May 2017 subject reports

Computer Science

Overall grade boundaries

Higher level

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 14	15 – 29	30 – 39	40 – 49	50 – 59	60 – 69	70 - 100

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 15	16 – 30	31 – 42	43 – 53	54 – 64	65 – 74	75 - 100

Internal assessment

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 5	6 – 10	11 – 15	16 – 19	20 – 23	24 – 27	28 - 34

The range and suitability of the work submitted

The work submitted largely followed the instructions as prescribed in the Computer Science Guide and the Handbook of Procedures for the Diploma Programme 2016, section B4.4.

The scenarios used usually enabled worthwhile projects to be completed. As expected, the majority of solutions were programming projects and the majority of those had been coded in Java. On the other hand, an encouraging number of candidates tried their hand at web design, [Access] databases and Android app design. It is hoped in future sessions that the range of solutions will continue to expand.

The quality of the solutions showed a wide range and not all solutions had been developed to the level of complexity expected of IB Diploma candidates. Some examples of trivial products included; Java programs that mainly focus on the GUI rather than functionality, OOP programs that consisted of one class only, Java programs that are based on a Greenfoot or HScode template with only a few methods overwritten, rudimentary versions of freely available games (like Sudoku, Battleship or chess), Access databases that contain just one or two tables or unjoined tables, websites that are template-based (WordPress, Wix or Weebly) or that have minimal content, basic Excel projects, Scratch or Snap projects that had not been properly designed.

Highly successful solutions tended to incorporate features from more than one type of software. For example, website projects that incorporate JavaScript / PHP / SQL functionality, or programming projects that interact with an Access database or with on-line resources.

Candidate performance against each criterion

Criterion A: Planning

Too many students still make a limited effort to fulfil the spirit of this criterion. Contrived tasks and clients were routinely seen in the weaker samples submitted. Too many students had generic success criteria – these [success] criteria must be specific and testable. The success criteria are essential to the project and must be explicitly addressed in the test plan (Criterion B) and in the evaluation (Criterion E) and in the screencast. Some reports described only the intended solution instead of describing a scenario.

Criterion B: Solution overview

The prescribed form for the Record of Tasks was generally used and showed sufficient detail for the stages that had been included. However, some Records of Tasks forms were only partially complete, typically because the final product had not been implemented / fully tested by the client. Some Records of Tasks forms were preoccupied with tasks related to the writing of the criteria, which is not their role.

For the Design Overview, students typically only provided an amalgam of design elements or even screenshots from the final product (which were discounted). The structured approach of prototyping together with client feedback allowed some students to achieve at a higher level. A wide variety of test plans were seen. The better ones aligned with the success criteria.

NOTE: The use of the proper template in forms.zip is mandatory – the use of a different version will be penalized. If no Record of Tasks is included or if there is no evidence of a design then 0 marks will be awarded.

Criterion C: Development

Most candidates made a good attempt at documenting the development of their product and some of the techniques used. However, the quality of the explanations and the completeness of techniques typically leaves something to be desired. The complexity of the product must be justified by the student in the write-up. A seemingly complex product without proper explanations of complex techniques used in the product, only achieves moderate complexity. Similarly, high levels of ingenuity and/or complexity must be illustrated in the algorithmic thinking (e.g. the use of complex data structures, algorithms or macros, and an explanation of why they have been included in the product). Design components have no place in this section and should be added to Criterion B.

Criterion D: Functionality and extensibility of the product

Screencasts should be less than 7 minutes in length and in a cross-platform format that can be viewed easily by the moderator. Some screencasts do not include narration which makes it harder for the moderator understand the rationale behind the development of the product. More candidates than in previous sessions were able to demonstrate the proper working of their solution within the 5-7 minutes that should be allocated for the screencast. Candidates who used their Criteria for Success (Criterion A) and their test plan (Criterion B) to structure the screencast, tended to be more successful.

The screencast should only show the proper working of the solution as outlined by the success criteria. Some screencasts also focused on the development of the solution, which made them too lengthy. Others only showed the working of the interface, without showing actual functionality of the intended solution.

