Cambridge International AS & A Level

Computer Science

Paper 3 Advanced Theory

Past Papers

2015-2019

Contents

Cambridge International A Level

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

COMPUTER SCIENCE **9608/31**

Paper 3 Advanced Theory **May/June 2015**

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

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Write in dark blue or black pen.
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DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

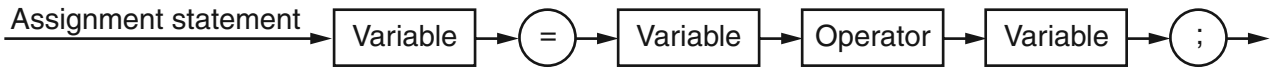
This document consists of **12** printed pages.

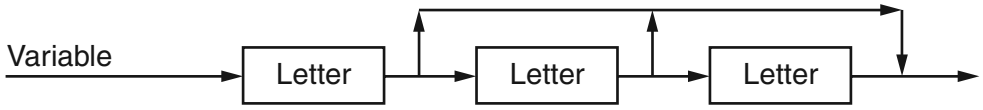
CAMBRIDGE International Examinations

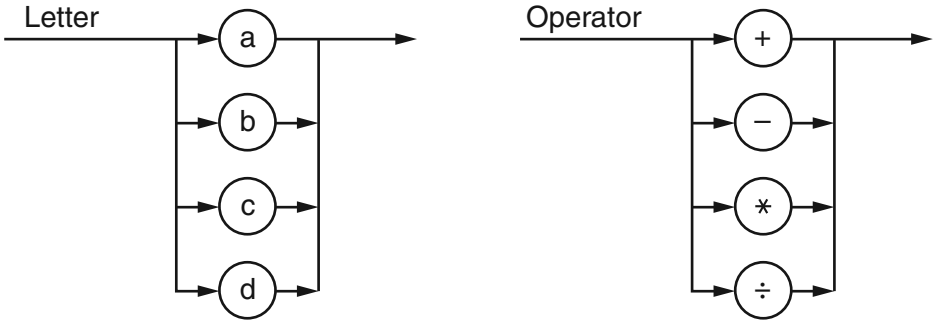
[Turn over

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]

(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]

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]

(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]

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]

(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.

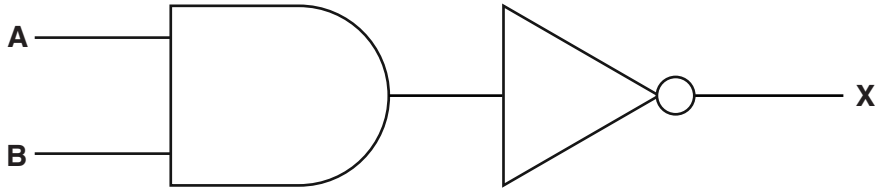
.....

.....

.....

.....[2]

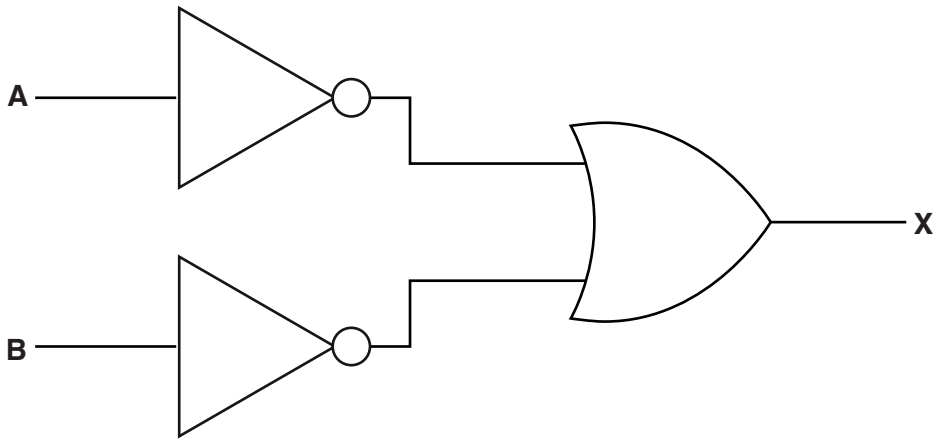
4 (a) (i) Complete the truth table for this logic circuit:



