COMPUTER SCIENCE

Paper 9608/11
Written Paper

Key messages

It is essential that candidates indicate clearly to the examiner when an answer continues either on an additional sheet, or on a blank space within the question paper.

This is a technical subject and candidates should use the technical language associated with the subject in an appropriate way. There is considerable misuse of terminology especially between words such as *record* and *file*, or *memory* and *storage*.

Candidates must read each question carefully and use the context provided when answering the questions. A question that begins with 'Describe' requires a different type of answer from one that begins with 'Explain'.

General comments

Candidates generally performed well on questions relating to logic expressions, number conversion, and compression techniques. Many candidates found the database question and the questions about hardware and systems more challenging.

Comments on specific questions

Question 1

(a) Candidates generally did well answering this question. The question asked candidates to draw **one** line to match each register to its description. There were many answers with more than one line from a register. Some candidates need to be aware of the difference between the Memory Address Register (MAR) and the Program Counter (PC) and the difference between the MAR and the Memory Data Register (MDR).

(b) (i) Many candidates were able to correctly name two other buses that exist within a computer, but they found it more challenging when writing the purpose of the buses. Responses such as ‘a bus is bi-directional’ are a description rather than its purpose. Some candidates need to understand that the control bus carries signals, not data, or information. An example of a good answer for the purpose is ‘The data bus transfers data to and from memory and the processor. The control bus carries control signals between the control unit and other components’.

(ii) The majority of candidates need to understand that increasing the width of the address bus from 16 bits to 32 bits does not mean that data can be transmitted faster or that more addresses can be transmitted at the same time. It means that the number of directly addressable memory locations is significantly increased.

(c) Candidates answered parts of this question well. Many candidates were able to name one of the groups for the processor's instruction set. Identifying a macro and a directive proved to be more challenging, with some confusion between the meanings of the two terms.

Question 2

(a) (i) Almost all candidates correctly identified two other appropriate input devices. By far the most popular choices were a microphone and either a scanner or a joystick.

(ii) Almost all candidates were able to identify two other appropriate output devices. By far the most popular choices were a printer and speakers.

(iii) Almost all candidates correctly chose either a Magnetic Hard Disk or Solid State Disk.

(iv) There were a small number of excellent answers to this question. Many candidates found it challenging to describe the internal operation of a tracker ball mouse. A common incorrect statement was that the discs were perpendicular to each other, rather than that the rollers that spin the discs were perpendicular to each other.

(b) Many candidates were able to use an example to describe the provision of a user interface. Most candidates found describing process management more challenging. There was some confusion between a process and a program or application. An example of a good description of process management is 'Process management schedules the allocation of CPU time to the different processes. It also allocates the resources that each process needs, such as virtual memory and resolves any conflicts when two or more processes require access to the same resource.

(c) Some candidates found describing the utility programs quite challenging. Many candidates gave descriptions such as 'a virus checker checks for a virus' or 'backup software backs up the data'. Candidates must understand that just repeating the words given in the question is insufficient. Better statements are 'A virus checker regularly scans the files on a computer system for any malicious software' or 'backup software automatically creates a copy of the data on the disk.

(d) This question asked candidates to describe how JavaScript is translated using an interpreter. There was considerable confusion between JavaScript and Java, with many candidates describing the two-stage translation of Java into machine code rather than the more straightforward interpretation of the JavaScript code. Many candidates need to improve their understanding of the differences between the two languages.

Question 3

(a) Most candidates answered this question well. The single most common error was the reversal of the last two gates.

(b) The majority of candidates were able to correctly complete the truth table for the given logic expression.

Question 4

(a) (i) There was considerable confusion when answering this question between the client computers used to access the bank's server and the customers of the bank. Many candidates need to understand that it is necessary to differentiate between the client computer (or the browser on the client computer) and the user who may be a customer of the bank.

(ii) A number of candidates provided correct answers to this part question. The most popular applications were online gaming and music streaming. A significant number of candidates need to understand that no marks are awarded for the use of brand names. A popular incorrect answer was 'Facebook'.

(b) The majority of candidates need to improve their understanding of why a web application such as that of a bank would use server-side scripting. A small number of candidates mentioned the security aspect, but the majority of responses were vague. An example of a good response is 'All the personal information of the customers is held on the bank's server. By using server-side scripting, the customer using the client computer does not have access to all the data, which keeps the data more secure'.

(c) (i) The majority of candidates were able to give two suitable benefits of changing over to fibre optic cables.

(ii) Candidates found it challenging to give two drawbacks of installing fibre optic cable. The question asked for the drawbacks of upgrading to fibre optic from copper cables, so an answer that just stated 'expensive' is not enough. There needs to be a comparison with the existing arrangement. A better answer is 'Fibre optic cables are more expensive to install and maintain than copper cables'.

(d) (i) Many candidates found it challenging to write the correct attributes for all three tables. The most common cause of error in the `CUSTOMER` table was the omission of any sort of primary key. The stem of the question stated that the database was normalised, and none of the three attributes given would be unique, even in combination. The attributes for the `ACCOUNT_TYPE` table were the most correct answers given. The most frequent cause of error in the `CUSTOMER_ACCOUNT` table was the omission of any foreign keys linking this table to the other two.

(ii) A significant number of candidates found identification of the three primary keys challenging. A frequent incorrect answer for the `CUSTOMER_ACCOUNT` table was a compound key created from the primary keys of the other two tables, but this would not be unique if a customer had more than one account of the same type. The question also stated that the `CUSTOMER_ACCOUNT` table had its own ID number.

(iii) Most candidates were able to identify a correct foreign key in one of their tables.

(iv) The majority of candidates were able to correctly identify one or more of the terms in the table. The one most commonly incorrect was the 'table'; the one most likely to be correctly identified was the 'attribute'. Several candidates wrote 'field', even though it had been included in the definition given.

Question 5

(a) (i) Many candidates need to improve their understanding of what is meant by colour depth. Common incorrect answers were 8 and 3.

(ii) The majority of candidates were able to convert the binary value into denary.

(b) A minority of candidates provided correct answers to this question. Some candidates were able to convert the negative denary number to binary. The most common mistake was to convert +194 to binary and then to forget to convert the positive binary value to a negative one.

(c) (i) The majority of candidates were able to convert the binary coded decimal (BCD) value into denary. The most frequently seen incorrect answer was 105, where candidates had converted the binary value to a denary number rather than BCD.

(ii) Almost all candidates were able to identify one practical use of BCD. The most popular correct answer was in a digital clock.

(d) Most candidates understood that each character in a character set is represented by a denary, hexadecimal, or binary value. Some candidates need to understand that these values are unique to each character in each character set.

(e) (i) The majority of candidates were able to justify the use of lossless compression for the program file.

(ii) Many candidates found it challenging to justify either the use of lossy or lossless compression for the photograph in this part question. Many of the answers described **how** the chosen compression method would reduce the file size rather than justifying **why** the compression method should be used in this situation.

(iii) Many candidates found it challenging to justify either the use of lossy or lossless compression for the video clip in this part question. Many of the answers described **how** the chosen compression method would reduce the file size rather than justifying **why** the chosen compression method should be used in this situation.

COMPUTER SCIENCE

Paper 9608/12
Written Paper

Key messages

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Candidates must read each question carefully and use the context provided when answering the questions. A question that begins with 'Describe' requires a different type of answer from one that begins with 'Explain'.

General comments

The questions about logic expressions and the database question were well done. Many candidates found the questions about video encoding and compression more challenging.

Comments on specific questions

Question 1

(a) The majority of candidates were able to match the type of software to the correct description. A small number of candidates need to improve their understanding of the difference between a library program and a utility program.

(b) Many candidates were able to state that this utility software checks the disk for errors and inconsistencies and marks bad sectors as unusable. There was some confusion with checking for errors and checking for viruses. Some candidates need to understand that restoring data from a backup is a different process from repairing the data on a damaged disk. Responses that simply re-iterate the question such as 'disk repair software repairs a disk' are far too vague.

Question 2

(a) There were many correct answers to this question. Some candidates correctly used a single NOR gate to represent NOT (A OR B). Some candidates need to improve their understanding of the XOR gate.

