Course Report 2015

Subject	Physics
Level	Higher

The statistics used in this report have been compiled before the completion of any Post Results Services.

This report provides information on the performance of candidates which it is hoped will be useful to teachers, lecturers and assessors 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 assessment and marking instructions for the examination.

Section 1: Comments on the Assessment

Component 1: Question paper

The question paper contained some questions that were common to the 'traditional' exam paper and in the revised exam paper. These were used when setting the grade boundaries as bench mark questions.

Component 2: Assignment

The Assignment performed mainly in line with expectations. However, many candidates found it difficult to achieve the mark assigned to uncertainties and this was taken into account when setting the grade boundaries.

Section 2: Comments on candidate performance

Component 1: Question paper

Candidates coped particularly well with the aspects of the question paper that focused on calculations in both familiar and unfamiliar contexts. However, they had more difficulty with areas that required them to give reasoned explanations or where they were required to analyse situations. Although there were some very good responses to the two open-ended questions, the majority of responses were limited and some candidates didn't attempt them at all.

Component 2: Assignment

There were few very high or very low marks for the Assignment. However, candidates who appeared to have followed the advice in the Candidate's Guide managed to access the majority of marks available.

Section 3: Areas in which candidates performed well

Question paper

In the objective section of the paper candidates performed well in the following questions:

- Question 2 (applying equations of motion for uniform acceleration)
- Question 3 (components of weight of an object on a slope)
- Question 8 (applying the Doppler equation)
- Questions 12 (energy released in a nuclear reaction)
- Question 13 (interference and determining frequency)
- Question 14 (mean value and approximate random uncertainty in the mean)
- Question 17 (determining the frequency of a source using an oscilloscope).

In addition, there was reasonable performance in questions 5 (tension in a coupling); 7 (length contraction); 9 (evidence for neutrinos); 10 (rearranging equations); 16 (Bohr model and electron transitions) and 20 (using an unfamiliar equation).

In Section 2, candidates performed well in the following questions:

- Question 1 was a common question in all three Higher Physics papers, based on putting the shot, and designed to give candidates a straightforward lead in to this section of the paper.

- Question 1(a)(i)(A), (B) and (C) were all well done, with most candidates being able to select the release speed from the graph for the stated angle. They could also calculate the horizontal and vertical components of the initial velocity. Where candidates did not select the correct release speed, they could still calculate the components correctly for their chosen value, without further penalty.

- Question 4 was a common question between this Higher paper and the Revised Higher paper. Questions 4(b)(ii) and 4(b)(iii) were well done in that most candidates could show that the redshift was 0·098, starting with and appropriate relationship, inserting the correct data and then showing the answer. Candidates also did well in calculating the approximate distance to the distant galaxy.

- Question 8c was well done, with most candidates able to apply the inverse square law to calculate irradiance.

- Question 9 was common to all three Higher Physics papers. Parts (a)(ii) and 9(b)(i) were well done, with most candidates able to calculate the speed of red light in a glass prism and calculate slit separation on a grating.

- Question 10 (b) (i) was well done, with most candidates able to find the e.m.f. from the graph.

- Questions 11(a), (b) and (c)(i) Although set in what may be an unfamiliar context of a defribulator, most candidates had little difficulty in showing the charge on the capacitor was 0·16 C, calculating the maximum energy stored by the capacitor or calculating the effective resistance of a patient.

It is worth noting that the majority of questions in which candidates performed well were ones that involved **selecting appropriate relationships** and **carrying out calculations**.

Component 2: Assignment

Candidates scored most highly in the sections of the Assignment that required them to give the aim and to select data that was relevant and sufficient.

Section 4: Areas which candidates found demanding

Component 1: Question paper

In Section 1 of the paper candidates had difficulty with Questions 4 (forces on accelerating objects) and 18 (calculating a peak current from power and potential difference).

In Section 2 of the paper candidates found several questions difficult.

In Question 1(a)(ii)(A), candidates had difficulty calculating the total time between the shot being released and hitting the ground.

Very few candidates used a correct method to find the time taken for the shot to fall from its maximum height. The time for the shot to reach maximum height from the thrower's hand was given as 0·76 s. Many candidates simply doubled this time, showing a lack of understanding that the time to fall to the ground would be longer than 0·76 s.

Some started correctly with a relevant relationship (such as $s = ut + ½at^2$) but then made an error during substitution — for example, giving opposite signs to s and a.

In Question 2 (b) (iii) candidates had trouble producing the required graph. To gain all three marks the candidates had to have the correct velocities, time for the change in velocity and the curved shape of the graph.

Some candidates failed to take into account the direction associated with each velocity and made both values positive.

Many candidates did not include the time for the collision and instead showed an instantaneous change in velocity between 'before' and 'after'. Of those that did include the time for the collision, almost all ignored the fact that the force was not constant and showed a constant acceleration by joining the two velocities with a straight line instead of an appropriately shaped curve.

In Question 3 (b), many candidates did not appreciate that this part was simply an application of $W=mg$, using the force from part (a) and the mass.

