May 2015 subject reports

Computer Science

Overall grade boundaries

Higher level

Grade:	1	2	3	4	5	6	7
Mark range:	0–14	15–28	29–38	39–47	48–56	57–65	66–100

Standard level

Grade:	1	2	3	4	5	6	7
Mark range:	0–14	15–29	30–42	43–51	52–60	61–70	71–100

Internal assessment – combined (HL & SL)

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0–7	8–14	15–20	21–24	25–29	30–33	34–40

Generally the work submitted for Internal Assessment moderation followed the instructions as laid out in the Computer Science Guide and the Handbook of procedures for the Diploma Programme 2015, section B4.4.

Some recommendations from the Principal Moderator:

- One CD/DVD/USB drive should be submitted per candidate in the sample.
- The teacher should check each CD/DVD/USB drive for functionality and content.
- 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, for example when the product is being developed on-line, the product folder should contain screenshots of the product being created.
- The video / screencast should be 5–7 minutes (maximum) and should only show the proper working of the final solution – the use of techniques should be described in criterion C using extended writing. It is suggested that students use their Criteria for Success (criterion A) and their test plan (criterion B) to script the screencast.
- Even though it is not a requirement, teachers are asked to provide pertinent comments on how they awarded marks to the candidates in their sample. This facilitates the moderator's validation of the teacher's marks.

The range and suitability of the work submitted

The described scenarios typically allowed for worthwhile projects. As expected, the majority of solutions concerned 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 that the range of solutions continues 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 candidates. Some examples of trivial products include: Java programs that mainly focus on GUI and not on actual functionality, rudimentary versions of freely available games (like Sudoku), Access databases that contain only one or two tables or non-relational tables, websites that are template-based (Wordpress or Weebly) or that have minimal content, basic Excel projects, Scratch projects that had not been properly designed.

High scoring solutions incorporated features from more than one 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.

A Planning – This remains the most straight-forward criterion. However, several candidates did not follow the expected sequence:

- investigate a situation,
- identify client/adviser,
- explicitly consult the client (and/or adviser),
- describe the scenario with reference to the consultation,
- choose a solution,
- describe the rationale for the solution and also for the software to be used,
- outline Criteria for Success for the chosen solution.

Too many students decided on a product ("I want to make a website/program a game") and then found a client to match. Some schools adopted a standard approach where the teacher was the client, setting a task for the student. These approaches should be discouraged. Contrived tasks and clients were routinely seen in the weaker pieces submitted. Too many students had generic success criteria – these criteria must be specific and testable. The Criteria for Success are essential to the project and must be explicitly addressed in the test plan and in the evaluation (and preferably also in the video).

B Solution overview – Comparatively this was the worst addressed criterion, and students typically only provided an outline design 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. Records of Tasks were generally only partially complete, typically because the final product had not been implemented by the client. A wide variety of test plans were seen. The better ones aligned with the Criteria for Success. NOTE: The use of the proper template in forms.zip is mandatory

C Development – Most candidates made a good attempt to document the development of their product and the techniques used. However, the quality of the explanations and the completeness of techniques typically left 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 ingenuity must be justified by algorithmic thinking (e.g. explanations of complex data structures, algorithms or macros).

D Functionality and extensibility of product – The video should only show the proper working of the solution as outlined by the Criteria for Success. Many videos focused instead 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. Very few videos were in formats that were not recognized by major video software or did not play audio properly.

E Evaluation – The final product (after testing) is expected to be implemented and used by the client before client feedback is given. For full marks evidence of feedback should be included (typically in the appendix) and referred to in the candidate's evaluation against the Criteria for Success. 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 the teaching of future candidates.

The aim of the IA in Computer Science is to create a working solution for a real client. The consultation (which should be included as an appendix) should be the basis for the description of the scenario, leading to Criteria for Success of a chosen solution. All high scoring projects showed ample evidence of client involvement.

Criterion B should provide evidence of a rigorous design stage with an overview of all five stages of the project (including the actual intended use of the product by the client) in the Record of Tasks, detailed layout design sketches that include annotations for complex techniques, evidence of algorithmic thinking (e.g. 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 Criteria for Success. High scoring projects included a thorough design stage.

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

Criterion D does not require written documentation. The video should be about 5 minutes and should only show the proper working of the final version of the solution. The structure of the video should be scripted by the candidate. For example, the video could show the testing of the implemented solution following the test plan from criterion B. Successful videos showed comprehensive evidence of the solution's functionality with lots of data, but were edited to avoid viewing tedious data entry. Candidates are advised to test their videos on different media players and devices to ensure the playback is correct.

