External Assessment Report 2009

Subject	Physics
Level	Advanced Higher

The statistics used in this report are pre-appeal.

This report provides information on the performance of candidates which it is hoped will be useful to teachers/lecturers in their preparation of candidates for future examinations. It is intended to be constructive and informative and to promote better understanding. It would be helpful to read this report in conjunction with the published question papers and marking instructions for the Examination.

Number of Candidates

- 2003 1374
- 2004 1391
- 2005 1401
- 2006 1422
- 2007 1370
- 2008 1396
- 2009 1525

AH Physics seems to be reversing a trend in the UK with an increase in numbers taking the subject.
Credit must go to the Physics teaching staff who run these classes, quite often with a reduced time allocation.

Comments on candidate performance

General comments

Examination

The paper was seen as fair with the vast majority of candidates making a good attempt at the paper.
There was no evidence of lack of time.
Excellent performances in the grade A questions indicated a strong cohort.

Investigation

The mean mark increased from 13.8 to 14.4. The message is getting through to most centres in relation to the standards expected in a report.

Areas in which candidates performed well

Examination

1(a)(i),(ii), (b)(ii) Good start to the paper

2(a)(i) Although a show question with all detail required, this was done well.

(b)(ii) Although there were slip ups in part(i) with *I*, candidates did realise that 3 arms and the cylinder should be taken into account.

2(c) Again previous mistakes not penalised and most were confident using $T = I \tilde{\square}$

4(c)(i),(ii) Although problem solving both these were tackled very well.

5(a) Show question plus use of standard equation – good response.

8(a),(c) Little difficulty with these parts.

Areas which candidates found demanding

1(b)(iii) Many candidates did not state that the total energy will be zero i.e $E_p + E_k = 0$

2(b)(i) Many took the wrong equation for the *I*. Equations in Booklet.
(d) Many recognised an increase in *I*, but then continued incorrectly with a conservation of

angular momentum explanation

3(c)(ii) Bell shape graphs were often given – still careless labelling of graphs.

4(a)(ii) Difficulty here in giving the correct explanation**-** very few gave answer in terms of test charge – they felt it was good enough to state that the charges were opposite. Would perhaps have had a better response if candidates had been directed towards using a diagram.

5(c) Many attained 0.07m but forgot that this is the radius and it must be doubled to hit B.

6(a)(iii) Too many forgetting to mention collapsing magnetic field or large rate of change of fall of magnetic field.

6(b)(i), (ii),(iii))
Disappointing the number who fell down on these questions, considering it is recommended as an outcome 3 experiment.

6(c) No mention was made of capacitive and inductive reactance in the explanation.

7(a)(i) Many started this question incorrectly **-** lack of knowledge of the equation. Unit ½ mark was often dropped.

(b)(i) No real feel for the situation – some had the electron flying off.

8(b) Definitions are clearly stated in the learning outcomes – most candidates had no knowledge of this.

9(a)(i) Looking for the idea of amplitude dividing on reflection and transmission/ refraction at the first surface.

9(b)(i), Many mixed up phase changes at the surfaces.

(ii) Confusion over opd and condition for max and min interference. Blooming of lens formula often quoted.

(iii) Candidates need a better understanding of this area.

10(a) Many students appreciated that the wave was reflected off the plunger, but few described the standing wave as being produced by interference.

Advice to centres for preparation of future candidates

Examination

- For questions where the numerical answer is given or the derivation of a formula is required, the candidate must show understanding **by demonstrating all the required steps**. This should also include the values of any physical constants.

- Care should be taken in substituting values into an equation involving a power. Too often the power is omitted.

- Definitions should be committed to memory – with understanding.

- The escape velocity should achieve the condition that $\boldsymbol{E_p + E_k = 0}$

- More practice required in sketching field patterns. Lines must touch and be at 90^o to the surface of a conductor. **Use a ruler when required.**

- In electric field problems, remember to include the sign of the charge.

- In some questions, there are 1/2 marks allocated for selecting the correct data.

- Remember to point out to candidates that moments of inertia and other information is on the page that follows the main equations in the Data Booklet.

