

Example Candidate Responses

Cambridge
International
AS & A Level

Cambridge International AS & A Level Computer Science

9608

Paper 3

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Version 1

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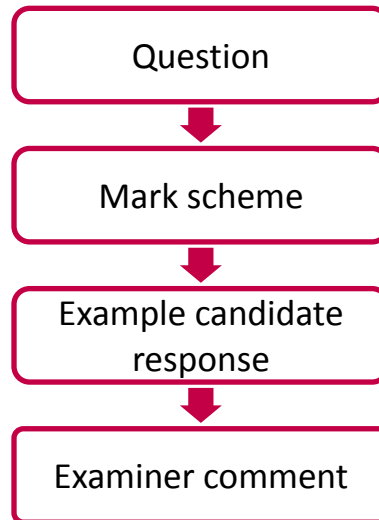
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Introduction

The main aim of this booklet is to exemplify standards for those teaching Cambridge International AS & A Level Computer Science (9608), and to show how different levels of candidates' performance relate to the subject's curriculum and assessment objectives.

In this booklet candidate responses have been chosen to exemplify a range of answers. Each response is accompanied by a brief commentary explaining the strengths and weaknesses of the answers.

For ease of reference the following format for each component has been adopted:



Each question is followed by an extract of the mark scheme used by examiners. This, in turn, is followed by examples of marked candidate responses, each with an examiner comment on performance. Comments are given to indicate where and why marks were awarded, and how additional marks could have been obtained. In this way, it is possible to understand what candidates have done to gain their marks and what they still have to do to improve their marks.

This document illustrates the standard of candidate work for those parts of the assessment which help teachers assess what is required to achieve marks beyond what should be clear from the mark scheme. Some question types where the answer is clear from the mark scheme, such as short answers and multiple choice, have therefore been omitted.

Past papers, Examiner Reports and other teacher support materials are available on Teacher Support at <https://teachers.cie.org.uk>

Assessment at a glance

For Cambridge International AS and A Level Computer Science, candidates may choose:

- to take Papers 1, 2, 3 and 4 in the same examination series, leading to the full Cambridge International A Level
- to follow a **staged** assessment route by taking Papers 1 and 2 (for the AS Level qualification) in one series, then Papers 3 and 4 (for the full Cambridge International A Level) in a later series
- to take Papers 1 and 2 only (for the AS Level qualification).

Components	Weighting (%)	
	AS	A
All candidates take		
Paper 1 Theory Fundamentals This written paper contains short-answer and structured questions. There is no choice of questions. 75 marks Externally assessed 1 hour 30 minutes	50	25
Paper 2 Fundamental Problem-solving and Programming Skills This written paper contains short-answer and structured questions. There is no choice of questions. Topics will include those given in the pre-release material. ¹ 75 marks Externally assessed 2 hours	50	25
Paper 3 Advanced Theory This written paper contains short-answer and structured questions. There is no choice of questions. 75 marks Externally assessed 1 hour 30 minutes	–	25
Paper 4 Further Problem-solving and Programming Skills This written paper contains short-answer and structured questions. There is no choice of questions. Topics will include those given in the pre-release material. ¹ 75 marks Externally assessed 2 hours	–	25

Advanced Subsidiary (AS) forms 50% of the assessment weighting of the full Advanced (A) Level.

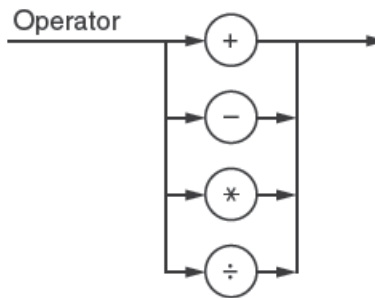
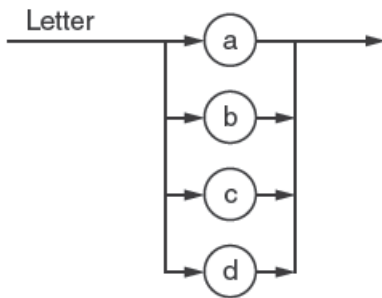
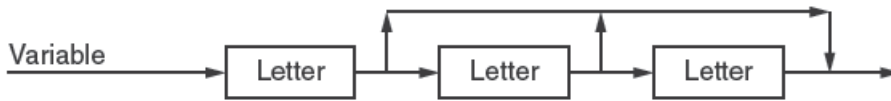
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Paper 3 – Advanced Theory

Question 1

1 The following syntax diagrams, for a particular programming language, show the syntax of:

- an assignment statement
- a variable
- a letter
- an operator



(a) The following assignment statements are invalid.

Give the reason in each case.

(i) $a = b + c$

Reason
[1]

(ii) $a = b - 2;$

Reason
[1]

(iii) $a = dd * cce;$

Reason
[1]

Question 1, continued

- (b) Write the Backus-Naur Form (BNF) for the syntax diagrams shown on the opposite page.

<assignmentstatement> ::=

.....

<variable> ::=

.....

<letter> ::=

.....

<operator> ::=

.....[6]

- (c) Rewrite the BNF rule for a variable so that it can be any number of letters.

<variable> ::=

.....[2]

- (d) Programmers working for a software development company use both interpreters and compilers.

- (i) The programmers prefer to debug their programs using an interpreter.

Give **one** possible reason why.

.....

.....[1]

- (ii) The company sells compiled versions of its programs.

Give a reason why this helps to protect the security of the source code.

.....

.....[1]

Mark scheme

1	(a) (i)	';' missing	1
	(ii)	'2' is not a variable	1
	(iii)	'e' is not a valid letter	1
	(b)	<pre> <assignment statement> ::= <variable> = <variable><operator><variable>; <variable> ::= <letter> <letter><letter> <letter><letter><letter> <letter> ::= a b c d <operator> ::= =+ - * ÷ </pre>	<p>2</p> <p>2</p> <p>1</p> <p>1</p>
	(c)	<pre> <letter> <letter><variable> // <letter> <variable><letter> </pre>	2
	(d) (i)	<pre> debugging is faster / easier // can debug incomplete code // better diagnostics </pre>	1
	(ii)	<pre> compiler produces executable version – not readable / no need for source code // difficult to reverse-engineer </pre>	1
			Total: 13

Example candidate response – high

(a) The following assignment statements are invalid.

Give the reason in each case.

(i) $a = b + c$

Reason ... A valid assignment statement should contain a ';' at the end.
one given
... but the above does not.[1]

(ii) $a = b - 2;$

Reason ... '2' is not a valid variable. Variables can only be
made up of 1-3 letters (a, b, c or d only).[1]

(iii) $a = dd * cce;$

Reason ... 'c.c.e' contains 'e' which is not a valid letter. Letter can
only contain a, b, c or d. Not e.[1]

(b) Write the Backus-Naur Form (BNF) for the syntax diagrams shown on the opposite page.

$\langle \text{assignmentstatement} \rangle ::=$

$\langle \text{variable} \rangle \langle \text{=} \rangle \langle \text{variable} \rangle \langle \text{operator} \rangle \langle \text{variable} \rangle \langle \text{;} \rangle$

$\langle \text{variable} \rangle ::=$

$\langle \text{letter} \rangle \mid \langle \text{letter} \rangle \langle \text{letter} \rangle \mid \langle \text{letter} \rangle \langle \text{letter} \rangle \langle \text{letter} \rangle$

$\langle \text{letter} \rangle ::=$

$a \mid b \mid c \mid d$

$\langle \text{operator} \rangle ::=$

$+ \mid - \mid * \mid \div$

[6]

(c) Rewrite the BNF rule for a variable so that it can be any number of letters.

$\langle \text{variable} \rangle ::=$

$\langle \text{letter} \rangle \mid \langle \text{variable} \rangle \langle \text{letter} \rangle$

[2]

Example candidate response – high, continued

(d) Programmers working for a software development company use both interpreters and compilers.

(i) The programmers prefer to debug their programs using an interpreter.

Give one possible reason why.

After executing a line of code, an interpreter produces useful error messages. [1]

(ii) The company sells compiled versions of its programs.

Give a reason why this helps to protect the security of the source code:

Compilers produce an object code file (.exe file) following translation. Source code is no longer necessary for execution. Maintains software privacy. [1]

Examiner comment – high

In part (a)(i) the candidate has identified that each assignment statement should end with a ‘;’. In part (a)(ii) they have justified their answer by stating that a variable can only consist of a certain number of letters. This is correct. However, the mark would have been awarded if the answer just consisted of the first sentence. It was sufficient to recognise that the ‘2’ was the reason why the assignment statement was invalid. Again, in (iii) their first sentence was sufficient to gain the mark.

In part (b) the candidate has demonstrated an ability to write BNF. This is shown by the correct answers for <variable>, <letter> and <operator>. However the candidate has enclosed the terminal symbols ‘=’ and ‘;’ with angle brackets in the answer for <assignment statement>. This was incorrect. One of the terminal symbols was part of the answer for the first mark and the second terminal symbol was part of the answer for the second mark. Consequently neither mark was awarded.

In part (c) the candidate has identified the two alternative possibilities, including the recursive option that allows for any number of letters.

The answer to part (d)(i) does not address the question being asked. It is not true that, after the execution of every line of code by an interpreter, error messages are produced. Only lines with errors would cause the production of error messages. It is also true that a compiler can produce useful error messages. In part (d)(ii) it was sufficient to write that an executable version of the code is produced.

Marks awarded for part (a) = (i) 1/1, (ii) 1/1, (iii) 1/1
Marks awarded for part (b) = 4/6
Marks awarded for part (c) = 2/2
Marks awarded for part (d) = (i) 0/1, (ii) 1/1

Total marks awarded = 10 out of 13

Example candidate response – middle

(a) The following assignment statements are invalid.

Give the reason in each case.

(i) $a = b + c$

Reason Addition cannot be performed on letters. [1]

(ii) $a = b - 2;$

Reason No constant is declared in assignment statements. [1]

(iii) $a = dd * cce;$

Reason e letter is not declared in letters. [1]

(b) Write the Backus-Naur Form (BNF) for the syntax diagrams shown on the opposite page.

`<assignmentstatement> ::=`

..... `<variable> <operator> <variable>`

`<variable> ::=`

..... `<letter> | <letter> <letter>`

`<letter> ::=`

..... `a | b | c | d`

`<operator> ::=`

..... `+ | - | * | /` [6]

(c) Rewrite the BNF rule for a variable so that it can be any number of letters.

`<variable> ::=`

..... `<letter>*` infinite [2]

Example candidate response – middle, continued

(d) Programmers working for a software development company use both interpreters and compilers.

(i) The programmers prefer to debug their programs using an interpreter.

Give one possible reason why.

Debugging is much easier as one instruction is executed at one time. [1]

(ii) The company sells compiled versions of its programs.

Give a reason why this helps to protect the security of the source code.

Source code is not present during execution of program. Only machine executable code is available which is difficult to understand. [1]

Examiner comment – middle

Part (a)(i) is clearly incorrect. Some latitude was exercised in part (a)(ii) where it is assumed that the reference to 'constant' was a comment about the presence of the '2'. Therefore the mark was awarded. The answer to part (a)(iii) was precisely the answer required.

In part (b) the BNF for <assignment statement> only made an attempt at the second of the two marks available. It failed to achieve this as a ';' has been omitted. The answer for <variable> correctly defined that it could consist of either one letter or two letters. However the fact that <variable> could consist of three letters is omitted. The BNF for <letter> and <operator> are correct.

