COMPUTER SCIENCE

Paper 9608/11
Written Paper

Key messages

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General comments

It is very important that the question stem is read carefully and the key words highlighted. Some of these key words will indicate the type of answer required, either a single statement or a more extended response, and others will indicate the context in which the question has been set. Identifying and understanding these key words will help candidates to give more appropriate answers to the questions. Several of the questions on this paper, for example, **Question 1(b)** and **Question 5** required answers in a particular context and generalised answers or answers in a different context were unacceptable.

There is considerable confusion between the terms *data* and *information* and between the terms *bits* and *bytes*. Candidates need to be aware of the difference and make sure that they use the correct terminology when answering questions.

Comments on specific questions

Question 1

Please see the comments in the **General** section above regarding both parts of **Question 1(b)**.

(a) Candidates found this question challenging. Whilst most candidates were able to describe the use of bit streaming in general terms, only a few candidates explained what bit streaming is in sufficient technical detail. It is insufficient to give vague answers such as '*sending the data bit by bit*', which could apply to many other scenarios and is not specific to bit streaming.

(b) (i) This question was very well answered. The majority of candidates were able to give two benefits of using bit streaming. However, candidates should take care to ensure that their answer is given in the context of the question. In this case, streaming a film from a website to a tablet computer.

(ii) Many candidates were also able to give two potential problems of using bit streaming, although there was some confusion between bandwidth in terms of download speed and individual data allowances for downloading. There is a need for greater precision in responses; '*bad internet*' is simply too vague to be awarded a mark at this level of study.

(c) Overall, there was a good understanding of the differences between on-demand bit streaming and real-time bit streaming in general terms. However, there is a need for greater understanding of the more technical differences between them.

Question 2

(a) Many candidates correctly named all three buses. The most common error was to reverse the answers for the address bus and the data bus through not recognising that the data bus was bi-directional.

(b) The majority of candidates found this question very challenging. The special purpose registers within the processor have very clearly defined roles that candidates would be expected to know. This is the type of question on a computer science question paper that needs a very precise answer and the use of the correct technical terminology is essential. There was a great deal of confusion between instructions and data and between the address of a memory location and the contents of the location. Imprecision in the use of language also needs to be addressed. Registers *hold* or *store* values they do not *execute* and the Current Instruction Register (CIR) holds or stores the single current *instruction* being executed, not plural *instructions*.

Question 3

(a) This question was well answered. The most common error was to tick the first row as well as, or instead of, the second row.

(b) (i) The majority of candidates recognised that http was the protocol being used and that computerscience.html was the web page or file being requested. Some candidates recognised the cie.org.uk as the domain name, although a common mistake was to try to expand the domain name into its constituent parts and explain what each individual part represented.

(ii) A small number of candidates correctly identified the functions of the characters. A common mistake was to assume that the %20 meant that 20% of the web page would be downloaded.

Question 4

This question was very well answered; the majority of candidates could recognise which were ethical and which were unethical behaviours. The most common single error was to assume that turning down job opportunities in the day job was unethical.

Question 5

Please see the comments in the **General** section above about context. This question was set in a very specific scenario.

(i) Many candidates failed to identify with the scenario in this question, and unfortunately omitted to realise that the monitoring needed to be continuous. Answers such as '*when the sensor detects seismic activity it will send data to the computer system*' were common. Some candidates did realise that there would need to be some processing before a decision could be made whether any activity was above 3 on the Richter Scale, but there needs to be greater understanding that answers to questions of this type will not follow a standard pattern but will need to be adapted to the scenario given.

(ii) Generally well answered. Most candidates were able to give a reason why hard copies were not the best way to inform operators of increased seismic activity.

(iii) Also very well answered, with the vast majority of candidates able to offer a sensible alternative warning device for the monitoring system with a good reason for their choice.

Question 6

This question required an implicit comparison; at this level of study these comparisons must be justified. It is insufficient to say, for example, '*fibre optic cable is better/faster/more expensive than copper cable',* there needs to be some justification of why fibre optic cable is better/faster/more expensive than copper cable. Many candidates could state two benefits of fibre optic cable, but some candidates found it more challenging to list benefits of copper cabling.

Question 7

(a) (i) This question was well answered and many candidates were able to describe that the server provided services that were requested by a client. Some candidates answered in terms of specific situations such as web servers or file servers, which were accepted if correct.

(ii) This part question was also very well answered. The majority of candidates understood that the client-server model made resource sharing possible and improved security. Candidates need to take care with terminology. Shared access to *data* is implemented, not shared access to *information*.

(b) The majority of candidates answered this question correctly.

(c) The majority of candidates answered this question correctly.

Question 8

(a) There were many completely correct answers to this part question. The most common causes of error were to either confuse the image resolution, the image file header and the screen resolution, or to reverse bitmap graphic and vector graphic.

(b) (i) There were many correct answers to this question. Candidates need to understand that when a value is given in the question, that is the value to be used to obtain the answer. The question clearly stated that 1 KB = 1024 bytes, yet a number of candidates divided their answer by 1000. Another common error was to add 54 bytes for a file header; this was not required in the question. Several candidates who correctly stated that the number of bits would be width * length * bit depth then gave the incorrect answer because they used a bit depth of 2 for a monochrome image.

(ii) Many candidates gave very good answers to this question, however some candidates need to understand that at this level responses such as '*we need to estimate the file size in order to know how big it is*' are insufficient to gain a mark.

Question 9

(a) Most candidates were able to give examples of verification and validation checks but candidates need to understand that neither verification nor validation will ensure that the data is correct. Verification ensures that it matches the original source, but that source may not be correct or accurate. Validation ensures that data matches required criteria and is sensible, but also does not check that the data is correct or accurate.

Responses that simply reworded the stem of the question were common, such as '*verification is to verify*...' or '*validation is to make sure that the data is valid…'*. This is much too imprecise to gain credit at this level of study.

(b) The majority of candidates recognised what was meant by parity, although descriptions of a parity check were sometimes muddled, with candidates confusing parity bits and parity bytes. A common misconception was that the parity bit was set to 1 if the number of 1 bits in the byte was odd, or set to 0 if the number of 1 bits was even, regardless of whether even or odd parity was being used.

Question 10

(a) This question was very well answered, with nearly all candidates able to describe a computer virus.

(b) This question was also very well answered, with the majority of candidates able to give two examples of when a virus checker should perform a check.

Question 11

This question was also very well answered, with many candidates able to complete the table correctly. The most common mistake was to confuse the two pieces of software and to completely reverse the entries in the table.

COMPUTER SCIENCE

Paper 9608/12
Written Paper

Key messages

Candidates should be encouraged to write their answers clearly in the spaces provided on the question paper. If there is insufficient space, candidates may use additional sheets or blank spaces within the question paper, but there is a need for an obvious indication that the answer is continued somewhere else. It is also essential, particularly in questions that require a calculation, that candidates indicate in some way the answer which is to be marked.

JavaScript has appeared on this paper for the first time this session. The best way to prepare candidates for questions on this topic is by exposing them to some practical work developing simple web pages that include some straightforward JavaScript code.

General comments

It is very important that the question stem is read carefully and the key words highlighted. Some of these key words will indicate the type of answer required, either a single statement or more extended response, and others will indicate the context in which the question has been set. Identifying and understanding these key words will help candidates to give more appropriate answers to the questions. Several of the questions on this paper, for example, **Question 4(a)**, **Question 8** and **Question 10(a)** required answers in a particular context, such that generalised answers or answers in a different context were unacceptable.

There is considerable confusion between the terms *data* and *information* and between the terms *bits* and *bytes*. Candidates need to be aware of the difference and make sure that they use the correct terminology when answering questions.

Comments on specific questions

This question proved challenging for many candidates.

Question 1

(a) Candidates need to improve their understanding of what is meant by media in the context of storage devices. A common mistake was to confuse media in this context with media in the context of sound, video, etc. and to describe how these could be saved on each of the storage devices, instead of identifying the type of physical material used in each device.

(b) The question says '*describe the internal operation...*' and some candidates were able to describe the operation of the devices in question. The majority of candidates, however, need to improve their understanding of the operation of these devices, and of the differences between them. At this level of study, it is insufficient to say for example '*data is read and written using a laser*', there needs to be an appreciation that different powered lasers are used for the read and write operations.

Question 2

(a) There were some very good answers to this question, with candidates able to describe in detail the operation of a laser mouse. Some candidates need to appreciate that it is not the mouse device that moves the cursor on the screen, the cursor movement is software controlled.

(b) The majority of candidates gave the correct sequence of actions. The most common mistake was to reverse the positions of step 1 and step 2.

Question 3

It is appreciated that candidates may need space to work out the answer to questions such as **Question 3** and so there is plenty of blank space available in the question paper. Some candidates put their working in the answer space and so obscured the answer. The number that is to be marked as the answer should be clearly visible.

(a) (i) The majority of candidates correctly converted the binary value to hexadecimal and many also correctly included the subscript and gave the answer as $46C_{16}$. The most common error was to include a leading zero in the answer, which was not required as the value to be converted had been given in 12-bit binary.

(ii) Most candidates were able to correctly convert the denary value to binary.

(b) (i) Many candidates realised that with just two colour options only, a single bit was required to store each pixel. A common misconception was that 2 bits would be needed, one for black and one for white.