(b) The majority of candidates answered this question well. As explained above, some candidates need to improve their understanding of operation of the XOR gate.

Question 3

(a) A minority of candidates provided a completely correct answer to this question. A number of candidates recognised value1 as a JavaScript identifier, but frequently candidates took the second identifier from the lines of HTML code rather than the JavaScript code. Some candidates need to improve their understanding of the difference between HTML and JavaScript. Some candidates also need to understand that JavaScript identifiers are case sensitive, so '`Multiply`' is a different identifier from '`multiply`'.

(b) A minority of candidates provided correct answers to this part question. The answer seen most often was 81 that is 9 * 9 where candidates had overlooked the incrementation of the variable `value1` on line 14 before the multiplication.

(c) Candidates need to improve their understanding of simple JavaScript code. A minority of candidates understood that the statement `value1++` incremented the value of the variable `value1`.

(d) Some candidates correctly recognised that the variable would no longer be converted to an integer. A minority of candidates also understood that adding two string values would result in concatenation rather than arithmetic addition. An example answer is 'The variable `value1` will not be converted to an integer, it will be a string data type, and therefore instead of adding the two values they will be concatenated. For example if value1 is 6, the output would be `66`.'

Question 4

(a) (i) Many candidates need to improve their understanding of the features of a relational database. An example of a good answer is 'In a relational database, multiple tables are linked together which reduces data redundancy and improves data integrity. Different users can be given different views of the data, so they do not see confidential information and data privacy is maintained'.

(ii) The majority of candidates were able to complete the given statements.

(b) (i) The majority of candidates were able to complete the E-R diagram.

(ii) A minority of candidates answered this question well. Many candidates need to improve their understanding of the SQL CREATE DATABASE command.

(iii) A minority of candidates answered this question well. Many candidates also need to improve their understanding of the SQL CREATE TABLE command.

(iv) There were more correct answers to this part question. Some candidates need to improve their understanding of Data Manipulation Language (DML) statements in SQL, particularly the order in which the statements are used.

Question 5

(a) Many candidates were able to state that encryption would be one way of preventing the installation of illegal copies of the software. Fewer candidates were able to correctly state a second method. Some candidates need to understand that copyrighting software does not actually prevent the installation of illegal copies of software.

(b) This question was generally answered well by most candidates. Many candidates stated that the way to distribute the software would be by issuing a compiled version, or executable file.

(c) (i) Some candidates should understand that using a commercial licence does not prevent further copies being made.

(ii) The majority of candidates were able to name two other correct types of software licence.

Question 6

(a) (i) Most candidates were able to identify whether the devices were used for input, for output or for both.

(ii) The majority of candidates could identify the correct sequence of events.

(b) (i) Many candidates provided vague answers to this question. A typical answer was 'to store data'. Candidates need to understand that data is also stored in primary memory, so an answer like this is not precise enough at this level of study.

(ii) A significant number of candidates were able to describe solid-state memory as non-volatile storage with no mechanical or moving parts. Candidates need to improve their understanding of the use of solid-state memory as internal secondary storage.

(c) The majority of candidates were able to state the correct purpose of both RAM and ROM.

(d) (i) Many candidates found this question challenging. Candidates should understand that when describing how an image or a sound is encoded, it is not enough to say 'use an analogue to digital converter'. An example answer is 'The images are stored in bitmap format and are made up of a number of pixels. Each pixel is of one single colour and each colour is encoded by a unique binary number'.

(ii) Many candidates found this question challenging. There was some confusion between the two terms. Candidates need to improve their understanding of interlaced and progressive encoding of videos.

(e) (i) The question asked **how** bit-streaming is used and many candidates need to understand the way to answer this question. Frequent incorrect answers described live or on-demand bit streaming instead of describing how bit streaming works. An example answer is 'Bit streaming is the transmission of the video as a sequence of bits. The video would be compressed and uploaded to a media or web server. On download the server sends the data to a buffer on the receiving computer'.

(ii) The majority of candidates were able to identify that the video would be streamed on-demand, because it was pre-recorded and because the colleagues could then watch at a time convenient to themselves.

(iii) Many candidates found it challenging. Some candidates need to be aware of the requirement for precision when describing the terms. It is not enough to say, for example, that 'temporal redundancy is when pixels have the same value in two different frames'. It must be clear that the pixels that have the same value are in the same location in consecutive frames. An example answer is 'temporal redundancy is when pixels in the same location have the same value in two or more consecutive frames'.

COMPUTER SCIENCE

Paper 9608/13
Written Paper

Key messages

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Candidates must read each question carefully and use the context provided when answering the questions. A question that begins with 'Describe' requires a different type of answer from one that begins with 'Explain'.

General comments

The questions about logic expressions and the database question were well done. Many candidates found the questions about video encoding and compression more challenging.

Comments on specific questions

Question 1

(a) (i) There were many correct answers to this part question, with a variety of appropriate input devices identified. Some candidates must ensure that they read the question carefully. A touchscreen was given in the question and candidates needed to identify **other** suitable input devices.

(ii) There were many correct answers to this part question, with a variety of appropriate output devices identified. Some candidates must ensure that they read the question carefully. A touchscreen was given in the question and candidates needed to identify **other** suitable output devices.

(iii) Almost all candidates correctly identified the statements needed in the first and last steps in the sequence. A significant number of candidates correctly completed the whole sequence. There was some confusion between the statements needed in steps 3 and 4. Some candidates need to understand that the change in the electrostatic field happens after the charge is drawn to the point of contact.

(b) (i) Many candidates found this question challenging. Candidates need to provide answers in the context of the self-checkout machine. Some candidates need to understand that individual self-checkout machines would not hold the database of item barcodes, prices etc. These data are held on the supermarket's server. Only the data pertaining to the current customer would be stored locally. An example of a good answer to this question is ‘The self-checkout machine needs primary storage in order to store the operating software for the machine and also to store the details of the purchases for the current customer’.

(ii) The majority of candidates were able to identify whether each statement applied to SRAM or DRAM.

(c) (i) There were a small number of good answers to this question, many of them in the correct context. Some candidates must understand that a client in a client-server network is not the user. An example of a good answer is ‘In a supermarket the self-checkout machine is the client. All the data

about the products such as their price is stored in a database on the supermarket's server. When a customer scans a barcode on a product, the client (self-checkout machine) requests the server to look up the details of the item corresponding to that barcode. The server will query its database and return the description and the price of the item to the self-checkout machine which can then display these details to the customer'.

(ii) Most candidates were able to identify two correct methods to minimise the security risk to the data on the server. The most popular correct answers were 'encryption' and the use of a 'firewall'. Many candidates found it more challenging to identify one method to protect the integrity of the data. Frequent incorrect answers were a third method of enhancing security rather than a method for maintaining integrity. There was also some confusion between validation and verification of data.

Question 2

(a) Many candidates found this question challenging. Candidates need to improve their understanding of the process management and memory management tasks carried out by an operating system. There was considerable confusion between memory management and the management of secondary storage, with incorrect references to files and directories.

(b) (i) There were some very good answers to this question. Some candidates need to understand that responses that simply re-iterate the question such as 'sampling means taking samples of the sound' are too vague for this level of study.

(ii) Most candidates were able to give one correct answer to this question, either the effect of the change on the recording or the effect on the file. The question asked for both.

(iii) The majority of candidates were able to describe two features of sound editing software other than delete and copy and paste.

Question 3

(a) (i) Many candidates found it challenging to correctly write the attributes for all three tables. The most common cause of error in the `CUSTOMER` table was the omission of any sort of primary key. The stem of the question stated that the database was normalised, and none of the three attributes given would be unique, even in combination. The attributes of the `ROOM` table were the most likely to be given correctly, although `RoomID` was frequently included instead of `RoomNumber`. The most frequent cause of error in the `BOOKING` table was the omission of any foreign keys linking this table to the other two.

(ii) A significant number of candidates found the identification of the three primary keys quite challenging. A frequent incorrect answer for the `BOOKING` table was a compound key created from the primary keys of the other two tables, but this would not be unique if a customer had bookings for the same room at different times. The question also stated that the `BOOKING` table had its own ID number.

