Advanced Higher Physics Investigation Guidance

Candidate Information

(a) Introduction

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

- research a physics topic from various sources which may include textbooks, journals and the worldwide web;
- design and plan experiments;
- carry out experiments safely and accurately to collect data;
- process and present the data, including uncertainties, in an appropriate format;
- evaluate procedures and results;
- produce a scientific report.

(b) Assessment

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

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

- **Internal assessment**
  The Investigation is 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
Performance criteria.
(a) A record is maintained in a regular manner.
(b) Experimental and observational techniques and apparatus are appropriate for the investigation.

Outcome 2: Collect and analyse information obtained from the investigation
Performance criteria.
(a) The collection of the experimental information is carried out with due accuracy.
(b) Relevant measurements and observations are recorded in an appropriate format.
(c) Recorded experimental information is analysed and presented in an appropriate format.
(d) Uncertainties are treated appropriately.

In order to provide satisfactory evidence of your achieving these Outcomes, you will be asked to submit a **Record** of your investigation. This may be in the form of a laboratory notebook, a loose leaf folder or any other suitable format.
Guidance on how to maintain your **Record** is provided in this document and in a separate candidates' guide in the NAB. Your **Record** should be regularly checked by your teacher during the investigation and collected from you, once you have completed the Investigation Report. **Like any unit assessment, you can either pass or fail and if you fail, you cannot receive the course award.**

(c) Timescale

The three important stages in the investigation are "Planning", "Experimental phase" and "Producing the Report".
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.
Timescale

Phase	**Start Date**	**Tasks**	**Deadlines**
Planning		Read this guide	
		Decide which topic you are going to investigate.	
		Show teacher your record with aims and outline of experiments.	
		Check that the apparatus will be available for you to start your experimental work.	
Experimental		Complete Experiment 1	
		Complete Experiment 2	
		Complete Experiment 3	
		Complete Experiment 4 (If applicable)	
Report		Hand in First Draft	
		Hand in Final 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 guidance, then you will be able to perform the practical part of the investigation in the recommended time allocation (10 – 15 hours) and producing the report will be straightforward;
- if you maintain your **Record** on a regular basis, then it should provide the necessary evidence to allow you to pass the unit assessment.

The steps in the planning stage of the investigation are outlined below.

- Select an investigation topic in consultation with your teacher.

- Research the background physics of your topic. You can look in books, search on the web, or speak to teachers and other scientists. Make notes of any useful information; remember to include full references. This will help you later when you write your report.

  The format of the references should be such that the information can be easily retrieved.

  Books

  You should give the author, title, edition and page numbers

  e.g

  Tom Duncan, A Textbook for Advanced Level Students, 2nd Edition, Pages 228 - 229.

  Websites

  You should give the full URL of the actual page which contains the information and not simply the homepage of the website. Include the date you accessed the material.

  e.g.

  http://en.wikipedia.org/wiki/Young's_modulus - accessed on 10/12/2006.

- In your **Record** you should include the broad aims of your investigation.

- List the experiments you plan to carry out. Check with your teacher that they are at the appropriate level and that suitable equipment is available. Include comments on any ideas that are rejected.

- Check apparatus will be available when you require 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.

Before each lab session

- You should plan each day's work in advance and organise that all the equipment you need is available for you.

During each lab session

- Your **Record** should be brought to every lab session.
- You should enter the date in your **Record**.
- Record **all** measurements (repeated where appropriate) and observations you make.
- Tables of data must have suitable headings and units.
- Graphs plotted while data is being collected will allow the identification of rogue points.
- An account of the experimental procedures, with any modification, will be useful when producing your final report.
- If you are uncertain about any procedure, take advice from a member of staff.

After each lab session

In your **Record**, you should:

- analyse the data collected during the lab session;
- ensure graphs have a line or curve of best fit with suitable scales. Axes should be labelled with quantities and units;
- include appropriate treatment of uncertainties;
- note any conclusions or findings;
- note the next step(s) in your investigation. You may wish to amend your plan in the light of what you have found out.

Investigation Report

Guidance on Course Assessment

General

For course assessment you are required to write an Investigation Report based on your work on the Advanced Higher Physics Investigation Unit. The Investigation Report is worth 25 marks and this is 20% of the total marks for the course award in Advanced Higher Physics.