(ii) There was some confusion here over what was meant by a 256-colour bitmap. Candidates who realised that it meant that each pixel could be any one of 256 colours generally also realised that each of these colours could be represented by an integer from 0 to 255 and that these values could all be represented in 8 bits. However, many candidates applied the misconception that 256 colours would need 256 bits, one for each colour. Some candidates realised that 256 colours could be represented by 256 values, but took 256 as the upper value rather than 255 and so gave an incorrect answer of 9 bits.

Question 4

Please see the comments in the **General** section of this report regarding context. The question specifically mentions sound, but a number of candidate responses talked about sampling images.

(a) There were a number of correct definitions for sampling resolution and sampling rate, although there was still some confusion between the terms and there is a need for improvement in the understanding of exactly what the terms mean. Responses which simply reworded the question stem were common, such as '*sampling rate is the rate of sampling'*; this is much too imprecise as a definition. The question asked for an explanation of the terms so additional information was required. Some candidates realised that improving sampling resolution and sampling rate would result in a more accurate representation of the sound but answers were often given in terms of sound quality, which is too vague.

(b) (i) Many candidates were able to correctly calculate the number of bytes required to store one second of sampled music and also showed clearly how this value had been obtained. The most common error was to omit the multiplication by 2 for the left and right speakers and so to give an incorrect answer of 88 200 bytes.

(ii) There were many correct descriptions of the calculation of the number of megabytes for four minutes of music; however, some candidates need to improve their understanding of the number of bytes in a megabyte (1024 * 1024).

(c) This was well answered and most candidates could explain how the music quality was apparently retained. The most common error was to not recognise MP3 as a lossy compressed format and to answer in terms of lossless compression techniques.

Question 5

This question was very well answered with many candidates correctly identifying the ethical and unethical actions. The action most often incorrectly categorised, was that source code developed at the software house and used in the development of the software for his *own* company was deemed to be ethical.

Question 6

(a) This question proved challenging for the majority of candidates. Candidates need to improve their understanding of the stored program concept, it involves much more than just the fetch-decode-execute cycle. Many candidates overlooked the words '*stored program concept*' in the stem of the question and wrote about the Von Neumann architecture instead, which was not what was required.

(b) (i) In general, the answers to this part were correct. Most candidates could name at least two of the three buses and many were able to give all three.

(ii) Candidates need to improve their understanding of the functions of the various components in the processor. There was considerable confusion between the *function* of the system clock, to generate the timing signals to synchronise events in the processor, and the *effect* of increasing the clock speed.

Question 7

This is a new topic for this syllabus and overall the questions were answered very well.

(a) The majority of candidates answered this question correctly. On this occasion, an answer of lines 7−16 was also given credit, although strictly speaking line 7 and line 16 are html tags surrounding the JavaScript. In future only the JavaScript lines will be accepted.

(b) (i) Nearly all candidates correctly identified the two variables used in the code. The most common error was to write `groupPrize` instead of `groupPrice`.

(ii) This question was very well answered, with most candidates able to identify the line numbers where selection occurred. A small number of candidates did not include the closing brace on line 13.

(c) (i)(ii) Both subpart questions asked for an explanation. Many candidates were able to make one good statement about each of the `prompt` function and the `var` keyword, but a greater understanding is needed that the `prompt` function also returns a value and that the `var` keyword *declares* a variable.

Question 8

Please see the comments in the **General** section of this report regarding context. The question specifically states that verification and validation can be applied *during data entry*. Many candidates overlooked the context of the question and answered in terms of data transmission, which was not required.

Most candidates were able to give examples of verification and validation checks but candidates need to understand that neither verification nor validation will ensure that the data is correct. Verification ensures that it matches the original source, but that source may not be correct or accurate. Validation ensures that data matches required criteria and is sensible, but also does not check that the data is correct or accurate.

Responses that simply reworded the stem of the question were common, such as '*verification is to verify*...' or '*validation is to make sure that the data is valid…'*. This is much too imprecise to gain credit at this level of study.

Question 9

(a) (i) The majority of candidates were able to correctly convert the four denary values to hexadecimal. The most common errors were the omission of the leading zero in the first byte and the omission of the full stops separating the hexadecimal integers.

(ii) Many candidates were able to correctly describe the format of an IP address. The most common error was to state that an IP address is made up of four *numbers* rather than *integers*, and there needs to be greater understanding that the range of these integers is 0−255 not 1−256. Quite a few candidates overlooked the word '*format*' in the question stem and explained the use of the IP address, which was not required.

(b) There were some excellent, detailed answers to this question and some candidates clearly understood exactly how a URL and DNS are used to locate a resource. There was, however, considerable confusion about exactly what the DNS was returning. Candidates need to improve their understanding of how the DNS operates and that it is an IP address that is returned, not the actual resource.

Question 10

Please see the comments in the **General** section of this report regarding context. In both parts of this question, a particular context was given.

(a) Some candidates gave good explanations of why a new disk needed to be formatted. However, many candidates overlooked the fact that the question stated, '*before it is used*' and that the disk was therefore being formatted for the first time prior to use. These candidates gave answers detailing the removal of viruses and erasing of data, which were not required.

(b) Many candidates were able to correctly name three other utility programs that might be required, but often candidates struggled to say why each would be needed. The question stated that '…*the performance of the hard disk deteriorates…*' and so the utility programs named needed to be those that would be useful in that context. Candidates also need to improve their understanding of the use of compression software. It does not increase the capacity of a disk; the disk is of a fixed size. Compression software enables more files to be stored on a fixed size disk.

COMPUTER SCIENCE

Paper 9608/13
Written paper

Key messages

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Please see the comments in the **General** section above regarding both parts of **Question 1(b)**.

(a) Candidates found this question challenging. Whilst most candidates were able to describe the use of bit streaming in general terms, only a few candidates explained what bit streaming is in sufficient technical detail. It is insufficient to give vague answers such as '*sending the data bit by bit*', which could apply to many other scenarios and is not specific to bit streaming.

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(a) This question was well answered. The most common error was to tick the first row as well as, or instead of, the second row.

(b) (i) The majority of candidates recognised that http was the protocol being used and that computerscience.html was the web page or file being requested. Some candidates recognised the cie.org.uk as the domain name, although a common mistake was to try to expand the domain name into its constituent parts and explain what each individual part represented.

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Question 5

Please see the comments in the **General** section above about context. This question was set in a very specific scenario.

(i) Many candidates failed to identify with the scenario in this question, and unfortunately omitted to realise that the monitoring needed to be continuous. Answers such as '*when the sensor detects seismic activity it will send data to the computer system*' were common. Some candidates did realise that there would need to be some processing before a decision could be made whether any activity was above 3 on the Richter Scale, but there needs to be greater understanding that answers to questions of this type will not follow a standard pattern but will need to be adapted to the scenario given.

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(ii) This part question was also very well answered. The majority of candidates understood that the client-server model made resource sharing possible and improved security. Candidates need to take care with terminology. Shared access to *data* is implemented, not shared access to *information*.

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(a) There were many completely correct answers to this part question. The most common causes of error were to either confuse the image resolution, the image file header and the screen resolution, or to reverse bitmap graphic and vector graphic.

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Responses that simply reworded the stem of the question were common, such as '*verification is to verify*...' or '*validation is to make sure that the data is valid…'*. This is much too imprecise to gain credit at this level of study.

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(a) This question was very well answered, with nearly all candidates able to describe a computer virus.

(b) This question was also very well answered, with the majority of candidates able to give two examples of when a virus checker should perform a check.

Question 11

This question was also very well answered, with many candidates able to complete the table correctly. The most common mistake was to confuse the two pieces of software and to completely reverse the entries in the table.

COMPUTER SCIENCE

Paper 9608/21
Written Paper

General comments

Pre-release materials for Paper 2 are provided to Centres ahead of sitting the paper. Although there is no evidence, it is strongly suspected that candidates who perform well in the examination are from those Centres that have made these materials available, and encouraged the completion of all the associated tasks and guides given.

The pre-release material contained a number of built-in functions expressed with pseudocode and these definitions were followed by a number of tasks. The rubric stated that "Candidates should be familiar with the syntax used in their chosen programming language". However, there was evidence in **Question 7 (b)** that candidates had not done this: the `FOR` loop was often terminated with the `ENDFOR` and not the language syntax (for example, `NEXT`, if the candidate was using Visual Basic.Net); program statements to isolate a single character wrongly used `ONECHAR`; and the length of the string was calculated using `CHARACTERCOUNT`. Such use of pseudocode, when the question required the writing of program code, gained no credit. See also the comment made for **Question 4** regarding the pre-release material.

The most popular language used by candidates was Visual Basic.Net, although there was a slight increase in the percentage of candidates using Python.

Comments on specific questions

Question 1

All candidates scored well with the evaluation of the four expressions. For **part (iii)**, the expected answer was 16. However, some candidates recognised that variable `z` had not been declared before its use and so stated this would generate an error, this was also credited.

Question 2

Candidates, who were exposed to the use of an IDE for their practical programming in preparation for the examination, should have found no problems in securing the marks. For **part (i)**, the answers expected were to state that an IDE is a software program and then follow this with at least two of the general features it provides for the programmer: program creation and amendment (with a text editor); program translation (either compiled or interpreted); identification of errors; and the execution of the code.

It was clear from the answers for **part (ii)** which candidates had used this software. Strong answers stated the IDE will identify many syntax errors before translation and then offer debugging features such as breakpoints, single-stepping through the code, a 'watch window' to display the changing value of variables or expressions and other features for the general display of the code.