(iii) Most candidates were able to identify a foreign key in one of their tables.

(b) Many candidates need to improve their understanding of these DBMS tools. There were more correct responses for the Query Processor than the Developer Interface. Examples of good answers are 'A developer interface allows user-friendly forms and reports to be created. An example of a report might be to show all the rooms available on a certain date. A query processor allows a user to create queries to select data based on certain criteria, which might then be displayed on a form. An example of a query might be to list all the customers with more than one booking on a particular date'.

(c) Many candidates were able to correctly identify whether each statement was a Data Definition Language (DDL) statement or a Data Manipulation Language (DML) statement. The statement incorrectly identified most frequently was the third one, `ALTER TABLE ADD PRIMARY KEY (FilmID)`.

Question 4

(a) There were a number of correct answers to this binary to denary conversion question. A frequent error was in the arithmetic addition of the powers of 2. Another common incorrect answer was 5 + 15 + 12 = 32, where candidates had added together the binary conversions of each group of four bits.

(b) Many candidates found the conversion of a negative denary number into binary quite challenging. The most common error was to correctly convert +239, but then to incorrectly complete the change of sign.

(c) Many candidates were able to correctly convert the two's complement binary value into denary.

(d) The majority of candidates were able to correctly convert the Binary Coded Decimal (BCD) value into denary. The most common incorrect answer was 101, where candidates had treated the binary value as an unsigned integer.

(e) Many candidates were able to correctly convert the given denary number into hexadecimal.

Question 5

(a) The majority of candidates had answered this question well. A significant number of candidates had also understood that the first part of the expression, that is, NOT (A OR C) could be implemented with a single NOR gate.

(b) The majority of candidates had answered this question well. The most common error was in the fifth and sixth rows, where these were both given as 0 instead of 1.

Question 6

(a) (i) Many candidates were able to identify three functions in the JavaScript code. Some candidates need to improve their understanding of the use of upper and lower case letters in this code. The most common incorrect answers were the names of elements from the HTML code rather than from the JavaScript code.

(ii) The majority of candidates identified the lines 17 and 19 produced an output. Fewer candidates understood that an output was also produced by line 12 of the JavaScript code. Here too, the most common error was the inclusion of line numbers from the HTML statements rather than from the JavaScript.

(iii) Many candidates found identifying the correct line number where an input was stored in a variable more challenging. The most common incorrect answer was line 05, which is a line of HTML not JavaScript.

(iv) Many candidates were able to describe the purpose of the code in general terms. Few candidates included the identifiers of the variables in their answers. Good answers include statements such as 'The variable answer is converted to a string and compared with the variable `userAnswer` which stores the user input to see if they are equal. Depending on the result of the comparison, different messages will be output from line 17 or line 19'.

(b) The majority of candidates were able to describe the benefits of using a JavaScript program library. While most of the responses concentrated on the more general reasons for using program libraries, there were a few excellent responses in context that gave the specific benefits of JavaScript program libraries.

Question 7

There were a small number of completely correct answers to this question. Many candidates found it challenging. These candidates need to improve their understanding of addressing modes. A frequent incorrect answer was the insertion of mnemonics for assembly language statements rather than the name of the appropriate addressing mode.

COMPUTER SCIENCE

Paper 9608/21
Written Paper

Key messages

The emphasis for this paper is on the application of practical skills. Candidates need to apply these skills to the scenarios presented. This is a technical subject and makes use of many technical words and phrases. It is important that candidates these correctly.

It is important that candidates writing program code use the correct syntax for their chosen programming language. The understanding of fundamental programming concepts is essential. Examples include the difference between a literal and an identifier and the difference between `OUTPUT` and `RETURN`.

Candidates need to read each question carefully before attempting to answer it. Questions may address topics in various ways and it is often necessary for candidates to respond in context.

General comments

Many candidates performed well on this paper, indicating a good, sound understanding of the subject. There were many excellent solutions seen to questions that required pseudocode and program code. Candidates generally made good use of built in functions and methods of the programming language. It is important that candidates, who use Python, take care to maintain the correct indentation.

Candidates need to read questions carefully. It was clear from a number of responses that many candidates had not read questions carefully enough. If candidates cross out any answers, they must write any new answers clearly. Many candidates make use of blank pages for rough work when preparing their final response. In these cases, it is extremely helpful if candidates cross out any rough work.

Comments on specific questions

Question 1

(a) (i) Many candidates successfully answered this question. Many candidates provided clear and precise answers. Others used imprecise statements such as ‘good variable names’ or ‘spaces’.

Other errors included candidates referring to specific programming features such as ‘declaration’ or ‘a loop’ and a small number of answers simply repeated lines from the original pseudocode.

(ii) The majority of candidates achieved at least two marks, one for `START` and `END`, one for the first three assignments. Candidates often omitted the brackets that denoted `GetLevel()` as a function rather than a variable.

The loop part of the flowchart appeared to be the most problematic. Most answers used a post-condition loop structure. Either conditional type was acceptable but often the number of iterations was incorrect.

Many candidates either missed the `RETURN` altogether or stated `OUTPUT` instead of `RETURN`.

Many candidates did not use the flow arrow lines and many used decision diamond boxes that had only one output.

(b) (i) The majority of candidates answered this question part successfully.

(ii) There was a variety of responses to this question. A common error was to omit the quotation marks from the expressions that evaluated to an object of type `STRING`.

Question 2

(a) A significant number of candidates provided a correct response to this question. Repetition and selection were the two most frequent answers.

A number of imprecise responses referred to data moving from one module to another but lacked specific technical wording. Many incorrectly referred to `INPUT`/`OUTPUT`.

A small number of candidates gave general computing terms that were unrelated to the question.

(b) Pretty print was a popular answer and most candidates stated that it applied colour coding to key words. Some answers were imprecise and did not mention the uses for the colour coding.

A significant number of candidates seemed to have missed the fact that the question was asking about program presentation and gave debugging features such as breakpoints, stepping and watch windows.

(c) Many candidates correctly identified 'by reference' and some went on to state it was the memory address that was passed.

Responses that described the fact that the original value would be changed were often imprecise and insufficient.

(d) Many candidates correctly referred to 'changes to the code' but the rest of the response was often imprecise. Many candidates confused adaptive with corrective maintenance in their descriptions.

Question 3

Many candidates scored 4 or more marks on this question. Some candidates had not read the question carefully and their responses did not address the question asked.

Question 4

(a) Candidates generally did not answer this question well. Many did not identify the process as stepwise refinement.

Most responses did check that character was in the range 'A' to 'Z'. There were few references to producing a unique array index, although several described incrementing an array element. A common mistake was to attempt to increment the character itself.

A significant number of responses simply repeated the phrase 'increment as required' from the question.

Many answers addressed several of the original steps, rather than just step 4 as directed.

(b) Many candidates recognised the need for a loop from 1 to the length of `InString` and then continued to extract each character using the `MID()` function.

Some candidates converted the extracted character to `ASCII` but used the wrong values, either in the comparison or as an array index. Some candidates seemed to be unaware of data types and attempted to use a character as an array index rather than an integer value.

Many candidates correctly checked that the character was in the range 'A' to 'Z' but had not first converted the extracted character to upper case, therefore losing any lowercase characters.

Many candidates were able to increment the value of an array element.

Some candidates went on to attempt to produce the required output but did not include a loop to output all the contents of the array.

Many of those that had successfully used `ASCII()` to create an index value realised that the `CHR()` function was needed to convert the value to the relevant character before it could be concatenated to form an output string.

Question 5

(a) Many responses correctly interpreted the pseudocode to describe the validation rules.

Several imprecise responses simply stated that the string must be valid and meet the rules, without describing what these were.

The third part of the rule caused some difficulty. Some stated that the difference between the number of digits and the other characters must be at least one. This was not correct as it suggests that it could be either more digits or more other characters.

(b) (i) The majority of candidates answered this question well achieving 3 or more marks.

A common error was the omission of quotation marks round the characters in the `NextChar` column. This gives the data a completely different meaning (for example, the difference between the numeric value 9 and the character '9'), which the majority of candidates did not recognise.