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

Criterion E should provide evidence of a rigorous evaluation stage. The client feedback (added in an appendix) should be used to inform the candidate's own evaluation of the solution against the Criteria for Success. 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 criteria A, D and E.

The recommended word count **for each section**, as indicated in the TSM, is only for guidance. The **overall** word count of 2000 words however, is a fixed limit and a moderator is not required to read beyond this limit, which could cause a loss in marks in criterion E.

Further comments

For additional information about the Computer Science Internal Assessment, please consult:

- Computer Science Guide (pages 56–72).
- Teacher Support Material (Internal Assessment).
- Forms.zip templates.
- Submission of the Computer Science IA in the Handbook for Procedures for the Diploma Programme 2015 (Section B4.4). Note that the Handbook is updated yearly.
- IB Coordinator Notes.

For additional professional development regarding the Computer Science IA, please consider:

- Getting involved in the Computer Science OCC discussion forum.
- Registering for Computer Science workshops (either face-to-face or online).

Paper One – Higher Level

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0–12	13–25	26–32	33–40	41–49	50–57	58–100

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

Constructing algorithms proved difficult to some candidates. Responses to questions 9(a) and 13(b) ranged from poor to excellent.

Some candidates did not pay attention to the marks allocated to each question and answer accordingly. Some candidates wrote rather short answers while others wrote far more that the mark allocation would suggest and without addressing the significant points.

Candidates find it hard to focus on “discussion” questions (for example, questions 12(c) and 12(d)) and “comparison” questions (for example 11(d)). Most candidates had enough knowledge to attempt all of the questions. Often their knowledge and understanding of a topic was evident but the discussion was insufficient to earn full marks.

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

There were some excellent responses to every question in this paper. It seems that the syllabus coverage in most schools is very good.

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

Question 1

Most candidates described one way that software developers could ensure that users were aware of any available updates for their products.

Question 2

Only a few candidates were not able to construct the truth table.

Question 3

Most candidates outlined one example of the use of a virtual private network.

Question 4

Most candidates correctly traced the given algorithm.

Question 5

Some candidates correctly listed results after each of the five passes. Some candidates confused selection sort with bubble sort.

Question 6

Most candidates knew that GPS works by communication with satellites. Some candidates failed to achieve full marks as result of incomplete and vague descriptions.

Question 7

Most candidates who attempted this question did either very well or very poorly.

Question 8

In part (a), only a few candidates did not state the order that the nodes are listed using the postorder traversal. In part (b) some candidates failed to sketch correctly the updated binary tree.

Question 9

In part (a), most candidates attempted to construct the algorithm, some of them showing that their skills and understanding were good. A few candidates had difficulties in constructing this algorithm.

Many candidates neglected the number of marks assigned to each question. Some candidates wrote very brief answers to part (b).

Questions in parts (c) and (d) were answered well by the majority of candidates.

Question 10

Parts (a) and (b) were well answered. Most candidates were able to outline the concept of the OSI model and the function of protocols in communication across a network. Part (c) was well answered.

In part (d) some candidates confused data structures with application programs. Part (e) suffered from vague, general and ambiguous answers.

Question 11

The features of the link list were described well. Most candidates provided a diagram of a linked list with correct data and links.

The majority of candidates were able to construct the algorithm to convert time given as the number of minutes since midnight in 24-hour format.

Most candidates seemed to have studied ADTs well and were prepared for the questions in part (c) and part (d).

Question 12

In part (a) most candidates were able to outline the role of sensors and a microprocessor in controlling the traffic lights. Many vague answers to part (b) were written.

In responses to part (c) and part (d), many candidates wrote far more that the mark allocation would suggest without addressing the significant points.

Question 13

Most candidates knew that the moves are needed in reverse order to the order in which they were input. They were able to explain that a stack is an appropriate data structure because it

is a LIFO data structure and the moves pushed onto the stack will be popped off the stack in reverse order to the order input.

Answers to part (b) vary from poor to excellent. Some candidates have excellent problem solving skills and they answered this question and all other algorithm related questions very well.

Most candidates were able to correctly complete the table by tracing the algorithm that was given in part (d).

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.

Candidates should analyse questions in order to determine what is being asked and they should pay attention to number of marks allocated; this should help to indicate the length and level of the response.

Candidates should be familiar with computer science terms and write answers that contain computer science and **not** general observations.

