UNIVERSITY OF MALTA

SECONDARY EDUCATION CERTIFICATE

SEC

PHYSICS

May 2007

EXAMINERS' REPORT

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

SEC Physics
May 2007 Session
Examiners' Report

Part 1: Statistical Information

During this session, 4508 candidates applied for the examination; this time round a greater number of candidates sat for Paper I+IIA (2307 – 51.2%) than for Paper I+IIB (2201 – 48.8%). Table 1 shows the distribution of grades obtained by the candidates.

Table 1: Distribution of the candidates' grades for SEC Physics May 2007.

Grade	1	2	3	4	5	6	7	U	Abs	Total
Paper A	215	369	532	770	319	-	-	94	8	2307
Paper B	-	-	-	356	609	551	279	356	50	2201
Total	215	369	532	1126	928	551	279	450	58	4508
% of Total	4.8	8.2	11.8	25	20.6	12.2	6.2	10	1.3	100

1116 candidates (24.8%) obtained grades 1-3
3082 candidates (68.4%) obtained grades 1-5
3998 candidates (88.7%) obtained grades 1-7

Part 2: Comments regarding candidates' performance

2.1 General Comments

This year more candidates opted for Paper I+IIA rather than for Paper I+IIB. More high ability candidates are opting out of Paper I+IIB making the lower grades more easily obtainable for the low ability candidates. More candidates obtained good grades (1-3) than in previous years. In general, Paper I+IIA candidates have shown mastery over the whole of the Physics syllabus. On the other hand, Paper I+IIB candidates perform better in Paper IIB than in Paper I and show that their mastery of certain topics is rather approximate. Furthermore, they often fail to respond properly to higher order questions; such questions are in fact providing the selection ground for the upper grade boundaries.

One major frequent error across the cohort suggests that candidates need to be more careful with units. The Physics SEC examination is in fact including specific questions requiring the candidates to express their answer in the correct units. The skill of using appropriate expressions seems to be improving although it is still one of the obstacles for certain candidates. The question format adopted gives candidates the necessary security to respond with confidence. Similarly, the write-on format this year including Paper 2A, has also given the candidates clear layout of the expected length for their answers. However, despite the fact that questions do not request extensive qualitative answers, a significant number of candidates still fail to express themselves in coherent English. Whilst they are not being penalised directly for this, they sometimes manage to bodge a straightforward answer or even write irrelevant lengthy material and get it wrong. The SEC Physics Examiners are finding that candidates are extensively failing in higher order level questions across all topics. It can be said that only those candidates that fare well at these levels gain access to the higher grades.

Evidence from this year's examination and from previous ones, indicates repeatedly that there is a drastically low performance across all candidates in the following topics: The Earth and the Universe (Section 22 of the syllabus) and Waves and related topics (Sections 11 to 15 of the syllabus). One must take this seriously into consideration during the learning of Physics.

Again as in previous years, questions requiring candidates to describe simple experiments were often not answered properly. Candidates seem to lack direct experience in using apparatus and sometimes show that they may not even have seen the experiment being done let alone handling it themselves. Interviews with particular candidates confirm that this is so. It is a well-known fact among all educators that first hand experience does not only enhance the students' enjoyment of the lesson but it also helps understanding of the concepts and allows for their interlinking. Students gain a sound grasp over the topics and their performance in examinations should show this (refer also to Section 3).

2.2 Paper I

Table 2: Mean and Standard Deviation of raw scores for Paper I questions by Paper choice

Question		*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*Tot*
Paper (IIA)	Mean	9.2	8.1	6.8	7.2	7.5	6.8	8.7	8.5	6.5	8.1	77.5
	S.D.	1.4	2.2	2.2	1.7	1.6	1.8	1.7	1.5	2.2	1.8	12.0
Paper (IIB)	Mean	6.6	4.0	4.0	4.5	4.6	4.5	5.4	6.3	2.9	5.1	47.8
	S.D.	2.4	2.8	2.6	2.7	2.5	2.0	2.9	2.1	2.2	2.6	18.6

Question 1. This question concerned density.