Many responses omitted the initialisation values.

(ii) The majority of candidates who answered the previous part correctly also answered this art correctly. The majority identified that the return value was of type Boolean, and most of those stated `FALSE` together with clear explanations.

Candidates, who stated `TRUE`, were awarded marks, if their response was supported by the values in their trace table.

Question 6

(a) Most responses indicated that candidates have some idea that data in a file is saved somewhere so it is not lost when the program is closed. Some explanations were too imprecise for this level of assessment, for example 'data is kept for ever'.

A number of candidates suggested that the data in files could still be accessed when the computer is turned off, which is an interesting idea unless the files are stored on some removable media, which was never stated.

A significant number of responses suggested that storage in files was 'easier'.

(b) A number of candidates provided some well-written programming code. These were usually in Python programming language where they made use of the built-in split function to extract the account number.

Most responses included an attempt at a function heading and some form of loop, together with statements for opening and closing files and returning a Boolean value.

Many solutions did not include a loop. Of those that did, the end of file check often omitted the reference to the file.

Few responses were seen that included a condition to terminate the loop once the data was found, although many (mainly Python) solutions included a break statement.

The extraction of the first 6 or 9 characters seemed to be the most problematic. Some good attempts performed two comparisons (for both the first 6 and the first 9 characters) without realising that a substring match could potentially give an invalid result.

(c) A minority of candidates answered this question part well.

Many solutions included an attempt to open file `UserListAtoM.txt`. It was common to see the other file also being opened suggesting that the module description in the question had not been understood.

Few conditional loops were seen that tested both for the end of file and for the `Duplicates` array being full.

A reasonable attempt was made by many to extract the required data using the `MID()` function but this was often not quite correct.

Incorrect syntax was common when calling the `SearchFileNtoZ()` function, with the majority attempting to call it as a procedure. This had the consequence that there was no return value to test. The parameter giving the account number was often omitted.

Only a small number of answers included correct statements to store the extracted value in the array. Many solutions contained methods specific to particular programming languages.

Several solutions wrote the account number to multiple array elements, often to all elements that were otherwise empty.

Many solutions included an attempt to check for array overflow. Often these were based on two integers, one used as the index and one as a count. It was common for the logic in these cases to be confused.

(d) (i) A minority of candidates answered this question part well. A significant number of candidates did not attempt this question part.

Candidates were often awarded marks for the loop and the assignment statement.

For the procedure heading, three parameters were specified. `ByRef` was rarely included for the array, which was often named using the key word `ARRAY`.

Some responses initialised the array elements to ‘’ rather than using the parameter value.

(ii) A minority of candidates answered this question part well.

Many candidates seemed to have overlooked the directive to ‘write **program code** for a statement that calls...’ and attempted to write the procedure, either in whole or in part.

Some candidates provided a statement that called the procedure but omitted the parameters.

COMPUTER SCIENCE

Paper 9608/22
Written Paper

Key messages

The emphasis for this paper is on the application of practical skills. Candidates need to apply these skills to the scenarios presented. This is a technical subject and makes use of many technical words and phrases. It is important that candidates these correctly.

It is important that candidates writing program code use the correct syntax for their chosen programming language. The understanding of fundamental programming concepts is essential. Examples include the difference between a literal and an identifier and the difference between `OUTPUT` and `RETURN`.

Candidates need to read each question carefully before attempting to answer it. Questions may address topics in various ways and it is often necessary for candidates to respond in context.

General comments

Many candidates performed well on this paper, indicating a good, sound understanding of the subject. There were many excellent solutions seen to questions that required pseudocode and program code. Candidates generally made good use of built in functions and methods of the programming language. It is important that candidates, who use Python, take care to maintain the correct indentation.

Candidates need to read questions carefully. It was clear from a number of responses that many candidates had not read questions carefully enough. If candidates cross out any answers, they must write any new answers clearly. Many candidates make use of blank pages for rough work when preparing their final response. In these cases, it is extremely helpful if candidates cross out any rough work.

Comments on specific questions

Question 1

(a) (i) Many candidates successfully answered this question. Many candidates provided clear and precise answers. Others used imprecise statements such as ‘good variable names’ or ‘spaces’.

Other errors included candidates referring to specific programming features such as ‘declaration’ or ‘a loop’ and a small number of answers simply repeated lines from the original pseudocode.

(ii) The majority of candidates gained at least two marks: one for `START` and `END` plus one for the first two assignments.

Many candidates made a reasonable attempt at the loop and the test for `Tries > 3`.

The loop part of the flowchart appeared to be the most problematic. Often the conditional check was only partially implemented. Many candidates attempted to combine the initial check (corresponding to the pseudocode statement `IF NOT Full`) with the check that was required at the start of each loop.

Many candidates did not use the flow arrow lines and many used decision diamond boxes that had only one output. Some candidates missed the `OUTPUT` command word.

(b) (i) The majority of candidates answered this question part successfully.

(ii) There was a variety of responses to this question. A common error was to omit the quotation marks from the expressions that evaluated to an object of type `STRING`. Many candidates did not convert the final value to an integer

Question 2

(a) Many responses stated that source code would be created using an editor or that source code was 'understandable by humans', but very few related the source code to an activity in the program development cycle.

Many candidates confused source code with object code.

Many successful responses stated for corrective maintenance as 'debugging' or by making reference to 'finding and fixing errors'.

(b) Most candidates correctly referred to the ability of an IDE to highlight a syntax error. Many responses were imprecise, for example by stating 'indentation' instead of 'auto indentation'.

A significant number of candidates seemed to have missed the fact that the question was asking about initial error detection and gave debugging features such as breakpoints, stepping and watch windows.

Question 3

(a) A minority of candidates provided a correct response to this question part.

Many candidates were unable to give a sensible array declaration. A common error was to give the length of `InString` for the upper array dimension.

Many candidates recognised that a `FOR ... ENDFOR` loop was involved in initialising all array elements. Often the array assignment within the loop was incorrect; in several cases the character '0' being used rather than the value zero.

(b) The majority of correct response included an attempt at the first `FOR ... ENDFOR` loop and the selection of each character in turn from `InString`. Some candidates used `LEFT()`instead of `MID()` to perform the selection.

Only a minority of candidates were able to identify the array element to increment. Many solutions simply incremented a single count variable.

Candidates were expected to use a separate second loop to perform the output. Solutions based on this simpler structure with two independent loops were more successful than those that attempted to use a single, nested loop.

Question 4

(a) There were many good answers to **part (b)** of this question, suggesting that the scenario had been understood.

Only a minority of solutions included the parameter value in the procedure heading. Some solutions confused the use of `MaxVol` and `VolLevel`. A common error was to include a call to the procedure being written.

Several solutions included parameter validation, although the final sentence of the question stated that this was not necessary.

The better solutions tested the value of the parameter and attempted to adjust `VolLevel` accordingly. Ensuring that `VolLevel` remained in the given range was only included in a few solutions, and even here it was usually limited to checking that value was still >= 0 when turning

the volume down. Very few solutions correctly addressed how the upper volume limit could be determined.

Many solutions included output statements, which were not required and which, arguably, would have no place in the given scenario.

(b) Most candidates provided a correct response to this question part.

(c) (i) Most response correctly identified either a logical or run-time error and of these many also included a correct description.

(ii) A minority of candidates provided a correct response to this question part. The concept of stub testing does not seem to be widely understood.

Many answers described testing of a modular program in general, commonly referring to the idea of testing each part of the program separately. References to the testing of an incomplete program were rare. Some responses occasionally mentioned use of a dummy module.

Question 5

(a) This question attracted heavily polarised responses. Many candidates provided perfect solutions. A small number of responses bore no relation to a structure chart.

A relatively common mistake was not to represent the correct sequence. Some confusion was evident as to whether circles on arrows should be filled or not, with some candidates drawing circles which were either too small to identify or appeared to be partly filled.

A minority of candidates used the correct double-headed arrow for the variable passed by reference.

Question 6

(a) A minority of candidates provided a correct response to this question part

Most responses included an attempt at a function heading and some form of loop.