- Care should be taken over labelling graphs – **origin, quantities, units**.

- The mass of an alpha particle is given in the data page – **this is not the same as the mass of 2 protons and 2 neutrons added together.**

- Know that the path of a charged particle in a magnetic field is dependent on the size of the charge and the mass of the particle – realise which has the greatest effect.

- **Worryingly, candidates had little experience of finding the relationship between the current and the frequency in an inductive circuit – a possible outcome 3 experiment.**
  Too many did not know the purpose of the voltmeter and did not realise they had to plot *I* vs 1/*f* to obtain the relationship.
  Many also quoted the relationship as being as *I* increases *f* decreases.

- Knowledge of capacitive and inductive reactance is a requirement at AH.

- $L = nh/2$ is not fully understood by candidates – care should also be taken with unit.

- Quantum Physics not the same as Quantum Mechanics.

- Care required over the understanding of interference by division of amplitude with regard to soap films.

Investigation

2009AH Physics Investigation **Average Mark per category**

Category		**Max Mark**	**Average Score**
Introduction	Summary	1	0.7
	***Underlying Physics**	**3**	**1.3**
Procedure	Diagrams	2	1.3
	Description	2	1.3
	***Level of Demand**	2	1.1
Results	Data	1	0.9
	***Uncertainties**	**3**	**1.3**
	Analysis	2	1.1
Discussion	Conclusion	1	0.8
	***Evaluation procedures**	**3**	**1.3**
	***Investigation as a whole**	**2**	**0.8**
Presentation	Title	1	1.0
	Clarity	1	0.9
	References	1	0.6
Mean Mark			**14.4**

Areas in which candidates performed well

Introduction
Summary: Improvement in purpose and findings at the beginning of the report.

Procedures
Diagrams: Better use of **labelled** photographs to detail equipment used.

Results
Uncertainties: Improvement in use of calibration, reading, random uncertainties and their combination – still a bit to go for many candidates.

Analysis: Spreadsheet use increasing, good use of LINEST function to calculate the uncertainty in the gradient of a straight line.

Presentation
The majority of candidates gained two marks for the first two areas,

Areas which candidates found demanding

Investigation Report See page 8 for advice

Introduction
Underlying Physics – very few candidates scored full marks – justification of formulae required. Where possible candidate should use their own language to describe / explain the theory. They should not just copy verbatim from textbooks / websites. This is an area where quality is rewarded.

Procedures
Diagrams - care should be taken to label photographs and include normal diagrams for clarity. Some diagrams were poorly drawn using the Word drawing package.

Descriptions - should be clear and to the point.

Level of demand – there should be three to four experiments attempted and not just coursework.

Results – **all** data should be recorded in the report.

Uncertainties - significant figures are a problem, inappropriate averaging used (see later)
Acceptable to use software to find the uncertainty in the gradient of a line.
Uncertainties booklet available on:
http://www.ltscotland.org.uk/resources/u/nqresource_tcm4229401.asp

Analysis - there has been an increase in the use of spreadsheet packages to produce graphs. Although improving, there are still some issues with size, zero not shown, scaling, grid lines too small or missing. Some software packages can show dot to dot lines if not used properly.

Discussion
Evaluation of experimental procedures – lack of reference to and discussion of uncertainties quoted in the experiment.

Evaluation of discussion as a **whole** – students still find this difficult. Further work, frustrations, physics points, modifications, lost time, etc.
(Quality areas)

Presentation -
References - cross referencing often omitted.

Advice to centres for preparation of future candidates

Investigation

- Guidance for both candidates and teachers / lecturers can be accessed through www.sqa.org.uk
  Each candidate should be given a copy of the Guidance to Candidates document.
  Included in the Guidance to Teachers/Lecturers is the markers' form AH6 which will allow staff to allocate marks for particular sections. This will assist candidates to improve the early draft of their report. Too many candidates fail to gain what should be "accessible marks" due to not having followed the advice.
- Some centres had duplicate investigations (results different) despite having a small number of candidates.
- It is important not to just hand out old projects / investigations for viewing or triggering ideas, without ensuring their collection afterwards. It is better to use brief accounts of possible investigations so the students can research / plan these using appropriate references.
- Markers commented that several investigations involved carrying out only one or two experiments – the majority of these investigations attained a very low mark.
  The investigation should comprise of **3 to 4** related experiments – only in exceptional circumstances will 1 or 2 be sufficient to cover the recommended time of 10 – 15 hours experimental work.
- Investigations that carried out the same procedures several times tended to score low marks e.g finding Young's modulus for 5 different materials using the same approach.