Paper One – Standard Level

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0–8	9–16	17–24	25–30	31–36	37–42	43–70

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

Gaps in some specific parts of the curriculum, such as usability, OSI and VPN, were evident even in some of the better responses. A significant number of candidates were not able to construct an algorithm, neither in pseudocode nor as a set of steps. These questions were sometimes not even attempted.

Many candidates did not spend time reading the questions in section B carefully and hence gave responses which were not relevant.

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

Constructing a truth table and tracing an algorithm were both well done by many candidates. Backup and advantages/disadvantages of wireless connection were well understood.

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

Question 1

This question was mostly well done, with one or two errors.

Question 2

Those who did not know guessed from the words “virtual”, “private” and “network”. Often answers were vague, talking about networks in general.

Question 3

Abstraction was known by most but they were not able to put it in context of sub-procedure, which seemed to be an unknown term.

Question 4

This question was mostly well done.

Question 5

It is evident that the term “usability” is not covered in many schools.

Question 6

This question was generally well done, showing experience with update messages.

Question 7

Surprisingly there was a significant number of candidates who could not extract the list of tasks and/or did not correctly identify concurrency.

Question 8

Part (a) was a challenging algorithm for many. Very few explained the calculations necessary to discern early from late payment.

In part (b), candidates gave lots of general knowledge with little Computer Science details given.

The answers to part (c) tended to be either good or vague: “will lose everything and do not know whether or not payments have been made” for both client and company.

In part (d), backup systems and secondary storage were identified but with rare details on timing and restoring methods.

Question 9

In part (a), the OSI system was not always familiar to candidates.

Similarly, in part (b), protocols were not always familiar, although most could give an example.

Advantages and disadvantages of wireless networking, in part (c), were fully understood but answers were rarely in context, restricted to “can be hacked” for a disadvantage and a significant number of candidates read the question as meaning wireless would replace the current cabled system.

In part (d), many of the answers were simply a rewrite of the question. Again, careless reading of the question meant that most candidates set up a system for maintaining the queue rather than finding the next job to print.

Question 10

The similarities and differences between bubble sort and selection sort, in part (a), were poorly attempted by candidates.

Hence, in part (b), not many were able to justify that selection sort was better for finding the 10 fastest.

In part (c), there were some good algorithms using selection sort and a few good bubble sorts followed by transferring the first 10 from TIMES to FASTEST.

Those who attempted part (d) generally answered this part well enough to get 2 or 3 marks.

Recommendations and guidance for the teaching of future candidates

- Introduce problem solving at the beginning of the course as well as throughout.
- Develop computational thinking skills through the mediums of flowcharts, pseudocode and coding.
- Ensure these skills are used frequently to tackle problems in all areas of the programme.
- Use frequent tests and past examination papers to enhance the examination taking skills.
- Stress the importance of reading a question carefully and defining the problem to be solved before attempting the solution.

Paper Two – Higher Level

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0–11	12–22	23–28	29–33	34–38	39–43	44–65

Paper Two – Standard Level

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0–7	8–15	16–20	21–24	25–28	29–32	33–45

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

Option A

Many candidates did not have adequate ability to write well-structured answerers or lacked understanding of specific theory related to databases.

The role of normalization and the ability to construct related tables was poorly understood.

Many candidates were not sufficiently familiar with database concepts relating to data warehousing: multi-dimensionality, data mining, data deviation and ETL.

Option B

In general students did not seem prepared to answer questions in a well set out, detailed and specific fashion.

Evaluating and testing of a model should be focused on.

HL P2 candidates found question 7 and question 8 the most difficult. The terms visualisation and rendering were not well understood. In question 8, neural networks, speech recognition, speech synthesis, natural language recognition and cogitative and heuristic approaches, were not well understood. The operation of a genetic algorithm was also not well understood.

Option C

Page rank theory and Black Hat techniques were not well explained by many students.

The concepts of Open Standards and Interoperability was not well understood.

Knowledge of directed graphs, web crawlers and bowtie structures was limited in many instances.

Many candidates were unaware of the concept of an Ontology and how it may apply in the given context.

Option D

Ethics related to project teams could be better addressed, it seems that candidates do not appreciate the difference between a project teams' responsibilities and those of the client (Library).

Concept of static variables, as an OOP technique, could be better understood.

Characteristics of binary trees and linked lists were not well understood by the majority of candidates.

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

Option A

A number of candidates were reasonably well prepared to address basic database concepts.

A small number of candidates understood normalization techniques so as to create tables.