The task was simply to write program code to perform a linear search of a 1D array. Many solutions attempted to include unnecessary file handling.

Many candidates chose to `OUTPUT` rather than `RETURN` the Boolean value.

A common mistake was to continue searching through the array even after the value was found. In many cases, this included assigning `FALSE` to the return value after each comparison, which meant that the return value would be incorrect, unless the searched-for value was the last one in the array.

(b) A minority of candidates provided a correct response to this question part.

Most responses included an attempt at a function heading and some form of loop, together with statements for opening and closing files, incrementing a count variable, and returning the count.

The majority of solutions recognised the need to extract the `Reference` from the string read from the file, but often the length calculation was incorrect.

Incorrect syntax was common when calling the `SearchLeavers()` function, with the majority attempting to call it as a procedure. This had the consequence that there was no return value to test.

(c) A minority of candidates provided a correct response to this question part.

Many candidates seemed to have overlooked the final sentence of the question, which stated:

Write a statement in **program code** that uses `CountTimes()` to assign the count of unused elements to the variable `Result`.

The last part of the sentence should have directly led to the left-hand side of the answer statement to give the first mark but this did not happen in the majority of cases. Some candidates used function headers and ad-hoc lines of code.

COMPUTER SCIENCE

Paper 9608/23
Written Paper

Key messages

The emphasis for this paper is on the application of practical skills. Candidates need apply these skills to the scenarios presented. This is a technical subject and makes use of many technical words and phrases. It is important for candidates to use these correctly, as they have specific meanings.

It is important that candidates write program code that uses the correct syntax for their chosen programming language. The understanding of fundamental programming concepts is essential. Examples include the difference between a literal and an identifier, and the difference between `OUTPUT` and `RETURN`. Candidates need to read each question carefully before attempting to answer the question. Answers may address individual topics in a number of different ways.

General comments

Many candidates achieved highly on this paper, indicating a good, sound understanding of the subject. There were many excellent solutions seen to questions that required pseudocode and program code. Candidates generally made good use of built in functions and methods of the programming language. It is important that candidates, who use Python, take care to maintain the correct indentation.

Candidates need to read questions carefully. It was clear from a number of responses that many candidates had not read questions carefully enough. If candidates cross out any answers, they must write any new answers clearly. Many candidates make use of blank pages for rough work when preparing their final response. In these cases, it is extremely helpful if candidates cross out any rough work.

Comments on specific questions

Question 1

(a) (i) Many successfully answered this question. Many candidates did not include quotes around the data if they used a string as an example.

(ii) A common response given by some candidates was ‘declarative’ instead of ‘declaration’. In Computing, declarative is a programming paradigm associated with logic programming.

The most common incorrect answer seen was ‘assignment’. These candidates are confusing giving a **value** to a variable with giving a **data type** to a variable.

(b) Many candidates correctly answered this question. Many candidates stated a list of variables instead of variable (or identifier) name.

(c) (i) Most candidates gained the marks for identifying input and output for the stage. Some example statements were in pseudocode when the question asked for program code. It is important that candidates used the correct program syntax.

(ii) The most popular correct statements involved an output statement which joined two strings or included a calculation in the output expression. The question asked for a single statement. A number of candidates gave two expressions.

(d) Many candidates provided correct responses to this question. Responses such as 'colour coding', were considered as too vague. Candidates must specify what the colour coding represents, such as 'colour coded key words'.

(e) Most candidates recognised that trace tables are used for white box testing.

Question 2

(a) (i) There were mixed responses to this question. Candidates who recognised that this was a count controlled loop (or FOR loop) were able to give a correct explanation. Some responses stated a While loop or Repeat Until loop. These are examples of Pre and Post condition loops.

(ii) There were many correct responses to this question, with most of these using a REPEAT..UNTIL loop. Some candidates attempted to use a WHILE statement. These candidates needed to recognise that to achieve the same outcome, the condition must be changed to:
WHILE Status1 = FALSE OR Status2 = FALSE.

(b) Many candidates answered this question well. Some responses indicated that they were unable to recognise, or were not familiar with, 'step value' in a count controlled loop.

(c) The majority of candidates correctly stated a compiler or a translator. Some responses gave an Assembler, when the question stated '..a **high level** language…'.

Question 3

Candidates must indicate clearly whether the arrow has a filled in circle or an empty circle to distinguish between a BOOLEAN and non-BOOLEAN value. Candidates who were familiar with structure charts achieved high marks. It was clear that a small number of candidates had little experience of structure charts, or had misread the question and attempted to draw an entity relationship (ER) diagram.

Question 4

(a) This question required an explanation of the line of code:
`IF (NumDots > = 1 AND NumAts = 1 AND NumOthers > 5)`. Many candidates gave clear and correct explanations and gained full credit. Candidates needed to recognise what the three variables in the expression represented in order to gain full credit. Some responses were vague, simply describing the term validation or stating that the rules check that the data is valid.

(b) (i) Many candidates correctly traced the code. Many of these candidates did not include the quotes around `NextChar` to indicate that it is a character (not a variable). Some candidates missed out the first three statements, which initialise the three variables to zero.

(ii) Most candidates recognised that the return value was `TRUE`.

(c) Most candidates recognised that the strings being tested must be correct for two of the validation rules and must only fail on one of them. These candidates' explanations were mostly very clear. A common error was to provide test strings that failed more than one rule.

Question 5

Candidates provided a wide range of solutions. Many solutions included a FOR loop to the end of the string which examined each character and tested for a space. They would then add the following character to a new string if the current character was a space. This method will work until reaching the end of the string. At this point, it does not take into account that the last character could be a space and this would result in an out of bounds error.

Candidates must remember that '← ' must be used in pseudocode for assignment rather than '='.

Question 6

(a) (i) The marks awarded for this array declaration were split into the three parts, involving the array name, the dimensions, and the data type. Most candidates achieved at least one of the marks. Many candidates need to be familiar with the correct pseudocode syntax for an array declaration.

(ii) This question required a program code solution. Most solutions seen were written in either VB or Python. There were a wide range of solutions, particularly in Python, which provides various functions and methods for reading files and stripping specific characters from strings. Credit was given to those solutions that correctly used these functions. Many Python candidates, in trying to extract the `Title` line of the file having read the (following) Author line were writing:

`Title = file.readline(n-1)` and then `Location = file.readline(n+2),` where `n` referred to the current (Author) file line.

This would however read the specified number of bytes from the current line and not from the previous or subsequent lines of the file.

(b) The solution to this question involved a loop to output the contents of a 2D array in a specified format. Three parameters were required in the procedure heading, one of which was the count value. Candidates did not need to include a count to be incremented in the code for output.

Many candidates attempted this question well. They used a correctly formatted loop and a check to ensure there was data to output, with the appropriate headings. The question gave the required format, indicating the alignment of `Title` and `Location` values under the headings. Candidates were expected to address the spacing and credit was given to those that made a reasonable attempt. A minority of candidates successfully provided a solution, which calculated the length of the `Title` string and the length of the `Title` heading, with the spaces between the two headings in order to calculate the position of the `Location` output.

Candidates must understand that output of a line in pseudocode, using string and numeric data, must include a type conversion of number to string.

COMPUTER SCIENCE

Paper 9608/31
Written Paper

Key messages

Candidates need to show an in-depth study of the topics and make good use of appropriate technical terminology on this paper. Candidates, who have studied the theory and have practised the precise use of these tools and techniques, were successful in solving problems on the examination paper.

Candidates need to follow carefully instructions given in examination paper questions.

Candidates need to ensure that they provide the information required by the question for their answer and not the information given in the question.

General comments

Candidates always need to read questions very carefully before attempting to write an answer. Instructions that state 'Explain why' and instructions that state 'Explain what is meant by' need different types of answer.

Comments on specific questions

Question 1

(a) (i) Most candidates found the correct denary value for the exponent. Some candidates found using the exponent with the mantissa to calculate the final answer more challenging and did not perform this part of the calculation correctly. Many candidates provided fully correct answers that showed detailed working.

(ii) Some candidates had difficulties using two's complement for the conversion of a negative number.