Criterion E: Evaluation

Many rudimentary evaluations were seen that just listed the success criteria together with the comment "met" and without any evidence of client involvement. The final product (after testing) is expected to be implemented and used by the client for an extended period of time before client feedback is given.

Recommendations for the teaching of future candidates

- The aim of the internal assessment in Computer Science is to create a working solution for a real client. Therefore planning should consist of the following steps:
    - investigate a situation,
    - identify client/adviser,
    - consult the client (and/or adviser) and ask meaningful questions,
      describe the scenario with explicit reference to evidence of the consultation added in an appendix,
    - choose a solution,
    - describe the rationale for the solution and also for the software to be used,
    - outline comprehensive success criteria for the chosen solution.

- Criterion B should provide evidence of a rigorous design stage with, in the Record of Tasks, an overview of all five stages of the project (including implementation - the actual intended use of the product by the client), plus detailed layout design sketches that include annotations for complex techniques, evidence of algorithmic thinking (in the form of flowcharts, UML diagrams, pseudo-code, ER diagrams, structured database decomposition using NF, query and macro design), and a test plan that addresses all success criteria. All high scoring projects included a thorough design stage.

- Please note that from May 2018 the following will not be receiving credit under Design: solution overviews that are generated by the IDE, UML design that is clearly derived from the final product, code fragments and screenshots from the final product.

- A few candidates have been using prototyping as part of their design documentation - which is a positive development, but not a requirement. In order not to be penalized under the previous restriction, they will need to explicitly document their prototyping effort and the final product should be a clear improvement on the prototype.

- Criterion C provides candidates with the opportunity to demonstrate their knowledge and understanding of the tools and techniques used in creating the product. The use of tools/techniques should be explained with reference to code fragments and screenshots that show their use.

- Criterion D does not require written documentation, specifically not a transcript of the screencast. The screencast should be limited to about 5 minutes and should only show the proper working of the final solution. The structure of the screencast should include the testing of the implemented solution against the success criteria from Criterion A. Successful screencasts show comprehensive evidence of the solution's functionality

with lots of data, but should be edited to avoid viewing tedious data entry. Screencasts must be included in cross-platform formats that are recognized by major video software like VLC player. There is no need to document extensibility in extended writing or in the screencast.

- Extensibility is evidenced by a detailed design in Criterion B, by a detailed description of the development process in Criterion C and, in case of a programming project, by a properly structured and annotated code listing in an appendix.

- For full marks in Criterion E evidence of client feedback must be included (in an appendix) and it must be discussed and referred to in the student's evaluation against the success criteria. Recommendations should be realistic in relation to the actual product – for example 'adding network capability' is not a realistic improvement for a low-level product. Recommendations for improvement should go beyond the success criteria that have not been met.

- A word of caution: treating the project as a purely academic exercise typically means that there is no proper client and that the solution is not being implemented, which will have an impact on criterion A, Criterion D and Criterion E.

- Teachers need to ensure sufficient time is allocated to this component. It is not possible to create the solution in a week.

- Teachers should not promote the use of a standard approach to the report where all students use the same components, layout and content but applied to different problems, leading to generic reports.

- Candidates are advised to test their screencasts on different media players and devices to ensure the playback is correct.

- The product folder must contain some evidence of the product – preferably both the final product and the product at design stage, for example both executable jar file and original java files, or an Access database client version (that opens a full-screen switchboard) and a design version that does not. In extreme cases, when the product cannot be submitted digitally, the product folder should contain screenshots of the product being created.

- Even though it is not a requirement, teachers should provide pertinent comments about how they arrived at their mark for each of the criteria. This makes it easier for the moderator to understand the rationale of the teacher in awarding the marks.

Higher level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 14	15 – 28	29 – 37	38 – 47	48 – 56	57 – 66	67 - 100

General comments

The syllabus seems to be covered by most schools. There are some outstanding candidates and only a few candidates who were very poor in their performance. Across the cohort there were some excellent responses to every question in this paper.

The areas of the programme and examination which appeared difficult for the candidates

Constructing algorithms proved difficult to many candidates. Responses to questions 13c, 14d and 15b and 15c ranged from poor to excellent. Algorithms have been constructed not addressing the specification. Some candidates used generic wording (rather than pseudocode) to illustrate algorithms when pseudocode was explicitly asked.