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]

(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:

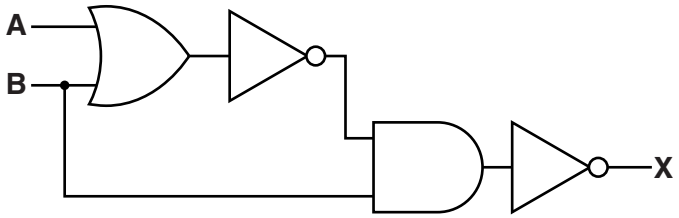
Circuit 1: **X** = ...

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]

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 .....

.....

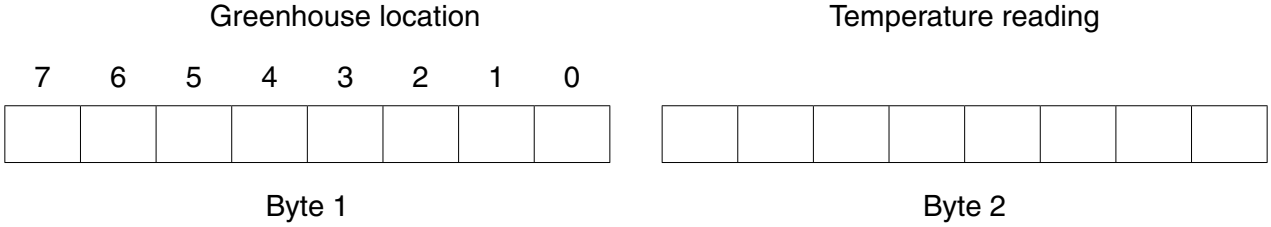
Item 3 .....

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).

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

7	6	5	4	3	2	1	0
0	0	1	0	0	0	0	1

Byte 1

0	0	0	1	1	0	0	0

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.

7	6	5	4	3	2	1	0

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]

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]

Cambridge International A Level

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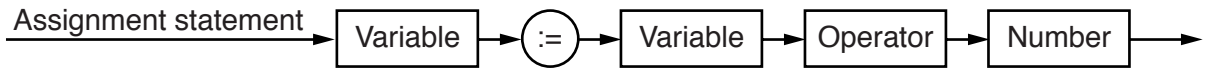
This document consists of **14** printed pages and **2** blank pages.

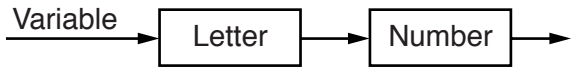
CAMBRIDGE International Examinations

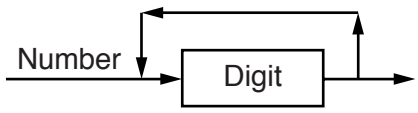
[Turn over

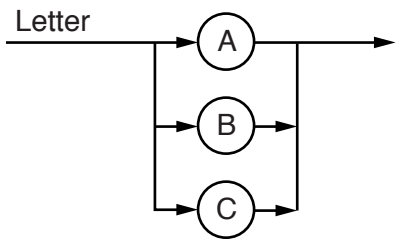
1 The following syntax diagrams, for a particular programming language, show the syntax of:

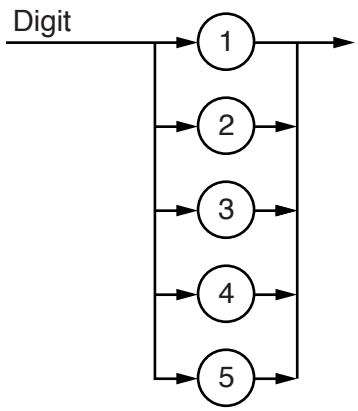
- an assignment statement
- a variable
- a number
- a letter
- a digit
- an operator

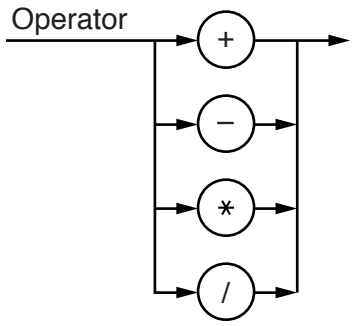












(a) The following assignment statements are invalid.