Question 3

Part (a) was well answered with most candidates securing the full four marks. For **part (b)**, many answers secured the full three marks with candidates realising that the pseudocode could be simplified with a condition of `InA = TRUE AND InB = TRUE` followed by the correct two assignment statements. An alternative simplified condition was to use `NOT(InA = TRUE AND InB = TRUE)` followed by the correct assignments.

Some candidates omitted the `ENDIF` keyword and were penalised.

Question 4

The question was similar to Task 2.2 on the pre-release materials and was well answered, with many candidates scoring the full six marks. Some candidates failed to appreciate that since the same symbol is used for both input and output on a program flowchart, the labelling of the box must indicate its use with INPUT or OUTPUT. Candidates were also penalised if:

- the language specific PRINT was used as an alternative to OUTPUT
- the flow lines following each condition box were not labelled with at least a 'YES' or 'NO' label.

Question 5

Part (a) was well answered, with most candidates identifying the three variables and scoring at least two of the available three marks. `YearCount` was described as either the loop counter or, many candidates stated it was the age of the car and gained credit. A common error was to state the data type for the `CurrentValue` variable as `INTEGER`. However, as it stores a calculated value that could produce a non-integer value, it must have data type `REAL`.

Question 6

The list of built-in functions given in the pre-release material included a function to generate a random number within a given range. An 'extension task' suggested that "the program might generate the same number more than once". This understanding was the basis of **part (a)** but was not answered well. Candidates could not express the fact that for this scenario, the issue was that the same pair of random numbers for the staff number and task could be generated more than once. If the program was generating only 60 pairs, then this would mean not all staff tasks had been produced. Many candidate answers only repeated the wording used in the question rubric of "60 pairs of random numbers will not generate all tasks" but were unable to express the consequences.

Most subparts of **part (b)** and **part (c)** were not answered well. All parts required the candidate to know the correct terminology used for a program and its constructs, and then be able to recognise these within some given pseudocode.

Many candidates did not understand that a local variable means it is local in scope to a procedure or function. Candidates incorrectly referred to the variables on lines `01`– `04`.

Part (b)(iii) was not well understood and weaker responses suggested the `FOR` loop headers on lines 27 and 28. The only correct answer was line 20.

For **part (b)(iv)** candidates who were familiar with the pre-release material would have recognised the `RANDOM` function used on lines 11 and 12.

Parts (c)((i) and **(c)(ii)** were well answered. For **part c(ii)**, either the condition `Completed <> 60` or `NewTask = FALSE` scored the mark. The inclusion of the `WHILE` keyword was not penalised. However, a candidate who understood the terminology 'condition' appreciated that the `WHILE` keyword should not have been included. Many candidates incorrectly stated that the code was validating each of the two random numbers generated.

For **part (c)(iii),** answers were weak. Candidates often repeated one or more lines of the pseudocode and gained no credit. The question wanted candidates to explain that this code tested for whether or not the current staff task had previously been generated.

Answers for **part (c)(iv)** were weak. Three key points were needed to secure the marks:

- the pseudocode stating `TaskGrid` is an `ARRAY`
- the correct upper and lower bounds for the two subscripts and the data type `BOOLEAN`.

The pseudocode syntax for the declaration of a 2D array is shown in Syllabus ***Section 2.2.2***, **Arrays**.

Answers for part **(d)** were again weak, with few candidates able to score more than one of the available marks. Common errors were:

- to omit the `StaffNo` variable from the `CASE` header
- the output of the staff names for each case, not the assignment of the string value to the `StaffName variable`
- the omission of the quotation marks from the strings.

The pseudocode used for a CASE structure is shown in Syllabus ***Section 2.3.3***, **Selection**.

Question 7

The evaluation of the expressions in **part (a)** was intended as preparation for the use of the pseudocode functions that followed in **part (b)**. All four subparts of **part (a)** were well answered.

Note the comments made in the **General comments** section about the use of pseudocode and questions that require the writing of program code. Weaker responses lost a significant number of the available marks by using the pseudocode assignment symbol throughout, confirming that they could not make the clear distinction between pseudocode and program language code.

Strong responses made the correct transition from the pseudocode or structures required:

- `CHARACTERCOUNT` – implemented with the `Len` function (Python, VisualBasic.Net or `Length` (Pascal)
- `ONECHAR` – implemented with the `MyString` array subscript (Python and Pascal) or using the `Mid` function (Visual Basic.Net)
- `ASC` – implemented with the `Ord` function (Python and Pascal) or `Asc` (Visual Basic.Net).

Some good answers were seen for **part (c)**. Candidates realised that the number stored by `StringTotal` could act as a verification check for the string of characters received by the remote computer. Many answers however, gained only one of the available marks by omitting to explain that the number would have to be recalculated by the software at the receiving end.

Question 8

As for **Question 7**, **parts (a)** and **(b)** were intended to give the candidate confidence with the function evaluations before they were needed in the problem described in **part (c)**. **Parts (a)** and **(b)** were well answered. This continued through into **part (c)**, with many candidates able to score 6 marks, or the full 7 marks.

For **(d)(i)**, the technical term ‘adaptive maintenance’ was well known.

Candidates were resourceful with their answers for **part (d)(ii)**. The most popular suggestions, which all gained credit, were:

- allow more than two fractions to be added
- allow a numerator and denominator which consisted of more than one digit
- output the final answer as a decimal value
- allow the multiplication and division of fractions

Some candidates misunderstand the question and instead suggested changes that could be made to the design of the given pseudocode.

COMPUTER SCIENCE

Paper 9608/22
Written Paper

General comments

Pre-release materials for Paper 2 are provided to Centres ahead of sitting the paper. Although there is no evidence, it is strongly suspected that candidates who perform well in the examination are from those Centres that have made these materials available, and encouraged the completion of all the associated tasks and guides given.

The pre-release material contained a number of built-in functions expressed with pseudocode and these definitions were followed by a number of tasks. The rubric stated that "Candidates should be familiar with the syntax used in their chosen programming language*".* However, there was evidence in **Question 7(b)(i)** that candidates had not done this. A `FOR` loop was often terminated with the `ENDFOR` and not the language syntax (for example, `NEXT`, if the candidate was using Visual Basic.Net). Program statements to isolate a single character incorrectly used `ONECHAR`, and the length of the string was calculated using `CHARACTERCOUNT`. Such use of pseudocode when the question required the writing of program code gained no credit. See also the comment made for **Question 4(a)** regarding the pre-release material.

The most popular language used by candidates was Visual Basic.Net, although there was a slight increase in the percentage of candidates using Python. Some candidates did not state the programming language used on the first line from which their code then follows.

Comments on specific questions

Question 1

All candidates scored marks but the full five marks were rarely seen. For **part (ii)**, many candidates did not evaluate the expression did not get credit.

For **parts (iii)** and **(iv)**, answers of NO and YES were not accepted as alternatives to the correct answers, FALSE and TRUE.

Part (v) proved to be challenging. Although the expression is correctly formed, candidates did not realise this would produce an error as the string is being assigned to a variable declared with data type `REAL`.

Question 2

Part (a) was well answered, with most candidates securing the full four marks. For **part (b)**, many answers securing the full three marks were seen, with candidates realising that the pseudocode could be simplified with a condition of `(P=1 AND Q=1)` followed by the correct two assignment statements. An alternative simplified condition was to use `(P=0 OR Q=0)` followed by the correct assignments. Some strong responses realised that because `P` and `Q` were storing integer values then the expression `P*Q` could be used as the basis for a simplified condition. However, no candidate appreciated that if the `X` value was calculated from `P*Q`, then no `IF` statement would be required.

Some candidates omitted the `ENDIF` keyword and were penalised.

Question 3

The question was similar to Task 2.2 on the pre-release materials and was well answered, with many candidates scoring the full six marks. Some candidates did not appreciate that since the same symbol is used for both input and output on a program flowchart, the labelling of the box must indicate its use with INPUT or OUTPUT. Candidates were also penalised if:

- the language specific PRINT was used as an alternative to OUTPUT
- the lines following the condition boxes were not labelled with at least a 'YES' or 'NO' label
- the text used for the OUPUT box prompts had the quotation marks missing.

Question 4

The list of built-in functions given in the pre-release material included a function to generate a random number within a given range. An extension task suggested that *"*the program might generate the same number more than once*"*. This understanding was the basis of **part (a)** but was not answered well. Candidates could not express the fact that for this scenario, the issue was that the same pair of random numbers for the suit and card could be generated more than once. If the program was generating only 52 pairs, then this would mean not all the cards had been dealt. Many candidate answers only repeated the wording used in the question rubric of *"*the program generates pairs of random numbers*"* but were unable to express the consequences.

All parts for **(b)** were not answered well. All parts of **(b)** and **part (c)** required the candidate to know the correct terminology used for a program and its constructs, and then be able to recognise these within some given pseudocode. A common wrong answer for **(b)(i)** was lines 20 or 22, where the candidate could not distinguish between a *'*count controlled loop*'*, asked for in the question, and the end of a WHILE loop.

For **part (c)**, the answer stating this code contained only one procedure was rare.

Part (d) was well answered, with either the condition `DealCount <> 52` or `NewCard = FALSE` scoring the mark. The inclusion of the `WHILE` keyword was not penalised. A candidate who understood the terminology 'condition' appreciated that the `WHILE` keyword should not have been included. Many candidates incorrectly stated that the code was validating each of the two random numbers generated.

