Physics Advanced Higher

External Assessment Report 2008

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.

Numbers

- 2003 1374
- 2004 1391
- 2005 1401
- 2006 1422
- 2007 1380
- 2008 1403

It is good to see last year's drop in numbers taking AH being reversed. This shows an overall increase despite a marked fall in Higher candidates since 2003. This is obviously a credit 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. One question worth 3 marks tended to throw most of the candidates – this was a grade A question. 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 13.1 to 13.8. The message is getting through to some centres in relation to standards expected in a report, but there are still many candidates who do not take on board simple advice given in the "Guidance to Candidates" document.

Areas in which candidates performed well

Examination

1(a)(i),(ii) Good grasp of circular motion equations.

7(a) (i) – (iii), (b)(i) No great difficulty here. Good response to inductor question.

8(c)(ii),(iii) Good attempts.

9(a)(i) Most recognised that there would be an increase in frequency.

10(a)(ii),(iii), (b) Good understanding of the question.

11(a),(c)(ii) Attempted well.

Investigation

Introduction
Summary: Improvement on 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.
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

Examination

1(b)(ii) There seemed to be a difficulty in recognising what provides the central force.

1(c) Many incorrectly gave an explanation in terms of the conservation of angular momentum or $T = I\alpha$.

2(a) In "show" questions many did not include sufficient steps to demonstrate their understanding.

3(a)(i) Should have been an easy mark. Too many candidates did not know the definition of SHM.
(e) Looking for the **amplitude** decreasing here**.**

4(a) Many candidates unable to state that interference /diffraction is a test for wave motion

4(b)(i) Poor understanding of the Bohr model.

5(a)(i) Many incorrect and poor diagrams here**.**
(ii) **Negative** potential was often omitted.
(b)(ii) Very poorly attempted – many used a right angled triangle in the treatment.

6(a)(ii) It is obvious that candidates are receiving little practice in **calculating** the uncertainty in the gradient of a straight line graph. This might be due to introduction of software that estimates the uncertainty.
(iii) Very few used the gradient found in part (i) but used values of F and I from the graph or table.
(b)(i) Poor attempts.

7(a)(iv) Often incorrect substitution with the emf across L being taken as positive.
(b)(iii) Should have mentioned that I remains constant. It is unacceptable to use the arrow notation to indicate increase or decrease in an explanation.
(c) Many incorrect shapes of graph.

8(a)(i) Care has to be taken to remember that the "r" should be squared in each formula.

9(b) Many recognised an increase in wavelength (frequency decrease) but failed to associate this with the star moving away.

11(c)(i) Many failed to recognise that there is a **percentage** uncertainty decrease in Δx.

Investigation Report See page 7 for advice

Introduction

Underlying Physics – This is an area where quality is rewarded.
Very few candidates scored full marks – justification of formulae required.

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 – in most cases there should be two to four experiments attempted.

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

Uncertainties - significant figures 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. Pasco 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

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.

Central force examples – more practice is required here. Many still cannot apply this idea to different situations.

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

Remember to add on the radius of the planet if given the height of a satellite in problems involving orbitals.

Definitions should be committed to memory – with understanding.

More practice required in sketching field patterns. Lines must touch and be at 90° to the surface of a conductor.

In electric potential problems remember to include the sign of the charge.
More practice required in problems involving 3 charged particles.

Candidates should be given the opportunity to calculate the uncertainty in the gradient or intercept of a graph using the formulae stated in the Data Booklet.

If one part of a question involves verifying the gradient of a graph, a derivation of an equation or a numerical answer, you can be sure that you will need it in the part(s) that follow.

In an inductance problem, if the final answer in the calculation of L or dI/dt is negative, then check the sign of the emf across L.

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

Be aware that the change in a parameter in an experiment can affect the **percentage** uncertainty of measured values.

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 "easy marks" due to not having followed the advice.

Some centres had duplicate investigations (results different) despite having a small number of candidates.

There is a fair chance that the Investigation Unit from these centres will be verified next session.

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, these should not be seen as quick fix so the investigation can be completed with one or two afternoon's 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 information 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. They can possibly be used as an initial experiment. Minimum of 3 to 4 procedures required – exception cases of 1 or 2 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 2007	1,380

Number of resulted entries in 2008	1,403

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	32.1%	32.1%	450	86
B	24.9%	57.0%	350	74
C	20.0%	77.0%	280	62
D	7.3%	84.3%	103	56
No award	15.7%	100.0%	220	-

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.