In part (c) the answer given by the candidate identified neither possibility for <variable> and scored no marks.

'Debugging is easier' was sufficient to gain the mark in part (d)(i). Part (d)(ii) is a very good answer. Either of the two sentences, given as the answer, would have scored the mark. The second sentence is of better quality than the first.

Marks awarded for part (a) = (i) 0/1, (ii) 1/1, (iii) 1/1

Marks awarded for part (b) = 3/6

Marks awarded for part (c) = 0/2

Marks awarded for part (d) = (i) 1/1, (ii) 1/1

Total marks awarded = 7 out of 13

Example candidate response – low

(a) The following assignment statements are invalid.

Give the reason in each case.

(i) $a = b + c$

Reason Semi-colon has not been added
.....[1]

(ii) $a = b - 2;$

Reason The number 2 is not defined in syntax diagram.
.....[1]

(iii) $a = dd * cce;$

Reason The letter 'e' is not defined in syntax diagram.
.....[1]

(b) Write the Backus-Naur Form (BNF) for the syntax diagrams shown on the opposite page.

`<assignmentstatement> ::=`
`<variable> <=> <variable> <operator> <variable> < ; >`

`<variable> ::=`
`<letter> | <letter> <letter> | <letter> <letter> <letter>`

`<letter> ::=`
`<a> , , <c> , <d>`

`<operator> ::=`
`<+> , <-> , <*> , <÷>`.....[6]

(c) Rewrite the BNF rule for a variable so that it can be any number of letters.

`<variable> ::=`
~~`<letter>`~~ `<n> * <letter>`.....[2]

Example candidate response – low, continued

(d) Programmers working for a software development company use both interpreters and compilers.

(i) The programmers prefer to debug their programs using an interpreter.

Give one possible reason why.

It is easy to locate the part of the code causing an error. [1]

(ii) The company sells compiled versions of its programs.

Give a reason why this helps to protect the security of the source code.

The code is translated as a whole so it can be encrypted. Individual lines in the code are not translated one by one in compiler. [1]

Examiner comment – low

In part (a)(i) recognition that a semi-colon was required gained the mark. It was not necessary to state that the semi-colon was needed at the end of the statement. Again in part (a)(ii) mention of the '2' is sufficient for the mark. In part (a)(iii) identification that the 'e' is the problem gained the mark.

In part (b) marks were lost here because every terminal symbol is surrounded by '<' and '>'. Precision was expected and, where demonstrated, credit would have been given. The BNF for <variable> contained no terminal symbols and therefore the candidate did not make this mistake. The answer for <variable> gained the full marks.

In part (c) even if the candidate had placed a '|' after <letter> this answer would still have been worth no marks. If the answer had a '|' before and after <letter> then a mark would have been awarded as this answer identifies a single letter as a possibility for <variable>.

In part (d)(i) if the candidate had written 'easier' rather than 'easy' a mark would have been given. The argument is that finding errors in code may not be easy but it is easier using an interpreter compared to using a compiler. In part (d)(ii) neither sentence had any value. Both sentences were incorrect statements about compilers.

Marks awarded for part (a) = (i) 1/1, (ii) 1/1, (iii) 1/1
Marks awarded for part (b) = 2/6
Marks awarded for part (c) = 0/2
Marks awarded for part (d) = (i) 0/1, (ii) 0/1

Total marks awarded = 5 out of 13

Question 2

2 The incomplete table below shows descriptions and terms relating to malware.

(a) Complete the table with appropriate descriptions and terms.

	Description	Term
A	Unsolicited emails containing advertising material sent to a distribution list.
B	A standalone piece of malicious software that can reproduce itself automatically.
C	Pharming
D	Phishing

[4]

(b) For one of the terms, describe:

- a problem that might arise for a user
- a possible solution to the problem

Choose between the terms:

A / B (circle your choice)

Problem

.....

Solution

.....[2]

Question 2, continued

(c) Explain the following terms:

Encryption

.....

.....

.....

Public key

.....

.....

.....[2]

(d) A user downloads software from the Internet.

(i) State what should be part of the download to provide proof that the software is authentic.

.....[1]

(ii) Describe the process for ensuring that the software is both authentic and has not been altered.

.....

.....

.....

.....

.....

.....

.....

.....[4]

Mark scheme

2 (a)	<ul style="list-style-type: none"> • Spam • Worm <p>Pharming redirect website to fake website // domain name server compromised // proxy server compromised</p> <p>Phishing <u>through email</u> attempt to obtain somebody's confidential data / install malware</p>	<p>1 1</p> <p>1</p> <p>1</p>
(b)	<p>Spam</p> <ul style="list-style-type: none"> • user's inbox is filled by large amount of unwanted email • user / email server employs filtering software that can divert / delete spam email <p>Worm</p> <ul style="list-style-type: none"> • could corrupt user's computer // delete data // consume bandwidth • run anti-virus software in the background // not connect to the Internet // keep OS up-to-date 	<p>1</p> <p>1</p> <p>or</p> <p>1</p> <p>1</p>
(c)	<p>encryption: process of turning plain text into cipher text</p> <p>public key: key widely available that can be used to encrypt message that only owner of private key can decrypt // can be used to decrypt a message thereby confirming originator of message</p>	<p>1</p> <p>1</p>
(d) (i)	digital signature	1
(ii)	<ul style="list-style-type: none"> • software is put through hashing algorithm • hash total is encrypted with private key (digital signature) • software + encrypted hash / digital signature are sent • receiver is in possession of sender's public key • the received hash total / digital signature is decrypted with public key (SH) • the receiver hashes received software (RH) • If SH matches RH then software is authentic and has not been altered 	<p>Any four points 1 mark each</p>
		Total: 13

Example candidate response – high

2 The incomplete table below shows descriptions and terms relating to malware.

(a) Complete the table with appropriate descriptions and terms.

	Description	Term
A	Unsolicited emails containing advertising material sent to a distribution list.	Spam
B	A standalone piece of malicious software that can reproduce itself automatically.	Worm
C	Pharming is a technique in which malicious code is installed on a ^{personal} computer or server misdirecting users to fraudulent websites without their consent. A particularly evil pharming tactic is domain name system poisoning.	Pharming
D	Phishing is a way of acquiring confidential user information such as usernames, passwords and credit card numbers by fake showing as a trustworthy entity in an electronic communication. Typically carried out by email spoofing and instant messaging misdirecting users to a fake website without whose look and feel are almost identical to the genuine one. It is an example of social engineering techniques used to deceive users.	Phishing

(b) For one of the terms, describe:

- a problem that might arise for a user
- a possible solution to the problem

Choose between the terms:

A / B (circle your choice)

Problem A worm could damage network by wasting network bandwidth. This could cause delay in data transmission.

The user would have to wait a lot of time before data is sent.

Solution Anti-Malware and firewalls should be used to protect a user's computer from worms. Also care should be taken while opening unknown links from the internet.

Example candidate response – high, continued

(c) Explain the following terms:

Encryption is a method of encoding messages or information in such a way that only the ~~intended~~ sender and intended receiver can read it. It involves applying a mathematical function, using a key value to a message.

Public key It is used to encrypt ^{plaintext} messages and is used to verify digital signatures. It is universally known.

[2]

(d) A user downloads software from the Internet.

(i) State what should be part of the download to provide proof that the software is authentic.

Digital Signature [1]

(ii) Describe the process for ensuring that the software is both authentic and has not been altered.

Software is hashed to get message digest. Message digest is processed with company's Private Key to produce the digital signature. Digital signature is attached to the software. The whole software is encrypted using client's Public Key and the software is sent. On receiving the software, the client decrypts the software using his Private Key. Then the client processes the digital signature of the company with company's Public Key, producing message digest. After this client applies the hashing algorithm again on software reproducing message digest. If the signature message digest is the same as software's ^{reproduced} message digest, the software is not tampered with and is authentic since it was signed by the company.

Examiner comment – high

In part (a) both 'spam' and 'worm' were correctly identified. For 'pharming', the phrase 'misdirecting users to fraudulent websites' was sufficient to gain the mark available. The answer given to explain 'phishing' was excellent. The crucial point concerning the use of electronic communication was present as was the purpose of phishing. The answer need not have been as long as it was; the single mark available and the space given to write an answer gave clues to candidates as to the length of the answer expected.

In part (b) the candidate selected worm as the basis of their answers. For a problem 'wasting network bandwidth' was worth a mark. 'Anti-malware' achieved the mark for identifying a solution.

In part (c) no marks were awarded for the answers given. Encryption is not encoding and explaining how encryption might be done is not the same as explaining what encryption actually is. The answer for 'public key' does not go far enough. 'It is used to encrypt plain text messages' is true. However for the mark something else was required so as to differentiate between public and private keys. A private key can be used to encrypt a plain text message.

Part (d)(i) was answered correctly. For part (d)(ii) the candidate produced an excellent answer and was awarded maximum marks. The first mark was for 'software is hashed'; the second mark for 'message digest is processed with company's private key'; the third mark for 'with company's public key'; and the fourth mark for 'applies the hashing algorithm again on the software'. There were a number of incorrect statements such as the 'software is encrypted'. The statement: 'If the signature message digest ...' was also worthy of a mark.

Marks awarded for part (a) = 4/4
Marks awarded for part (b) = 2/2
Marks awarded for part (c) = 0/2
Marks awarded for part (d) = (i) 1/1, (ii) 4/4

Total marks awarded = 11 out of 13

Example candidate response – middle

2 The incomplete table below shows descriptions and terms relating to malware.

(a) Complete the table with appropriate descriptions and terms.

	Description	Term
A	Unsolicited emails containing advertising material sent to a distribution list.	Spam Virus
B	A standalone piece of malicious software that can reproduce itself automatically.	Worm
C	Re-directing the user from the original webpage to a somewhat similar page which is fake, using this user's information is derived	Pharming
D	Using emails and other methods to derive user's information such as credit card numbers, when the user clicks on the link he is directed to a page where all his information is entered	Phishing

[4]

(b) For one of the terms, describe:

- a problem that might arise for a user
- a possible solution to the problem

Choose between the terms:

A / B (circle your choice)

Problem ~~Attaching itself to~~ can harm the computer by ~~deleting~~ deleting important files / slowing down the computer / complete annihilation of the system

Solution Use anti-virus software or virus checker that is updated regularly to detect and remove the ^{worm} ~~virus~~

[2]

Example candidate response – middle, continued

(c) Explain the following terms:

Encryption ... Encryption is the process of changing data into a form which is unreadable to anyone except the ones with the decoding device or language.

Public key ... A public key is known ~~only~~ to all parties in the communication and is used to encode a plain text message.

[2]

(d) A user downloads software from the Internet.

(i) State what should be part of the download to provide proof that the software is authentic.

... Digital Signature [1]

(ii) Describe the process for ensuring that the software is both authentic and has not been altered.

To ensure the software is both authentic and has not been altered user can use dual key encryption also known as public key encryption where the user encodes the plain text message using the receiver's public key and when the message is sent to the destination, the receiver has to decode the data using his private key ~~only~~ which only he has access to.

[4]

Examiner comment – middle

In part (a) both 'spam' and 'worm' were correctly identified. The answer for 'pharming' matches the first answer given on the mark scheme. The statement on 'phishing' identifies the use of email 'to derive' personal data. Both the mark scheme and the candidate's response do not state explicitly that this confidential data is likely to be misused. This is assumed from the nature of the question being asked.

In part (b) the candidate selected worm as the basis of their answers. For a problem 'slowing down a computer' was worth a mark. 'Antivirus' achieved the mark for identifying a solution.