Answers for **part (e)** were weak. Candidates often repeated one or more lines of the pseudocode and gained no credit. The question required candidates to explain that this code tested for whether or not the current card drawn had previously been drawn.

Answers for **part (f)** were weak. Three key points were needed to secure the mark: the keyword `ARRAY`, the correct upper and lower bounds for the two subscripts, and the data type `BOOLEAN`. The pseudocode syntax for the declaration of a 2D array is shown in Syllabus ***Section 2.2.2*** **Arrays**.

Answers for part **(g)** were again weak, with few candidates able to score 3 or 4 of the available marks. The pseudocode used for a CASE structure is shown in Syllabus ***Section 2.3.3*** **Selection**. Common errors were:

- to omit the `CardValue` variable from the `CASE` header
- the output of the card names for each case and not the assignment of the string value to the `CardName` variable.

Question 5

The full range of marks was seen for **part (a)(i)**, with some attempts suggesting candidates had never been exposed to the practical use of a trace table. However, many candidates were able to secure 6, 7 or the maximum 8 marks.

For **part (ii)**, the stronger answers for **(i)** then recognised the algorithm as a bubble sort. It was sufficient to state 'sorting the elements in the array into ascending order'.

Part (iii) proved challenging to all but a very few candidates who recognised that the dataset had been completely sorted before the final pass of the loop was carried out.

For part **(b)**, the majority of candidates gained the mark for stating the four variables would all have data type `INTEGER`. The descriptions however, required the candidate to clearly express themselves and answers were often vague. To score each mark:

- `i` should be described as a 'loop counter'
- for `j`, the technical terms index or subscript should be used, rather than a 'pointer' or 'position'
- for `Temp`, the description should state the variable is used when two numbers are swapped; a 'temporary store' is insufficient.

Question 6

Candidates scored well for both parts of **(a)**. A common error was the answer 'a' for part **(ii)**. Candidates need to read the rubric of the function definition that included *"*counting from the start of the string with value 1*"*. The wrong answer 'a' was arrived at by using an index value of zero for the first character position. Candidates need to be made aware that the detail of a pseudocode definition might differ from the equivalent function in their chosen programming language.

For **part (b)(i)**, candidates rarely scored the four available marks and the question proved challenging for all but a very few candidates. All possible errors were seen, including weaker responses that suggested `CHARACTERCOUNT` and `ONECHAR` were variables. Weak descriptions did not make clear whether it was the original string or the calculated string that was referred to.

The completion of the pseudocode for **part (ii)** proved beyond many candidates. A common error was a statement to `OUTPUT NewString` rather than `RETURN` its value. Candidates need to make the meaning clear when writing the statement for '`NewString` assigned value empty string'. Many answers instead wrote a statement that suggested the assignment was of a significant number of <Space> characters, and this was penalised. Candidates need to be exposed to practical exercises like this in their programming preparation for the examination.

Question 7

For the four parts of **(a)**, most candidates were able to score at least two of the available marks. A precise answer was required for **part (ii)** and minor variations were penalised, such as the presence of comma or apparent <Space> characters between the characters.

For **part (b)(i)**, see the comments made in the **General comments** section regarding program code. Weak responses lost a significant number of the available marks by using the pseudocode assignment symbol throughout.

For **part (b)(ii)**, most candidates scored by stating that a change was made to all of the characters within `MyMessage`. Some candidates misinterpreted the rubric requirement and gave a general description of why encryption is used, rather than the working of the given algorithm.

COMPUTER SCIENCE

Paper 9608/23
Written Paper

General comments

Pre-release materials for Paper 2 are provided to Centres ahead of sitting the paper. Although there is no evidence, it is strongly suspected that candidates who perform well in the examination are from those Centres that have made these materials available, and encouraged the completion of all the associated tasks and guides given.

The pre-release material contained a number of built-in functions expressed with pseudocode and these definitions were followed by a number of tasks. The rubric stated that "Candidates should be familiar with the syntax used in their chosen programming language". However, there was evidence in **Question 7 (b)** that candidates had not done this: the `FOR` loop was often terminated with the `ENDFOR` and not the language syntax (for example, `NEXT`, if the candidate was using Visual Basic.Net); program statements to isolate a single character wrongly used `ONECHAR`; and the length of the string was calculated using `CHARACTERCOUNT`. Such use of pseudocode, when the question required the writing of program code, gained no credit. See also the comment made for **Question 4** regarding the pre-release material.

The most popular language used by candidates was Visual Basic.Net, although there was a slight increase in the percentage of candidates using Python.

Comments on specific questions

Question 1

All candidates scored well with the evaluation of the four expressions. For **part (iii)**, the expected answer was 16. However, some candidates recognised that variable `z` had not been declared before its use and so stated this would generate an error, this was also credited.

Question 2

Candidates, who were exposed to the use of an IDE for their practical programming in preparation for the examination, should have found no problems in securing the marks. For **part (i)**, the answers expected were to state that an IDE is a software program and then follow this with at least two of the general features it provides for the programmer: program creation and amendment (with a text editor); program translation (either compiled or interpreted); identification of errors; and the execution of the code.

It was clear from the answers for **part (ii)** which candidates had used this software. Strong answers stated the IDE will identify many syntax errors before translation and then offer debugging features such as breakpoints, single-stepping through the code, a 'watch window' to display the changing value of variables or expressions and other features for the general display of the code.

Question 3

Part (a) was well answered with most candidates securing the full four marks. For **part (b)**, many answers secured the full three marks with candidates realising that the pseudocode could be simplified with a condition of `InA = TRUE AND InB = TRUE` followed by the correct two assignment statements. An alternative simplified condition was to use `NOT(InA = TRUE AND InB = TRUE)` followed by the correct assignments.

Some candidates omitted the `ENDIF` keyword and were penalised.

Question 4

The question was similar to Task 2.2 on the pre-release materials and was well answered, with many candidates scoring the full six marks. Some candidates failed to appreciate that since the same symbol is used for both input and output on a program flowchart, the labelling of the box must indicate its use with INPUT or OUTPUT. Candidates were also penalised if:

- the language specific PRINT was used as an alternative to OUTPUT
- the flow lines following each condition box were not labelled with at least a 'YES' or 'NO' label.

Question 5

Part (a) was well answered, with most candidates identifying the three variables and scoring at least two of the available three marks. `YearCount` was described as either the loop counter or, many candidates stated it was the age of the car and gained credit. A common error was to state the data type for the `CurrentValue` variable as `INTEGER`. However, as it stores a calculated value that could produce a non-integer value, it must have data type `REAL`.

Question 6

The list of built-in functions given in the pre-release material included a function to generate a random number within a given range. An 'extension task' suggested that "the program might generate the same number more than once". This understanding was the basis of **part (a)** but was not answered well. Candidates could not express the fact that for this scenario, the issue was that the same pair of random numbers for the staff number and task could be generated more than once. If the program was generating only 60 pairs, then this would mean not all staff tasks had been produced. Many candidate answers only repeated the wording used in the question rubric of "60 pairs of random numbers will not generate all tasks" but were unable to express the consequences.

Most subparts of **part (b)** and **part (c)** were not answered well. All parts required the candidate to know the correct terminology used for a program and its constructs, and then be able to recognise these within some given pseudocode.

Many candidates did not understand that a local variable means it is local in scope to a procedure or function. Candidates incorrectly referred to the variables on lines `01`– `04`.

Part (b)(iii) was not well understood and weaker responses suggested the `FOR` loop headers on lines 27 and 28. The only correct answer was line 20.

For **part (b)(iv)** candidates who were familiar with the pre-release material would have recognised the `RANDOM` function used on lines 11 and 12.

Parts (c)((i) and **(c)(ii)** were well answered. For **part c(ii)**, either the condition `Completed <> 60` or `NewTask = FALSE` scored the mark. The inclusion of the `WHILE` keyword was not penalised. However, a candidate who understood the terminology 'condition' appreciated that the `WHILE` keyword should not have been included. Many candidates incorrectly stated that the code was validating each of the two random numbers generated.

For **part (c)(iii),** answers were weak. Candidates often repeated one or more lines of the pseudocode and gained no credit. The question wanted candidates to explain that this code tested for whether or not the current staff task had previously been generated.

Answers for **part (c)(iv)** were weak. Three key points were needed to secure the marks:

- the pseudocode stating `TaskGrid` is an `ARRAY`
- the correct upper and lower bounds for the two subscripts and the data type `BOOLEAN`.

The pseudocode syntax for the declaration of a 2D array is shown in Syllabus ***Section 2.2.2***, **Arrays**.

Answers for part **(d)** were again weak, with few candidates able to score more than one of the available marks. Common errors were:

- to omit the `StaffNo` variable from the `CASE` header
- the output of the staff names for each case, not the assignment of the string value to the `StaffName variable`
- the omission of the quotation marks from the strings.

The pseudocode used for a CASE structure is shown in Syllabus ***Section 2.3.3***, **Selection**.

Question 7

The evaluation of the expressions in **part (a)** was intended as preparation for the use of the pseudocode functions that followed in **part (b)**. All four subparts of **part (a)** were well answered.

Note the comments made in the **General comments** section about the use of pseudocode and questions that require the writing of program code. Weaker responses lost a significant number of the available marks by using the pseudocode assignment symbol throughout, confirming that they could not make the clear distinction between pseudocode and program language code.