Use of University Facilities

It is pleasing to see schools using university support where possible. This not only gives the students experience of working in another environment, but also creates an opportunity for the universities to demonstrate the facilities available.

However, it must be said that if using these facilities for an investigation, this should not be seen as quick fix so that the investigation can be completed with one or two afternoons of lab work.

The high scoring "university investigations" are clearly well planned and have either introductory experiments done in school or a more specialised experiment attempted at university to round off the investigation.

There was some evidence of universities treating the students' visits as a lab afternoon with technicians on hand to aid the students. Some experiments had tenuous links which highlighted poor planning.

Investigation Unit Award

To pass the unit award, the teacher must be satisfied that the pupils have passed Outcomes 1 and 2.

Centres should ensure that evidence of Outcomes 1 and 2 is kept in an investigation **record**.

This **record** could well be required for verification.

Again refer to latest guidance for teachers / lecturers.

It is recommended that the following information on how the marking scheme is applied should be photocopied and distributed to the students.

Notes on Marking of Investigation		
No **half marks** are awarded throughout.		
Introduction		
Summary: purpose findings.	**Must** be at the beginning of the report, immediately following the content page. Findings were often omitted. Findings should be consistent with purpose e.g. comparison of different methods of measurement or stating numerical values with their uncertainties.	**(1,0)**
Underlying Physics:	**Not good enough to just give equations.** Physics behind the equations should be explained. Opportunity for markers to reward commensurate / good investigations. Physics explained should be relevant to experimental procedures.	**(3,2,1,0)**
Procedures		
Diagrams / descriptions	Generally well done. Increase in use of digital photographs. These must be clear and labelled. Apparatus / circuit diagrams should also accompany these.	**(2,1,0)**
Apparatus use	Should include a detailed account of how all measurements were taken. Description should be clear enough to allow replication of experimental work.	**(2,1,0)**
Level of demand	Centres should ensure that the investigation is at an appropriate level. Basic Outcome 3 experiments alone are unacceptable. One might be used as an introductory experiment. Minimum of 3 to 4 procedures required – **in exceptional cases** 1 or 2 can be acceptable provided 10 to 15 hours experimental work is carried out.	**(2,1,0)**
Results		
Data sufficient/relevant	Most candidates awarded a mark here. (Must show all readings taken – no short cuts to average).	**(1,0)**
Uncertainties	Candidates should quote, where appropriate, calibration, scale reading and random uncertainty for each measurement made and combine these appropriately. Candidates were penalised for inappropriate use of random uncertainty (e.g. applied to different methods of finding refractive index) and for not finding the uncertainty in the gradient of a straight line graph, where required. (It is sufficient to show one example of each type of calculation involving data and the combination of uncertainties).	**(3, 2,1,0)**
Analysis of data	Improvement in use of spreadsheet packages. Excel – use of LINEST good but care should be taken with size of points. Still some problems **- lack of grid lines** for graphs, size of graphs, origin omitted, error bars missing where appropriate. Spreadsheets packages may be used to establish the equation of a straight line plus the uncertainty in the gradient and intercept. **Lines should not be forced through the origin.**	**(2,1,0)**

