Physics 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.

Comments on candidate performance

General comments

Markers commented that a small proportion of candidates were very poorly prepared for the examination and received very low marks. However, the majority of candidates made good attempts and a small proportion showed an excellent grasp of Physics at Higher.

Despite the Physics Data Booklet being available to candidates during the examination, markers reported that there were still a significant number of examples of candidates attempting to use inappropriate or wrong formulae.

As in previous years it was found that questions requiring candidates to perform calculations were generally answered well. However, candidates are still performing more poorly in questions requiring written descriptions and explanations.

There were more examples this year of candidates who numbered their answers incorrectly or in an unclear way. There were also more examples of candidates writing two, mutually incompatible answers to the same part of a question.

Areas in which candidates performed well

The multiple choice section of the paper was found to be fairly straightforward by most candidates, with questions 1, 2, 4, 12, 15, 16, 18 and 20 being answered particularly well.

Question 21 – Part (a) was well answered by many candidates. The selection and use of an appropriate equation of motion was carried out well by most. However, a significant number of candidates transposed the values of initial and final velocities when substituting into the equation and failed to realise that the acceleration must be negative in this calculation.

Question 22 – Part (a)(i) required the candidate to calculate the component of weight down the slope. This was answered better than were similar questions in the 2006 and 2007 Higher Physics examinations. However, there were still many candidates who could not quote or derive the appropriate formula needed to carry out this calculation.

Question 23 – The Gas laws calculation in part (a)(i) was well answered by many candidates. A sizeable minority of candidates, however, failed to change the temperature values to Kelvin. A few candidates started their answer by writing ‘pressure x temperature = constant’. This mistake is surprising given the availability of the Physics Data Booklet.
Part (b)(i) was very well answered – the vast majority of candidates being able to quote the density formula, substitute and calculate the mass correctly.

Question 24 – Parts (a)(i) and (ii) were well answered – candidates showing a good ability to analyse the circuit diagram and apply Ohm’s law appropriately.

Question 25 – Parts (b)(i) and (ii) were well answered – most candidates showing a good ability to use information from a circuit diagram and graphs of potential difference and current against time.

Question 26 – In part (a), most candidates carried out a correct calculation to find the unknown resistance in the balanced Wheatstone bridge. However, a surprisingly large number did not then go on to use this value of resistance to quote any value of irradiance from the graph. Of those who did, a significant proportion made an error in using the scale of the graph.

Question 27 – In part (a)(i), most candidates were able to substitute into Snell's law and calculate the angle of refraction in the glass for the ray of red light.
Part (ii) was also well done, although a significant number of candidates inappropriately rounded an intermediate answer in this double calculation.

Question 28 – In part (a), most candidates were able to use the formula I = P/A to calculate the irradiance. However, a significant minority attempted to use $I = k/d^2$ to answer this question.

Question 30 – A high proportion of candidates were able to gain full marks in part (b) in which they were required to carry out calculations using absorbed dose, equivalent dose and equivalent dose rate.

Areas which candidates found demanding

In the multiple-choice section of the examination, the most poorly answered question was number 17, which was correctly answered by just over half of the candidates.

Question 21 – In part (a), a significant minority of candidates did not substitute ***u***, ***v*** and ***a*** correctly into their selected equation(s) of motion. Often ***u*** and ***v*** were transposed and ***a*** was wrongly taken to be positive.
In part (b), a few candidates discussed effects of adding passengers but failed to answer the question as they did not make any statement about the final speed of the car, for example "it will take longer to slow down". Some were on the right lines but their answers were incomplete, for example, by failing to refer to F = ma in their answer. A number of candidates showed poor understanding of the situation by arguing that the final speed would be less because the increased mass would result in a smaller acceleration. Some of this poor understanding may have been due to careless reading of the question.
In part (c)(i), very few candidates showed the necessary understanding that electrons and holes recombine at the junction to produce photons. The vast majority gave poor responses. There were many answers which said that "electron-hole pairs are created". Other answers were simply nonsense, for example "photons of light are emitted through the holes". Similar questions in previous papers have also been badly answered – so this continues to be a disappointing area of candidate response.
In part (c)(ii), many candidates used the voltage and power values for the LED in the formula $P = V^2/R$. They then left the value of R from this calculation as their answer for the value of the series resistance.