In part (c) a mark was awarded for that part of the first sentence that stated: '... process of changing data into a form that is unreadable ...'. Mention of 'decoding device or language' was ignored. The answer for 'public key' needed more than 'known to all parties'; that much is obvious from the word 'public'. Mention of 'encode' rather than 'encrypt' ensured that the rest of the answer was not worth any credit.

Part (d)(i) was answered correctly. In part (d)(ii) the process is described only in terms of what keys were used and at what stage. There were no other details given. Stating that the encryption required a public key and decryption required a private key was wrong in this context. Consequently the answer was not awarded a mark.

Marks awarded in part (a) = 4/4

Marks awarded in part (b) = 2/2

Marks awarded in part (c) = 1/2

Marks awarded in part (d) = (i) 1/1, (ii) 0/4

Total marks awarded = 8 out of 13

Example candidate response – low

2 The incomplete table below shows descriptions and terms relating to malware.

(a) Complete the table with appropriate descriptions and terms.

	Description	Term
A	Unsolicited emails containing advertising material sent to a distribution list.	Spam
B	A standalone piece of malicious software that can reproduce itself automatically.	Virus
C	It is the act of redirecting a user from an email through a link that leads to a fake website similar to the real one to ask user to input personal details.	Pharming
D	It is the act of causing the user to input his personal information on a fake website to which he was redirected through Pharming (Information is received)	Phishing

[4]

(b) For one of the terms, describe:

- a problem that might arise for a user
- a possible solution to the problem

Choose between the terms:

A / B (circle your choice)

Problem It can result in corruption and loss of data. It can also delete important files and folders

Solution An anti virus software can be installed to prevent viruses from installing. They all get quarantined / deleted. [2]

Example candidate response – low, continued

(c) Explain the following terms:

Encryption It is a method of converting a given text or document of data into a form that cannot be easily understood by anyone except the user. in order to keep the data safe

Public key It is a key shared with everyone during the encryption process. It can be used to encrypt a file which can then only be decrypted using a private key. [2]

(d) A user downloads software from the Internet.

(i) State what should be part of the download to provide proof that the software is authentic.

..... It should have a digital certificate signature [1]

(ii) Describe the process for ensuring that the software is both authentic and has not been altered.

..... The use of digital certificates are important since they help ensure that the software which is being downloaded will have come from an authentic source and since it is impossible to decrypt or alter the original message.

..... The private key can be used to decrypt the document then. [4]
 the hash algorithm and the public key will make up the digital certificate which can be converted back using the foreign key)

Examiner comment – low

In part (a) only 'spam' was identified correctly. Similarities between 'phishing' and 'pharming' mean that answers needed to be very clear for the mark to be awarded. The answer for 'pharming' states the use of email. It is the use of email that characterises 'phishing'. Consequently, and despite the answer referring to 'fake website', the mark was not awarded. The answer for 'phishing' is again not entirely accurate and consequently failed to score. Reference to 'fake website' is more about 'pharming' than 'phishing'. Not every phishing email leads to a fake website.

In part (b) although the candidate had given 'virus' rather than 'worm' the similarities between the two meant that marks for this part of the question could still be awarded. Consequently the statements 'loss of data' and 'anti virus' gained both the marks available.

In part (c) for the answer for 'encryption' the candidate wrote: '... cannot be easily understood ...'. This was not considered to be worthy of a mark as it suggests that the encrypted text could be understood with difficulty. This is not true. The answer for 'public key' was given a mark as it states that a file encrypted with a public key can be decrypted with a private key.

Part (d)(i) was answered correctly. In part (d)(ii), despite correctly giving digital signature in part (d)(i), the candidate wrote about digital certificate. In the second part of the answer the process is incorrectly described as one where the encryption is done with the public key and the decryption with the private key. This answer received no marks.

Marks awarded for part (a) = 1/4
Marks awarded for part (b) = 2/2
Marks awarded for part (c) = 1/2
Marks awarded for part (d) = (i) 1/1, (ii) 0/4

Total marks awarded = 5 out of 13

Question 3

- 3 (a) A particular programming language allows the programmer to define their own data types.

ThisDate is an example of a user-defined structured data type.

```

TYPE ThisDate
  DECLARE ThisDay      : (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,
                          13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23,
                          24, 25, 26, 27, 28, 29, 30, 31)
  DECLARE ThisMonth    : (Jan, Feb, Mar, Apr, May, Jun, Jul, Aug,
                          Sep, Oct, Nov, Dec)
  DECLARE ThisYear     : INTEGER
ENDTYPE

```

A variable of this new type is declared as follows:

```

DECLARE DateOfBirth : ThisDate

```

- (i) Name the non-composite data type used in the ThisDay and ThisMonth declarations.

.....[1]

- (ii) Name the data type of ThisDate.

.....[1]

- (iii) The month value of DateOfBirth needs to be assigned to the variable MyMonthOfBirth.

Write the required statement.

.....[1]

Question 3, continued

(b) Annual rainfall data from a number of locations are to be processed in a program.

The following data are to be stored:

- location name
- height above sea level (to the nearest metre)
- total rainfall for each month of the year (centimetres to 1 decimal place)

A user-defined, composite data type is needed. The programmer chooses `LocationRainfall` as the name of this data type.

A variable of this type can be used to store all the data for one particular location.

(i) Write the definition for the data type `LocationRainfall`.

.....
.....
.....
.....
.....
.....
.....
.....
.....[5]

(ii) The programmer decides to store all the data in a file. Initially, data from 27 locations will be stored. More rainfall locations will be added over time and will never exceed 100.

The programmer has to choose between two types of file organisation. The two types are serial and sequential.

Give **two** reasons for choosing serial file organisation.

.....
.....
.....
.....[2]

Mark scheme

3	(a) (i)	enumerated	1
	(ii)	record	1
	(iii)	MyMonthOfBirth ← DateOfBirth.ThisMonth	1
	(b) (i)	<pre> TYPE LocationRainfall DECLARE LocationName : STRING DECLARE LocationHeight : INTEGER DECLARE TotalMonthlyRainfall : <u>ARRAY[1..12]</u> OF REAL ENDTYPE </pre>	1 1 1 1 + 1
	(ii)	<ul style="list-style-type: none"> no need to re-sort data every time new data is added only a small file so searching will require little processing new records can easily be appended 	1 1 1 [max 2]
			Total: 10

Example candidate response – high

3 (a) A particular programming language allows the programmer to define their own data types.

ThisDate is an example of a user-defined structured data type.

```
TYPE ThisDate
  DECLARE ThisDay      : (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,
                          13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23,
                          24, 25, 26, 27, 28, 29, 30, 31)
  DECLARE ThisMonth    : (Jan, Feb, Mar, Apr, May, Jun, Jul, Aug,
                          Sep, Oct, Nov, Dec)
  DECLARE ThisYear     : INTEGER
ENDTYPE
```

A variable of this new type is declared as follows:

```
DECLARE DateOfBirth : ThisDate
```

(i) Name the non-composite data type used in the ThisDay and ThisMonth declarations.

..... Set Enumerated. data type. [1]

(ii) Name the data type of ThisDate.

..... ~~Record set.~~ Set [1]

(iii) The month value of DateOfBirth needs to be assigned to the variable MyMonthOfBirth.

Write the required statement.

..... MyMonthOfBirth := DateOfBirth.ThisMonth; [1]

Example candidate response – high, continued

(b) Annual rainfall data from a number of locations are to be processed in a program.

The following data are to be stored:

- location name
- height above sea level (to the nearest metre)
- total rainfall for each month of the year (centimetres to 1 decimal place)

A user-defined, composite data type is needed. The programmer chooses `LocationRainfall` as the name of this data type.

A variable of this type can be used to store all the data for one particular location.

(i) Write the definition for the data type `LocationRainfall`.

```
Type LocationRainfall = Record
LocationName : String;
HeightAboveSeaLevel : Integer;
TotalRainfallThisMonth : Real;
EndType;
```

[5]

(ii) The programmer decides to store all the data in a file. Initially, data from 27 locations will be stored. More rainfall locations will be added over time and will never exceed 100.

The programmer has to choose between two types of file organisation. The two types are serial and sequential.

Give two reasons for choosing serial file organisation.

- (1) Only few records are created $100 \leq ?$.
Will not take much processing time with serial file access.
 - (2) More locations added over time, can add the location to the end of the file without creating a new file.
- [2]

Examiner comment – high

'Enumerated' was correct in part (a)(i) and 'set' was incorrect in part (a)(ii). In part (a)(iii) the assignment statement uses the given identifiers accurately and the dot notation is correctly applied to derive the required field from the given record. Although '←' is on the mark scheme – and is used in assignment statements on 9608 papers – ':=' is perfectly acceptable. Even '=' in this context would have been acceptable.

In part (b)(i) the answer had a suitable structure and used the given identifier. The correct data types were selected for the location name, location height and the rainfall. The answer failed to achieve full marks as there was no recognition that the rainfall data need to record twelve values. The presence in the answer of '= RECORD' and a number of semi-colons was not an issue.

In part (b)(ii) the candidate's answer scored full marks as two correct reasons were stated. The first reason matched the second mark point on the mark scheme. The second reason described the addition of records to the end of the file and therefore matched the third point given on the mark scheme.

Marks awarded for part (a) = (i) 1/1, (ii) 0/1, (iii) 1/1

Marks awarded for part (b) = (i) 4/5, (ii) 2/2

Total marks awarded = 8 out of 10

Example candidate response – middle

- 3 (a) A particular programming language allows the programmer to define their own data types.

ThisDate is an example of a user-defined structured data type.

```

TYPE ThisDate
  DECLARE ThisDay      : (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,
                          13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23,
                          24, 25, 26, 27, 28, 29, 30, 31)
  DECLARE ThisMonth    : (Jan, Feb, Mar, Apr, May, Jun, Jul, Aug,
                          Sep, Oct, Nov, Dec)
  DECLARE ThisYear     : INTEGER
ENDTYPE

```

A variable of this new type is declared as follows:

```
DECLARE DateOfBirth : ThisDate
```

- (i) Name the non-composite data type used in the ThisDay and ThisMonth declarations.

Set[1]

- (ii) Name the data type of ThisDate.

Record[1]

- (iii) The month value of DateOfBirth needs to be assigned to the variable MyMonthOfBirth.

Write the required statement.

MyMonthOfBirth = DateOfBirth.ThisMonth[1]

Example candidate response – middle, continued

(b) Annual rainfall data from a number of locations are to be processed in a program.

The following data are to be stored:

- location name
- height above sea level (to the nearest metre)
- total rainfall for each month of the year (centimetres to 1 decimal place)

A user-defined, composite data type is needed. The programmer chooses `LocationRainfall` as the name of this data type.

A variable of this type can be used to store all the data for one particular location.

(i) Write the definition for the data type `LocationRainfall`.

```
Type
Enum LocationRainfall
.....
LocationRainfall = Record
.....
    Name := String [20] ;
.....
    Height := Integer ;
.....
    TotRam := Real ;
.....
End ;
.....[5]
```

(ii) The programmer decides to store all the data in a file. Initially, data from 27 locations will be stored. More rainfall locations will be added over time and will never exceed 100.

The programmer has to choose between two types of file organisation. The two types are serial and sequential.

Give two reasons for choosing serial file organisation.

```
There is no pre-defined order of records. All records have small number
of records.
.....
.....[2]
```

Examiner comment – middle

'Set' was incorrect in part (a)(i) but 'record' was correct for part (a)(ii). In part (a)(iii) the assignment statement uses the given identifiers accurately and the dot notation is correctly applied to derive the required field from the given record.