Discussion Conclusion	**Must** relate to the purpose of the investigation. **(1,0)**
Evaluation of Procedures	Not specific / detailed enough. Sometimes better to break down into [1]assessment criteria where applicable. Sources of uncertainties ignored, no mention of limitations of equipment. Compare percentage uncertainties – comment on reduction of these. **Better at the end of each experiment**. **(3,2,1,0)**
Evaluation of Investigation	Candidates had difficulty with this section. Very little mention of modifications and further improvements in sufficient detail. Describe difficulties, frustrations with problems encountered. **Should be at the end of the report.** **(2,1,0)**
Presentation	Title, contents, page numbers **-** any one omitted **-** (0) **(1,0)** Readability **Write up experiments sequentially.** **(1,0)** References **-** must be cited in text **-** e.g. ref 1, ref 2, etc. Reference at back should not only list the book or website, but also the appropriate page number or date accessed so the marker can easily check on these. References for diagrams alone not sufficient. **(1,0)**

[1] See assessment criteria in **Guidance on Course Assessment for Candidates.**

Incorrect Application of Random Uncertainty

e.g. Finding **g** using a Pendulum

Varying the length l and measuring the period T of the pendulum.

Different values of g were calculated for each l and T.

A mean value of g was calculated with associated random uncertainty. **This is incorrect.**

Allowance for random uncertainty in the measurement of time is made when measurements are repeated for one value of length.

A better way of finding g is to plot a graph of T^2 against l and then calculate the gradient of the line.

Investigations frequently classed as non-commensurate with AH.

Output of a Solar Cell

Golf Ball **-** basic bouncing experiments, Standard Grade angle of launch.

Specific Heat Capacity **-** simple Standard Grade experiments with uncertainties included.

Efficiency of Electric Motor

Efficiency of a Transformer.

Investigations where no measurements were taken e.g. making a hologram, construction of an electronic device.

Impulse experiments.

(Those listed were Higher or Standard Grade level with no real attempt at extension work.)

Popular Investigations

Comparisons of different methods of measuring g.

Comparisons of different methods of measuring refractive index.

LCR circuits. Factors affecting Capacitance. Factors affecting Inductance.

Measurement of Magnetic Field Strength using a Hall probe.

Stretched Strings, Interference of Light.

e/m for an Electron, Young’s Modulus, Surface Tension, Viscosity, Focal Length of Lenses.

Speed of Sound – comparison of different methods.

Measurement of Planck’s Constant

Aerofoil lift.

Statistical information: update on Courses

Number of resulted entries in 2008	1403

Number of resulted entries in 2009	1550

Statistical information: Performance of candidates

Distribution of Course awards including grade boundaries

Distribution of Course awards	%	Cum. %	Number of candidates	Lowest mark
Maximum Mark - 125				
A	31.9%	31.9%	494	87
B	23.9%	55.8%	371	74
C	21.0%	76.8%	325	61
D	8.9%	85.7%	138	54
No award	14.3%	100.0%	222	-

General commentary on grade boundaries

- While SQA aims to set examinations and create marking instructions which will allow a competent candidate to score a minimum of 50% of the available marks (the notional C boundary) and a well prepared, very competent candidate to score at least 70% of the available marks (the notional A boundary), it is very challenging to get the standard on target every year, in every subject at every level.
- Each year SQA therefore holds a grade boundary meeting for each subject at each level where it brings together all the information available (statistical and judgemental). The Principal Assessor and SQA Qualifications Manager meet with the relevant SQA Business Manager and Statistician to discuss the evidence and make decisions. The meetings are chaired by members of the management team at SQA.
- The grade boundaries can be adjusted downwards if there is evidence that the exam is more challenging than usual, allowing the pass rate to be unaffected by this circumstance.
- The grade boundaries can be adjusted upwards if there is evidence that the exam is less challenging than usual, allowing the pass rate to be unaffected by this circumstance.
- Where standards are comparable to previous years, similar grade boundaries are maintained.
- An exam paper at a particular level in a subject in one year tends to have a marginally different set of grade boundaries from exam papers in that subject at that level in other years. This is because the particular questions, and the mix of questions are different. This is also the case for exams set in centres. If SQA has already altered a boundary in a particular year in say Higher Chemistry this does not mean that centres should necessarily alter boundaries in their prelim exam in Higher Chemistry. The two are not that closely related as they do not contain identical questions.
- SQA's main aim is to be fair to candidates across all subjects and all levels and maintain comparable standards across the years, even as arrangements evolve and change.