Give a reason in each case.

(i) `A2 = B3 + 123`

Reason .....

.....[1]

(ii) `B3 := B3 - 203`

Reason .....

.....[1]

(iii) `A2414 := A3 * B`

Reason .....

.....[1]

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

<letter> has been done for you.

<assignmentstatement> ::=

.....

<variable> ::=

.....

<number> ::=

.....

<letter> ::= A | B | C

<digit> ::=

.....

<operator> ::=

.....
[6]

(c) A company develops software. It provides virtual machines for its software developers. The company has a large number of clients who use a wide range of hardware and software.

(i) Explain the term virtual machine. Ensure that your answer includes the terms **hardware** and **software**.

.....

.....

.....

.....[2]

(ii) Give **one** benefit to the company of using virtual machines.

.....

.....[1]

(iii) Give **one** drawback to the company of using virtual machines.

.....

.....[1]

2 **(a)** Four descriptions and three types of local area network (LAN) are shown below.

Draw a line to connect each description to the type of LAN it applies to.

Description	Type of LAN
Any packet the listening computer receives may be part of a message for itself	Bus with terminators at each end
Connection provided through an access point	Star
A process for handling collisions has to be implemented	Wireless
Listening computer only receives packets that are addressed to itself	

[4]

(b) A user downloads a file using the FTP protocol.

Explain the function played by each of the following:

(i) Server .....

.....

.....[2]

(ii) Command .....

.....

.....[2]

(iii) Anonymous .....

.....

.....[2]

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

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

	Description	Term
A	Sending emails which contain a link to a website that attempts to trick users into giving confidential personal data.	.....
B	It replicates by inserting itself into another piece of software.	.....
C	....	Worm
D	....	Spam

[4]

(b) Choose term A **or** term B and describe:

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

Term .....

Problem .....

.....

Solution .....

.....[2]

(c) Explain the following terms:

Cipher text .....

.....

.....

Private key .....

.....

.....[2]

(d) Bill, a manager of a company, sent an email with very sensitive information to a work colleague, Alison. However, Bill also accidentally sent it to everybody in the company.

Describe the method used that ensured only Alison was able to read the original contents of the email.

.....

.....

.....

.....

.....

.....[4]

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

An example of a user-defined data type for an address is:

```
TYPE ThisAddress
   DECLARE ThisHouseNo : INTEGER
   DECLARE ThisStreet  : STRING
   DECLARE ThisTown    : STRING
ENDTYPE
```

A variable of this new type is declared as follows:

```
DECLARE HomeAddress : ThisAddress
```

(i) Write the statement that assigns the house number 34 to `HomeAddress`.

.....[1]

(ii) The type definition for `ThisAddress` is to be changed.

Rewrite one line from the definition for each of the following changes.

House numbers are in the range from 1 to 10.

`DECLARE` .....

The possible towns are limited to: Brightown, Arunde and Shoram.

`DECLARE` .....[2]

(b) Temperature data from a number of weather stations are to be processed by a program.

The following data are to be stored:

- weather station ID (a unique four-letter code)
- latitude (to 2 decimal places)
- average temperature (to the nearest whole number) for each year from 2001 to 2015 inclusive

A programmer designs a composite data type `WeatherStation`. A variable of this type can be used to store all the data for one particular station.

(i) Write the definition for the user-defined data type `WeatherStation`.

.....

.....

.....

.....

.....

.....[5]

(ii) The programmer decides to store all the data in a file. The number of weather stations could grow to reach 20000, but not all stations will be present at first.