Option B

Candidates were reasonably well prepared to address question 5 in HL P2 (question 4 in SL P2), being able to determine the variables, but often the setting out of answers was poor and made it difficult to award full marks.

Pleasingly, students were able to address the longer questions (question 6(d) and question 7(d) in HL P2) , but attention needs to be made to setting out the answer.

Students were able to address the hardware and software needs of running a game simulation in HL paper 2 question 7(c).

Option C

General concepts of web protocols and standards were reasonably well understood.

Students showed understanding of file compression, Web 2.0 and cloud services.

Only some candidates appeared well versed in the role of web directed graphs, crawlers and bowtie structures.

Many candidates demonstrated good understanding of ambient technologies.

Option D

Students were able to construct and trace algorithms, and the use of appropriate syntax was typically good.

General OOP concepts were reasonably well understood: inheritance, polymorphism etc.

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

Option A

Question 1 Higher Level Paper 2 / Question 1 Standard Level Paper 2

In part (a), many students addressed the idea of the code on its own being data and the email representing information, and clearly outlined the differences.

In parts (b) and (c), many students were able to explain what a transaction is and how it maintains database consistency; part (d) was equally well answered.

In part (e), candidates often poorly structured their answers and did not clearly refer to two stakeholders. Many understood the idea, and the benefits, of database data sharing.

Question 2 Higher Level Paper 2 / Question 2 Standard Level Paper 2

In parts (a) and (b), candidates could outline the role of a database administrator and also a data dictionary.

In part (c), many candidates did not address different users, or focused only on one. The precise nature of the concept of database view needs to be made clear in teaching; often candidates gave answers that were vague and showed a lack of specific understanding.

Question 3 Higher Level Paper 2 / Question 3 Standard Level Paper 2

In part (a), many candidates were able to outline why the table was not in normalized form, identifying blank cells or multiple entries.

Part (b) was reasonably answered, but often answers were vague and lacked specific knowledge of the advantages of normalization.

Most candidates were able to address part (c) correctly, explaining why totalprice could not be a primary key, identifying that it was not unique.

In part (d) a large number of candidates did not seem to understand that “Description” needed to be split, possibly not understanding the theoretical term 'atomic'.

Parts (e) and (g) were poorly answered and considerable effort should be made to address this lack of knowledge to decompose related tables. Progression from 1NF to 2NF to 3NF is clearly outlined in the subject guide.

Part (f) was reasonably attempted, indicating that many candidates had been taught theory but often could not answer more application level questions (see above). Teachers need to address both the theory and how to apply it in problem-solving situations.

Question 4 Higher Level Paper 2

In part (a), a number of candidates identified time and location as additional dimensions, but on the whole many candidates lacked sufficient understanding to relate to the specifics of the questions.

Candidate responses to part (b) were mixed. An issue here was the poor structuring of responses. Data mining was often not specifically referred to, instead candidates gave vague suggestions.

In part (c), a number of candidates were able to describe how data deviation can be used.

In part (d), candidates knew there were differences, but often answers were poorly structured and lacked specific detail.

In part (e), candidates demonstrated some knowledge of the need to convert data sets into compatible formats, but did not address (e)(ii) particularly well, often due to poor structure in the answers.

Option B

Question 5 Higher Level Paper 2 / Question 4 Standard Level Paper 2

Part (a) was reasonably done, although candidates were often not specific, or did not focus on Collecting and Recording.

In part (b), many candidates identified the variables and set out their answers clearly.

In part (c), candidates identified a suitable software type, but often lacked specifics about the way the data would be laid out and processed.

Part (d) was not well done; candidates did not focus on testing how the simulation performed.

Question 6 Higher Level Paper 2 / Question 5 Standard Level Paper 2

In part (a), candidates were able to clearly identify the four factors.

In part (b), many candidates missed the word "presented" and hence did not answer the question with reference to a graphical representation and/or how to show patterns.

In part (c), candidates lacked specifics but often described the process.

In part (d), candidates were able to identify advantages like being able to take corrective action and disadvantages by considering the limits of models.

Question 7 Higher Level Paper 2 / Question 6 Standard Level Paper 2

Responses to part (a) were not well defined. It was clear that candidates were not well prepared for this theoretical aspect where visualization has a specific meaning.

In part (b), candidates understood the role of lighting to produce 3D images, but often lacked a more detailed knowledge of rendering.

In part (c), candidates were able to outline the software and hardware, but often did not attempt to outline the specifications e.g. high speed CPU. Many included keyboard and mouse, which in this context are not relevant.