Density is a topic that is usually covered in Form III in schools. This is because it is considered rather straight forward with easy introductory calculations. However, it is not an easy concept to master and the difference seen in Table 2 between the low ability candidates of Paper I+IIB and the Paper I+IIA candidates was precisely this. Indeed the low scores above could be attributed to parts which asked the candidates to explain their answers, i.e. part (b) and (c)(ii). One surprising thing about this question was that about a quarter of the candidates failed to name an instrument that measures mass. Candidates who wrote 'scales' or 'lever' or 'electronic' without mentioning the term *balance* were penalised.

Question 2. This question concerned linear motion.

This question was again about a topic usually tackled in Form III. There is once again a conspicuous gap between the performance of Paper I+IIA candidates and Paper I+IIB candidates. This time the difference is not attributable to a higher order question but rather to one of recall. It seems that the Paper I+IIB candidates could not work out the distance travelled by finding the area under the v-t graph. The higher order part in this question was part (c) which was a failure for most candidates. Getting this part correct meant in most cases acquiring the percentage of marks required by the Paper I+IIA candidates to obtain a higher grade.

Question 3. This question concerned satellites.
This area of knowledge forms part of the topic Earth and the Universe. Past performance in Physics SEC indicates that there are some misconceptions in its learning. This year is no exception. Despite the fact that this question was built on recalling ideas about satellites, the misconceptions emerged as exemplified by the low mean scores for all candidates. The candidates were strong in recalling *geostationary orbit* and could mention its uses. Most candidates could also relate the advantage of a *polar orbit* but very few its uses. It was quite disappointing to note that the majority of candidates did not know that the natural satellite of the Earth is the moon and only a small majority could attribute all this phenomenon to the force of gravity; a rather important and basic concept.

Question 4. This question concerned work done and energy changes.
The overall performance of the candidates in the first part of the question, i.e. the part concerning work done was appreciably good in most cases. However, the candidates could not complete the part involving energy changes properly. The question should not have presented itself to be a very difficult question; the difficulty came from the fact that the candidates were given the task of applying the energy change concept by extending it further to include the five energy forms involved. However, only about half of the marks for this part were gained and indeed the ones who could plan the energy changes carefully managed to gain other marks in this question as well.

Question 5. This question concerned plotting a cooling curve.
Unlike in previous years, candidates did not perform very well in this question, although with respect to other questions the scores are not that low. The graph was on the whole well drawn, but still marks were lost in this part especially for a wobbly curve and in some cases the axes were inverted. Another very common error was setting an inappropriately small scale. Paper I+IIB candidates could not answer the last two parts where higher order thinking was called for. Part (e) also proved challenging for the Paper I+IIA candidates as very few of them could interpret the graph and relate it to the concept. It seems that most of the marks gained by the candidates are those of purely mathematical nature; candidates seem not well trained to interpret graphs and drawing the correct inferences that relate to the application of the physical concept/s concerned. This has been observed repeatedly over a number of years.

As indicated earlier on in the general comments, the Board of Physics SEC Examiners wishes to stress *the importance of the practicals being done by the students themselves*. During the learning process students are expected to have repeated this skill during their practical sessions where they must have been lead to graph interpretation and drawing up the *correct conclusions individually*.

Question 6. This question concerned conservation of momentum.
Candidates seemed well prepared for momentum mostly in the mathematical part. However, surprisingly a number of them could not tell that they were travelling in opposite directions in part (b)(iii). Candidates even lost marks in part (a), the definition of conservation of momentum was often simply stated as momentum before = momentum after without stating its condition. There were also many mistakes in part (b)(iv); the candidates fell quite short since they could not apply the formula for calculation of impulse to the situation presented. Once again Paper I+IIA candidates outperformed Paper I+IIB, but the differences were not so big demonstrating a general lack of understanding of part of this topic.

Question 7. This question concerned alternative energy sources and energy efficiency.
In general, candidates showed familiarity with the items in this question. Both paper I+IIA and paper I+IIB candidates obtained a mean pass mark (Table 2). However, the difference in performance between the two sets of candidates was rather big. Indeed Paper I+IIA candidates showed a mastery over the question asked and obtained a very high average score. On the other hand, paper I+IIB candidates could only scrape a pass mark. In particular, they failed in parts (a)(ii) and (a)(iii) which were very simple conversions of energy from potential to kinetic. They also lacked in recalling and/or properly differentiating between renewable and non-renewable sources of energy.