The programmer decides on random organisation for the file.

Describe **three** steps which show how a new weather station record is added to the file.

1 .....

.....

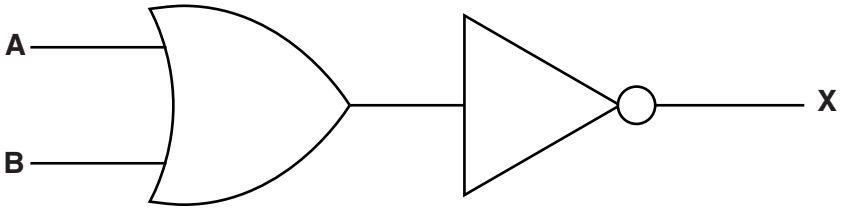
2 .....

.....

3 .....

.....[3]

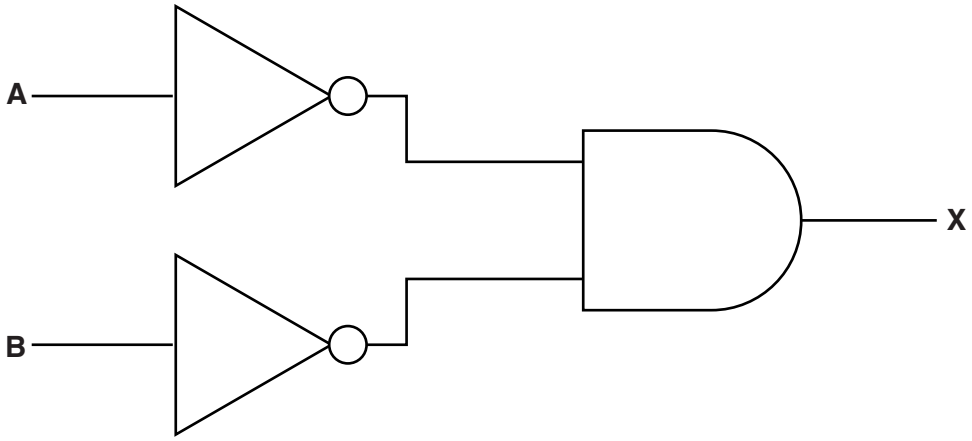
5 (a) (i) Complete the truth table for this logic circuit:



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]

(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:

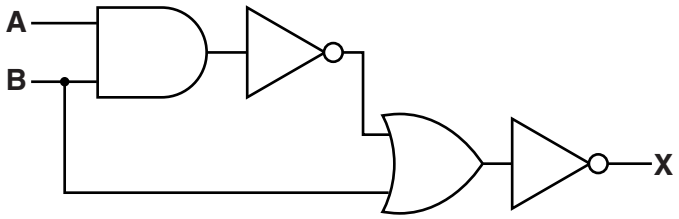
Circuit 1: **X** = ...

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]

6 A company grows vegetables in a number of large greenhouses. For the vegetables to grow well, the temperature, light level and soil moisture need to always be within certain ranges.

The company installs a computerised system to keep these three growing conditions within the best ranges. Sensors are used for collecting data about the temperature, light level, and moisture content of the soil.

(a) Name the type of system described.

.....[1]

(b) Give **three** items of hardware that would be needed for this system. Justify your choice. Do not include sensors in your answer.

Item 1 .....

Justification .....

.....

Item 2 .....

Justification .....

.....

Item 3 .....

Justification .....

.....[6]

(c) **(i)** Describe what is meant by feedback in the above system.

.....

.....

.....

.....

.....

.....[3]

(ii) When the system was designed, various parameters for temperature were set.

Name **one** of these parameters.

.....

.....[1]

(iii) Explain how this parameter value is used by the feedback system.

.....

.....