Where candidates attempted to use $\boxed{g = \frac{GM}{r^2}}$

and neglected to add on the radius of Mars to the height above the surface for a second time, having made the same error in part (a), no further penalty was applied.

In Question 4 (a) candidates had difficulty telling the difference between emission and absorption spectra and in stating that the absorption took place in the outer layers of the Sun.

Few candidates appeared to know why dark lines appear in the visible spectrum of sunlight.

Those who knew about absorption of the energy did not say that it only occurs for certain frequencies — their answers simply said that 'the dark lines are because light is absorbed'

Many who did refer to certain frequencies of light being absorbed were vague about where and how this absorption occurs — some answers wrongly said ‘elements in the Sun’s core absorb the light’.

Some candidates said that the absorption occurs in space between the Sun and the Earth; others thought it occurs in the Earth’s atmosphere.

Question 5: This is the first of two open-ended questions in this year’s paper. It uses the context of a quote from a science fiction writer to provide opportunities for candidates to demonstrate their knowledge about the origins of the Universe and the Big Bang Theory.

An open-ended question allows candidates to answer the question in their own chosen way. Candidates should use the opportunity to show to the marker that they know which areas of Physics are relevant. They should also provide some discussion and/or analysis to demonstrate the depth of their understanding of that knowledge.

There is no ‘checklist’ that is used by markers to allocate marks to a particular answer. Each candidate’s answer is considered as a ‘whole’ and is awarded a mark depending on the level of understanding demonstrated. Zero marks are awarded if the answer demonstrates ‘no understanding’ of relevant Physics. The answer receives one mark if it shows ‘limited understanding’, two marks for ‘reasonable understanding’ and three marks for ‘good understanding’.

While there were some good and what may be termed excellent responses from candidates, most candidates who attempted the question demonstrated little or no understanding of this part of the course. Many candidates repeated the same point several times over. This was not gaining them any marks and was potentially wasting time that they could have used for other answers.

In Question 6 (b) (ii) few candidates showed an understanding of orders of magnitude. It was clear that many candidates did not understand what was meant by ‘order of magnitude’, despite this being mandatory content. There were many answers that simply said ‘the mass of the Higgs boson is greater than the mass of a proton’. A number of candidates could work out the ratio of the masses but then could not relate this to the difference in their order of magnitude. Answers of 130 or 100 were fairly common, but only 14% of candidates were then able to state that the mass of the Higgs boson was two orders of magnitude greater.

Question 7: This is the second of the two open-ended questions in this year’s paper. It uses the context of a coconut shy to provide opportunities for candidates to demonstrate their knowledge about the photoelectric effect.

An open-ended question allows candidates to answer the question in their own chosen way. Candidates should use the opportunity to show to the marker that they know which areas of Physics are relevant. They should also provide some discussion and/or analysis to demonstrate the depth of their understanding of that knowledge.

There is no ‘checklist’ that is used by markers to allocate marks to a particular answer. Each candidate’s answer is considered as a ‘whole’ and is awarded a mark depending on the level of understanding demonstrated. Zero marks are awarded if the answer demonstrates ‘no understanding' of relevant Physics. The answer receives one mark if it shows 'limited understanding', two marks for 'reasonable understanding' and three marks for 'good understanding'.

Specific areas of weakness in the answers from candidates were:

A significant proportion of candidates wrote a lot about the photoelectric effect but did not make many comments on the coconut shy analogy as the question had asked them to do. This was obviously a weakness in their answers.

Again, some candidates repeated the same point several times over.

In Question 8 (d) candidates had difficulty suggesting a **suitable** improvement to the experimental procedure. Many candidates seem to be using a stock answer of 'repeat the experiment more times' instead of considering the individual situation and suggesting an improvement to the experimental set up given.

In Question 8 (e) very few candidates realised that a small lamp would act as a point source and therefore the light would radiate as a sphere. Approximately half of the candidates who attempted this question could select the correct irradiance formula but did not then go on to find the area of the sphere of light. Centres are reminded that there is an additional relationships sheet which includes such formulae as the area of a sphere.

In Question 9 a number of candidates confused refraction and diffraction throughout the question.

Parts (a)(ii) and (b)(i) were well done [they were both calculations], but the responses to parts (a)(i) and (b(ii) were poor.

Specific areas of weakness in the answers from candidates were:

Part (a)(i): (Explain why a spectrum is produced when a ray of white light enters a glass prism.) Very few candidates were able to explain that the refractive index depends on the frequency of the incident light.

A significant number of candidates tried to explain the spectrum by saying that it is due to diffraction occurring in the prism.

Part (b)(ii): (Explain why the angle to the second order maximum is different for blue light than for red light.)

Some candidates' answers said that this is due to differing amounts of refraction for red and blue light — this is obviously incorrect physics.

Many candidates said that this is due to '*red light diffracting more than blue light*'. This is not a correct physics explanation. At the slits on the grating red and blue light are both diffracted so much that they are then effectively semicircular waves which overlap and interfere on the right hand side of the grating. The different colours have different wavelengths and so they meet in phase at different positions (because path difference must equal $n\lambda$ for constructive interference). Hence the blue and red maxima are seen at different places on the screen.