Question 8. This question concerned conductors and insulators of electricity.
The first part consisted of a straightforward exercise that asked the candidates to predict whether particular objects would conduct electricity or not. In this part, virtually all candidates got their answers correct. However, in the second part that asked about nomenclature and explanation about why certain materials conduct while others do not, problems arose. Few Paper I+IIB candidates could answer this part of the question. Indeed, very few of them mention current as being a flow of electrons – they mostly confuse this answer with properties of magnetic materials stating that conductors are magnetic because of their nature.

Question 9. This question concerned optics.
In this question, a general depression of the mean score was registered. Indeed both Paper I+IIA and Paper I+IIB candidates obtained their lowest mean scores (Table 2). This question showed that there is no consolidation between the topics of optics and waves. It seems that they are perceived as separate topics since candidates fell short in the question that should not present itself too difficult. It required use of concepts from both topics interchangeably. In the first part, very few students answered this part correctly. Many did mention a change in velocity but very few mentioned the change in wavelength. The performance of Paper I+IIB candidates was further diminished by the fact that they confused the total internal reflection part. In the last part (e), some even described the conditions necessary for total internal reflection rather than mention two practical uses.

Question 10. This question concerned electromagnetism.
In general, candidates showed familiarity with the topic electromagnetism. Most candidates obtained a score of 5 or higher in this question (Table 2). The difference between Paper I+IIA and Paper I+IIB is mostly attributable to part (b) especially when working with numbers with powers of 10. The latter candidates' mastery of this skill is lacking even though a good part of them could work out the subject of the formula correctly. Furthermore, they could not match all the electromagnetic waves with their function correctly resulting in a further reduction of score.

2.3 Paper IIA

Table 3: Mean and Standard Deviation of raw scores for Paper IIA questions

Question		1	2	3	4	5	Tot
Paper IIA	Mean	11.9	13.9	15.0	11.2	14.2	66.2
	S.D.	3.5	3.4	3.6	4.3	3.5	14.6

Question 1. This question concerned magnetic fields.
On the whole, candidates did not obtain a very good score in this question. The mean is a pass mark and the S.D. shows that distribution of scores was quite close (Table 3). The first part of the question was quite straightforward for most candidates. However, a number of candidates mixed up the second part of the question; in fact, some answers reflected confusion with electromagnetic induction and subsequently answered accordingly. In particular, the write up of the experiment was evidence of this. In many cases, important steps were left out. Descriptions lacked detail, for example candidates just stated that current was read without indicating the instrument used. The majority stated that the electronic balance gave directly the reading of the force. Some also stated that they could actually measure the amount by which the wire moved by means of a ruler. A number did not describe the experiment. They stated the conclusion of the experiment and explained it in one or more different ways.

Question 2. This question concerned moments.
The mean score for this question shows that candidates are quite conversant with this area of the topic (Table 3). However, candidates found difficulty in explaining terms, principle and experiment. In the first part, many incomplete definitions were given; giving an equation instead of a statement or simply stated that moment is turning without stating what causes the turning effect. The majority of candidates also gave half the answer for the principle; leaving out the condition for equilibrium. In addition, a good number confuse the term moment with momentum. They also found difficulty in describing the simple experiment to investigate the principle. Quite a number of candidates gave inadequate experiment descriptions such as equal masses should be placed equidistant from pivot. Furthermore, candidates omitted certain important details such as that the unloaded ruler should be initially balanced on the pivot and that all distances should be measured from the pivot. Part (b)(i) indicates that most candidates do not even differentiate between clockwise and anticlockwise. Candidates often wrote irrelevant material that has no link whatsoever with answering the question or left out important details as stated earlier.

Question 3. This question concerned radioactivity.
Candidates obtained the highest mean score in this question. The low S.D. indicates that the candidates' performance was rather homogeneous. Candidates are familiar with the various aspects of this topic because their performance in question 10 of Paper I was also very good. Surprisingly, a number of candidates found difficulty in explaining what is meant by half life although they could calculate it in part (a)(ii). In part (c), most students could recall how each type of radiation can be stopped. However, when it comes to the application of this knowledge, they misinterpreted the results given during this experiment and came out with the wrong conclusions.