(b) A common error by candidates was to add an incorrect statement about a decrease in precision.

(c) Many candidates correctly stated that there is no exact conversion for some decimal numbers.

(d) Most candidates inserted the correct missing terms in to the descriptions.

Question 2

(a) (i) Most candidates correctly identified that 35 was not a variable as required by the syntax. A common error was for candidates to state that 35 was not a letter. This was not sufficient, as it did not relate to the appropriate syntax rule.

(ii) Most candidates correctly identified that ':=' was not an operator as required by the syntax**.** A common error was for candidates to state that ':' was not an operator. This was not sufficient, as it did not relate to the whole operator.

(iii) Most candidates correctly identified that 9 was not included in the syntax for digit.

(b) Many candidates provided correct BNF for the syntax diagrams. A common error was for candidates not to use '|' correctly as the delimiter for each phrase rather than a single term.

For example, incorrectly writing `<variable><operator><number>|<variable>` instead of `<variable><operator><number>|<variable><operator><variable>`

Question 3

(a) Many candidates correctly identified that protocols were essential to provide a set of rules. Few candidates provided any further explanation.

(b) Many candidates correctly stated that CSMA/CD stands for Carrier Sense Multiple Access (with) Collision Detection. Fewer candidates correctly identified that the devices follow these rules. Some candidates did not attempt this part of the question.

Question 4

(a) Those candidates who correctly wrote their answer as a sum-of-products usually gained full marks. A common error was to write $\overline{A.B.C}$ as $\bar{A}.\bar{B}.\bar{C}$.

(b) Many responses showed a correctly completed Karnaugh Map.

(c) Most responses showed correct grouping. The most common error was to group the four products in the bottom row.

(d) Most candidates provided a correct simplified sum-of-products for the answer to **part (c)**.

Question 5

(a) Many candidates correctly stated why user-defined data types are necessary. A common error was to state an advantage of using user-defined data types, for example, 'They will make a program less error prone.'

(b) (i) Many candidates provided correct pseudocode statements for the user-defined data type. A common error was to declare `EmployeeID` as an integer rather than a string.

(ii) Many candidates correctly identified the data type as enumerated.

(iii) Most candidates provided a correct assignment statement.

(iv) Many candidates included record as a composite data type. This was given in the stem of the question and could not be used by candidates as an answer.

Question 6

(a) A minority of candidates provided acceptable explanations about the operating system's memory management technique of paging. Some candidates did not attempt this part of the question.

(b) Some candidates provided good explanations of why an operating system needs to use scheduling algorithms.

(c) A minority of candidates correctly stated what was meant by an interrupt. An example of an acceptable answer is 'A signal from a software source or hardware device seeking the attention of the processer.'

(d) Most candidates provided one or more of the correct missing processes. Some candidates did not attempt this part of the question.

Question 7

(a) Many candidates achieved good marks for their answers to this part of the question.

(b) (i) Many candidates were able to explain why packet switching is used. Some candidates described packet switching, which was not required.

(ii) Many candidates successfully described the purpose of a packet header. Some candidates provided examples of the contents of a packet header, which was not required.

(iii) Many candidates were able to identify clearly three items included in a packet header. Common errors were not to specifically identify an exact item, for example, 'source address' instead of 'IP address of source'.

Question 8

(a) Many candidates were able to identify clearly two items included in a digital certificate. Some candidates need to be more specific with their answers, for example, 'public key' instead of 'subject's public key'.

(b) Most candidates correctly identified the first two terms. The third term proved more challenging; a common incorrect answer was 'public key'.

Question 9

(a) Most candidates were able to insert the correct terms in the table.

(b) Many candidates were able to give one of more characteristics of massively parallel computers. Other found this quite challenging. An example of a good response is 'A large number of processors working collaboratively on the same task and communicating with each other via a messaging interface.'

COMPUTER SCIENCE

Paper 9608/32
Written Paper

Key messages

Candidates need to show an in-depth study of the topics and make good use of appropriate technical terminology on this paper. Candidates, who have studied the theory and have practised the precise use of these tools and techniques, were successful in solving problems on the examination paper.

General comments

Candidates need to read questions very carefully before attempting to write an answer.

For example, in **Question parts 8(a)(i)** and **8(a)(ii)** the answer must be shown in binary, in **Question parts 7(a)(i)** and **7(a)(ii)**, types of data stored in the keyword and symbol tables were required, examples of data were not sufficient for answers to these questions.

Candidates need to show an understanding of user-defined data types in their answers to **Question 6(a)**. Many candidates gave responses that only gave benefits.

Comments on specific questions

Question 1

(a) Most candidates correctly identified some of the terms from the descriptions given. Common errors included incorrectly stating term B was a digital signature.

(b) (i) Many candidates partially explained the purpose of a digital signature. Fewer responses explained that as well as ensuring authenticity, a digital signature ensures that a document has not been altered during transmission.

(ii) Candidates who understood the process of producing a digital signature provided excellent responses to this part of the question. Other candidates found this part of the question challenging. Some candidates did not attempt this part of the question.

Question 2

(a) (i) Those candidates who correctly wrote their answer as a sum-of-products usually gained full marks. A common error was to write $\overline{A.B.C}$ for $\bar{A}.\bar{B}.\bar{C}$.

(ii) Many responses showed a correctly completed Karnaugh Map.

(iii) Many responses showed correct grouping. The most common error was the lack of understanding that the two groups overlapped.

(iv) Many responses showed a correct simplified sum-of-products for the answer to **part (a) (iii)**.

(b) Candidates who understood the process of simplification using De Morgan's laws provided excellent responses to this part of the question. Other candidates found this part of the question challenging. Some candidates did not attempt this part of the question.

Question 3

(a) Most candidates correctly identified at least two of the four terms required to complete the description of sending a message on a bus network. The protocol required was the term least likely to be correct.

(b) Many candidates were able to provide a correct response for this question regarding the how a router and a Network Interface Card are used in the operation of a bus network.

(c) (i) Many responses were imprecise. A common incorrect answer was router.

(ii) A minority of candidates gave appropriate descriptions that applied to a wireless connection sending and receiving data. Other candidates found this part of the question challenging.

Question 4

(a) A minority of candidates gave good descriptions of virtual memory. The most common error was to describe a virtual machine.

(b) (i) Candidates who understood how paging is used to manage virtual memory gained good marks. Other candidates found this part of the question challenging. Some candidates did not attempt this part of the question.

(ii) A minority of candidates gave a suitable page replacement algorithm. A common incorrect answer was thrashing. Some candidates did not attempt this part of the question.

(iii) Some candidates correctly described the continuous swapping of the same pages from disk to RAM and vice versa. A common incorrect answer was the data held on the disk had been corrupted.

Question 5

(a) The majority of candidates identified a difference between monitoring and control systems. Fewer responses went on to provide a description. The most common error was to describe a virtual machine.

(b) (i) Candidates who explained that it was easier to append each reading to the end of the file, so they are stored in chronological order gained good marks. The most common error was to incorrectly add files instead of readings or records.

(ii) A minority of candidates explained how sequential access could be used for the temperature readings file. A common incorrect answer was to search on the key field.

(iii) Most candidates correctly identified the method as random access. There was a full range of responses was seen for the description with some achieving good marks.

Question 6

(a) Many candidates correctly stated why user-defined data types are necessary. A common error was to state an advantage of using user-defined data types. For example, ‘They will make a program less error prone.’ is an advantage and gains no credit.

(b) (i) Many candidates correctly identified the data type as enumerated.

(ii) Most candidates wrote a correct declaration statement.

(iii) Many candidates wrote a correct assignment statement.

Question 7

(a) (i) A minority of candidates correctly identified two types of data stored in the keyword table. A full response identified reserved words and operators with their matching tokens.

(ii) A minority of candidates correctly identified two types of data stored in the symbol table. A full response included identifier names, the data type and role. A common error was to include operators.

(iii) A small number of candidates explained the use of the keyword and symbol tables during translation. Other candidates found this part of the question challenging. Some candidates did not attempt this part of the question.