Strong responses made the correct transition from the pseudocode or structures required:

- `CHARACTERCOUNT` – implemented with the `Len` function (Python, VisualBasic.Net or `Length` (Pascal)
- `ONECHAR` – implemented with the `MyString` array subscript (Python and Pascal) or using the `Mid` function (Visual Basic.Net)
- `ASC` – implemented with the `Ord` function (Python and Pascal) or `Asc` (Visual Basic.Net).

Some good answers were seen for **part (c)**. Candidates realised that the number stored by `StringTotal` could act as a verification check for the string of characters received by the remote computer. Many answers however, gained only one of the available marks by omitting to explain that the number would have to be recalculated by the software at the receiving end.

Question 8

As for **Question 7**, **parts (a)** and **(b)** were intended to give the candidate confidence with the function evaluations before they were needed in the problem described in **part (c)**. **Parts (a)** and **(b)** were well answered. This continued through into **part (c)**, with many candidates able to score 6 marks, or the full 7 marks.

For **(d)(i)**, the technical term ‘adaptive maintenance’ was well known.

Candidates were resourceful with their answers for **part (d)(ii)**. The most popular suggestions, which all gained credit, were:

- allow more than two fractions to be added
- allow a numerator and denominator which consisted of more than one digit
- output the final answer as a decimal value
- allow the multiplication and division of fractions

Some candidates misunderstand the question and instead suggested changes that could be made to the design of the given pseudocode.

COMPUTER SCIENCE

Paper 9608/31
Written Paper

General comments

Some candidates showed a limited knowledge of many of the topics examined on the paper. There were few candidates who scored well on a majority of the questions. It was encouraging to see many candidates display competence in using Karnaugh Maps to derive Boolean functions. There were some good answers to the question on types of processor and pipelining.

Comments on specific questions

Question 1

Many candidates did not demonstrate adequate knowledge of binary floating-point representation and the application of that knowledge. Candidates struggled to deal with normalisation and the fact that most real numbers can only be represented approximately.

(a) (i) Some candidates found this question straightforward and had no problem in deriving the correct denary value. Many candidates did less well, as they did not use correct values in either, or both, of the mantissa and the exponent. The binary pattern was often treated as a 16-bit fixed point fraction with an assumed binary point between the mantissa and the exponent. Many candidates scored just one mark for giving a correct value for the exponent.

(ii) Many answers included reference to normalised numbers needing to start with 01 or 10. However, few answers acknowledged that the question was specifically asking about the number given in part **(i)** and therefore there should have been reference to a normalised positive number.

(iii) There were few totally correct answers to this question. A sizeable minority of candidates gave a correct mantissa but an incorrect exponent.

(b) (i) This was often answered correctly.

(ii) There were very few totally correct answers to this question. Candidates who scored one mark were better at giving a correct exponent than giving a correct mantissa.

(iii) A few candidates recognised that overflow would occur. Most answers showed little understanding that adding a positive number to the largest positive number would have an effect.

(c) A large majority of candidates were unable to score any marks on this question. Only a few recognised that the problem was due to the fact that fractions such as 0.1 cannot be represented exactly in binary. Those who did score a mark for this fact, then found it very difficult to explain why the sequence of numbers output was as shown in the question. Many of the large number of incorrect answers described problems with the interpreter or problems with the code written by the candidate.

Question 2

This question showed that the candidates had limited knowledge of the various processes involved in compilation.

(a) Many candidates found it difficult to give a fully correct symbol table but candidates showed enough understanding to add some correct entries.

(b) As for **part (a)**, those candidates who understood the lexical process found this question on tokenisation straightforward. Some candidates managed to achieve the first mark as it was not dependent on the answer to **part (a)**.

(c) (i) The majority of candidates did not correctly identify the final stage in the compilation process.

(ii) Very few candidates gave a correct answer that removed the two unnecessary instructions. Many answers that gained no marks were either blank, an exact copy of the code given in the question or an attempted rewrite of the original high-level assignment statement.

(iii) This question was not answered well, with few candidates giving a correct benefit. An answer with two correct benefits was very rare. Answers that gained no credit were numerous and varied.

Question 3

This question was not answered well. There was little evidence of an understanding of the routing process. Candidates also struggled to explain how the use of the particular switching method was appropriate in **part (c)** and also found it difficult to justify their choice in **part (e)**.

(a) Answers that just referred to address sender or receiver were given no credit as it was unclear whether this was a reference to an email address or an IP address. An email address would be part of the data and therefore not a valid answer to the question.

(b) Descriptions often stated that only two routers participated in the transfer of the email. There was a common assumption that a router on the sending network would send packets directly to the router on the receiving network. A mniority of candidates conveyed the idea that there were many routers participating in the transfer and that the email packets could take different paths using different routers. There was some mention of the use of IP addresses by the routers.

(c) Answers often repeated the description of the process that was given in **part (b)** and did not address the issue of why packet switching was appropriate. There was some reference to the fact that sending an email was not a real-time activity but there was little attempt to explain how the drawbacks of packet switching (packets arriving out of order and lost packets) were not an issue in this application.

(d) Most candidates gave the correct answer to this question.

(e) Telephone calls and video conferencing were the two popular applications that were awarded a mark. Although there was reference to a single circuit, very few answers described it as a dedicated circuit.

Question 4

Candidates with knowledge of pipelining usually scored well on this question.

(a) Most candidates scored one or two marks but a fully correct answer was rare. There was no description that caused a greater number of incorrect responses than any other.

(b) (i) Answers to this question demonstrated either no understanding, or a full understanding, of how pipelining can be used to process three instructions. Very few candidates demonstrated a clear understanding of pipelining but had made errors in completing the table. Some candidate answers showed that they understood that more than one instruction could be processed at the same time, but their answers displayed, incorrectly, that at any particular interval only one instruction was actively being processed.

(ii) Those candidates who had scored the maximum mark in **part (b)(i)** had few problems in deriving the correct number of clock cycles saved. Some candidates who showed an incomplete understanding of pipelining in part **(i)**, gained some marks here because their answers demonstrated knowledge of how to calculate the clock cycles saved.

Question 5

This question was the one on the paper that candidates coped with best. Many displayed skills in setting up and then using Karnaugh Maps.

(a) (i) About half of the answers given by the candidates gained full marks. Some candidates gave an answer that was a simplification of the two terms required. This was not necessary. The question paper showed the first term of the expression and this was meant to act as a clue as to how the rest of the answer should be written. If expressions are to be simplified then the question will state this.

(ii) The majority of candidates completed the table correctly.

(iii) Those candidates who had given a correct table usually had no problem drawing the appropriate loops. Some candidates who had given an incorrect table demonstrated grouping skills and were given credit.

(iv) Most candidates who scored marks in **part (iii)**, were successful in deriving the associated terms that were required in this question.

(b) (i) The question required the candidates to fill in not only the table but also the row and column headers. Some candidates were unable to give the correct headers and gave the incorrect sequence 00, 01, 10 and 11. These candidates were still awarded marks if their tables were consistent with their headers.

(ii) Many candidates identified the two groups required for a correct answer: one with four 1s and one with two 1s. Those candidates with the incorrect answer, still often managed to gain some credit due to evidence of successful grouping. Some candidates did not gain credit as there were so many lines on their table that it was impossible to discern what grouping was being shown. The fact that there were two 1s on the top row and two 1s on the bottom row caused some problems.

(iii) Those candidates who had coped well with the rest of the question found little difficulty in giving a correct answer, including deriving the correct term for the group of four 1s. Where there had been mistakes in deriving the table, or mistakes in the grouping, some credit was still given for evidence of being able to derive correct terms.

Question 6

Candidates' lack of knowledge of the blocked state and also the high-level scheduler meant that this question was usually not well answered.

(a) A small number of candidates gave a clear, precise explanation of the difference between a program and a process.

(b) A minority of candidates demonstrated knowledge of the blocked state. Many thought that a process entered the blocked state as the result of an interrupt or an error. Candidates showed knowledge of the ready state and knowledge of the running state and how they differ. Often, answers did not explain what conditions would cause a process to move from one state to the other.

(c) The lack of knowledge of the blocked state meant that answers in this part were rarely worthy of credit. Some candidates did get credit for stating that the running state can only be entered from the ready state. However, these answers did not describe why a process would be transferred from the blocked state to the ready state.

(d) The answers to this question showed that candidates knew little about the role of the high-level scheduler.

COMPUTER SCIENCE

Paper 9608/32
Written Paper

General comments

A number of candidates showed a limited knowledge of many of the topics examined on the paper. There were few candidates who scored well on the majority of the questions on the paper. It was, however, encouraging to see many candidates display competence in using Karnaugh Maps to derive Boolean functions.

Comments on specific questions

Question 1

Many candidates were unable to demonstrate adequate knowledge of binary floating-point representation and the application of that knowledge. Candidates also struggled with normalisation, the effect of differing allocation of bits to the mantissa and exponent, and the fact that most real numbers can only be represented approximately.

(a) (i) Some candidates found this question straightforward and scored full marks. Many candidates did less well as they did not use correct values in either, or both, of the mantissa and the exponent. The mantissa was often treated as an 8-bit unsigned integer and the exponent as a binary fraction with an assumed binary point just to the left of the exponent. Many candidates scored just one mark for giving a correct value for the exponent.