Candidates find it hard to focus on the mark allocation; writing far more that the mark allocation would suggest (for example, questions 1, 2,3,6,9) and without addressing the significant points (for example, 12a,12b,16).

The areas of the programme and examination in which candidates appeared well prepared

Most candidates have completed very well Section A showing very broad knowledge of Computer science factual information.

Constructing a truth table (12c) and tracing an algorithm (13a) were both well done by many candidates.

The strengths and weaknesses of the candidates in the treatment of individual questions

SECTION A

Question 1

This question was well answered. Most candidates correctly described the use of beta testing.

Question 2

Almost all candidates identified two causes of data loss.

Question 3

Almost all candidates identified two reasons of releasing a software update.

Question 4

This question was reasonably well answered except a few candidates whose answered writing just “because it is fast”.

Question 5

This question was reasonably well answered.

Question 6

Most candidates identified two layers of the OSI model as requested.

Some candidates misspent the time writing everything they know about the seven OSI layers. A general impression is that these students struggled with time in order to complete the exam paper and spending too long on these short answer questions can have deleterious effects later in the paper (a form of self-penalisation).

Question 7

Many candidates provided well explanations as well as giving examples. Lossy compression discard data, decompression will not return the complete file which in some cases may be unacceptable and if the original is not saved there is no way to recover it.

Question 8

Most candidates stated that the MAC address identifies a specific device. Many candidates were not able to explain how the use of MAC addresses could improve security.

Question 9

This question was reasonably answered except by weaker candidates.

Question 10

Most candidates provided vague or too general points in their responses.

Question 11

Most candidates who answered this question identified autonomy and reactive behaviour as two features of an autonomous agent acting within a larger system.

SECTION B

Question 12

Part 12a was well answered. Most students were able to define the term data migration. Descriptions in 12a concentrated on the problems, which for the most part were identified as data loss and format incompatibility.

Some candidates described more than two aspects of change management. Lengthy paragraphs in response to the question 12b (and also 12a) may mean wasted time in the examination.

Most candidates earned full marks in 12c. A few weaker candidates were unable to construct a truth table correctly.

Question 13

Most candidates traced the algorithm successfully.

Only a few weaker candidates were not able to outline the steps involved in performing a binary search on an array of ascending numbers.

Many candidates constructed excellent algorithms.

Reasonably well answered with many gaining at least 1 or 2 of the marking points.

Question 14

Most candidates outlined the use of paging in relation to virtual memory.

The limitations and consequences of using the laptop for multimedia gaming programs were generally well explained.

Many excellent responses to Part d and Part c. Some candidates were not being able to use the appropriate access methods for stacks and queues. Some candidates did not assume that the stack and the queue were of a fixed length.

Part e was generally well answered.

Question 15

Some candidates demonstrated excellent problem solving skills with answers to the questions 15b and 15c, and also answered other algorithm related questions very well.

Some candidates confused collections and arrays.

Some candidates incorrectly used subscripts in two dimensional array.

Some responses to 15d were verbose while missing crucial information that would award the mark.

Question 16

Most candidates answered well Part a and Part b.

When an application or context is given (Part c and Part d), it is important to keep this in mind and answer appropriately.

Some candidates shown poor understanding of control systems.

Some candidates confused input and output transducers. Some answers contained incorrect or imprecise sentences (confusion between the role of a sensor and an actuator) and marks lost.

Some candidates wrote long repetitive paragraphs for questions 16c and 16d.

Some candidates did not attempt questions 16 c and 16d at all.

Recommendations and guidance for the teaching of future candidates

- Candidates should be exposed to programming concepts and pseudocode. They need to develop their confidence in understanding and writing algorithms.
- Classes should spend time on problem solving, giving candidates the experience of breaking down unfamiliar problems into algorithmic steps and pseudocode.
- Candidates should be taught to understand the command terms (which are linked to a specific level of assessment object) and a question's mark total in order to gauge the appropriate length of a response, and consequently better manage their time during the examination. Candidates should be discouraged from writing long repetitive paragraphs for questions which are worth one or two marks.
- When an application or context is given, it is important to keep this in mind and answer appropriately.
- Teachers should ensure that all basic terms, given in the syllabus, are familiar to the candidates. Candidates should be familiar with computer science terms and write answers that contain computer science, not general observations.