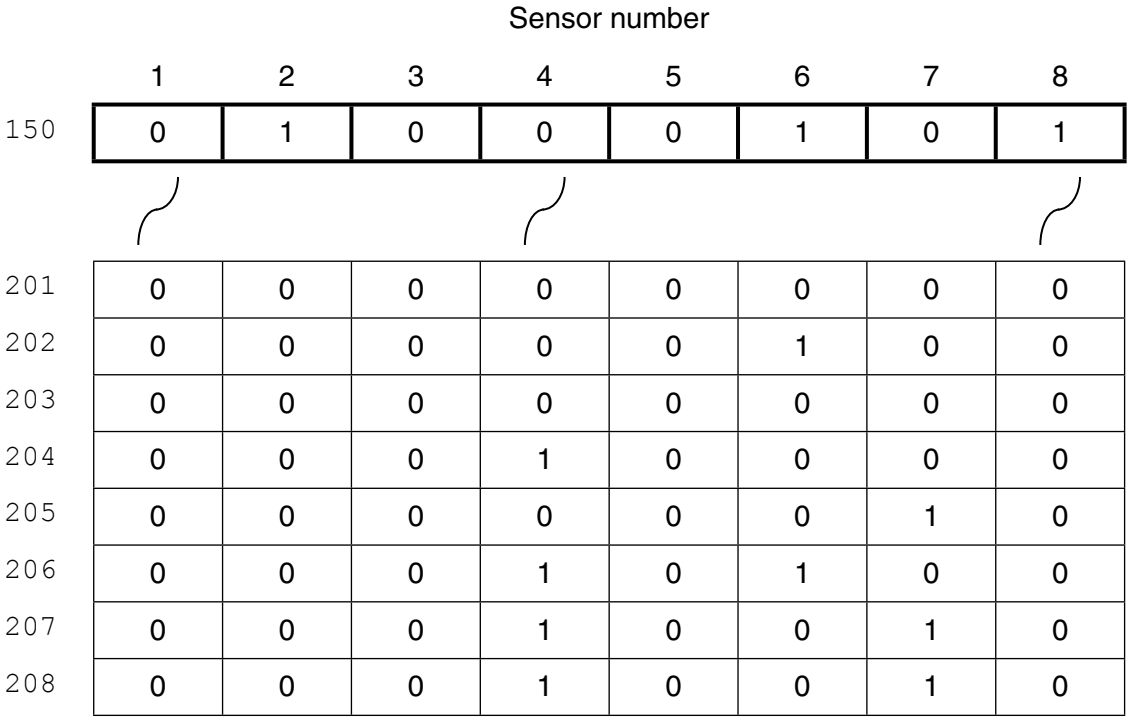
.....

.....[2]

Question 6 continues on page 14.

Each greenhouse has eight sensors (numbered 1–8).

- The byte at address 150 is used to store eight 1-bit flags.
- A flag is set to indicate whether its associated sensor reading is waiting to be processed.
- More than one sensor reading may be waiting to be processed at any particular moment.
- Data received from the sensors is stored in a block of eight consecutive bytes (addresses 201–208).
- The data from sensor 1 is at address 201, the data from sensor 2 is at address 202, and so on.



	Sensor number							
	1	2	3	4	5	6	7	8
150	0	1	0	0	0	1	0	1
201	0	0	0	0	0	0	0	0
202	0	0	0	0	0	1	0	0
203	0	0	0	0	0	0	0	0
204	0	0	0	1	0	0	0	0
205	0	0	0	0	0	0	1	0
206	0	0	0	1	0	1	0	0
207	0	0	0	1	0	0	1	0
208	0	0	0	1	0	0	1	0

(d) (i) Interpret the current reading for sensor 2.

.....

.....[2]

(ii) The accumulator is loaded with the data from location 150.

Write the assembly language instruction to check whether there is a value waiting to be processed for sensor 6.

```
LDD 150                 // data loaded from address 150
```

.....[3]

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Cambridge International **A Level**

Cambridge International Examinations
Cambridge International Advanced Level

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COMPUTER SCIENCE **9608/31**

Paper 3 Advanced Theory **October/November 2015**

1 hour 30 minutes

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[Turn over

1 In a particular computer system, real numbers are stored using floating-point representation with:

- 8 bits for the mantissa, followed by
- 8 bits for the exponent

Two's complement form is used for both mantissa and exponent.