(ii) Many candidates scored a mark for correctly writing the binary equivalent of + 3.5. However, candidates then struggled to normalise the binary number and to give the correct values for the mantissa and the exponent. Few candidates supplied a totally correct answer.

(iii) There were few totally correct answers to this question. A minority of candidates mentioned two's complement. However, it was often not obvious what the two's complement process was being applied to. A common error was to apply a two's complement to the exponent.

(b) (i) This was answered correctly by a minority of candidates.

(ii) Those who gave a correct answer to part **(b)(i)** usually gave a correct answer to this question.

(c) A large majority of candidates did not score any marks on this question. Only a few recognised that the problem was due to the fact that fractions such as `0.1` cannot be represented exactly in binary. Those who did score a mark for this fact, then found it very difficult to explain what was seen on the screen. Many of the large number of incorrect answers, described problems with the interpreter or problems with the line of code or that overflow had occurred.

Question 2

This question showed that candidates had limited knowledge of the various processes involved in compilation.

(a) Many candidates found it difficult to give a fully correct symbol table. Evidence that the construction of the symbol table was not understood by many candidates was shown by the symbol tables containing keywords or `0.2` and `0.3`.

(b) As for part **(a)**, those candidates who understood the lexical process found this question on tokenisation straightforward. Some candidates managed to achieve the first mark as it was not dependent on the answer to part **(a)**.

(c) (i) Only about half of the candidates correctly identified the stage following lexical analysis as the syntax analysis stage.

(ii) Only a minority of candidates gave two correct tasks for syntax analysis. Good answers mentioned parsing and the checking of the grammar of statements. Not many answers described the reporting of errors, although 'error checking' was a vague statement that appeared quite often. 'Analysis of syntax' and references to BNF were answers that gained no marks.

(d) (i) Only a small minority of candidates gave an answer that related to minimising the execution time of the compiled code. Some answers that mentioned execution time did not achieve a mark, as their answer tended to indicate that they were referring to the time taken by the compiler.

(ii) Some candidates thought that this question was about RPN and gave the expression in RPN form. A minority recognised that optimisation would result in the calculation of the two constants being performed by the optimising compiler rather than have the calculation performed, possibly many times if in a loop, when the compiled code was executed.

(iii) Fully optimised code was rare. One common error that was a partial solution was to include an unnecessary `LDD 612` instruction immediately after the `STO 612` instruction. A sizeable minority of candidates attempted to write code based on the original high-level code given in the question, rather than the given assembly language code.

Question 3

Most candidates demonstrated some knowledge of circuit switching and packet switching and how they differ.

(a) Only a few candidates could give an explanation that covered the two distinguishing features of circuit switching: the dedicated, but temporary, nature of the circuit. There were many answers that discussed the single path but did not indicate the fact that it was a reserved path.

(b) The majority of candidates had enough knowledge to gain some marks on this question. There were some good descriptions of both circuit switching and packet switching. However, many descriptions did not use this knowledge to state clearly why circuit switching was preferable to packet switching. A number of candidates wrote, incorrectly, about security issues.

(c) Candidates often scored well on this question and gave a good narrative as to how packets are used to transfer a web page from server to browser.

Question 4

Many candidates showed little understanding of the nature of parallel processing and the associated software and hardware issues.

(a) Candidates usually scored some marks on this question. Only a very few candidates scored full marks. It was not unusual to see an answer where the first three descriptions led to correct architectures but the fourth description led to the incorrect MISD architecture. It would appear that candidates thought, incorrectly, that all four architectures should have a description attached to them. There was nothing in the question that stated that this would be the case.

(b) (i) A minority of candidates answered that 'massive' was concerned with a very large number of processors. Those answers that gave 'several processors', were not given the mark and nor were answers that ignored the fact that this was a single computer.

(ii) Candidate explanations for 'parallel' were much more successful.

(c) There was very little evidence that candidates understood how a parallel computer, with processors executing instructions simultaneously, presents a number of challenges. Candidates often thought that the hardware issue was the need for large amounts of memory. Only a small minority of

candidates recognised the complexities involved in providing connections between the many processors. There was a little more understanding of the need for software that could deliver and utilise simultaneous processing of instructions.

Question 5

This question was the one on the paper that candidates coped with best. Many displayed skills in setting up and then using Karnaugh Maps.

(a) (i) About half of the answers given by the candidates gained full marks. Some candidates gave an answer that was a simplification of the two terms required. This was not necessary. The question paper showed the first term of the expression and this was meant to act as a clue as to how the rest of the answer should be written. If expressions are to be simplified, then the question will state this.

(ii) The majority of candidates completed the table correctly.

(iii) Those candidates who had given a correct table usually had no problems drawing the appropriate loops. Some candidates who had given an incorrect table demonstrated grouping skills and were given credit.

(iv) Very few of the candidates who had scored marks in part **(iii)**, were not successful in deriving the associated terms that were required in this question.

(b) (i) The question required the candidates to fill in not only the table but also the row and column headers. Some candidates did not give the correct headers and gave the incorrect sequence 00, 01, 10 and 11. These candidates were still awarded marks if their tables were consistent with their headers.

(ii) Many candidates identified the two groups required for a correct answer: one with four 1s and one with two 1s. Those candidates with an incorrect table still often managed to gain some credit due to evidence of successful grouping. Some candidates did not gain credit as there were so many lines on their table that it was impossible to discern what grouping was being shown.

(iii) Those candidates who had coped well with the rest of the question found little difficulty in giving a correct answer, including deriving the correct term for the group of four 1s. Where there had been mistakes in deriving the table, or mistakes in the grouping, some credit was still given for evidence of being able to derive correct terms.

Question 6

Candidates often displayed limited knowledge of why processes move from one state to another as they are executed from start to finish in a computer.

(a) Few candidates demonstrated knowledge of the blocked state. Many thought, incorrectly, that a process entered the blocked state as the result of an interrupt or an error. As a consequence, few candidates could describe why a process would move out of the blocked state and into the ready state. There was evidence that candidates knew more about the ready state and about the running state. Consequently, answers about why a process would move from the running state to the ready state were more likely to gain credit.

(b) Some of the better answers recognised that the ready state is always followed by the running state and this gained credit. A full explanation was rare, as the lack of understanding of why a process entered the blocked state gave rise to an incomplete answer.

(c) (i) Anything that definitely indicated that the process was over was allowed. Many of the names given by candidates conveyed the idea that the process was undergoing some final steps before it finished.

(ii) Given the opportunity to identify when a process would enter this state, candidates were more successful in scoring a mark.

(d) Only a few candidates gave an answer that displayed understanding of the role of the low-level scheduler in managing which process would get next use of the processor.

COMPUTER SCIENCE

Paper 9608/33
Written Paper

General comments

Some candidates showed a limited knowledge of many of the topics examined on the paper. There were few candidates who scored well on a majority of the questions. It was encouraging to see many candidates display competence in using Karnaugh Maps to derive Boolean functions. There were some good answers to the question on types of processor and pipelining.

Comments on specific questions

Question 1

Many candidates did not demonstrate adequate knowledge of binary floating-point representation and the application of that knowledge. Candidates struggled to deal with normalisation and the fact that most real numbers can only be represented approximately.

(a) (i) Some candidates found this question straightforward and had no problem in deriving the correct denary value. Many candidates did less well, as they did not use correct values in either, or both, of the mantissa and the exponent. The binary pattern was often treated as a 16-bit fixed point fraction with an assumed binary point between the mantissa and the exponent. Many candidates scored just one mark for giving a correct value for the exponent.

(ii) Many answers included reference to normalised numbers needing to start with 01 or 10. However, few answers acknowledged that the question was specifically asking about the number given in part **(i)** and therefore there should have been reference to a normalised positive number.

(iii) There were few totally correct answers to this question. A sizeable minority of candidates gave a correct mantissa but an incorrect exponent.

(b) (i) This was often answered correctly.

(ii) There were very few totally correct answers to this question. Candidates who scored one mark were better at giving a correct exponent than giving a correct mantissa.

(iii) A few candidates recognised that overflow would occur. Most answers showed little understanding that adding a positive number to the largest positive number would have an effect.

(c) A large majority of candidates were unable to score any marks on this question. Only a few recognised that the problem was due to the fact that fractions such as 0.1 cannot be represented exactly in binary. Those who did score a mark for this fact, then found it very difficult to explain why the sequence of numbers output was as shown in the question. Many of the large number of incorrect answers described problems with the interpreter or problems with the code written by the candidate.

Question 2

This question showed that the candidates had limited knowledge of the various processes involved in compilation.

(a) Many candidates found it difficult to give a fully correct symbol table but candidates showed enough understanding to add some correct entries.

(b) As for **part (a)**, those candidates who understood the lexical process found this question on tokenisation straightforward. Some candidates managed to achieve the first mark as it was not dependent on the answer to **part (a)**.

(c) (i) The majority of candidates did not correctly identify the final stage in the compilation process.

(ii) Very few candidates gave a correct answer that removed the two unnecessary instructions. Many answers that gained no marks were either blank, an exact copy of the code given in the question or an attempted rewrite of the original high-level assignment statement.

(iii) This question was not answered well, with few candidates giving a correct benefit. An answer with two correct benefits was very rare. Answers that gained no credit were numerous and varied.

Question 3

This question was not answered well. There was little evidence of an understanding of the routing process. Candidates also struggled to explain how the use of the particular switching method was appropriate in **part (c)** and also found it difficult to justify their choice in **part (e)**.