Standard level paper one

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 11	12 – 22	23 – 29	30 – 36	37 – 44	45 – 51	52 - 70

General comments

Apart from a proportion of weak responses, the general level of knowledge and application was higher in this examination than in previous years. Responses demonstrated that students understood the command terms and answered accordingly.

Some extremely weak responses did seem to indicate that little or no teaching had taken place.

The areas of the programme and examination which appeared difficult for the candidates

Some basic terms such as MAC address were unfamiliar to students. Answers to others such as memory management and compression were answered vaguely leaving out important.

Binary search and selection sort were unknown to some candidates.

Constructing algorithms in pseudo code was disappointing as was explanation of algorithms and processes.

The areas of the programme and examination in which candidates appeared well prepared

Straightforward definitions in section A were well answered on the whole, as was the logic gate question and the social benefits of WIFI in public places. A sound knowledge of systems in organisations was also demonstrated.

The strengths and weaknesses of the candidates in the treatment of individual questions

Section A

Qs 1 to 4 were well answered

Q5. Many students were unaware of allocation and deallocation of memory. Most answers were vague and many described multi-tasking.

Q6 Apart from a few, the answers were generally correct.

Q7 Details on lossy compression and the consequences of data loss were not well explained.

Q8 A fair proportion of students did not understand MAC address. Many described it as controlling access to media files to specific users.

Q9 This was poorly answered by many. Some were not familiar with the selection sort. Those who knew the sort left out details when describing the process.

Q10 Generally well answered.

Section B

Q.11 Parts (a) and (b) were mostly well answered although some answers to (b) were repetitive and did not gain marks for two separate consequences to the company.

Part (c) was almost always correctly answered.

Clarity of response in part d was missing. Comparing the results of two truth table is not enough as the outputs must be the same for the equivalent inputs.

Q12 caused the most difficulties.

(a) The trace table showed four clear loops through the algorithm but the contents in array B did not always show [2, 4] and C often contained -1

(b) Those who knew how a binary search is carried out did a reasonably good job but often left out important details such as ending if the search value was found at MID before splitting the array or failing to be precise on the steps that should be repeated.

(c) The construction of the algorithm caused difficulties, mostly because the difference between the access methods of arrays and collections was not known.

(d) It seemed that many candidates had not clearly understood the question, which asked that as the numbers are being read into D they need to be checked to see if they are in order. There was no requirement to sort them or to stop the process of transfer if they were not in order.

Q13 Responses to this question displayed some lack of knowledge in networking.

In part (a) most students identified a VPN but struggled to find an appropriate network to give secure communication between the offices. The security characteristics of a VPN were well known.

Part (b) was not successful for many students. Answers were often vague and repetitive with very little detail on the way protocols are involved in packet switching.

Most students were able to identify two advantages to society of the increased availability of WIFI in part (c) although the descriptions often lacked concrete expansion.

Recommendations and guidance for the teaching of future candidates

- Start early on with problem solving techniques and require that these are consequently used in many different areas of the curriculum.
- Encourage students to describe in works specific algorithms and processes.
- Ensure that networking is thoroughly covered clearly understood by the students and that they can identify appropriate networks and understand the process of the transfer of data across a network.

Paper two

Component grade boundaries

Higher level

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 10	11 – 20	21 – 26	27 – 31	32 – 37	38 – 42	43 - 65

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 6	7 – 13	14 – 19	20 – 23	24 – 27	28 – 31	32 - 45

General comments

This report focusses on both SL Paper 2 and HL Paper 2. This is because the SL paper is a complete subset of the HL paper, and as many schools offer both levels in the same classroom. This will ensure teachers receive a consistent message.

At both levels, the most popular option is Option D, followed by a comparable number of responses in Option C and Option A (more Option C candidates at HL, and more Option A candidates at SL), and finally by Option B (predominantly at SL candidates).

When making comparisons between the two levels, examiners have noted there tends to be a better quality of responses at SL than at HL. These [better] responses tended to demonstrate better use of technical terminology, more precise explanations and a focus on computational/algorithmic thinking. This was the same as in May 2016.

