitates forming, gases forming, colours of solutions or precipitates etc., must be recorded using the most appropriate format.

Where appropriate, observations should be quantitative e.g. in preparing a chemical, a percentage yield calculation must be presented and be clearly structured.

In quantitative aspects of a qualitative Investigation, you must take care with significant figures. For example, an initial mass reading must be quoted as 25·20 g and not 25·2 g when a balance reading to two decimal places has been used.

NB How the sections on Procedures and Results are structured is entirely up to you, e.g. if the Investigation falls into two distinct parts then you may wish to describe the two procedures before going on to give the results of both parts. Alternatively you may wish to describe the first procedure and immediately follow this up with the results pertaining to that part before going on to the procedure and results of the second part.

Discussion

The Discussion section is arguably the most important part of the Investigation Report and in it you must discuss your findings in a critical and scientific manner. It provides you with the opportunity to show off your depth of chemical knowledge and understanding.

The Discussion section should begin with the conclusions of the Investigation. These conclusions must relate back to the aims of the Investigation given in the introduction and there must be a conclusion for each aim. The conclusions must be based solely on the results obtained and must be valid for these results.

The Discussion section must also include an evaluation of both the procedures and the results.

In the evaluation of the procedures you should address such points as:

- accuracy of measurements
- the main sources of error and how these were or could have been reduced
- control experiments
- precision of procedures i.e. how close were the results in repeat experiments
- modifications made or could have been made to improve the Investigation
- any procedures that were attempted but did not work.

In the evaluation of the results you must include

- a valid analysis and interpretation of your results
- discuss what effect the errors you identified had on the results.

When appropriate, you should also comment on the accuracy of your results e.g. how close
are your results to the accepted values.

You may also evaluate your results by carrying out uncertainty calculations.

Suggestions for further work may also be included in the Discussion section.

References

A reference is any piece of material to which a writer 'refers' in the text. More specifically, it is an entry at the end of the Report giving information about the source of the material 'referred to'. Such an entry allows the reader of the Report to consult the original work if necessary and is also an acknowledgement of the work of other authors.
There must be a minimum of three references and these should be listed in alphabetical order and must be written in standard form as follows:

Books

Author(s), (surname followed by initials) (Year of publication) *Title*, Publisher, Place of publication, Page number(s).

eg Aldridge, S (1998) *Magic Molecules: how drugs work*, Cambridge University Press, Cambridge, p134.

Journals/Periodicals

Author(s), (surname followed by initials) (Year of publication) Title of article, *Name of Journal*, **Volume number** (Part number if appropriate), Page number(s).

eg Brown, TM, Cooksey, CJ and Dronsfield, AT (2001) Indigo – forever in blue jeans, *Education in Chemistry*, **38**(3), pp69-71.

Websites

As many of the following items as are available should be given: author, date, title, publisher, date material was accessed (because the 'site' may be updated between the time the writer uses it and the point at which a reader refers to it) and the URL.

eg PDR health Malic Acid. Visited: September, 2005.
URL:
http://www.pdrhealth.com/drug_info/nmrdrugprofiles/nutsupdrugs/mal_0292.shtml

In addition to this list of references, each one must be cited in the main body of the text, i.e. in the Introduction, Procedures, Results and Discussion sections, using the author's surname and the year of publication as in the exemplars below:

> The reduced form of indigo is soluble and colourless while the oxidised form is insoluble and blue (Brown et al, 2001).
>
> Malic acid, also known as apple acid, hydroxybutanedioic acid and hydroxysuccinic acid, is a chiral molecule (PDRhealth.com).

Acknowledgements (Optional)

Any assistance you receive while carrying out the Investigation may be acknowledged in this section.