(a) (i) A real number is stored as the following two bytes:

Mantissa

0	0	1	0	1	0	0	0

Exponent

0	0	0	0	0	0	1	1

Calculate the denary value of this number. Show your working.

.....

.....

.....

.....

.....

.....[3]

(ii) Explain why the floating-point number in **part (a)(i)** is not normalised.

.....

.....[2]

(iii) Normalise the floating-point number in **part (a)(i)**.

Mantissa

Exponent

[2]

(b) (i) Write the largest positive number that can be written as a normalised floating-point number in this format.

Mantissa

Exponent

[2]

(ii) Write the smallest positive number that can be written as a normalised floating-point number in this format.

Mantissa

Exponent

[2]

(iii) If a positive number is added to the number in **part (b)(i)** explain what will happen.

.....

.....

.....

.....[2]

(c) A student writes a program to output numbers using the following code:

```
X ← 0.0
FOR i ← 0 TO 1000
   X ← X + 0.1
   OUTPUT X
ENDFOR
```

The student is surprised to see that the program outputs the following sequence:

0.0 0.1 0.2 0.2999999 0.3999999 ……

Explain why this output has occurred.

.....

.....

.....

.....

.....

.....[3]

2 A compiler uses a keyword table and a symbol table. Part of the keyword table is shown below.

- Tokens for keywords are shown in hexadecimal.
- All the keyword tokens are in the range 00 – 5F.

Keyword	Token
←	01
+	02
=	03
IF	4A
THEN	4B
ENDIF	4C
ELSE	4D
FOR	4E
STEP	4F
TO	50
INPUT	51
OUTPUT	52
ENDFOR	53

Entries in the symbol table are allocated tokens. These values start from 60 (hexadecimal).

Study the following piece of code:

```
Counter ← 1.5
INPUT Num1
  // Check values
IF Counter = Num1
   THEN
      Num1 ← Num1 + 5.0
ENDIF
```

(a) Complete the symbol table below to show its contents after the lexical analysis stage.

Symbol	Token	
	Value	Type
Counter	60	Variable
1.5	61	Constant

[3]

(b) Each cell below represents one byte of the output from the lexical analysis stage.

Using the keyword table and your answer to **part (a)** complete the output from the lexical analysis.

60	01														

[2]

(c) This line of code is to be compiled:

```
A ← B + C + D
```

After the syntax analysis stage, the compiler generates object code. The equivalent code, in assembly language, is shown below:

```
LDD 234     //loads value B
ADD 235     //adds value C
STO 567     //stores result in temporary location
LDD 567     //loads value from temporary location
ADD 236     //adds value D
STO 233     //stores result in A
```

(i) Name the final stage in the compilation process that follows this code generation stage.

.....[1]

(ii) Rewrite the equivalent code given above to show the effect of it being processed through this final stage.

.....

.....

.....

.....

.....

.....[2]

(iii) State **two** benefits of the compilation process performing this final stage.

Benefit 1 .....

.....

Benefit 2 .....

.....[2]

3 An email is sent from one email server to another using packet switching.

(a) State **two items** that are contained in an email packet apart from the data.

1 .....

2 .....[2]

(b) Explain the role of routers in sending an email from one email server to another.

.....

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.....[3]

(c) Sending an email message is an appropriate use of packet switching.

Explain why this is the case.

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.....[2]

(d) Packet switching is not always an appropriate solution.

Name an alternative communication method of transferring data in a digital network.

.....[1]

(e) Name an application for which the method identified in **part (d)** is an appropriate solution. Justify your choice.

Application .....

Justification .....

.....

.....

.....

.....[3]

4 **(a)** Three descriptions and two types of processor are shown below.

Draw a line to connect each description to the appropriate type of processor.