At both levels, the percentage of high quality responses remains more or less comparable to previous years.

It has been noted in specific options (primarily in Option B, but also in Option A) some candidates produced very brief or irrelevant responses.

There were a number of concerns raised about the nature of candidate responses. These included a lack or very poor usage of technical language/terminology and very short answers, as if candidates were answering a quiz. This superficiality of the response, especially for responses to AO3 command verbs (Discuss, Explain, Suggest) leads to candidates effectively self-penalizing.

The options will be discussed individually with overarching recommendations after Option D.

Option A

The areas of the programme and examination which appeared difficult for the candidates

There were a number of weak responses. In many cases the language used by candidates was generic rather than technical. Many candidates seemed unable to describe steps of computations/algorithms, instead they produced narratives.

Some questions were simply attempted by providing general background knowledge without much effort to address the question. For example, in some responses isolation, atomicity and transactions were used as synonyms.

Several candidates produced relational tables, showing that they have some initial ideas of how to organize information, however, they returned incomplete/partially correct structures (no keys, extra fields not related to the stimulus materials).

At HL many responses displayed little or no knowledge of data warehouses, or to be able to distinguish them from a database or information system. There was also very little understanding of clustering or association analysis. The concept of data mining is generally understood, yet we found several incorrect responses referring to data mining as the linking across tables.

The areas of the programme and examination in which candidates appeared well prepared

The candidates demonstrated a good understanding of the concepts of keys/tables/ERD/ELT.

The strengths and weaknesses of the candidates in the treatment of individual questions

SL and HL questions

1.a There was the repetition of text in the stimulus material in the question paper.

1.b This question was reasonable well answered.

1.c Some candidates could not distinguish between data verification and data validation.

1.d Some candidates gave the description of the system rather than the interactions taking place.

1.e In most cases the understanding of this concept was demonstrated, but many candidates preferred to develop the response on the role of transactions and recited their knowledge rather than answering the question.

2.a This question was reasonable well answered.

2.b Many of the responses lacked detail and the use of appropriate technical language.

2.c Many of the responses were reasonable, but others lacked detail and the use of appropriate technical language.

2.d.i Many of the responses lacked detail and the use of appropriate technical language. In some cases, there was an overlapping of the response of this question and the previous question.

2.d.ii Referential integrity is well understood in most cases, but some responses did not refer to the context as required by the wording of the question.

3 a.i This question was reasonable well answered.

3.a.ii Many responses were correct with others being incomplete, for example they did not show the key. Some candidates were unable to organize a table and/or used less fields than the ones suggested by the stimulus materials. Other responses added unnecessary fields.

3b This question was reasonable well answered.

3.c This question depended on the solution returned in 3.a.ii and in some cases the errors were carried forward. However, candidates were not doubly penalized.

3.d Many responses were descriptive in nature and failed to indicate how, for example, a field in a table may be accessed.

3.e This question was reasonable well answered.

3.f This question was usually well answered.

HL questions

4.a Although many candidates understand the concept of a data warehouse, many were unable to distinguish it from a database or an information system.

4.b This question was understood, but many candidates simply unpacked the acronym and failed to answer the question in the depth required.

4.c Most candidates responded superficially and failed to use any technical language.

4.d Most candidates understood the concept of data mining, although a few had misconceptions about what data mining is.

4.e The wording of the question required an explicit reference to the scenario, but many candidates wrote generic responses. In other cases, the analysis was superficial.

4.f Many responses tended to be generic and failed to discuss the negative effects of cluster analysis and association analysis in the specified scenario.

Option B

The areas of the programme and examination which appeared difficult for the candidates

There were a large number of very descriptive answers that lacked the specificity and technical accuracy to score highly. This was also observed in May 2016.

Concerning many candidates appeared to lack an understanding of the mathematical notation such as misusing the mathematical symbols < and >. The very few mathematical prerequisites for Computer Science are given in the first pages of the subject guide, but it should be noted that these symbols are included in the 'Prior Learning' in the Maths Studies Guide (page 14).