In part (b)(i) the answer does not follow exactly the syntax for a user-defined structured data type given in the stem of the question. This was not an issue. The structure is clear, the correct identifier has been used, and the data types for the fields are appropriate. A mark was lost as the candidate failed to include recognition that the rainfall data was more than a single value and needed to be stored appropriately.

In part (b)(ii) the first sentence just states a fact about serial files and the second sentence repeats a fact given in the question. Neither are reasons for choosing a serial organisation in the application given. Consequently the answer gained no marks.

Marks awarded for part (a) = (i) 0/1, (ii) 1/1, (iii) 1/1

Marks awarded for part (b) = (i) 4/5, (ii) 0/2

Total marks awarded = 6 out of 10

Example candidate response – low

3 (a) A particular programming language allows the programmer to define their own data types.

ThisDate is an example of a user-defined structured data type.

```
TYPE ThisDate
  DECLARE ThisDay      : (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,
                          13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23,
                          24, 25, 26, 27, 28, 29, 30, 31)
  DECLARE ThisMonth    : (Jan, Feb, Mar, Apr, May, Jun, Jul, Aug,
                          Sep, Oct, Nov, Dec)
  DECLARE ThisYear     : INTEGER
ENDTYPE
```

A variable of this new type is declared as follows:

```
DECLARE DateOfBirth : ThisDate
```

(i) Name the non-composite data type used in the ThisDay and ThisMonth declarations.

..... Set [1]

(ii) Name the data type of ThisDate.

..... ~~Integer~~ Structure [1]

(iii) The month value of DateOfBirth needs to be assigned to the variable MyMonthOfBirth.

Write the required statement.

..... Declare MyMonthOfBirth : ~~ThisMonth~~ DateOfBirth.ThisMonth [1]

Example candidate response – low, continued

(b) Annual rainfall data from a number of locations are to be processed in a program.

The following data are to be stored:

- location name
- height above sea level (to the nearest metre)
- total rainfall for each month of the year (centimetres to 1 decimal place)

A user-defined, composite data type is needed. The programmer chooses `LocationRainfall` as the name of this data type.

A variable of this type can be used to store all the data for one particular location.

(i) Write the definition for the data type `LocationRainfall`.

```
Type LocationRainfall
  Declare LocationName : String
  Declare Height : Integer
  Declare Rainfall : Decimal
  Declare Month : (Jan, Feb, Mar, Apr, May,
                  Jun, Jul, Aug, Sep, Oct, Nov, Dec)
END Type
```

[5]

(ii) The programmer decides to store all the data in a file. Initially, data from 27 locations will be stored. More rainfall locations will be added over time and will never exceed 100.

The programmer has to choose between two types of file organisation. The two types are serial and sequential.

Give two reasons for choosing serial file organisation.

Serial file is easier to insert data. There will never be more locations more than hundred so its easier to find data as well.

[2]

Examiner comment – low

'Set' was incorrect in part (a)(i). In part (a)(ii) the question used the term 'structured data type'. The candidate's answer was 'structured'. Consequently no mark was awarded. Those familiar with programming in C (and its derivatives) would call ThisDate a 'struct'. If the candidate had written 'struct' the mark would have been given, albeit reluctantly. The syllabus does not include C, or any of its derivatives, as one of the recommended languages and uses "record" as the preferred term for structures of the type given in the question. In part (a)(iii) there are two incorrect parts to the answer: firstly, the presence of 'DECLARE' and, secondly, the use of ':'. The presence of either of these on their own would have resulted in the awarding of a mark of zero.

In part (b)(i) the answer closely matched the answer given on the mark scheme. 'Decimal' was an acceptable alternative to 'real'. The presence of the additional field 'Month' was not penalised.

In part (b)(ii) the first sentence is not incorrect but to be awarded the mark the candidate needed to state that a new record would be appended to the file. In the second sentence 'easier to find data' is far too vague.

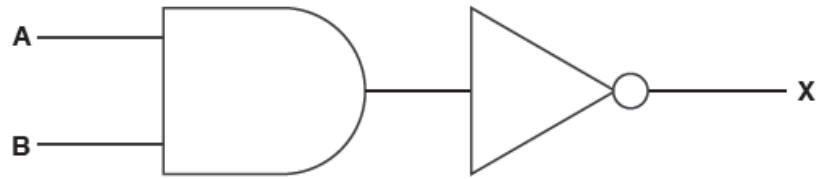
Marks awarded for part (a) = (i) 0/1, (ii) 0/1, (iii) 0/1

Marks awarded for part (b) = (i) 4/5, (ii) 0/2

Total marks awarded = 4 out of 10

Question 4

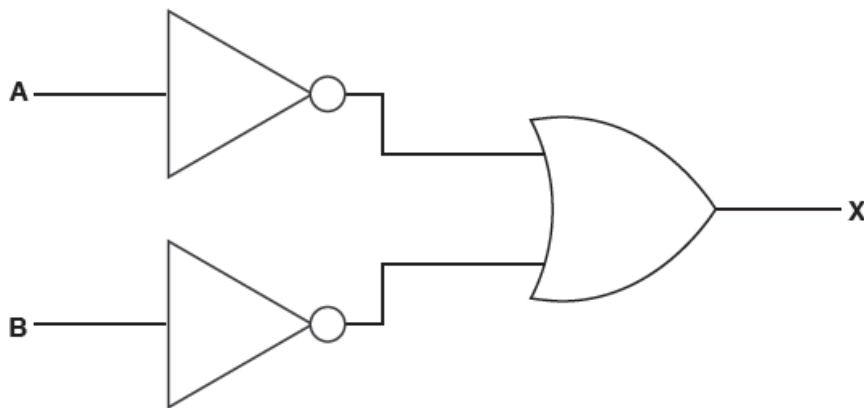
4 (a) (i) Complete the truth table for this logic circuit:



A	B	Working space	X
0	0		
0	1		
1	0		
1	1		

[1]

(ii) Complete the truth table for this logic circuit:



A	B	Working space	X
0	0		
0	1		
1	0		
1	1		

[1]

Question 4, continued

(b) A student decides to write an equation for **X** to represent the full behaviour of each logic circuit.

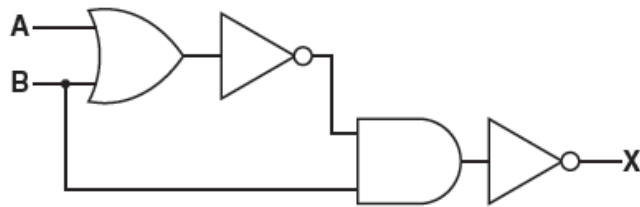
(i) Write the Boolean expression that will complete the required equation for **X** for each circuit:

Circuit 1: **X** =

Circuit 2: **X** =[2]

(ii) Write the De Morgan's Law which is shown by your answers to **part (a)** and **part (b)(i)**.
.....[1]

(c) Write the Boolean algebraic expression corresponding to the following logic circuit:



.....[3]

(d) Using De Morgan's laws and Boolean algebra, simplify your answer to **part (c)**.

Show all your working.

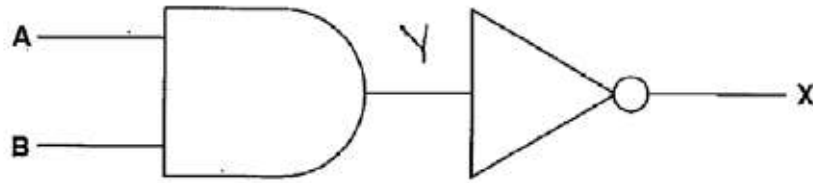
.....
.....
.....
.....
.....
.....
.....[3]

Mark scheme

4 (a) (i)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="3">Circuit 1</th> </tr> <tr> <th>A</th> <th>B</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>1</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>1</td> <td>0</td> </tr> </tbody> </table>	Circuit 1			A	B	X	0	0	1	0	1	1	1	0	1	1	1	0	1
Circuit 1																				
A	B	X																		
0	0	1																		
0	1	1																		
1	0	1																		
1	1	0																		
(ii)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="3">Circuit 2</th> </tr> <tr> <th>A</th> <th>B</th> <th>X</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>1</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>1</td> <td>0</td> </tr> </tbody> </table>	Circuit 2			A	B	X	0	0	1	0	1	1	1	0	1	1	1	0	1
Circuit 2																				
A	B	X																		
0	0	1																		
0	1	1																		
1	0	1																		
1	1	0																		
(b) (i)	<ul style="list-style-type: none"> • circuit 1: $\overline{A.B}$ • circuit 2: $\overline{A+B}$ 	1 1																		
(ii)	$\overline{A.B} \equiv \overline{A+B}$	1																		
(c)	$\overline{\overline{(A+B).B}}$ Mark as follows: $\overline{(A+B)}$ $.B$ bar over whole expression	1 1 1																		
(d)	$\overline{\overline{(A+B).B}}$ $= \overline{\overline{(A+B)} + \overline{B}}$ $= \overline{(A+B) + \overline{B}}$ $= A + \overline{(B + \overline{B})}$ $= A + 1$ $= 1$ allow f.t. from (c)	1 1 1 1 1 [max 3]																		
		Total: 11																		

Example candidate response – high

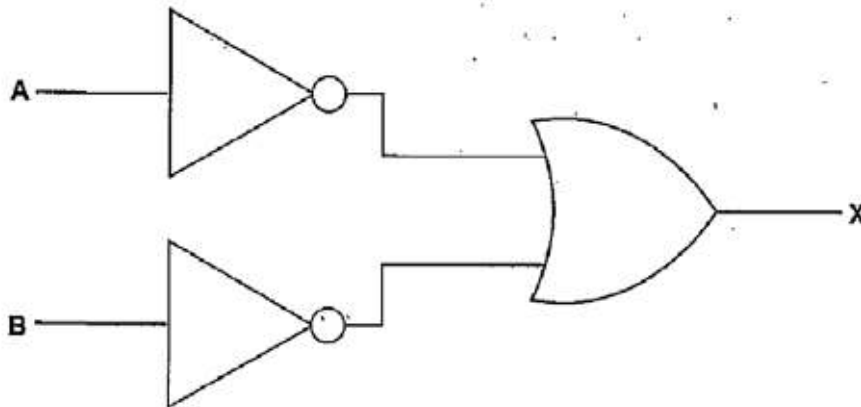
4 (a) (i) Complete the truth table for this logic circuit:



A	B	Y	Working space	X
0	0	0		1
0	1	0		1
1	0	0		1
1	1	1		0

[1]

(ii) Complete the truth table for this logic circuit:



A	B	A'	B'	Working space	X
0	0	1	1		1
0	1	1	0		1
1	0	0	1		1
1	1	0	0		0

[1]

Example candidate response – high, continued

(b) A student decides to write an equation for X to represent the full behaviour of each logic circuit.

(i) Write the Boolean expression that will complete the required equation for X for each circuit:

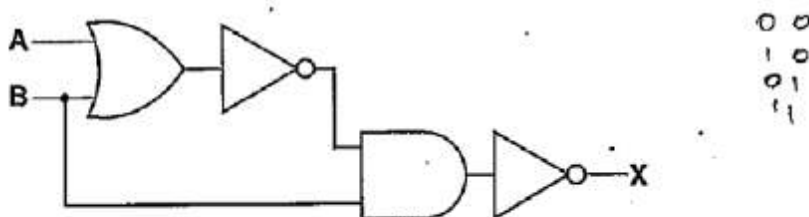
Circuit 1: $X = \overline{A \times B}$

Circuit 2: $X = \overline{A} + \overline{B}$ [2]

(ii) Write the De Morgan's Law which is shown by your answers to part (a) and part (b)(i).