Question 22 – In part (a)(i) a significant number of candidates could not write down or derive the formula for the component of weight down the slope.
In part (b)(i), many candidates correctly described the motion shown by the graph as negative acceleration (or deceleration) but failed to say that it was uniform (or constant).
In part (b)(ii), when using values from the velocity-time graph, many candidates made mistakes in calculating the numerical values of acceleration. Many also incorrectly showed these values as positive on their acceleration-time graph.
In part (b)(iii), very few candidates realised that the change in the magnitude of the acceleration was due to the change in direction of the force of friction relative to the component of weight when the object changes its direction of motion on the slope. The answers given by most candidates displayed very poor comprehension of the relationships between unbalanced force, acceleration and velocity.

Question 23 – In part (a)(ii), candidates' answers demonstrated a poor understanding of density and how it depends on mass and volume. It was perhaps surprising then that, despite this, most candidates went on in part (b)(i) to use the density formula perfectly in a calculation to find mass.

In part (b)(ii), while attempting to explain why the pressure falls as gas escapes from the cylinder, few candidates mentioned anything about the frequency of collisions of the molecules with the walls of the container despite this being critical to the argument.
In part (b)(iii), rather than using the correct terminology of “atmospheric pressure”, many candidates only referred to “air pressure”– it is obviously possible for air to be at a wide range of pressures.

Question 24 – In part (a)(iii) a significant minority of candidates tried to calculate the power output of the heating element by using P = IV but substituted the value of the e.m.f. rather than the p.d. across the heating element.
In part (b), a comprehensive answer should refer to a formula for calculating power with an associated description of what happens to each of the variables as the internal resistance increases – many candidates made no reference to any formula. Some candidates gave answers describing what would happen if the internal resistance decreased – perhaps due to careless reading of the question.

Question 25 – Part (a) was answered very poorly. Very few candidates demonstrated the familiarity with content statement 2.3.3 needed to give a correct definition of *capacitance*. Most answers were either wrong (e.g. “the number of joules per coulomb”) or too imprecise (e.g. “storing charge”).
In part (b)(ii) many candidates failed to notice that the values on the current axis were in milliamperes, not amperes.
In part (b)(iii) many candidates did not change millijoules into joules correctly (for example, by using 10^{-6}).
In part (c), candidates were asked to state and then explain what happens to the time taken for the capacitor to fully charge (when another resistor is connected in parallel). Only about half of the candidates answered this correctly. Again it seems there were many who did not read the question carefully enough as some answers referred to the capacitor discharging and many candidates failed to include any mention of ‘time’ in their answers.

Question 26 – In part (a), a surprisingly large number of candidates did not use their calculated value of resistance to quote a value of irradiance from the graph. Perhaps they had ‘forgotten’ that there was a further stage to this part of the question – re-reading the question would help prevent such mistakes. A significant number of candidates made an error in reading the scale of the graph. Many failed to notice that the resistance axis of the graph was in kiloohms, not ohms.
Part (b)(ii) was poorly answered with less than half of the candidates answering correctly. This should have been no more than selecting the differential mode formula and substituting the given values. However, many candidates started with wrong Physics by selecting the inverting mode formula. A very large proportion of wrong answers were due to candidates writing the correct formula but interchanging the values of V_1 and V_2 at the substitution stage.
In part (b)(iii), candidates were very poor in identifying which of the LEDs is forward biased. Of those who chose the correct LED, the explanation was often imprecise and lacked the technical language expected at Higher; for example writing “it is the right way round” rather than “it is forward biased”.

Question 27 – Part (b) was poorly answered. Many candidates attempted to justify their choice (of the path taken by the ray of light through the lens) by using wrong Physics, for example; “blue light diffracts more than red”, “blue light has a longer wavelength than red”, “blue light has a lower frequency than red”. There were also many examples of candidates failing to use the terminology expected at Higher, for example writing “blue light bends more than red”.

Question 28 – Although part (a) was generally well done, a significant minority of candidates attempted to use $I = k/d^2$ to calculate irradiance.

Question 29 – In part (a) many candidates failed to label the origin in their graph – it is important to <u>show</u> that zero frequency corresponds to zero energy.
In part (b), many candidates did not work out the work function as instructed. Instead, they gave the value of the threshold frequency as their final answer. It appears that many candidates are confused between the terms *threshold frequency* and *work function*.
In part (c), very few candidates gave the essential reason why the kinetic energy of the photoelectrons remains the same, i.e. that the energy of the individual photons has not changed. Markers reported that many candidates showed confusion between photons and photoelectrons and about the whole process of photoemission.
The photoelectric effect remains an area of poor candidate understanding and response.

Question 30 – Part (a)(i) was very poorly answered. When attempting to state what is meant by an *activity of 12 k Bq*, most candidates displayed a lack of familiarity with content statement 3.5.1. Candidates' answers referred to "count rate", "particles breaking down", "decays per minute" and many did not include use of the value of 12 000.
In part (b), a significant number of candidates made mistakes in dealing with the prefix 'micro'.