Candidates often struggled to display evidence of computational/ algorithmic thinking. In many cases the variables could not be identified and the organization of data could not be presented clearly.

Most candidates know the theoretical differences between a mathematical model and a simulation, but fail to address how some elements could be considered when refining a model, or how to formalize this in mathematical terms.

The areas of the programme and examination in which candidates appeared well prepared

The majority of responses in this option demonstrated a good understanding of the differences between a model and a simulation. Some candidates also made intuitive decisions about modelling information on spreadsheets.

The strengths and weaknesses of the candidates in the treatment of individual questions

SL and HL questions: SL 4 - 6, HL 5 – 8

The question numbers in the information below are those on the HL paper

5.a This question was reasonable well answered.

5.b Many candidates were unable to reference cells in a 2D array.

5.c It was unfortunate that many candidates seemed unable to carry out the calculations required in this question.

5.d Many candidates were unable to demonstrate how the content of the missing cells were calculated.

5.e Most candidates made an attempt at writing pseudo-code but there were mixed results.

5.f Very few candidates were able to relate the definitions that had appeared have been rote learned to the scenario.

5.g Many candidates were unable to describe the benefits obtained from comparing the results obtained with the expected results.

6.a Many candidates produced a narrative rather than stating the relationship as required in the question.

6.b Many candidates produced a narrative rather than factors to consider when identifying suitable ranges as specified in the question

6.c Many candidates produced superficial responses that did not apply to the scenario.

6.d Some candidates did not understand that the model would inform the design and answered in terms of a control system.

7.a This question was well answered.

7.b Most candidates were able to show a good knowledge of the advantages of CAD.

7.c Most candidates were not able to identify the steps required in rendering.

HL questions

8.a Most candidates were able to outline the advantages of using NLP techniques.

8.b This question was well answered.

8.c The methods to derive a fitness function were not well understood.

8.d Most candidates only produced superficial knowledge of ANNs or provided narratives that did not use technical language.

8.e Very few candidates had an understanding of the differences between supervised and unsupervised learning.

Option C

The areas of the programme and examination which appeared difficult for the candidates

Some candidates appeared to have lost a considerable number of marks due to providing vague or repetitive responses, or by simply losing the focus from the Computer Science perspective.

In SL Question 7 (HL Question 9) that addressed the interaction with a web form, some candidates misread or misunderstood the program, describing steps in the program that did not exist, mixed up input and output ("the user inputs the image..."), and in some cases included irrelevant text ("...and then the user will be happy to receive their shoes at home, once delivered, and go for a run!").

Although the concept of collective intelligence is understood, many candidates were unable to develop a coherent discussion that addressed technical aspects as well.

The areas of the programme and examination in which candidates appeared well prepared

The majority of responses in this option demonstrated a good understanding of the P2P networks, the relationship between web crawlers and search engine optimization, and at HL, on power laws.

The strengths and weaknesses of the candidates in the treatment of individual questions

SL and HL questions: SL 7 - 9, HL 9 – 12

The question numbers in the information below are those on the HL paper

9.a Many candidates lost marks for repetition and vagueness. Other candidates tended to produce superficial responses that looked at the benefits from a marketing perspective instead of from that of system design or system architecture.

9.b This question was reasonable well answered.

9.c.i This question was reasonable well answered.

9.c.ii This question was reasonable well answered.

9.d.i Candidates tended to provide generic responses rather than using appropriate technical language.

9.d.ii Candidates did reasonably well, but some gave examples of an extra option which was not an example of scripting.

10.a Candidates had an understanding of the terms but many did not make reference to the scenario.

10.b Many candidates were able to describe the general working of a web crawler, but without reference to the scenario.

10.c This question was reasonable well answered.

11.a.i Some candidates demonstrated a general misunderstanding of “ubiquitous computing” with the everyday connectivity for mobile phones (that addresses the ‘anytime, anywhere’ concept).

11.a.ii Some responses did not refer to digital devices at all, while others showed repetitions between the two examples.

11.b Many candidates did not focus on the technical considerations of public or private cloud instead they only considered the suitability of one or the other for personal and/or sensitive data. Only a few responses provided a deeper and more technical discussion.

11.c This question was reasonable well answered.