$\overline{A \times B} = \overline{A} + \overline{B}$ [1]

(c) Write the Boolean algebraic expression corresponding to the following logic circuit:



$\overline{(\overline{A+B})} \times B$ [3]

(d) Using De Morgan's laws and Boolean algebra, simplify your answer to part (c).

Show all your working.

$\overline{(\overline{A+B})} \times B$
 $= (A+B) + \overline{B}$
 $= A + B + \overline{B} \Rightarrow B + \overline{B} = 1$
 $= A + 1$
 $= 1$

..... [3]

Examiner comment – high

In parts (a)(i) and (a)(ii) both truth tables were completed accurately.

In part (b)(i) despite the use of 'x', rather than the preferred '.', the answer for Circuit 1 was accepted. The answer for Circuit 2 was correct. The candidate made the required deduction in part (b)(ii) and wrote the appropriate De Morgan's law. Again, the use of 'x' was accepted.

In part (c) all elements required for full marks were present. Again, the use of 'x' was accepted.

In part (d) although the final answer is correct only two marks were awarded. The first mark was for using the rule that $B + B = B$ and a second mark for using the rule that $A + 1 = 1$. Although the second line is correct the question asked for all working to be shown. As itemised on the mark scheme there is an intermediate expression between the starting expression and the expression given on the second line by the candidate. Consequently no mark was awarded for the expression on the second line.

Marks awarded for part (a) = (i) 1/1, (ii) 1/1

Marks awarded for part (b) = (i) 2/2, (ii) 1/1

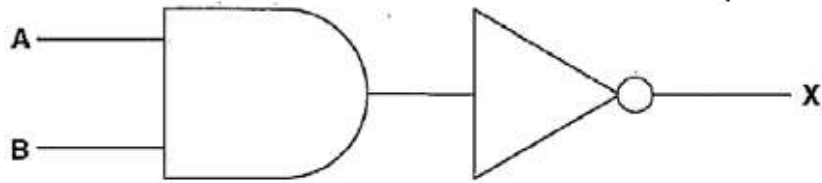
Marks awarded for part (c) = 3/3

Marks awarded for part (d) = 2/3

Total marks awarded = 10 out of 11

Example candidate response – middle

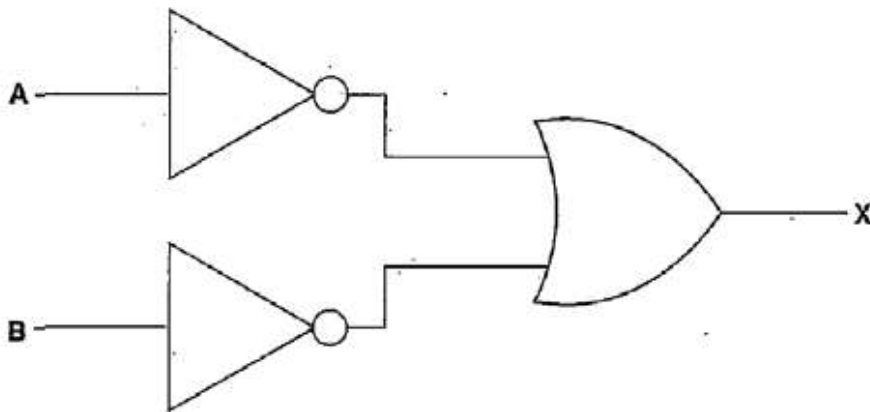
4 (a) (i) Complete the truth table for this logic circuit:



A	B	$A \cdot B$	Working space $\overline{A \cdot B}$	X
0	0	0	1	1
0	1	0	1	1
1	0	0	1	1
1	1	1	0	0

[1]

(ii) Complete the truth table for this logic circuit:



A	B	\bar{A}	\bar{B}	Working space $\bar{A} + \bar{B}$	X
0	0	1	1	1	1
0	1	1	0	1	1
1	0	0	1	1	1
1	1	0	0	0	0

[1]

(b) A student decides to write an equation for **X** to represent the full behaviour of each logic circuit.

(i) Write the Boolean expression that will complete the required equation for **X** for each circuit:

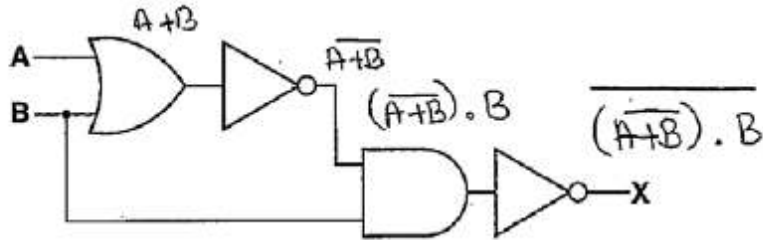
Circuit 1: $X = \overline{A + B}$

Circuit 2: $X = \overline{A \cdot B}$ [2]

(ii) Write the De Morgan's Law which is shown by your answers to part (a) and part (b)(i).

$\overline{A \cdot B} = \overline{A} + \overline{B}$ [1]

(c) Write the Boolean algebraic expression corresponding to the following logic circuit:



$\overline{(\overline{A+B}) \cdot B}$ [3]

(d) Using De Morgan's laws and Boolean algebra, simplify your answer to part (c).

Show all your working.

$\overline{(\overline{A+B}) \cdot B}$
 $(A+B) \cdot \overline{B}$

.....

 [3]

Examiner comment – middle

In parts (a)(i) and (a)(ii) both truth tables were completed accurately.

In part (b)(i) the candidate has seemingly confused the two circuits and consequently scored no marks. However in part (b)(ii) the appropriate De Morgan's law has been given and therefore the mark was awarded.

In part (c) the candidate gave a fully correct answer. The candidate's script showed an annotated logic circuit. This was not asked for but it seemed to be a beneficial technique in arriving at the answer.

In part (d) the one attempt at simplification of the original expression scored no marks. Despite the successful attempt at producing the appropriate De Morgan's law the candidate applied the law incorrectly. Also, if their answer had included '+' instead of their '.', no marks would have been awarded as the necessary working would not have been shown.

Marks awarded for part (a) = (i) 1/1, (ii) 1/1

Marks awarded for part (b) = (i) 0/2, (ii) 1/1

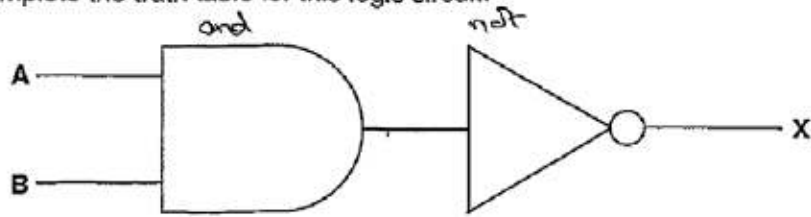
Marks awarded for part (c) = 3/3

Marks awarded for part (d) = 0/3

Total marks awarded = 6 out of 11

Example candidate response – low

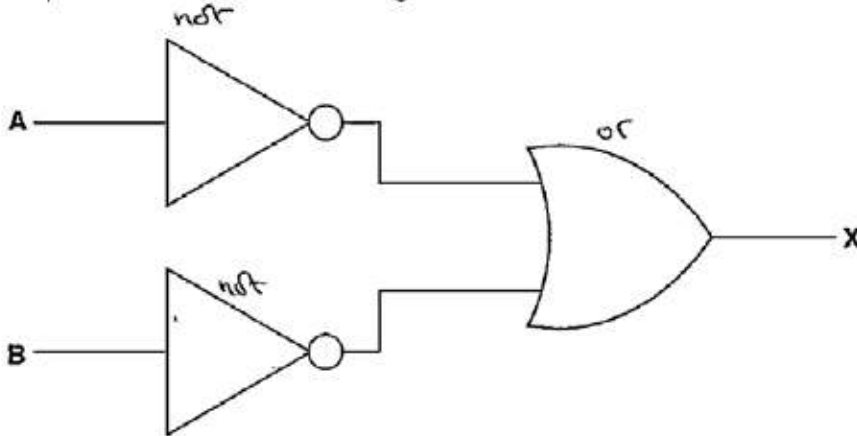
4 (a) (i) Complete the truth table for this logic circuit:



A	B	Working space	X
0	0		1
0	1		0
1	0		0
1	1		0

[1]

(ii) Complete the truth table for this logic circuit:



A	B	Working space	X
0	0		1
0	1		1
1	0		1
1	1		0

[1]

$$\bar{A} + \bar{B}$$

Example candidate response – low, continued

(b) A student decides to write an equation for X to represent the full behaviour of each logic circuit.

(i) Write the Boolean expression that will complete the required equation for X for each circuit:

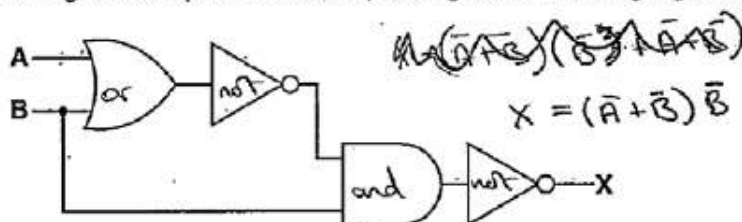
Circuit 1: $X = \bar{A} \cdot \bar{B}$

Circuit 2: $X = \bar{A} + \bar{B}$ [2]

(ii) Write the De Morgan's Law which is shown by your answers to part (a) and part (b)(i).

$\bar{A} \cdot \bar{B} = \overline{A + B}$ and $\bar{A} + \bar{B} = \overline{A \cdot B}$ [1]

(c) Write the Boolean algebraic expression corresponding to the following logic circuit:



$X = \bar{B}(\bar{A} + \bar{B})$ [3]

(d) Using De Morgan's laws and Boolean algebra, simplify your answer to part (c).

Show all your working.

$X = \bar{B}(\bar{A} + \bar{B})$

$X = \bar{B}\bar{A} + \bar{B}\bar{B}$

$X = \bar{B}\bar{A} + \bar{B}$

$\bar{A} \cdot \bar{A} = \bar{A}$

00	0
01	0
10	0
11	1

$\bar{A} \cdot \bar{A} = \bar{A}$

Examiner comment – low

The truth table in part (a)(i) was incorrect. The candidate labelled the logic gates correctly so the problem was not one where a logic gate had been incorrectly identified. This candidate may have benefitted from using the working space and adding a column which gave the output from the AND gate. The truth table for part (a)(ii) was correct.

In part (b)(i) the Boolean expression for Circuit 1 was incorrect but the Boolean expression for Circuit 2 was correct. In part (b)(ii) the candidate demonstrated no knowledge of De Morgan's law.

In part (c) the candidate annotated the logic circuit and correctly labelled each of the logic gates. However the Boolean expression has no correct elements and no marks were awarded.

The candidate's answer to part (c) was incorrect and therefore the starting expression in part (d) was also incorrect. However, marks were given for any working that showed a correct application of De Morgan's laws or Boolean algebra rules. In this answer the expression on the second line is an incorrect derivation from the first line. However the expression on the third line has been produced using the rule $A \cdot A = A$. Consequently the candidate was awarded a mark.