Your report:

- must be clear, concise and easy to read;
- can be word processed;
- can contain tables and graphs produced by spreadsheet software. If you decide to use IT then it is your responsibility to make sure that you make appropriate use of these powerful tools.

The structure of your report should be based on the following categories.

- **Title page** - this page should have the title of your investigation, your name and Scottish Candidate Number and the name and number of your centre.

- **Contents page** - the contents page must list the sections within the investigation, along with their corresponding page numbers for the purpose of cross referencing. It is essential that all pages throughout the report are numbered.

- **Introduction** – this should be at the beginning of your report and should be divided into sub-sections entitled 'Summary' and 'Underlying Physics'.

- **Procedures** – a description of your apparatus and how you used it to obtain your data.

- **Results** – include all the measurements taken and show, perhaps by sample calculation, how they were analysed to produce a final result**.** Treatment of uncertainties should be shown in this section.

- **Discussion** – this divides into three parts**.**
  Conclusion and evaluation of each individual experiment.
  Overall conclusion to reflect the aim of the investigation.
  Evaluation of the investigation as a whole.

  References – Again, list these in a format that can be easily checked.

  Books - Author, title, edition, page numbers
  e.g
  Tom Duncan, A Textbook for Advanced Level Students, 2nd Edition, pages 228 - 229.

  Websites
  You should give the full URL of the actual page which contains the information an not simply the homepage of the website. Include the date you accessed the material.
  e.g.
  http://en.wikipedia.org/wiki/Young's_modulus - accessed on 10/12/2006

NB
Depending on the structure of the investigation it may be appropriate to group the background physics, procedures, results and individual evaluations of each experiment together, before proceeding to the overall conclusion and evaluation of the investigation.

Your report should be around 2000–2500 words, excluding the title and contents pages, tables, figures, graphs, diagrams, references, acknowledgements and any appendices. Please note that you will not lose marks simply because the number of words in your report is outwith the range indicated above; the quality of what you write will determine the number of marks you are awarded. However, you should note that a report which has significantly fewer that 2000 words may not include all of the necessary information, or sufficient detail to gain a high mark. Similarly a report which contains significantly more than 2500 words may lack clarity, be difficult to understand, include irrelevant information etc.

Assessment

A marker appointed by SQA will assess your report using the following assessment categories and mark allocations:

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

Advice on each of these assessment categories is included below.

1 Introduction (4 marks)

The introduction to your report must include a summary of your investigation in which you give a clear statement of the **purpose(s)** and/or aims of your investigation together with your **overall findings**. **This summary must immediately follow the contents page.**

(1 or 0)

You must also include an account of the underlying physics. Simply stating equations is not sufficient. You must demonstrate an understanding of the physics behind these equations.

You might draw on a variety of sources of information when you are researching your chosen topic. In your account of the underlying physics, terms must be used accurately and ideas must be explained clearly. You should also include diagrams and relationships, as appropriate.

(3, 2, 1 or 0)

2 Procedures (6 marks)

You must include **labelled diagrams and/or descriptions** of the apparatus that you used for experimental work. Photographs of assembled apparatus, **with appropriate labelling**, are acceptable.

(2, 1 or 0)

You must also give clear descriptions of **how you used** the apparatus to obtain your experimental results. You must give **sufficient detail** to allow your investigation to be repeated by another person.

(2, 1 or 0)

Please note that the experimental procedures that you use in your investigation must be at an **appropriate level of demand** for Advanced Higher Physics; factors that will be considered in assessing the adequacy of your procedures will include:

- range of procedures;
- control of variables;
- accuracy;
- originality of approach and/or experimental techniques;
- degree of sophistication of experimental design and/or equipment.

(2, 1 or 0)

3 Results (6 marks)

The experimental data that you collect must be relevant to the purpose(s) of your investigation. Also, the data you collect and present in your report must be **sufficient in quantity** and with a **degree of accuracy appropriate to your investigation**.

(1 or 0)

You must include **uncertainties** in the values of each of the physical quantities that you measure and in the final result(s) of your investigation. Your analysis should show clearly how you have calculated/estimated the uncertainty in your final result(s). Your treatment of uncertainties must be appropriate for Advanced Higher level and so your report must include evidence that relates to the Content Statements for uncertainties detailed in the Advanced Higher Physics course. You must quantify all **(calibration, reading and random)** uncertainties that have a bearing on the accuracy of your experimental work.