(a) Answers that just referred to address sender or receiver were given no credit as it was unclear whether this was a reference to an email address or an IP address. An email address would be part of the data and therefore not a valid answer to the question.

(b) Descriptions often stated that only two routers participated in the transfer of the email. There was a common assumption that a router on the sending network would send packets directly to the router on the receiving network. A mniority of candidates conveyed the idea that there were many routers participating in the transfer and that the email packets could take different paths using different routers. There was some mention of the use of IP addresses by the routers.

(c) Answers often repeated the description of the process that was given in **part (b)** and did not address the issue of why packet switching was appropriate. There was some reference to the fact that sending an email was not a real-time activity but there was little attempt to explain how the drawbacks of packet switching (packets arriving out of order and lost packets) were not an issue in this application.

(d) Most candidates gave the correct answer to this question.

(e) Telephone calls and video conferencing were the two popular applications that were awarded a mark. Although there was reference to a single circuit, very few answers described it as a dedicated circuit.

Question 4

Candidates with knowledge of pipelining usually scored well on this question.

(a) Most candidates scored one or two marks but a fully correct answer was rare. There was no description that caused a greater number of incorrect responses than any other.

(b) (i) Answers to this question demonstrated either no understanding, or a full understanding, of how pipelining can be used to process three instructions. Very few candidates demonstrated a clear understanding of pipelining but had made errors in completing the table. Some candidate answers showed that they understood that more than one instruction could be processed at the same time, but their answers displayed, incorrectly, that at any particular interval only one instruction was actively being processed.

(ii) Those candidates who had scored the maximum mark in **part (b)(i)** had few problems in deriving the correct number of clock cycles saved. Some candidates who showed an incomplete understanding of pipelining in part **(i)**, gained some marks here because their answers demonstrated knowledge of how to calculate the clock cycles saved.

Question 5

This question was the one on the paper that candidates coped with best. Many displayed skills in setting up and then using Karnaugh Maps.

(a) (i) About half of the answers given by the candidates gained full marks. Some candidates gave an answer that was a simplification of the two terms required. This was not necessary. The question paper showed the first term of the expression and this was meant to act as a clue as to how the rest of the answer should be written. If expressions are to be simplified then the question will state this.

(ii) The majority of candidates completed the table correctly.

(iii) Those candidates who had given a correct table usually had no problem drawing the appropriate loops. Some candidates who had given an incorrect table demonstrated grouping skills and were given credit.

(iv) Most candidates who scored marks in **part (iii)**, were successful in deriving the associated terms that were required in this question.

(b) (i) The question required the candidates to fill in not only the table but also the row and column headers. Some candidates were unable to give the correct headers and gave the incorrect sequence 00, 01, 10 and 11. These candidates were still awarded marks if their tables were consistent with their headers.

(ii) Many candidates identified the two groups required for a correct answer: one with four 1s and one with two 1s. Those candidates with the incorrect answer, still often managed to gain some credit due to evidence of successful grouping. Some candidates did not gain credit as there were so many lines on their table that it was impossible to discern what grouping was being shown. The fact that there were two 1s on the top row and two 1s on the bottom row caused some problems.

(iii) Those candidates who had coped well with the rest of the question found little difficulty in giving a correct answer, including deriving the correct term for the group of four 1s. Where there had been mistakes in deriving the table, or mistakes in the grouping, some credit was still given for evidence of being able to derive correct terms.

Question 6

Candidates' lack of knowledge of the blocked state and also the high-level scheduler meant that this question was usually not well answered.

(a) A small number of candidates gave a clear, precise explanation of the difference between a program and a process.

(b) A minority of candidates demonstrated knowledge of the blocked state. Many thought that a process entered the blocked state as the result of an interrupt or an error. Candidates showed knowledge of the ready state and knowledge of the running state and how they differ. Often, answers did not explain what conditions would cause a process to move from one state to the other.

(c) The lack of knowledge of the blocked state meant that answers in this part were rarely worthy of credit. Some candidates did get credit for stating that the running state can only be entered from the ready state. However, these answers did not describe why a process would be transferred from the blocked state to the ready state.

(d) The answers to this question showed that candidates knew little about the role of the high-level scheduler.

COMPUTER SCIENCE

Paper 9608/41
Written Paper

Key messages

To succeed in this paper, it is essential that candidates have practical experience of programming using one of the following languages: Pascal, VB.NET, or Python. Programming and pseudocode questions from 9691 past papers and the tasks in the pre-release material for 9608/4, provide ideal topics for practical work.

General comments

This is the first year of this written paper examination, which has replaced coursework. It is a paper that tests programming skills and therefore it is expected that candidates have had experience of using at least one of the three stated programming languages.

There are many candidates who do not appear to have worked through the pre-release material. The responses to questions requiring the use of a programming language often showed a mismatch of stated programming language and the language used in the solution. Candidates need to be aware that they must produce program code in the language they declare at the beginning of the question part.

Comments on specific questions

Question 1

(a) Most candidates correctly labelled the PERT chart and were able to state the critical path and the minimum number of weeks required to complete the solution.

(b) Some candidates correctly read the earliest and latest start time off the chart.

(c) Few candidates could explain the reason why a project manager would use a PERT chart, that is, to show what activities could be done in parallel.

Question 2

Declarative programming has been a topic in the 9691 Paper 3 and should be well known.

(a) Most candidates were able to write the required facts using the syntax of the declarative programming language given in the question. Some candidates did not take note that predicates and atoms must be written starting with a lower case letter.

(b) Most candidates correctly stated that the result of the goal is: `ahmed, aisha, raul.`

(c) Most candidates correctly wrote the goal to find Ahmed's father: `father(F, ahmed).`

(d) Many candidates correctly wrote the rule for mother:

```
mother(X, Y) IF male(X) AND parent(X, Y).
```

(e) The stronger responses were able to complete the rule correctly and write:

```
grandparent(X, Z)
IF parent(X, Y) AND parent(Y, Z).
```

A common error was to write an imperative IF statement.

(f) Some candidates realised they could make use of the clause grandparent when defining grandfather and wrote:

```
grandfather(G, K)
IF male(G) AND grandparent(G, K).
```

Question 3

The pre-release material contained a task with an inheritance diagram and candidates were supposed to use this material to write program code to implement the classes. A hint was given to make use of polymorphism and inheritance. However, evidence suggests that candidates did not have sufficient practice with object-oriented programming in a practical setting.

(a) Most candidates chose suitable attributes and methods. However, some candidates did not implement inheritance and added attributes from a subclass to the base class. Only the stronger responses also included the inheritance arrows pointing up from the subclasses to the base class.

(b) (i) Some answers indicated no practical programming experience of declaring a class and unfamiliarity with writing a class structure. Some answers used procedures (in VB) rather than classes.

(ii) The stronger responses were able to write correct program code to declare a subclass. Although many candidates realised this was an inherited class, they were unfamiliar with the syntax for the language stated in how this is defined. Some answers included the attributes and methods from the base class.

(iii) Very few answers gave the correct statement to create a new instance of the class `Book`. A common mistake in VB.NET was to omit "`= New Book`". Some answers made use of constructors.

Question 4

(a) Some candidates drew the binary tree with the given items added in the correct places.

(b) Most candidates added the names into the correct part of the array. The stronger responses also showed the correct pointer values for left pointer right pointer and the root and free pointers.

(c) (i) The stronger responses correctly completed the pseudocode for an in-order tree traversal.

(ii) The textbook answer of 'a recursive procedure is one that calls itself', was popular. Some candidates were able to identify the line number where the recursive call was made.

(iii) The majority of candidates gave the correct procedure call as:

```
TraverseTree(RootPointer)
```

Question 5

(a) Some candidates correctly applied the hashing function and placed the Member IDs into the correct `MembershipFile` addresses.

(b) (i) Many candidates correctly completed the statement to assign `NewAddress`. Some candidates then correctly completed the `SEEK` statement. Very few candidates were able to write the given record to the file. Candidates need practical experience of writing records to random files to get an understanding of the steps involved.

(ii) The pre-release material contained a task to focus on exception handling. Candidates need to have practical experience of exception handling. The stronger responses completed the exception handling code correctly:

```
01 TRY
02    OPENFILE "MembershipFile" FOR RANDOM
03 EXCEPT
04    OUTPUT "File does not exist"
05 ENDTRY
```

(iii) The majority of candidates correctly stated that the member ID 9001 would hash to the same value as member ID 1001, and many correctly used the term 'collision'. However, it was then stated by many that this would cause an error rather than that it would overwrite the original value.

(iv) The most common correct answer seen was 'to keep searching through the file for the next available empty record…'.

(v) The stronger responses correctly identified the extra code that should be inserted between lines 40 and 50:

```
41 GETRECORD "MembershipFile", CurrentRecord
42 WHILE CurrentRecord.MemberID <> 0
43    NewAddress ← NewAdress + 1
44    IF NewAddress > 99 THEN NewAddress ← 0
45    SEEK NewAddress
46    GETRECORD "MembershipFile", CurrentRecord
47 ENDWHILE
```

COMPUTER SCIENCE

Paper 9608/42
Written Paper

Key messages

To succeed in this paper, it is essential that candidates have practical experience of programming using one of the following languages: Pascal, VB.NET, or Python. Programming and pseudocode questions from previous 9691 syllabus past papers and the tasks in the pre-release material for 9608/4 provide ideal topics for practical work.