In Question 10 (b)(iii)(A) few candidates realised that the potential differences had to be subtracted, as well as the two resistances being added, before the current was calculated.

In Question 10(b)(iii)(B) very few candidates could explain why the charging current decreases. Many candidates gave an answer relating to the charging of capacitors.

In Question 11 (c) (ii) few candidates could state that the potential difference across a capacitor decreases as it discharges.

In Question 11(c)(iii) Many candidates either started with the same initial charging current or made the time to discharge the same.

In Question 12 (e) the same situation occurred as in Question 8 (d), with many candidates using a stock answer of 'repeat the experiment more times' or 'take more measurements' without being specific about 'close to the minimum' , instead of considering the individual situation and suggesting improvements to the experimental procedure given.

It was disappointing to see that a number of candidates made no attempt at either open-ended question.

Component 2: Assignment

There were a number of areas of the Assignment in which candidates performed poorly.

In the underlying physics section, many candidates gave little or even no physics that was at Higher level or equivalent. Many gave only underlying physics from the National 5 or even National 4 courses.

Many candidates found it difficult to gain the mark for the uncertainties. In some cases, this was due to candidates not including all the reading uncertainties. For example, where a metre stick was used to measure a distance, many candidates did not give the reading uncertainty in the distance. Some candidates included random uncertainties but did not include a sample calculation to show how these had been arrived at (it should be noted it is not necessary to show a calculation for every random uncertainty in a set of results — one sample one is sufficient). Many candidates made errors in these calculations.

In the analysis section few candidates are making any attempt to interpret their data. For example, few candidates are calculating constants (if appropriate) or attempting to relate their uncertainties to their findings.

Some candidates are failing to gain the conclusion mark, either because: their aim was overly complex and the conclusion did not address all aspects of the aim; or the conclusion was not actually supported by the data in the report.

Some candidates struggled with the evaluation section of their report and there was some evidence that candidates and/or centres had assumed that the criteria being applied were the same as National 5, with candidates saying why one source was reliable (often incorrectly) and another was relevant (relevance of data is covered in the selecting information criteria).

Some candidates lost marks carelessly in the presentation category. ‘Higher Assignment’ is not an appropriate title for the Assignment report; the title should reflect what is being investigated eg Detection of Exoplanets, Skin Cancer — Prevention and Cure, etc. Others lost marks by not having the references listed at the end of the report or not giving sufficient detail in the references.

Section 5: Advice to centres for preparation of future candidates

Question paper

- Candidates should be encouraged to think about the specific circumstance and make an appropriate response in light of this when they are asked to suggest an improvement to an experimental procedure.

- Candidates should be clear on the difference between refraction and diffraction, and when to use each term.

- Centres should ensure that candidates understand what is meant by ‘orders of magnitude’.

- Candidates need to have a clear understanding of how to deal with potential differences in electric circuits.

- Candidates need to have a clear understanding of the difference between absorption and emission spectra.

- Candidates should be given sufficient opportunities to practise answering open-ended questions.

- Centres are reminded that, although containing half-marks, the Revised Higher Past Papers are a very useful resource for candidates to practise the types of questions they will encounter in new Higher Physics, including open-ended questions, skills based questions and questions on the content that was different from the traditional Higher.

Assignment

- Candidates should be given guidance on the use and calculation of uncertainties. They should also be given guidance on how to interpret their data in light of their uncertainties.

- When analysing their data, candidates should be encouraged to consider what information can be extracted from their findings. For example, the calculation of a constant if appropriate, how uncertainties have influenced their processed data, or a discussion of any systematic uncertainties in their processed data.

- When carrying out the evaluation of their investigation, centres should make candidates aware that the three marks available are for three distinct evaluative comments. For example, it is not sufficient to gain three marks to state that three internet sources are reliable because they are government websites.

- Candidates should be made aware that the final item in their report (excluding any clearly labelled appendices) should be their references.

- Candidates should be encouraged to differentiate between raw data and processed data. Candidates should present all of their raw data in the report and then show how it has been processed.

- Candidates should be encouraged to follow the advice given in the Candidate's Guide.

Statistical information: update on Courses

Number of resulted entries in 2014	0

Number of resulted entries in 2015	3662

Statistical information: Performance of candidates

Distribution of Course awards including grade boundaries

Distribution of Course awards	%	Cum. %	Number of candidates	Lowest mark
Maximum Mark - 120				
A	23.5%	23.5%	862	77
B	24.7%	48.3%	905	65
C	21.7%	69.9%	793	54
D	9.1%	79.0%	334	48
No award	21.0%	-	768	-

For this Course, the intention was to set an assessment with grade boundaries at the notional values of 50% for a Grade C and 70% for a Grade A. A 2 mark adjustment was made for the assignment as it was agreed that there was a general insufficiency in support and the uncertanties mark for Physics was almost non-functioning.

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.