(3, 2, 1 or 0)

Your report must include **analysis of your experimental data** that is appropriate to your investigation. This may involve drawing graphs or calculating and tabulating numerical values.

(2, 1 or 0)

4 Discussion (6 marks)

You must include overall **conclusion(s)** that are relevant to the purpose(s) of your investigation and which are **valid** for the experimental results obtained.

(1 or 0)

You must also include a **critical evaluation of each experiment**. It is often appropriate to include this after the procedures and results of each experiment. This should be a significant part of your report and should focus on the quality of your experimental work. Issues that you could consider in this part of your report include:

- accuracy of your experimental measurements;
- adequacy of repeated readings;
- adequacy of range over which variables are altered
- how well you controlled variables;
- limitations of the equipment that you used;
- reliability of your experimental methods;
- sources of errors and uncertainties.

(3, 2, 1 or 0)

Finally, you must include a discussion of your overall conclusions together with a **critical evaluation of your investigation as a whole.** This should be a more wide ranging discussion of your investigation. It is an opportunity to explain what you have learned as a result of your investigation and the significance of your findings. You could also demonstrate the depth of your understanding of the physics related to your investigation. This part of your report could include comment on:

- problems that you experienced and how you dealt with these;
- modifications that you made to procedures in the light of findings;
- the significance of your findings;
- interpretation of your results in the context of the underlying physics, and/or in a wider context;
- suggestions for further improvements to experimental procedures;
- suggestions for further investigative work – for example identification of issues that you would have pursued further, if you had had more time available.

(2, 1 or 0)

5 Presentation (3 marks)

Your report must include a **title** page, a **table of contents** page and the pages of your report **must be numbered**.

(1 or 0)

Your report must be **clear**, **concise** and **easy to read and understand**. The sequence and development of ideas must be **logical** and there must be **sufficient detail** to allow the investigation to be repeated.

(1 or 0)

References must be **sufficient** in quantity, **relevant** to your investigation and **specific**. **References must be cited within the text of your report.** In many cases these will occur in the "Underlying Physics" section. At the end of your report, you must include details on all of the references (e.g. books, journals/periodicals and websites) that you cite. You must include sufficient information to allow a reader to consult the original work to confirm its relevance to your investigation. You should only include details on references; do not include information on materials that were part of your background reading but are not cited as references in your report.

(1 or 0)

AH Physics Investigation – summary of assessment scheme for the course report

Assessment category and assessment criteria	Marks
Introduction	
• Summary stating the purpose(s) and overall findings of the Investigation.	**1**
• Account of the underlying physics that is: - relevant to the Investigation; - complete; - of an appropriate level (i.e. commensurate with the demands of AH Physics); - not a simple repetition of course work.	**3**
Procedures	
• Labelled diagrams and/or descriptions of apparatus, as appropriate.	**2**
• Clear descriptions of how the apparatus was used to obtain experimental readings.	**2**
• Appropriate level of demand; factors to be considered include: - range of procedures; - control of variables; - accuracy; - originality of approach and/or experimental techniques; - degree of sophistication of experimental design and/or equipment.	**2**
Results	
• Data sufficient and relevant to the purpose of the Investigation.	**1**
• Uncertainties in individual and final results.	**3**
• Appropriate analysis of data, e.g. graphs, calculations.	**2**
Discussion	
• Conclusion(s) relevant to the purpose(s) of the Investigation;	**1**
• Evaluation of experimental procedures to include, as appropriate, comment on: - accuracy of experimental measurements; - adequacy of repeated readings; - adequacy of range over which variables are altered; - adequacy of control of variables; - limitations of equipment; - reliability of methods; - sources of errors and uncertainties.	**3**
• Coherent discussion of overall conclusion(s) and critical evaluation of the Investigation **as a whole** to include, as appropriate, comment on: - problems overcome; - modifications to procedures; - significance/interpretation of findings; - suggestions for further improvements to procedures; - suggestions for further work.	**2**
Presentation - the report must include a title, table of contents and pages must be numbered; - the report must be clear, concise and readable; - the sequence and development of ideas must be logical; - there must be sufficient detail to allow the Investigation to be repeated; - the length of the text should be around 2000-2500 words, excluding tables, figures, graphs; - references must be sufficient, relevant and specific.	**3**
Total marks	**25**