General comments

This is the first year of this written paper examination, which has replaced coursework. It is a paper that tests programming skills and therefore it is expected that candidates have had experience of using at least one of the three stated programming languages. There are many candidates who do not appear to have worked through the pre-release material. The responses to questions requiring the use of a programming language often showed a mismatch of stated programming language and the language used in the solution. Candidates need to be aware that they must produce program code in the language they declare at the beginning of the question part.

Comments on specific questions

Question 1

(a) (i) Most candidates recognised that activities M and N would be the last activities to be undertaken and they were correctly shown on the GANTT chart.

(ii) Many candidates gave a correct answer relating to their previous response.

(b) (i) Some very good answers were seen. A very common error was to add two more weeks to the end of Activity C (week 10) without realising that it could not start until after Activity E. Many candidates did score marks for assigning the correct weeks for Acitivities D, E and F in relation to C. Although the second main bullet point states 'hardware delivery is delayed by 16 weeks', many candidates still started this activity in week 4. A large number of candidates incorrectly moved it to start in week 19.

(ii) Many candidates gave a correct answer relating to their previous response.

Question 2

Declarative programming has been a topic in the previous 9691 syllabus, Paper 3, and should be well known.

(a) Most candidates were able to write the required facts using the syntax of the declarative programming language given in the question. Some candidates did not take note that predicates and atoms must be written starting with a lower case letter.

(b) Most candidates correctly stated that the result of the goal is: `ahmed, aisha.`

(c) Most candidates correctly wrote the goal to find Gina's mother: `mother(M, gina).`

(d) Many candidates correctly wrote the rule for father:
`father(F, C) IF male(F) AND parent(F, C).`

(e) Only the stronger responses were able to complete the rule correctly and write:

```
brother(X, Y)
IF male(X) AND parent(A, X) AND parent(A, Y) AND NOT X=Y.
```

A common error was to write an imperative IF statement.

Question 3

The pre-release material contained a task with an inheritance diagram and candidates were expected to use this material to write program code to implement the classes. A hint was given to make use of polymorphism and inheritance. Evidence suggests that candidates did not have sufficient practice with object-oriented programming in a practical setting.

(a) Most candidates chose suitable attributes and methods. Some candidates did not implement inheritance and added attributes from a subclass to the base class. Only the stronger responses also included the inheritance arrows pointing up from the subclasses to the base class.

(b) (i) Some answers indicated no practical programming experience of declaring a class and unfamiliarity with writing a class structure. Some answers used procedures (in VB) rather than classes.

(ii) Candiates who produced stronger responses throughout were able to write correct program code to declare a subclass. Although many candidates realised this was an inherited class, they were unfamiliar with the syntax for the language stated in how this is defined. A very common error seen here was the incorrect data type given for telephone number (integer instead of string). This shows a lack of understanding of data types. Some answers included the attributes and methods from the base class and some gave the part-time student attributes and methods instead of those for the full-time student.

(iii) Very few answers gave the correct statement to create a new instance of the class `FullTimeStudent`. A common mistake in VB.NET was to omit "`= New FullTimeStudent`". Some answers made use of constructors.

Question 4

(a) Many candidates gave a parameter for the function but did not give a data type. Some passed 'Dictionary' as the parameter rather than a string value. Only the candidates with stronger responses throughout deducted 64 in the calculation and gave a return of the function. A common error was to output the number.

(b) (i) Some candidates correctly placed the entries into the dictionary, with `Computer` at index 3, `Disk` at index 4, `Error` at index 5 and `File` at index 6.

(ii) The majority of candidates correctly stated that `Drive` would hash to the same value as `Disk`, and many correctly used the term 'collision'. However, it was then stated by many that this would cause an error rather than that it would overwrite the original value.

(iii) A range of answers were seen. The commonest correct answer seen was 'to keep searching through the index for the next available space…'.

(iv) The candidates with stronger responses throughout, correctly identified the extra code that should be inserted between lines 20 and 30:

```
21 WHILE Dictionary[Index,1] > ""
22   Index ← Index + 1
23   IF Index > 2000
24     THEN
25       Index ← 1
26   ENDIF
27 ENDWHILE
```

Question 5

(a) (i) The majority of candidates were able to complete the first 4 to 5 instructions and showed 0, 7, 0, 1 in the Accumulator. There were many candidates who correctly looped twice but stopped at 2 and 14 in the last 2 columns as the last loop was missed.

(ii) Many candidates only stated that the location gets updated. The candidates with stronger responses throughout noted that the role this memory location has is as a counter to control the loop.

(b) The majority of candidates were able to store the value held in the accumulator in location 509. The candidates with stronger responses throughout realised that `LDM #12` would generate the value 12 in the accumulator.

Question 6

(a) Many candidates gave correct answers for the structure heading and ending. This type of question has been given before in in the previous syllabus, paper 2, so candidates should be familiar with this. At tomes and within the structure, there were lines of input / output code and many incorrect data types, such as integer for price. Some candidates gave data types that did not match the programming language stated, such as `Real` and `Currency` in VB.NET.

(b) The pre-release material contained a task to focus on exception handling. Candidates need to have practical experience of exception handling. The candidates with stronger responses throughout were able to complete the exception handling code and explain that line 01 alerts the system to check for possible run-time errors (the exception) and that lines 03 and 04 handle the exception without the program crashing.

(c) Only a few correct answers were seen for this part. Many candidates recognised that a loop must be used, although some tried to use a `For ... Next` loop with `EOF`. Very few candidates used the correct notation for accessing the fields of the record. Many simply wrote 'Output ProductCode' and 'Output NumberInStock'. The line to read the record was often not included. An example of a correct response is:

```
WHILE NOT EOF("StockFile")
   READFILE "StockFile", ThisStockItem
   OUTPUT ThisStockItem.ProductCode
   OUTPUT ThisStockItem.NumberInStock
ENDWHILE
```

COMPUTER SCIENCE

Paper 9608/43
Written Paper

Key messages

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General comments

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(a) Most candidates correctly labelled the PERT chart and were able to state the critical path and the minimum number of weeks required to complete the solution.

(b) Some candidates correctly read the earliest and latest start time off the chart.

(c) Few candidates could explain the reason why a project manager would use a PERT chart, that is, to show what activities could be done in parallel.

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Declarative programming has been a topic in the 9691 Paper 3 and should be well known.

(a) Most candidates were able to write the required facts using the syntax of the declarative programming language given in the question. Some candidates did not take note that predicates and atoms must be written starting with a lower case letter.

(b) Most candidates correctly stated that the result of the goal is: `ahmed, aisha, raul.`

(c) Most candidates correctly wrote the goal to find Ahmed's father: `father(F, ahmed).`

(d) Many candidates correctly wrote the rule for mother:

```
mother(X, Y) IF male(X) AND parent(X, Y).
```

(e) The stronger responses were able to complete the rule correctly and write:

```
grandparent(X, Z)
IF parent(X, Y) AND parent(Y, Z).
```

A common error was to write an imperative IF statement.

(f) Some candidates realised they could make use of the clause grandparent when defining grandfather and wrote:

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grandfather(G, K)
IF male(G) AND grandparent(G, K).
```

Question 3

The pre-release material contained a task with an inheritance diagram and candidates were supposed to use this material to write program code to implement the classes. A hint was given to make use of polymorphism and inheritance. However, evidence suggests that candidates did not have sufficient practice with object-oriented programming in a practical setting.

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(iii) Very few answers gave the correct statement to create a new instance of the class `Book`. A common mistake in VB.NET was to omit "`= New Book`". Some answers made use of constructors.

Question 4

(a) Some candidates drew the binary tree with the given items added in the correct places.

(b) Most candidates added the names into the correct part of the array. The stronger responses also showed the correct pointer values for left pointer right pointer and the root and free pointers.

(c) (i) The stronger responses correctly completed the pseudocode for an in-order tree traversal.

(ii) The textbook answer of 'a recursive procedure is one that calls itself', was popular. Some candidates were able to identify the line number where the recursive call was made.

(iii) The majority of candidates gave the correct procedure call as:

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TraverseTree(RootPointer)
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Question 5

(a) Some candidates correctly applied the hashing function and placed the Member IDs into the correct `MembershipFile` addresses.

(b) (i) Many candidates correctly completed the statement to assign `NewAddress`. Some candidates then correctly completed the `SEEK` statement. Very few candidates were able to write the given record to the file. Candidates need practical experience of writing records to random files to get an understanding of the steps involved.

(ii) The pre-release material contained a task to focus on exception handling. Candidates need to have practical experience of exception handling. The stronger responses completed the exception handling code correctly:

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(iii) The majority of candidates correctly stated that the member ID 9001 would hash to the same value as member ID 1001, and many correctly used the term 'collision'. However, it was then stated by many that this would cause an error rather than that it would overwrite the original value.

(iv) The most common correct answer seen was 'to keep searching through the file for the next available empty record…'.

(v) The stronger responses correctly identified the extra code that should be inserted between lines 40 and 50:

```
41 GETRECORD "MembershipFile", CurrentRecord
42 WHILE CurrentRecord.MemberID <> 0
43    NewAddress ← NewAdress + 1
44    IF NewAddress > 99 THEN NewAddress ← 0
45    SEEK NewAddress
46    GETRECORD "MembershipFile", CurrentRecord
47 ENDWHILE
```