Question 4. This question concerned mechanical waves.

Candidates' performance in this question was rather poor when compared to the other questions. Indeed, candidates obtained the lowest mean score for this question (Table 3). Candidates encountered the most difficulties in part (d) about resonance. In part (d)(i), many different answers were given including: reverberation, echo, refraction, reflection. Only about half the candidates gave the correct answer. In part (d)(iii), most candidates gave skimpy descriptions of the practical examples. A number of candidates did not know the definition of frequency and got mixed up in this question in part (b)(i). While most candidates had a good idea of how the ultrasound scanner worked, a significant number of them failed to mention that the ultrasound which penetrates the body is reflected back to produce an image on the screen.

Question 5. This question concerned pressure.

This question was rather straightforward and the mean score was about 70% (Table 3). The S.D. is also low, showing that the candidates had similar performances. The candidates surprisingly found difficulties in part (a) especially in (a)(i) where a good number gave incomplete definitions of pressure. Candidates also tried to give more than one unit for pressure, sometimes giving one correct and one incorrect unit. In part (b)(i) diagrams given were generally correct, although there were some diagrams which lacked accuracy. Many candidates wrote down that oil is denser so the pressure is greater in part (b)(iii). However, those who gave the correct answer failed to state that the paths followed by the oil are closer to the can.

2.4 Paper IIB

Table 4: Mean and Standard Deviation of raw scores for Paper IIB questions

Question		*1*	*2*	*3*	*4*	*5*	*Tot*
Paper IIB	Mean	11.1	11.4	9.7	7.0	11.6	50.8
	S.D.	3.6	3.9	5.3	4.0	5.3	18.5

Question 1. This question concerned magnetic fields.

Overall, candidates obtained a 'pass' score in this question (Table 4). The low S.D. also indicates that the low performance is general. For the first part (a), most candidates mentioned iron showing that they do not know the difference between hard and soft magnetic material. Of those who answered correctly very few gave the correct reason for their choice. As for part (b) most candidates seem to find difficulty in expressing direction because answers varied from left, right, clockwise … However, the experiment in part (b) was often answered correctly. As for the last part, the precautions mentioned were mostly ones that are common for the majority of experiments; such as repeated readings or else ones that do not make sense in the light of the accuracy of the readings; such as do not eat in the lab. It must be emphasised that precautions listed must be specific to the experiment. This was also stressed by the examiners in last year's report.

Question 2. This question concerned moments.

The mean score for this question, is again just above pass mark, and again the S.D. is quite low as in question 1 (Table 4). As has also been said about the paper A candidates, it seems that all candidates confuse moments with momentum. For the principle of moments, candidates only give half the answer; they fail to mention that it is when the system is in equilibrium that the moments are equal. For part (a)(iii), they failed to mention that the distances must be measured and recorded (from pivot). Part (b)(i) indicates that most candidates do not differentiate between clockwise and anticlockwise, as was also the case for paper A candidates. For part (b)(ii), some used momentum = mass x velocity, then substituted with force and distance and obtained the correct answer. This again indicates the confusion between these two concepts. Few answered (b)(iv) correctly. Some seemed to be taking moments about the centre of the soil not about the given pivot. Part (b)(v) asked at application level, and almost all candidates failed to give a feasible explanation.

Question 3. This question concerned radioactivity.

Candidates obtained a very low mean score in this question (Table 4). Very few could define half life entirely, i.e. mentioning both time and decay of half the substance. The most common mistake was that the final time was indicated as 100min. As a result, most candidates gave straight line graphs rather than exponential. Most candidates found part (b) easy to tackle, they could recognise and name the radiations for the given characteristics. However, they failed to give proper explanations and interpretations to the experiment in part (c) and (d). In general, it seems that these candidates lack the skill of expressing themselves using the correct terms.

Question 4. This question concerned mechanical waves.