(iv) Many candidates correctly stated an additional task completed at the lexical analysis stage. A popular correct response was the removal of comments. Some candidates did not attempt this part of the question.

(b) Many responses showed good reasons why code is optimised.

Question 8

(a) (i) Most candidates correctly identified the binary value of the exponent. A common error was to state the denary value of the exponent.

(ii) Most candidates correctly identified the binary value of the mantissa. A common error was to state the denary value of the mantissa.

(iii) Most candidates correctly identified that the number stored was positive and gave a correct justification for their answer.

(iv) Some candidates correctly converted the number shown in **part (a)(i)** to denary and showed their working. A common error was to incorrectly use a positive value for the exponent.

(b) Most candidates correctly stated the effects of the change.

COMPUTER SCIENCE

Paper 9608/33
Written Paper

Key messages

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(b) Many candidates were able to give one of more characteristics of massively parallel computers. Other found this quite challenging. An example of a good response is 'A large number of processors working collaboratively on the same task and communicating with each other via a messaging interface.'

COMPUTER SCIENCE

Paper 9608/41
Written Paper

Key messages

Candidates must be reminded that they will not be awarded any marks if they do not use VB.NET, Pascal/Delphi or Python programming languages.

Some candidates struggled with the simplification of decision tables. Candidates need to have experience of working with decision tables and identifying the redundancies to create the simplified version.

Few candidates appeared familiar with a circular queue and treated this as though it was a standard queue ADT.

General comments

A large number of candidates were able to write object-oriented programming code in their chosen language. A number of these candidates were able to define get and set methods appropriately. Fewer candidates could then use these in a program to manipulate an object.

Candidates did particularly well in the PERT chart, state-transition diagram and the low-level programming language questions. Candidates found the questions where explanations were required more challenging.

Comments on specific questions

Question 1

(a) (i) This question was answered well by the majority of candidates who were able to write the correct activity label and time to the activity lines. Some candidates attempted to create a cumulative time and added the length of each activity instead, and some candidates attempted to add activities onto the dummy lines.

(a) (ii) Many candidates were able to identify the critical path as being the longest path but fewer were able to then equate this with the shortest time to complete the project. A common incorrect answer was that it was the longest time taken to complete the project.

(a) (iii) Most candidates were able to correctly identify a GANTT chart. Of these candidates, many gave a suitable description of the chart, such as the time is on the *x* axis, activities on the *y* axis and the boxes are coloured to identify the timings. Some candidates did not give sufficient information in their description, for example, they repeated what the table at the start of question 1 displayed, which was the time in weeks and predecessors.

(b) (i) This question was generally answered well. A common error was not identifying that task D was added to the queue before task C.

(b) (ii) Some candidates were able to correctly follow through with their answer from **part (b)(i)**. Common errors included the movement of the tasks to the first box and then creating a standard queue from this point i.e. not keeping the StartPointer at its current position and moving it along the tasks as they were completed. Some candidates were able to put the items in the correct positions in the queue, but did not add the required points to identify the start and the end of the queue.

(b) (iii) There was a mix of responses to this question. Most candidates were able to follow through from their response to **part (b)(ii)**. The question required candidates to identify what would happen, but many responded with what would not happen i.e. the item would not be added to the list. These candidates did not answer the question.

(b) (iv) Many candidates found this question challenging and could not demonstrate a clear understanding of how a circular queue would work. Many candidates often put the `EndPointer` in place of the `StartPointer`. The most common correct answers were the two values to indicate the start and end of the queue.

(b) (v) The most common responses described how a queue is FIFO and a stack is LIFO. Fewer candidates were able to go further and explain how the use of pointers differs between these two abstract data types.

(c) This question was answered well, and most candidates were able to demonstrate a good understanding of state-transition diagrams, using the information provided in the table to complete the diagram. Some candidates attempted to add additional lines, such as looping in one state, which were not required by the question.

(d) (i) Many candidates were able to give a suitable description of a decision table, usually for it showing the actions for the different conditions, by looking at the table in the next part. Fewer were able to give additional detail such as showing the activities for **all** the possible combinations of conditions.

(d) (ii) This question was answered well, and many candidates were able to clearly identify the activities for the conditions. Some candidates did not follow the different combinations of conditions, for example they only ticked check ink status when only the quality is poor is correct as opposed to every time the quality is identified as poor.

(d) (iii) Candidates usually made a good attempt at simplifying the solution. Some candidates rewrote every possible condition again, instead of attempting to simplify this. Some candidates identified all the combinations apart from all three being N, in which case, no action is required. Where a condition does not matter whether it is N or Y, candidates must use an appropriate symbol to represent this e.g. a dash (-) or Y/N to show the simplification. Some candidates wrote the conditions twice, once with the Y and one with the N.

(e) (i) A significant number of candidates were able to use their language specific constructor in place of the method `Constructor( )`. Candidates were required to read the description of the problem and the detail in the table to identify the function of the constructor. The attributes in the table stated that they were sent as parameters to the constructor, therefore candidates needed to pass these, and use these to assign values within the constructor. A common error was reading in these values instead of using parameters. The attribute credits stated that this was initialised to 50 in the constructor, where candidates had not read this part of the table, they assigned it a parameters, or read in a value to it.

(e) (ii) Many candidates were familiar with a set method and its purpose. Fewer candidates were aware that a set method will take a value as a parameter to then be set, usually to allow validation to take place. Candidates who did not use a parameter often read in a value and stored it in the appropriate attribute.

(e) (iii) Many candidates were familiar with a get method and its purpose. This question required candidates to read the table at the start of **part (e)** to identify that the function returned the attributes `FirstName` and `LastName`, concatenated with a space between. Those candidates who had not read this often returned only the `FirstName` or `LastName`, or concatenated them without a space. Candidates should be familiar with the difference between procedures and functions, a common error was a candidate defining the get method as a procedure when it was to return a value.

(e) (iv) This question required candidates to use a method to alter the values for an object. There were many different ways that candidates tackled the calculations in this question. The more efficient solutions calculated the basic amount first and then added the extras if they were required. Some candidates put a separate selection statement for each comparison, often meaning that someone with more than 20 had the additional credits for 10 and 20 added to the total. A common error was

for candidates not adding the number of credits to their already existing balance; they instead overwrote the value. The question stated that candidates should make use of constants where appropriate, in VB.NET and Pascal responses very few candidates were able to use the language to correctly declare constants, for example in VB.NET using `Dim` instead of `Const`.

(e) (v) This question was answered well by many candidates who were able to declare an array of the appropriate size, with the correct identifier and of the correct data type. Some candidates did not correctly allocation 1000 spaces, for example 0 to 1000, or 1 to 999.

(e) (vi) This question required candidates to use the attributes and methods that they have defined within the main part of the program, to declare and manipulate objects. The ID generated was required to be lower case, and this was often missed out by candidates who just used the data as input without the conversion.

The question needed candidates to loop through all of the students that were already in the array. A common error was learners looping through all the array elements, without taking into account that these may not all be used, few candidates used the global variable given in the question to control the loop.

When a value needs to be read from an object, or added to an object, candidates should be using the get and set methods that are identified in the question. Candidates should be aware of encapsulation and how the attributes should not be accessed directly. Few candidates made use of these appropriate and consistently.

A significant number of candidates were able to increment the value in the username throughout the loop and then correctly generate the final ID for the student.

Question 2

The majority of candidates answered this question well, with providing a fully correct response. Some common errors included adding < > around the operands which should not be present, and adding symbols such as '#' inappropriately.

Question 3

Most candidates were able to identify at one or two reasons, most commonly by identifying logic and run-time errors. Many candidates then repeated an answer e.g. by giving two examples of logic errors, or run-time errors, instead of identifying a different reason.

Question 4

Many candidates were able to give names of suitable types of test for at least the first response. Some candidates put acceptance and beta testing the wrong way around.

COMPUTER SCIENCE

Paper 9608/42
Written Paper

Key messages

Candidates should have experience of programming a range of abstract data types, and should be able to both program solutions for these ADTs as well as provide descriptions for example of how to add an item to a specific ADT. Candidates should be prepared for these ADTs to be given in a variety of ways, and apply their understanding to the one they are required to manipulate.