In part (d), students were able to use direct experience and answered this question well. It should be noted that in “discuss” questions a conclusion is expected.

Question 8 Higher Level Paper 2

Part (a) was not well answered; candidates seemed to be unable to explain the roles of hidden units and weights.

In part (b), the notion of compare and contrast seemed to not be appreciated; often candidates did a good job describing OCR and speech recognition, but as such did not answer the question.

Part (c) was reasonably well addressed, but the question asked candidates to “distinguish” and many only “outlined”.

Part (d) was not well done; the theoretical differences between cognitive and heuristic approaches were not well understood.

Despite its difficulty, many candidates addressed part (e) well, showing an understanding of the parameters of a timetable problem and the possible way that a genetic algorithm could approach finding a possible solution.

Option C

Question 9 Higher Level Paper 2 / Question 7 Standard Level Paper 2

Parts (a) and (b) were well done; many candidates understood the differences and similarities between HTML and HTTP.

Part (c) was reasonably well attempted, but answers often lacked clear detail.

Part (d) was poorly answered; many candidates could not show an understanding of matching the fields to the fields in a database record.

In part (e), most candidates knew that the domain name server would try to resolve the address, but did not address what would happen if this was unsuccessful.

In part (f), candidates made a reasonable attempt of distinguishing between standard and protocol (i), but did not address with specific reference to ONE protocol and standard in part (ii).

Question 10 Higher Level Paper 2 / Question 8 Standard Level Paper 2

In part (a), many candidates did not clearly address the specific purpose of a Page Rank.

In part (b), many candidates could not adequately identify two factors.

The role of meta-tags was reasonably understood in part (c).

In part (d), candidates often knew some of the Black Hat theory but did not structure answers well nor address three examples.

Question 11 Higher Level Paper 2 / Question 9 Standard Level Paper 2

Candidates answered part (a) well by identifying audio and picture files.

In part (b), candidates were not able to adequately describe the difference between open standards and interoperability. The key idea is that interoperable allows different computer systems and/or components to work together, whereas open standards are freely available software to perform specific functions.

All candidates attempted part (c), but many failed to address specifics and provided vague rambling outlines of their personal use of social media.

In part (d), candidates understood the issues of cloud computing but often failed to either address both aspects, or gave poorly structured answers.

Question 12 Higher Level Paper 2

In part (a), many candidates did not understand the role of a web access path directed graph.

A number of candidates knew the theory of bowtie structures and answered part (b) well.

In part (c), most candidates knew what web crawlers did but many could not explain the recursive algorithm.

Question 13 Higher Level Paper 2

The concept of ontology was poorly understood, but a number of candidates appreciated that the publisher could develop their own standard of tags.

Question 14 Higher Level Paper 2

This was usually well attempted by the candidates.

Option D

Question 15 Higher Level Paper 2 / Question 10 Standard Level Paper 2

Many candidates answered part (a) well, recognizing OOP features that aided the team: reduced coding, good testing etc.

In part (b), candidates often concentrated on issues that were not the project team's responsibility e.g. level of fines etc. Candidates are expected to understand ethical issues and relate them to a specific group rather than a broad group of users and developers.

Encapsulation is well understood and part (c) on the whole was well answered. Candidates should note that [3] marks will usually equate to 3 separate points. Candidates need to be encouraged to answer questions in full e.g. private [1], prevent outside access [1], prevent accidental data changes [1].

Part (d) was a simple question that on the whole was well answered.

Part (e) was not well done; some candidates knew about class only variables but most thought static variables were either restricted in access or functioned as constants.

Question 16 Higher Level Paper 2 / Question 11 Standard Level Paper 2

Part (a) was on the whole very well done, demonstrating candidates could read and trace algorithms.

Part (b) was reasonably well attempted, although a check for null was regularly omitted. Candidates on the whole were able to write Java style algorithms; teachers need to stress to candidates that error conditions should be included for full marks.

Part (c) was reasonably well done.

Part (d) was poorly done.

Question 17 Higher Level Paper 2 / Question 12 Standard Level Paper 2

In part (a), identifying initial requirements was well done by a large number of candidates.

Part (b) was well done by those candidates that understood the term attributes as a variable.

In part (c), many candidates could construct basic UML diagrams, with lines linking each component. However, candidates were not able to include arrows or indicate the type of link.

In part (d), a few candidates reused the idea of the static variable, while others simply processed the borrowers array.

Question 18 Higher Level Paper 2

In part (a), while candidates did understand the issue they often were not able to adequately describe the factors that caused slowness.