Throughout, there were frequent examples of candidates being careless with the transfer of data from the examination paper to their answers. This can be very costly because wrong substitution means that no further marks can be gained.

Advice to centres for preparation of future candidates

- Candidates must ensure they are very familiar with all the relationships listed for Higher Physics in the Physics Data Booklet. This includes memorising all the standard symbols and the units of the quantities they represent.

- Candidates should be aware that they may need to state or derive relationships which are not listed in the Physics Data Booklet; for example, the component of weight of an object down a slope.

- Candidates must read questions very carefully and ensure their responses really do answer what has been asked. They should be encouraged to re-read a question immediately after writing their answer. This procedure could reduce the frequency of inappropriate or incomplete answers.

- Candidates must take care to label their answer to match the appropriate part of the question. A wrongly labelled answer can result in no marks being awarded.

- Candidates must be trained to leave only one answer to any question. When they make more than one attempt at an answer, they must then score through any work they wish the Marker to ignore.

- Candidates should be encouraged to present their numerical analyses in a clear and structured way – markers need to be able to follow the logic in their answers.

- Candidates must take great care to transfer data accurately from the examination paper to their answers. Developing a habit of double-checking that figures have not been transposed or omitted could reduce the number of such costly errors.

- Candidates must take great care to substitute the initial value of velocity for ***u*** and the final value of velocity for ***v*** in the equations of motion.

- Candidates must be careful to take into account the vector nature of ***u***, ***v*** and ***a*** in the equations of motion and ensure that they substitute the values as being positive or negative as appropriate.

- To be full and complete, many written explanations require inclusion of an appropriate formula. Candidates must ensure that they quote that formula and state what happens to each of the listed variables, including any which remain constant.

- Candidates could benefit from more practice at describing how a forward biased LED produces photons. They must learn that a description of the production of electron-hole pairs is only appropriate when discussing the operation of a photodiode.

- Information on the number of marks allocated to each part of a question should be used by candidates as a guide to the extent of calculation or explanation required. For example, it is very unlikely that a question which has been allocated three marks can be answered fully by a single calculation using one formula.

- Most candidates would benefit from further practice at using data from a velocity-time graph to sketch a corresponding acceleration-time graph.

- Candidates should label the origin and the axes on sketch graphs.

- Most candidates need more practice at writing descriptions and explanations in Physics.

- Candidates should be able to write descriptions of situations in which several forces act on an object and how the resulting acceleration and velocity of the object change with time.

- Candidates need to be more careful in the detail and precision of the language used in their descriptions and explanations. For example, in question 23, saying that gas escaping from the cylinder causes “fewer collisions and a lower pressure” is, at best, incomplete. A more precise description would be to say “There are now fewer molecules in the cylinder. There are therefore fewer collisions per second between the molecules and the container walls. This causes a smaller force and so lowers the pressure”.

- Candidates should be encouraged to study the content statements and be prepared to use these in their answers. For example, in their answer to Q 25(a), they should be able to write “capacitance is the ratio of charge to potential difference” (content statement 2.3.3). In their answer to Q 30(a), they should be able to write “an activity of 12 k Bq means that 12 000 nuclei decay each second” (content statement 3.5.1).

- For an op-amp in differential mode, candidates must ensure they know which input voltage is V_1 and which is V_2. They must ensure they substitute these correctly into the formula.

- Candidates could benefit from more practice at describing the variables and processes involved in the photoelectric effect. There could be a place for the use of computer simulations to enhance understanding. Peer discussion and marking of descriptive answers may also help candidates discriminate between good and weak responses and so improve their own attempts.

- In numerical calculations, candidates should round off figures only at their final answer. The answer to an intermediate calculation should not be rounded.

- Some candidates would benefit from further advice and practice at presenting numerical final answers to an appropriate number of significant figures.

- Candidates should memorise and practise using all the prefixes listed in the content statements for the course.

Statistical information: update on Courses

Number of resulted entries in 2007	8,580

Number of resulted entries in 2008	8,762

Statistical Information: Performance of candidates

Distribution of Course awards including grade boundaries

Distribution of Course awards	%	Cum %	Number of candidates	Lowest mark
Maximum Mark - 90	-	-	-	-
A	28.8%	28.8%	2,527	66
B	24.3%	53.2%	2,131	55
C	21.0%	74.1%	1,838	45
D	8.4%	82.5%	735	40
No award	17.5%	100.0%	1,531	-

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.