Candidates need to continue to practise implementing classes and manipulating objects within a program.

Candidates must be reminded that they will not be awarded any marks if they do not use VB.NET, Pascal/Delphi, or Python programming languages when answering programming questions.

General comments

The majority of candidates were able to access all questions on the paper, and many gave correct responses to the practical activities such as completing the state-transition diagram, and the Program Evaluation Review Technique (PERT) chart.

Candidates appeared to have had experience of defining classes and using objects, and had a better understanding of the purpose of the constructor, get and set methods.

Comments on specific questions

Question 1

(a) (i) The majority of candidates were able to write the correct activities and durations on the lines. Some candidates incorrectly added activities to the dummy activity lines, and some added together the duration to create a cumulative duration.

(ii) Many candidates found this question challenging. A minority of candidates were able to give the accurate purpose of a dummy activity. Common inaccurate answers included an activity that does not have a time, or an activity that cannot be done before another. These are both inaccurate because it is not an activity, it is used to show that the dependencies for the next activity.

(b) Most candidates were able to give the correct actions. Candidates should be familiar with the range of symbols that can be used to identify the actions, e.g. ticks, crosses, dashes etc. Some candidates attempted to write the percentages in the boxes where they were applied, or use +s and –s to identify additions or subtractions, which where they were obvious as to their use were permitted but this should not be an ongoing usage.

(c) (i) This question required candidates to read the descriptions and identify the missing attributes and methods. Many candidates attempted to add an attribute and method for the weekly payment, not identifying from the methods already given that there was a need for `HoursThisWeek`.
Few candidates considered the inheritance between the classes; of those that did, many of the inheritance additions were correct. Some candidates drew the arrows the wrong way, and others attempted to show containment which was not appropriate here.

(ii) Many candidates were familiar with the constructor for their chosen language, and many used this appropriately. The question only required candidates to write the constructor, but many attempted to write the whole class definition, or at least the attribute declarations unnecessarily. Some candidates did not appear to understand the purpose of a constructor, and the actions that it should contain. Candidates should be familiar with writing constructors for a range of classes, including identification of its purpose to initialise attributes within the object.

(iii) Many candidates appeared familiar with the purpose of a get method and were able to accurately define one to return the required value. Some candidates attempted to send a parameter to the function and then returned the same value. Candidates should be able to write get methods for a given class and should be familiar with their purpose.

(iv) Candidates should be familiar with set methods and their purpose. A common error by candidates was to attempt to read in a value from the use within the method. A set method should take a given parameter to allow for encapsulation. Some candidates put the assignment the wrong way around, for example, by assigning the parameter the value of `EmployeeID`.

(v) This question required candidates to validate a parameter and to only set the value when the parameter is valid. Candidates found this question challenging, and often when the value was valid, they returned `True` before setting the value to `Pension`. This meant that the code returned before running this assignment and therefore not meeting all of the requirements.

(vi) There were a mix of responses to this question, which required candidates to use the object and methods they had defined within the main program. Candidates often found the calculations challenging, and attempted to multiply a value by a percentage e.g. 3% as opposed to the actual calculation 3/100 or 0.03.

Some candidates did not allow for all three values to be checked each time. For example, the pension was only checked when they had less than 160 hours, which meant that the calculation was not applied for all appropriate values.

Candidates should be familiar with using methods to access data from objects. A minority of candidates were able to accurate use the get methods to access the data from the given object, with many attempting to pass these values to the function as parameters instead of passing the object from which the values could be accessed.

(d) Most candidates were able to give the correct response.

Question 2

(a) This question required candidates to demonstrate an understanding of a circular queue. Candidates found this challenging and few gave correct values to the algorithm. A minority of candidates were able to correctly identify the constant value for the last index, with common answers including 0 and 8.

(b) Many candidates were able to gain some marks for a standard description of a queue, most commonly for checking if the queue was empty, and accessing the data at the start pointer. Few candidates were able to gain the mark for the circular queue, that if the start pointer exceeds the last index then it returns to the first index. Candidates should be familiar with using the range of ADTs and be able to describe the steps and write algorithms for additions and deletions.

(c) Most candidates were able to identify at least two ADTs. Some candidates repeated a queue, or circular queue, despite the question requiring other ADTs. The most common answers included stacks, trees and linked lists.

Question 3

(a) Many candidates were able to identify at least two different types of test data. Some candidates mixed types of test data with types of test, giving answers such as black box etc.

(b) (i) This question was usually answered well, breakpoints was most commonly given correctly, and there were a range of alternate names for stepping that were given by candidates.

(ii) Some candidates found this question challenging. The most common response was variable watch windows and many candidates gave a suitable description of this. As with **part (a)**, some candidates confused debugging features with types of test, giving responses such as black box testing.

Question 4

This question was answered well by the majority of candidates who were able to complete the diagram accurately. Some candidates attempted to add additional lines such as between Checking PIN and Transaction cancelled, or transitions that looped on a state.

Question 5

(a) Responses to this question were mixed. Many candidates were able to gain the loading, storing and end statements, but fewer could correctly identify a shift to multiply a value. Right shifts were often seen, and values other than #2 such as #1 and #4. Candidates should be familiar with a left and right shift, and the effect these have on a binary number.

(b) Many candidates were able to complete some of these parts accurately. Some candidates attempted to increment and decrement the memory locations e.g. `INC COUNT` instead of loading the value, incrementing the accumulator and then storing the new value. Many candidates did not recognise the need for indexed addressing of `STRING` to access each value from it in turn, instead using `LDD` to access its value.

COMPUTER SCIENCE

Paper 9608/43
Written Paper

Key messages

Candidates must be reminded that they will not be awarded any marks if they do not use VB.NET, Pascal/Delphi or Python programming languages.

Some candidates struggled with the simplification of decision tables. Candidates need to have experience of working with decision tables and identifying the redundancies to create the simplified version.

Few candidates appeared familiar with a circular queue and treated this as though it was a standard queue ADT.

General comments

A large number of candidates were able to write object-oriented programming code in their chosen language. A number of these candidates were able to define get and set methods appropriately. Fewer candidates could then use these in a program to manipulate an object.

Candidates did particularly well in the PERT chart, state-transition diagram and the low-level programming language questions. Candidates found the questions where explanations were required more challenging.

Comments on specific questions

Question 1

(a) (i) This question was answered well by the majority of candidates who were able to write the correct activity label and time to the activity lines. Some candidates attempted to create a cumulative time and added the length of each activity instead, and some candidates attempted to add activities onto the dummy lines.

(a) (ii) Many candidates were able to identify the critical path as being the longest path but fewer were able to then equate this with the shortest time to complete the project. A common incorrect answer was that it was the longest time taken to complete the project.

(a) (iii) Most candidates were able to correctly identify a GANTT chart. Of these candidates, many gave a suitable description of the chart, such as the time is on the *x* axis, activities on the *y* axis and the boxes are coloured to identify the timings. Some candidates did not give sufficient information in their description, for example, they repeated what the table at the start of question 1 displayed, which was the time in weeks and predecessors.

(b) (i) This question was generally answered well. A common error was not identifying that task D was added to the queue before task C.

(b) (ii) Some candidates were able to correctly follow through with their answer from **part (b)(i)**. Common errors included the movement of the tasks to the first box and then creating a standard queue from this point i.e. not keeping the StartPointer at its current position and moving it along the tasks as they were completed. Some candidates were able to put the items in the correct positions in the queue, but did not add the required points to identify the start and the end of the queue.

(b) (iii) There was a mix of responses to this question. Most candidates were able to follow through from their response to **part (b)(ii)**. The question required candidates to identify what would happen, but many responded with what would not happen i.e. the item would not be added to the list. These candidates did not answer the question.

(b) (iv) Many candidates found this question challenging and could not demonstrate a clear understanding of how a circular queue would work. Many candidates often put the `EndPointer` in place of the `StartPointer`. The most common correct answers were the two values to indicate the start and end of the queue.

(b) (v) The most common responses described how a queue is FIFO and a stack is LIFO. Fewer candidates were able to go further and explain how the use of pointers differs between these two abstract data types.

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