Marks awarded for part (a) = (i) 0/1, (ii) 1/1

Marks awarded for part (b) = (i) 1/2, (ii) 0/1

Marks awarded for part (c) = 0/3

Marks awarded for part (d) = 1/3

Total marks awarded = 4 out of 11

Question 5

- 5 A gardener grows vegetables in a greenhouse. For the vegetables to grow well, the temperature needs to always be within a particular range.

The gardener is not sure about the actual temperatures in the greenhouse during the growing season. The gardener installs some equipment. This records the temperature every hour during the growing season.

- (a) Name the type of system described.

.....[1]

- (b) Identify **three** items of hardware that would be needed to acquire and record the temperature data. Justify your choice for each.

Item 1

Justification

.....

Item 2

Justification

.....

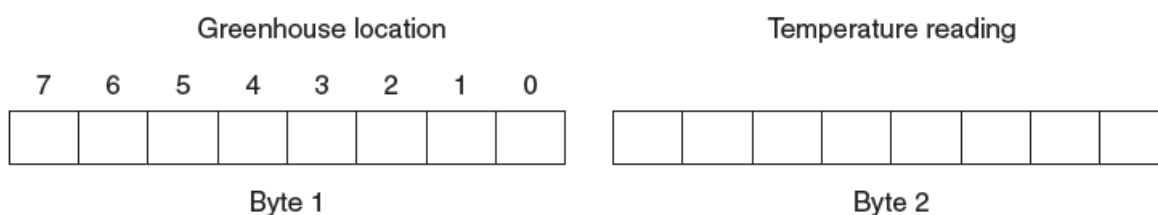
Item 3

Justification

.....[6]

- (c) The equipment records temperatures in the greenhouse. It does this for seven locations.

Each recording is stored as two successive bytes. The format is shown below:



The location is indicated by the setting of one of the seven bits in byte 1. For example, location 4 is indicated by setting bit 4.

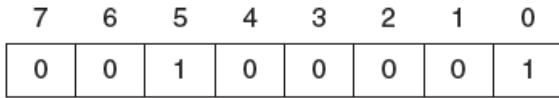
Bit 0 of byte 1 acts as a flag:

- the initial value is zero
- when the reading has been processed it is set to 1

Byte 2 contains the temperature reading (two's complement integer).

Question 5, continued

(i) Interpret the data in byte 1 shown below:



Byte 1

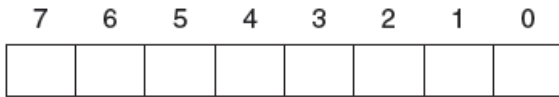


Byte 2

.....
.....
.....
.....[2]

(ii) The system receives a temperature reading of –5 degrees from sensor 6.

Complete the boxes below to show the two bytes for this recording. The reading has not yet been processed.



Byte 1



Byte 2

[2]

(d) (i) The accumulator is loaded with the value of byte 1 from location 106.

Write the assembly language instruction to check whether the reading in byte 2 came from location 4.

```
LDD 106          // data loaded from address 106
```

.....[4]

(ii) Write the assembly language instruction to set the flag (bit 0) of the byte contained in the accumulator to 1.

.....[2]

Mark scheme

5 (a)	Monitoring system	1
(b)	<ul style="list-style-type: none"> • temperature sensor ... • transmits measured temperature • analogue to digital converter ... • converts analogue signal from sensor to digital value that can be stored • storage device // data logger... • for recording readings from sensor • transmission hardware ... • to transfer data from sensor to storage device • processor ... • to process incoming data 	1 1 1 1 1 1 1 1 1 [max 6]
(c) (i)	temperature reading in location 5 has been processed	1 1
(ii)	0100 0000 1111 1011 1 mark per byte	2
(d) (i)	AND #B00010000 // AND #&10 // AND #16 1 mark for AND, 1 mark for address mode, 1 mark for mask, 1 mark for indication of numbering system	1 + 1 + 1 + 1
(ii)	OR #B00000001 // OR #&01 // OR #1 1 mark for OR, 1 mark for mask	1 + 1
		Total: 17

Example candidate response – high

- 5 A gardener grows vegetables in a greenhouse. For the vegetables to grow well, the temperature needs to always be within a particular range.

The gardener is not sure about the actual temperatures in the greenhouse during the growing season. The gardener installs some equipment. This records the temperature every hour during the growing season.

- (a) Name the type of system described.

~~Success~~ Monitoring system [1]

- (b) Identify three items of hardware that would be needed to acquire and record the temperature data. Justify your choice for each.

Item 1 Sensors

Justification Sensors are used to measure a physical quantity such as temperature and then sensors send data to processor

Item 2 Microprocessor

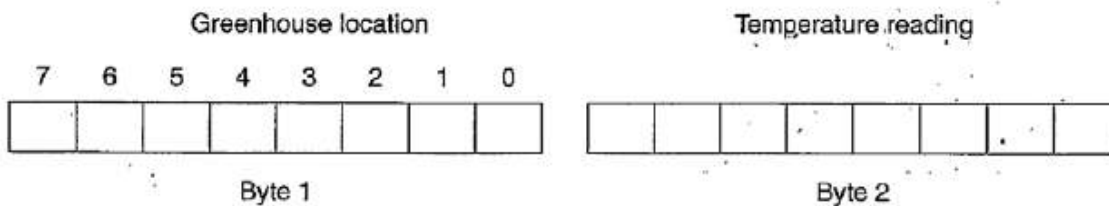
Justification It is used to process the data collected by sensors so that it can be saved and manipulated.

Item 3 Hard-disk

Justification It is used to store temperatures of greenhouse every hour during the growing season. We would need a large hard disk. [6]

- (c) The equipment records temperatures in the greenhouse. It does this for seven locations.

Each recording is stored as two successive bytes. The format is shown below:



The location is indicated by the setting of one of the seven bits in byte 1. For example, location 4 is indicated by setting bit 4.

Bit 0 of byte 1 acts as a flag:

- the initial value is zero
- when the reading has been processed it is set to 1

Byte 2 contains the temperature reading (two's complement integer).

Example candidate response – high, continued

(i) Interpret the data in byte 1 shown below:

7	6	5	4	3	2	1	0	-128	64	32	16	8	4	2	1
0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	0

The equipment ^{Byte 1} has taken readings.

The temperature reading for location 5 and 0 has been processed. The temperature value is 24 for both locations.

[2]

(ii) The system receives a temperature reading of -5 degrees from sensor 6.

Complete the boxes below to show the two bytes for this recording. The reading has not yet been processed.

7	6	5	4	3	2	1	0	-128	64	32	16	8	4	2	1
0	1	0	0	0	0	0	0	1	1	1	1	1	0	1	1

Byte 1

Byte 2

$$\begin{array}{r} -128 \\ 64 \\ \hline 64 \\ 32 \\ \hline 232 \\ 16 \\ \hline 248 \\ 8 \\ \hline 256 \\ 8 \\ \hline 264 \end{array}$$

[2]

(i) The accumulator is loaded with the value of byte 1 from location 106.

Write the assembly language instruction to check whether the reading in byte 2 came from location 4.

```
LDD 106 // data loaded from address 106
```

```
LDD 4  
CMP #B11111011 → (d) (i) Answer after line [4]
```

(ii) Write the assembly language instruction to set the flag (bit 0) of the byte contained in the accumulator to 1.

```
LDD 106  
OR #B01000  
OR #B00000001  
STO 106 [2]
```

(d) (i) :- OUT "Yes it matches"

Examiner comment – high

In part (a) the type of system was correctly identified.

In part (b) the answer was awarded the maximum mark. Although 'sensor' was given for the first item the justification statement refers to a temperature sensor. This was sufficient to gain the first mark. The last part of the justification for the temperature sensor states: '... sends data to processor'; this was sufficient to gain the second mark. 'Microprocessor' and 'process the data collected by sensors' gained both marks for the second item. 'Hard-disk' and 'store temperatures' were sufficient to gain marks for the third item.

In part (c)(i) the interpretation of the relevant byte was not totally accurate. The reference to location 0 as well as location 5 was deemed to be not worthy of the first mark on the mark scheme. A mark was awarded for 'has been processed'.

In part (c)(ii) the binary patterns for both bytes were totally correct and both marks were awarded.

In part (d)(i) two marks were awarded for this answer. No mark was given for the operation as the candidate had used 'CMP' and 'AND' was required. For the operand two marks were awarded: one for indicating immediate address mode – the '#' – and one mark for the use of 'B' to indicate that the actual operand value was in binary. The binary value in the operand was wrong and no mark was given.

In part (d)(ii) the answer was awarded the maximum mark. Both the operation and the operand are stated correctly.

Marks awarded for part (a) = 1/1
Marks awarded for part (b) = 6/6
Marks awarded for part (c) = (i) 1/2, (ii) 2/2
Marks awarded for part (d) = (i) 2/4, (ii) 2/2

Total marks awarded = 14 out of 17

Example candidate response – middle

- 5 A gardener grows vegetables in a greenhouse. For the vegetables to grow well, the temperature needs to always be within a particular range.

The gardener is not sure about the actual temperatures in the greenhouse during the growing season. The gardener installs some equipment. This records the temperature every hour during the growing season.

- (a) Name the type of system described.

Control system [1]

- (b) Identify three items of hardware that would be needed to acquire and record the temperature data. Justify your choice for each.

Item 1 Temperature sensor

Justification the sensor records the temperature and sends to the computer

Item 2 Analogue-to-digital-converter

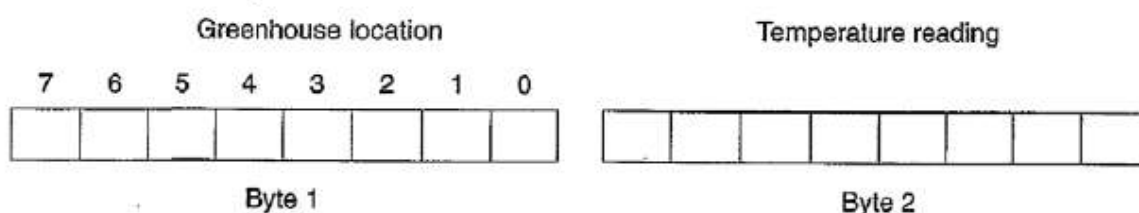
Justification converts the analogue data collected by the sensor for the computer to record

Item 3 Humidity sensor

Justification to record humidity levels and send data to the computer [6]

- (c) The equipment records temperatures in the greenhouse. It does this for seven locations.

Each recording is stored as two successive bytes. The format is shown below:



The location is indicated by the setting of one of the seven bits in byte 1. For example, location 4 is indicated by setting bit 4.

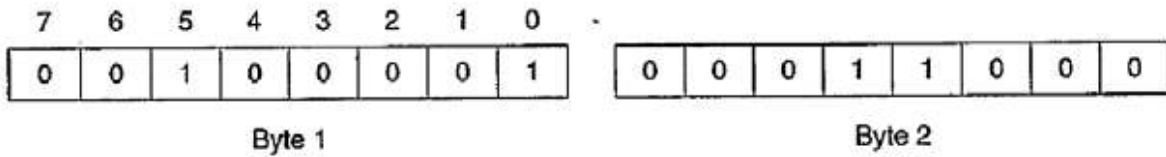
Bit 0 of byte 1 acts as a flag:

- the initial value is zero
- when the reading has been processed it is set to 1

Byte 2 contains the temperature reading (two's complement integer).