Part (b) was answered well by candidates that selected a Binary Tree.

In part (c), the features of a linked list were not understood by a large number of candidates; the notion that the data structure was dynamic but inefficient to search using only a linear search.

Part (d) was poorly answered; candidates did not seem well versed in the basic algorithmic forms for a linked list, in terms of low level reference (pointer) manipulation or higher level use of methods from the LinkedList class shown in JETS.

Recommendations for the teaching of future candidates.

Clearly, candidates need to know the basic theory and it is recommended that this be the first step in teaching the course, linking to specific applications. For example, students cannot answer question on “visualisation” unless they know the specific way that this term is being used.

Candidates need to be prepared more thoroughly in how to structure answers clearly so as to answer the question. The amount of marks given to a question should guide the length of the response and the number of clear points that are made.

Finally, poor handwriting should be addressed as marks can only be awarded if the response is understood. Candidates with extremely poor handwriting should seek guidance as to whether they are able to word process their responses.

Paper Three – Higher Level

Component grade boundaries

Grade:	1	2	3	4	5	6	7
Mark range:	0–3	4–7	8–10	11–13	14–16	17–19	20–30

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

Higher Level Paper 3 is a paper that demands significant research on the part of the candidate, guided, of course, by the class teacher. When it comes to answering questions, the focus throughout the paper is on the depth of understanding of the subject material. This depth was not shown by the majority of the candidates. This is not a paper that can be answered successfully with general knowledge acquired through brief encounters with the material, but only through a well-planned course which places sufficient emphasis on the candidates' own responsibility to research the case study in depth.

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

Most candidates displayed at least some superficial knowledge of the case study topics, which allowed them to pick up descriptive marks where they were available, particularly in the first question.

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

Question 1

This question was reasonably well-answered. This question will always deal with definitions or brief descriptions of the terms that are listed at the end of each case study in the section named "Additional Terminology", and it was clear that candidates were familiar with these terms. Many referred to passwords instead of encrypted text in part (a); these are not necessarily synonymous. Candidates should not copy out sections directly from the case study unless they include further explanations.

Question 2, part (a)

This question was reasonably well-answered. There were several areas in which security and usability are in conflict and most candidates managed to relate their answers to one of them. However, many candidates generically mentioned "mobile banking" as an example, without further elaboration.

Question 2, part (b)

This question showed that few candidates actually understood why both types of encryption were used. Most were able to relate some correct facts about each, but the majority of marks went to showing an understanding, which was not always there.

Question 3, part (a)

This question dealt with a specific type of attack, but many answers were very generic describing the general purpose of attacks – stealing data/impersonation etc. – without specifically focusing on Man-in-the-Browser.

Question 3, part (b)

Most candidates correctly identified out-of-bound verification although not all could explain it. Many candidates did not seem to know the difference between the authentication and verification, and used these two terms interchangeably.

Question 4

As with May 2014, this question was in general poorly answered with very few reaching the top mark band (9–12). The areas under discussion were technology, security, availability, cost and usability, and most responses touched on some of these areas, but usually with only a descriptive answer. For example, it is not enough to outline the security features of each (or lack of) without then explaining why or how one is better than the other. Many candidates wrongly believed that the wording of the question suggested that QR codes must be shown to be better in all areas. The final conclusion should have been used to provide a balanced judgement based on the previous discussion which may not have been completely in favour of the final choice.

The *Challenges Faced* section in the case study highlights where candidates should focus their research in preparation for these 12 mark questions.

Recommendations for the teaching of future candidate

It cannot be stressed enough how important it is to plan for this paper a year in advance. The case study is published on the Online Curriculum Centre's website each May, twelve months prior to the May examination, and it is then that the HL P3 preparation should begin. Teachers who run a normal two-year course are able to take the opportunity provided to them by the days at the end of year/semester to give the students an overview of the material and possibly preliminary studies to be undertaken before the start of the new school year. Although each case study is different, the structure remains the same, therefore the same planning can be used each time. One possible way to start is to get the students to contextualize the various terms and ideas, many of which will initially be unfamiliar. Getting the class to construct mind maps linking these terms and ideas is one possibility. Dividing up the additional terminology amongst the class and setting them research over their vacation is another. This part of the course is allotted 30 hours which should be divided up throughout the final year although it is envisaged that research undertaken outside of the classroom will feature heavily.

This paper clearly rewards those students who are prepared to research in depth the various areas in the relevant case study and who are able to demonstrate their understanding in the examination. This should be made clear to each cohort of students