11.d This question was reasonable well answered.

11.e Many candidates had a knowledge of protocols and standards. Many candidates focused on the socio-economic and cultural dimension rather than the computational aspects.

HL questions

12.a Most candidates provided reasonable responses, although in some cases the responses were vague and superficial.

12.b This question was reasonable well answered.

12.c Some responses simply described the multimedia web as the web “as we know it now, with all music and movies”. This is not sufficient, as it does not focus on the operations of search/retrieval that are triggered by an input (not just the output) that has to be multimedia in nature as opposed to plain text.

12.d Most candidates provided reasonable responses, although in some cases the responses were vague and superficial.

12.e Many responses were generic responses that could have been applied to any similar question. Candidates need to ensure they apply their knowledge to the specified scenario.

12.f Many responses demonstrated an understanding of collective intelligence but lacked the depth of analysis and articulated reasoning/elaboration required for a question that is at Obj 3 (AO3).

Option D

The areas of the programme and examination which appeared difficult for the candidates

Some candidates performed badly on the questions that addressed the basic concepts, such as understanding the concept of polymorphism.

Some candidates did not construct code in OO style when it was explicitly required, and used instead a form of pseudo-code.

Only a few students made reasonable attempts in addressing the last HL question, and some attempted it only in part. The consensus amongst the examiners was that candidates were running a bit short of time.

Many candidates did well in writing code such as the use of complex searches, but some lost marks for using either the incorrect data structures to retrieve information, or for using incorrect loops/iterations, incorrect boundaries, or by using int instead of double, or the inconsistent usage of data types throughout the code. This suggests that candidates are able to construct an algorithm or program that works, but without the focus or the fine detail of data structures that would be required to reach full marks.

The areas of the programme and examination in which candidates appeared well prepared

The majority of responses in this option demonstrated a good or very good level of conceptual understanding, and many also demonstrated a very competent application of concepts of OO programming. Some responses demonstrated sophisticated skills in programming,

There were many examples of programming using multiple complex structures, with many candidates achieving full marks.

The strengths and weaknesses of the candidates in the treatment of individual questions

SL and HL questions: SL 10 - 11, HL 13 – 16

The question numbers in the information below are those on the HL paper

13.a This was answered well in most cases, although some candidates were unable to differentiate between the two terms.

13.b Some candidates did not refer to two examples when explaining the principles of inheritance.

13.c This question was answered well.

14.a This question was well answered, although some candidates had syntax errors.

14.b Some candidates did not specify the nature of “private” variables or specifying accessibility from “outside the class”.

14.c.i In some cases the UML was incorrect with no relationship between boxes, and/or no 3-tier box organization, and/or no distinction between private and public.

14.c.ii This question was reasonable well answered.

14.d Most candidates were able to get the first two parts correct.

14.e Many candidates struggled with this question. Examples of problems were; an incomplete calculation of the new total was returned: the update was present, but the information to use for update was either incorrect, or incomplete, with an inconsistent use of dot notation.

14.f The loop was often incorrect, the data type for the total was int, despite it was previously declared as double. The calculation of the total was attempted, the update is present but the accessors might be incomplete.

14.g Most candidates answered this question reasonably well but there was an occasional loss of marks for using incorrect data structures.

14.h Most candidates answered this question reasonably well but some responses lacked detail.

14.i Most responses tended to be superficial.

HL questions

15.a This question was answered well.

15.b A few candidates got it right (or almost right), but many referred to the incorrect structures, and possibly using incorrect loop boundaries, obtaining programs that eventually are not a solution to the question.

16.a This question was answered well.

16.b Some candidates appeared to have run out of time when they reached this question. The majority of those who attempted this question provided reasonable descriptions or attempts, focusing on the dynamics, but a few others were just returning a post-order traversal that did not reflect in any way the dynamics of tracing.

16.c Some candidates attempted this question either using an iterative method or by using a recursive call. Marks were awarded, when there was evidence that the iterations were made on nodes, and these were specified correctly in the signature.

Recommendations and guidance for the teaching of future candidates

- Teachers and students must bear in mind that all options are comparable in standards of difficulty. Therefore, teachers should adopt a structured teaching methodology for the option they choose, regardless of which one it is.