Example candidate response – middle, continued

(i) Interpret the data in byte 1 shown below:

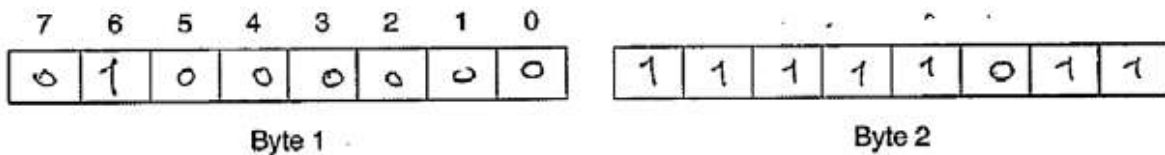


~~The temperature is 24 and the~~
 The location is 5 and the reading
 has been processed

[2]

(ii) The system receives a temperature reading of -5 degrees from sensor 6.

Complete the boxes below to show the two bytes for this recording. The reading has not yet been processed.



[2]

(d) (i) The accumulator is loaded with the value of byte 1 from location 106.

Write the assembly language instruction to check whether the reading in byte 2 came from location 4.

LDD 106 // data loaded from address 106
 AND B 0001 0000

[4]

(ii) Write the assembly language instruction to set the flag (bit 0) of the byte contained in the accumulator to 1.

OR B 0000 0001

[2]

Examiner comment – middle

In part (a) the type of system was incorrectly identified.

In part (b) 'Temperature sensor' was an appropriate item and given a mark. For the justification '... stores the temperature' was not worth a mark as sensors are not storage devices. However '... sends (temperature) to the computer' did gain a mark. An analogue-to-digital convertor was an appropriate item and also gained a mark. However the justification required an answer that described that sensors provide analogue data whereas a processor requires digital data. The answer given by the candidate doesn't quite do that and consequently no mark was awarded. The third item – humidity sensor – was not awarded a mark as there was nothing in the question that indicated that humidity was a variable that needed to be monitored in this system.

In part (c)(i) the candidate's answer included both the points required and gained the maximum mark.

In part (c)(ii) the binary patterns for both bytes were totally correct and both marks were awarded.

In part (d)(i) three marks were awarded. The operation – 'AND' – was correct, the numerical part of the operand was correct and the fact that it is in binary was also indicated. The answer lacked the presence of a '#' – to indicate immediate addressing – and therefore the fourth mark was not given.

In part (d)(ii) the operation was correct and a mark was awarded. For this part of the question only a totally correct operand would gain the mark. The candidate failed to indicate that immediate address mode should be used and therefore failed to gain a second mark.

Marks awarded for part (a) = 0/1
Marks awarded for part (b) = 3/6
Marks awarded for part (c) = (i) 2/2, (ii) 2/2
Marks awarded for part (d) = (i) 3/4, (ii) 1/2

Total marks awarded = 11 out of 17

Example candidate response – low

- 5 A gardener grows vegetables in a greenhouse. For the vegetables to grow well, the temperature needs to always be within a particular range.

The gardener is not sure about the actual temperatures in the greenhouse during the growing season. The gardener installs some equipment. This records the temperature every hour during the growing season.

- (a) Name the type of system described.

Greenhouse monitoring[1]

- (b) Identify three items of hardware that would be needed to acquire and record the temperature data. Justify your choice for each.

Item 1 Sensor

Justification to automatically input the temperature levels in the greenhouse

Item 2 Actuator

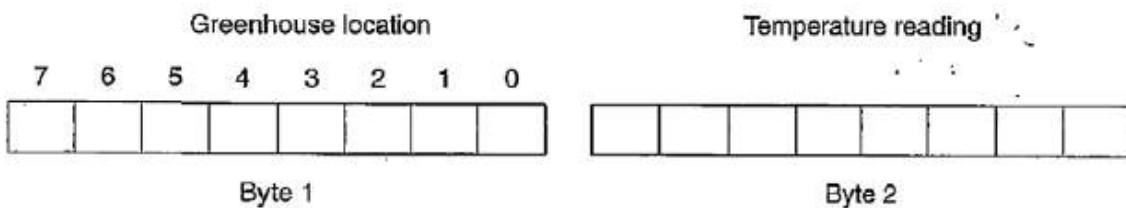
Justification such as air conditioning can be turned on if the heat level is not suitable for the vegetables

Item 3 Analogue-Digital Converter (ADC)

Justification as computers only understand digital data, sensors output in analogue form so its necessary to convert[6]

- (c) The equipment records temperatures in the greenhouse. It does this for seven locations.

Each recording is stored as two successive bytes. The format is shown below:



The location is indicated by the setting of one of the seven bits in byte 1. For example, location 4 is indicated by setting bit 4.

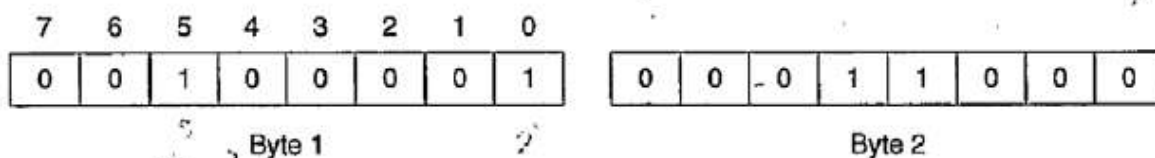
Bit 0 of byte 1 acts as a flag:

- the initial value is zero
- when the reading has been processed it is set to 1

Byte 2 contains the temperature reading (two's complement integer).

Example candidate response – low, continued

(i) Interpret the data in byte 1 shown below:



$$2^5 + 2^0$$

$$32 + 1$$

$$33$$

$$2^4 + 2^3$$

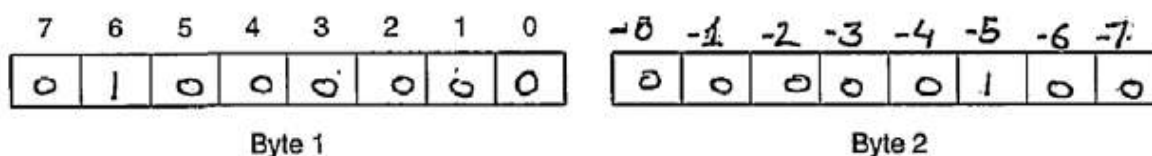
$$16 + 8$$

$$24$$

[2]

(ii) The system receives a temperature reading of -5 degrees from sensor 6.

Complete the boxes below to show the two bytes for this recording. The reading has not yet been processed.



[2]

(d) (i) The accumulator is loaded with the value of byte 1 from location 106.

Write the assembly language instruction to check whether the reading in byte 2 came from location 4.

```
LDD 106 // data loaded from address 106
```

~~...OR #16~~[4]

(ii) Write the assembly language instruction to set the flag (bit 0) of the byte contained in the accumulator to 1.

~~...OR #1~~ AND #00000001[2]

Examiner comment – low

In part (a) the answer given was not the correct answer.

In part (b) a mark was awarded for temperature sensor, with the mention of temperature in the justification statement being used to give the candidate credit for the correct type of sensor. However the justification itself was not worth a mark. The candidate's answer just states that a temperature sensor inputs temperatures. An actuator was not worth a mark as this was not a control system. The third item – the analogue to digital convertor – was correct and gained a mark. The justification was also worth a mark as there was a clear statement that sensors produce analogue data whereas computers 'only understand digital data'.

In part (c)(i) clearly the candidate did not understand the question and gained no marks.

In part (c)(ii) only the binary pattern for the first byte was correct and therefore only a single mark was awarded.

In part (d)(i) three marks were awarded for this answer. The operation – 'OR' – was incorrect. However the operand gained the three marks that were available for this part of the instruction. A '#' sign was present for one mark. The operand value, '16', is not only correct but its value indicated the use of the denary number system and therefore the lack of a symbol ('B' or '&') was credited with another mark.

In part (d)(ii) the operation was incorrect. In the operand immediate address mode was indicated and the numerical value was correct. However with the numerical value given in the operand it was necessary to indicate that it was actually a binary value. The lack of a 'B' resulted in the candidate failing to get the second mark available.

Marks awarded for part (a) = 0/1
Marks awarded for part (b) = 3/6
Marks awarded for part (c) = (i) 0/2, (ii) 1/2
Marks awarded for part (d) = (i) 3/4, (ii) 0/2

Total marks awarded = 7 out of 17

Question 6

- 6 (a) Four descriptions and three protocols are shown below.

Draw a line to connect each description to the appropriate protocol.

Description	Protocol used
email client downloads an email from an email server	HTTP
email is transferred from one email server to another email server	POP3
email client sends email to email server	SMTP
browser sends a request for a web page to a web server	

[4]

- (b) Downloading a file can use the client-server model. Alternatively, a file can be downloaded using the BitTorrent protocol.

Name the model used.

.....[1]

- (c) For the BitTorrent protocol, explain the function of each of the following:

(i) Tracker

[2]

(ii) Seed

[2]

(iii) Swarm

[2]

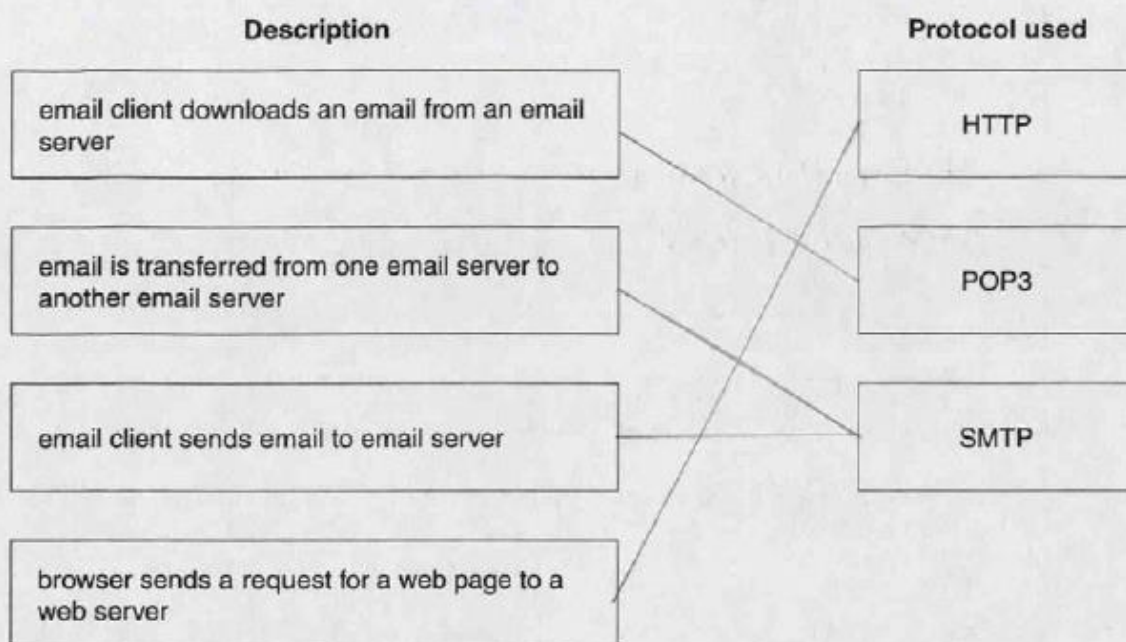
Mark scheme

<p>6 (a)</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Description</th> <th style="width: 50%;">Protocol used</th> </tr> </thead> <tbody> <tr> <td style="border: 1px solid black; padding: 5px;">email client downloads an email from an email server</td> <td style="border: 1px solid black; padding: 5px; text-align: center;">HTTP</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">email is transferred from one email server to another email server</td> <td style="border: 1px solid black; padding: 5px; text-align: center;">POP3</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">email client sends email to email server</td> <td style="border: 1px solid black; padding: 5px; text-align: center;">SMTP</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">browser sends a request for a web page to a web server</td> <td style="border: 1px solid black; padding: 5px;"></td> </tr> </tbody> </table>	Description	Protocol used	email client downloads an email from an email server	HTTP	email is transferred from one email server to another email server	POP3	email client sends email to email server	SMTP	browser sends a request for a web page to a web server		<p>1 mark for correct arrow from each description</p>
Description	Protocol used											
email client downloads an email from an email server	HTTP											
email is transferred from one email server to another email server	POP3											
email client sends email to email server	SMTP											
browser sends a request for a web page to a web server												
<p>(b)</p>	<p>peer-to-peer</p>	<p>1</p>										
<p>(c) (i)</p>	<p>Tracker: central server that: stores details of other computers that have all / part of file to be downloaded // has data on those peers downloading and uploading file // shares IP addresses with other clients in swarm allowing them to connect</p>	<p>1 1</p>										
<p>(ii)</p>	<p>Seed: peer computer that has 100% of file // is uploading downloaded content</p>	<p>1 1</p>										
<p>(iii)</p>	<p>Swarm: all the connected peer computers that have all or part of the file to be downloaded / uploaded // share a torrent</p>	<p>1 1</p>										
		<p>Total: 11</p>										

Example candidate response – high

6 (a) Four descriptions and three protocols are shown below.