Candidates managed to obtain a very low mean score in this question. Furthermore, the S.D. is quite low indicating that almost none of the candidates did well in it. There was no one general pattern for the candidates' performance. Errors were spread over all the parts of the question. Surprisingly there were a lot of wrong answers even in part (a)(i). In (a)(ii), most candidates did know that longitudinal waves cannot travel in a vacuum but very few could give a reason for their answer. Part (b) was characterised by a series of guesses rather than answers. Very few gave correct answers; the majority hit one guess only. In part (c), the calculations were more often than not worked out incorrectly. Few remembered the formula T=1/f in (c)(ii). Even in the uses of ultrasound for part (d), rarely was *sonar* mentioned even though quite a number mentioned the depth of the sea. 'To see the baby' and 'for pregnancy' were typical answers. Others mentioned bats and dog whistles. On the whole, the responses leave much to be desired reaffirming the difficulty often experienced in this topic.

Question 5. This question concerned pressure.

In this question, the mean score was the highest when compared to the first four questions (Table 4). The question was rather straightforward and but it still provided some pitfalls for the candidates as the score was just above the pass mark. Part (a)(i) – (iii) provided easy answers where most got a complete score in this part. However, from this point onward the candidates started experiencing problems. It seems that in part (a)(iv), some of the candidates did not make the connection with the previous part and attempted to work out the problem from scratch with scarce success. In part (b), there was a large contrast between the perfect answers to part (b)(i) with the lack of correct answers in the last part. The high S.D. for this question indicates that there was a very divergent performance between the candidates. Some managed to get a reasonably high score but the rest were below pass mark.

Section 3: Comments regarding the school-based Practical Coursework

Thirty schools were chosen by MATSEC to have their Physics laboratory scripts moderated between the 2nd and the 20th April 2007. The total number of scripts moderated (including private candidates) was 2033, which represents almost half of all the 4508 candidates for Physics SEC May 2007.

There seems to be an increased number of schools that are doing better experiments and producing better lab reports that reach the required SEC level. However, comparison between the moderators' comments and the actual marks awarded shows that in particular schools, marks are still being considerably inflated at the expense of other schools that assess more fairly. In some schools, class reports are compiled and very little individual work is evident in the report. Furthermore, interviews with both school leavers and private candidates gave evidence of practical work that was only discussed in theory or performed as teacher demonstration. As a result, most of the candidates' marks presented by particular schools were changed accordingly to match the candidates' performance.

In addition, the variety of experiments is at fault in some schools and no proper balance across the syllabus is achieved. At times experiments presented individually should have been grouped and presented as one experiment. It should be evident that the candidates *themselves* have recorded data, plotted the best graph/s, made calculations and have drawn inferences/conclusions. Evidence from the examination scripts shows that the majority of candidates are not familiar with investigations through experimental testing (refer to comments Paper IIA and IIB, and Q5 of Paper I). Greater attention also needs to be given to the precautions required in experiments, as argued earlier, which was evident during the marking of the scripts.

The practice of using a fill-in or ready-to-copy teacher-prepared handouts for performing experiments is a commendable one especially during the first year of Physics learning but should be discontinued during Forms IV and V. It is highly recommended that the students should be aided by the teacher to follow instruction sheets/guidelines and to construct their own experimental report. It is also advisable that the teacher/tutor endorses each of the student's dated experiment as soon as this is submitted along with the given mark on the index sheet that should be placed at the front of the lab report. This reduces the possibility that some students deliberately inflate their mark over and above that given by their teacher. Furthermore, it is not advisable that more than one experiment is performed in a single session. Experiments should be well planned throughout the academic year and should allow time for the students to assimilate the knowledge. This should also be beneficial to the students in applying scientific concepts and hence in more sound learning.

The trend for better experiments and producing better lab reports recognised in recent years seems to be consolidated. Although, there is room for improvement as regards the variety and quality of experiments in particular schools and the proper balance achieved, the quality of the work is in general improving and there is room for building on positive practices. A greater number of schools are in fact producing better work than vice versa. Finally, this year MATSEC piloted a feedback sheet that had to be filled by moderators for each school moderated which should be regarded by the respective schools as a guideline in the light of what has been reported above.

Chairperson
Board of Examiners
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