- Many responses were extremely brief and suggested a lack of knowledge of the option. Teachers must ensure they allocate sufficient time to teach students the option.

- Algorithmic thinking and logical sequencing of ideas are critical skills that must be developed by students for them to be able to tackle the option with the required level of knowledge and understanding.

- Students need to be taught to use technical vocabulary at every opportunity. Generic terminology is not appropriate in a Computer Science examination.

- In some cases, candidates appeared to be running out of time at the end of the examination so time management skills should be practiced throughout the course.

- Many candidates do understand the relationship between the command term used (Obj 1 (AO1), Obj 2 (AO2) or Obj 3(AO3)) and the depth of the response required. Some responses to AO3 questions were superficial and no more than lists. Teachers need to emphasize the relationship between the command term used in the question, the depth of response required and the time that should be allocated to the question.

Higher level paper three

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0 – 4	5 – 9	10 – 11	12 – 14	15 – 17	18 – 20	21 – 30

General comments

This paper was based on the case study *Computer Science in Medicine* with questions being asked on fuzzy logic, NFC and RFID, interoperability, the introduction of electronic health records and the effect that new technology is having on doctors' roles.

The areas of the programme and examination which appeared difficult for the candidates

For many, the depth in terms of the computer science involved was lacking in their responses. This was particularly noticeable in Question 4.

The areas of the programme and examination in which candidates appeared well prepared

Most of the students appeared to have a reasonable general knowledge of the issues and the computer science addressed in this paper. There didn't appear to appear any terminology used in the questions that was not understood. This included the many new terms that were not part of the normal course.

The strengths and weaknesses of the candidates in the treatment of individual questions

1. This question was reasonably well-answered with most students being able to differentiate between Boolean logic and fuzzy logic. Some responses mistakenly focused on expert systems.

2. Marks were awarded for being able to put both NFC and RFID into the given context, with NFC providing the link between the device measuring the health data and a local computer/smartphone and RFID being used as a means of identification. There were a lot of general responses that didn't successfully identify the roles played by these two technologies and some in which the they were used interchangeably, although most students were aware of the benefits gained from allowing patients to be monitored at home.

3a. The focus in part (a) was on interoperability and the problems involved in making diverse systems interoperable. This question proved difficult to answer with many responses dealing with the more general issues and consequences of the introduction of EHRs instead of exploring issues related directly to interoperability.

3b. The focus in part (b) was on the application of Electronic Health Records, with the assumption being that the system is at least partly in place. As this was a discussion question, students were rewarded for their ability to consider at least 3 issues in depth (including at least one advantage and one disadvantage). Most students were able to identify at least 3 issues but were not always able to provide enough depth to their answers.

4. The extended response question in HLP3 always links in relevant computer science with a question that requires students to discuss a specific aspect of the case study (and one that is hinted at in the Challenges section). In this paper it was the effect that technology is having on the roles of doctors and surgeons.

Many of the responses focused on the probability of doctors actually losing their jobs and, interestingly, earning less money. The better responses, however, considered how their role would be changed with the introduction of technology. They discussed the additional elements that would have to form part of their training such as being able to apply new technology and the way that technology would support their roles.

There were some very good responses that discussed several technologies giving each time detail about how they work at a computer science level and the consequent effects that each would have on doctors. The majority, however, gave a more general overview which showed a certain degree of knowledge but not necessarily the understanding.

Recommendations and guidance for the teaching of future candidates

- Schools are reminded that the inclusion of text verbatim from the case study in a response will not on its in gain any credit. It was noticeable that this issue was not as much of a problem as in previous years but it still happened.

- Schools should also impress on students that this paper is an opportunity to demonstrate their understanding of the computer science involved in the specific area of study that is addressed each year. Each case study clearly identifies this science and the onus is therefore on the students to explore it in depth so that they can apply this understanding to the paper they will sit.

- Several responses made reference to some local issue related to the case study which showed that some school had including visits to hospitals or had arranged visits by specialists as part of the teaching strategy. It is strongly recommended that all schools take up this approach which helps to put the computer science in each year's case study into context thereby increasing the students' overall understanding of the various issues.