Draw a line to connect each description to the appropriate protocol.



[4]

(b) Downloading a file can use the client-server model. Alternatively, a file can be downloaded using the BitTorrent protocol.

Name the model used.

TCP/IP model.....[1]

(c) For the BitTorrent protocol, explain the function of each of the following:

(i) Tracker *Consists of IP addresses of peers involved in the file. eg. seeders.*
.....
.....[2]

(ii) Seed *Once a part of the file is downloaded by a peer, it can be made available to other peers. Thus reducing burden on servers.*
.....[2]

(iii) Swarm *General term used to describe all the peers involved in the particular file. (seeders as well as downloaders)*
.....[2]

Examiner comment – high

In part (a) all the descriptions were correctly matched with the appropriate protocol.

In part (b) the answer given was incorrect. This was surprising given the understanding of the topic displayed in part (c).

In part (c)(i) this answer was awarded one mark for 'IP addresses for peers'. Although not totally matching the point on the mark scheme the answer conveyed the idea of the tracker maintaining the IP addresses of those peers in the swarm.

In part (c)(ii) this answer was awarded both marks. There is reference to a seed being a peer for the first mark. The statement 'Once a file is downloaded ... it can be made available to other peers' was worth the second mark.

In part (c)(iii) both points required for the two marks were present in this answer. '... all the peers ...' was worth the first mark. The statement 'seeders as well as downloaders' was worth the second mark.

Marks awarded for part (a) = 4/4

Marks awarded for part (b) = 0/1

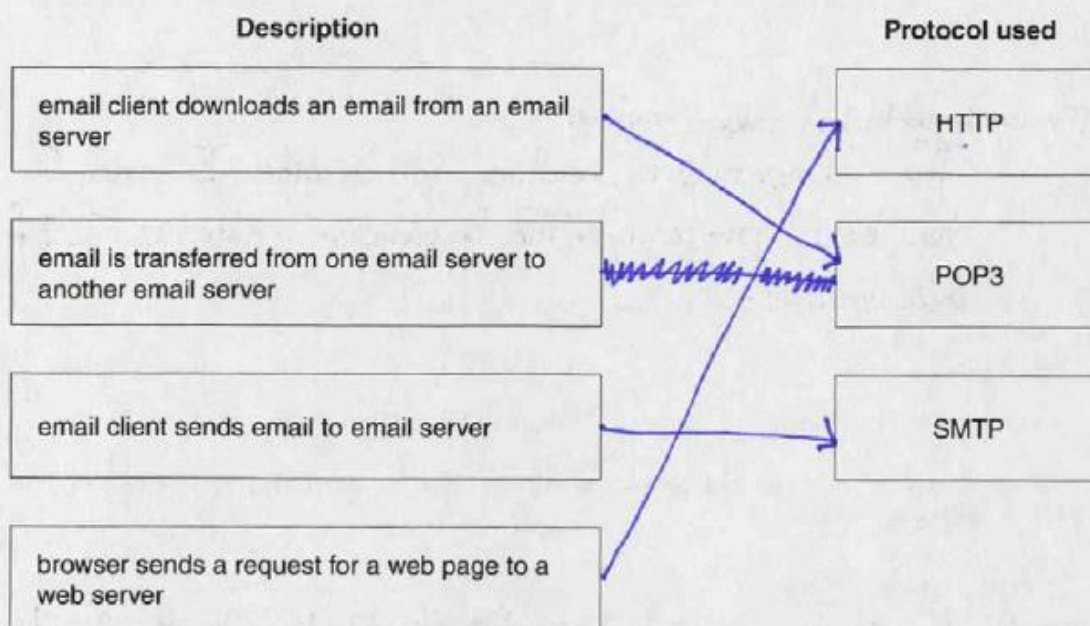
Marks awarded for part (c) = (i) 1/2, (ii) 2/2, (iii) 2/2

Total marks awarded = 9 out of 11

Example candidate response – middle

6 (a) Four descriptions and three protocols are shown below.

Draw a line to connect each description to the appropriate protocol.



[4]

(b) Downloading a file can use the client-server model. Alternatively, a file can be downloaded using the BitTorrent protocol.

Name the model used.

Peer-To-Peer file sharing model is used. [1]
 (c)(i) to make sure that tracker is providing the file.

(c) For the BitTorrent protocol, explain the function of each of the following:

(i) Tracker A tracker is a website (server) that links you to other peers so that you can exchange files which you want. You could also search for a torrent (file) through this. [2]

(ii) Seed Seeds are the people who have the file and are uploading the file that many people want to download and seeders are running the peer-to-peer software. The more the seeders, the higher the data transfer rate (i.e. download speed). [2]

(iii) Swarm Swarm are the people who are downloading the file and do not have the complete file yet. The more the swarms, the data transfer gets low. (i.e. download speed) [2]

Examiner comment – middle

In part (a) three of the four descriptions were matched with the appropriate protocol. The candidate failed to connect the second description to any protocol. Did the candidate not know the appropriate protocol and was not going to make a guess? Or did the candidate misunderstand the question and believe that each protocol should only be matched with one description? The question is clear that each description should match to a protocol.

In part (b) the correct model was given.

In part (c)(i) this answer was awarded both marks. The tracker is described as a server for the first mark. The second mark was given for ‘... links you to other peers so that you can exchange files ...’. This statement conveys the idea that the tracker uses the data that it stores to provide information that allows peers to connect to each other and exchange file(s).

In part (c)(ii) the answer was awarded one mark. Although there is mention of peer-to-peer the candidate does not state explicitly that a seed is a peer (computer). Credit was given for ‘... have the file that many people want to download and are uploading the file ...’

In part (c)(iii) the answer gained no credit. The swarm is described as only those ‘downloading the file’, thereby ignoring the seeds.

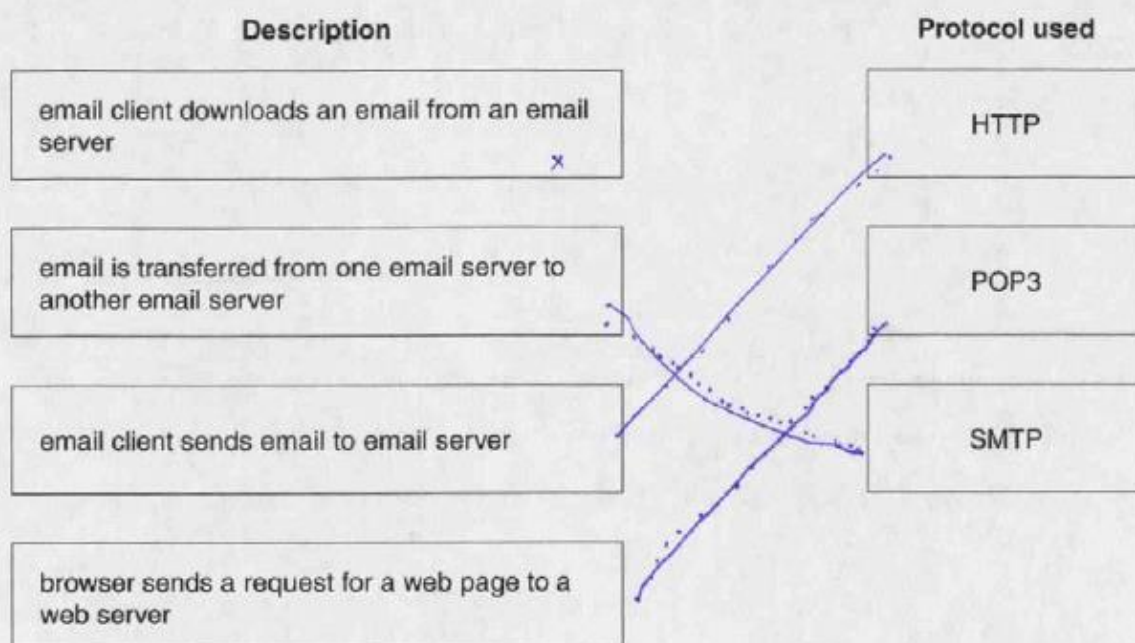
Marks awarded for part (a) = 3/4
Marks awarded for part (b) = 1/1
Marks awarded for part (c) = (i) 2/2, (ii) 1/2, (iii) 0/2

Total marks awarded = 7 out of 11

Example candidate response – low

6 (a) Four descriptions and three protocols are shown below.

Draw a line to connect each description to the appropriate protocol.



[4]

(b) Downloading a file can use the client-server model. Alternatively, a file can be downloaded using the BitTorrent protocol. 2/2

Name the model used.

File Transfer protocol Peer to Peer downloading. [1]

(c) For the BitTorrent protocol, explain the function of each of the following:

(i) Tracker Tracker is the server, which knows location of every file, leecher, seeder etc. [2]

(ii) Seed Groups of PC connected together in networking. Larger the seeds, more will be the speed. [2]

(iii) Swarm It is a place the main hub where every file is, for downloading file is downloaded from swarm, for uploading the file is uploaded to swarm. [2]

Examiner comment – low

In part (a) only one of the descriptions matches to an appropriate protocol. Again it is surprising that one of the descriptions does not have a line from it to one of the protocols.

In part (b) the correct model was given.

In part (c)(i) the answer was awarded both marks. The tracker is described as a server for the first mark. The statement ‘... knows location of every file leecher, seeder ...’ was awarded the second mark.

In part (c)(ii) the answer scored no marks. There is a correct statement that the more seeds there are the greater the possible download speed. However this does not explain the function of a seed and therefore was given no credit. There is also no reference to seeds being peers in this peer-to-peer network.

In part (c)(iii) the answer was awarded no marks. The swarm is described as a repository for file(s) that are to be downloaded or a file that is uploaded. The swarm does this but there is no recognition in the answer that the swarm is actually all the peer computers.

Marks awarded for part (a) = 1/4
Marks awarded for part (b) = 1/1
Marks awarded for part (c) = (i) 2/2, (ii) 0/2, (iii) 0/2

Total marks awarded = 4 out of 11

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