Description	Type of processor
Makes extensive use of general purpose registers	RISC
Many addressing modes are available	CISC
Has a simplified set of instructions	

[3]

(b) In a RISC processor three instructions (A followed by B, followed by C) are processed using pipelining.

The following table shows the five stages that occur when instructions are fetched and executed.

(i) The 'A' in the table indicates that instruction A has been fetched in time interval 1.

Complete the table to show the time interval in which each stage of each instruction (A, B, C) is carried out.

Stage	Time interval								
	1	2	3	4	5	6	7	8	9
Fetch instruction	A								
Decode instruction									
Execute instruction									
Access operand in memory									
Write result to register									

[3]

(ii) The completed table shows how pipelining allows instructions to be carried out more rapidly. Each time interval represents one clock cycle.

Calculate how many clock cycles are saved by the use of pipelining in the above example.

Show your working.

.....

.....

.....

.....

.....

.....[3]

5 (a) (i) Complete the Boolean function that corresponds to the following truth table.

INPUT			OUTPUT
A	**B**	**C**	**X**
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

X = $\overline{A}$. B . C + ...[3]

The part to the right of the equals sign is known as the sum-of-products.

(ii) For the truth table above complete the Karnaugh Map (K-map).

		AB			
		00	**01**	**11**	**10**
C	**0**				
	1				

[1]

The K-map can be used to simplify the function in **part(a)(i)**.

(iii) Draw loop(s) around appropriate groups of 1's to produce an optimal sum-of-products. [2]

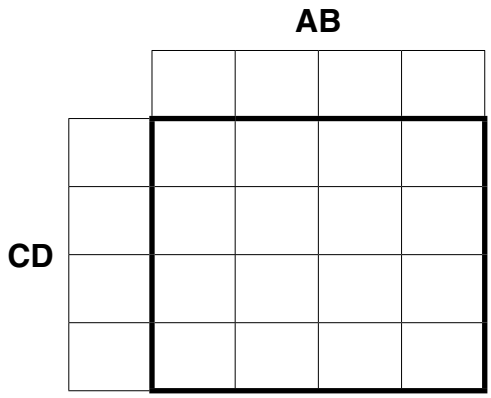
(iv) Using your answer to **part (a)(iii)**, write the simplified sum-of-products Boolean function.

X = ...[2]

(b) The truth table for a logic circuit with four inputs is given below:

INPUT				OUTPUT
A	**B**	**C**	**D**	**X**
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	1
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	0
1	1	1	0	1
1	1	1	1	1

(i) Complete the K-map corresponding to the truth table above.



[4]

(ii) Draw loop(s) around appropriate groups of 1's to produce an optimal sum-of-products. [2]

(iii) Using your answer to **part (b)(ii)**, write the simplified sum-of-products Boolean function.

X = ...[2]

6 A number of processes are being executed in a computer.

(a) Explain the difference between a program and a process.

.....

.....

.....

.....[2]

A process can be in one of three states: running, ready or blocked.

(b) For each of the following, the process is moved from the first state to the second state. Describe the conditions that cause each of the following changes of the state of a process:

From running to ready .....

.....

.....

.....

From ready to running .....

.....

.....

.....

From running to blocked .....

.....

.....

.....[6]

(c) Explain why a process cannot be moved from the blocked state to the running state.

.....

.....

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.....

.....[3]

(d) Explain the role of the high-level scheduler in a multiprogramming operating system.

.....

.....

.....

.....[2]

Cambridge International A Level

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6550085963

COMPUTER SCIENCE **9608/32**

Paper 3 Advanced Theory **October/November 2015**

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

This document consists of **11** printed pages and **1** blank page.

CAMBRIDGE International Examinations

[Turn over

1 In a particular computer system, real numbers are stored using floating-point representation with:

- 8 bits for the mantissa, followed by
- 4 bits for the exponent

Two's complement form is used for both mantissa and exponent.

(a) (i) A real number is stored as the following 12-bit binary pattern:

0	1	1	0	1	0	0	0	0	0	1	1

Calculate the denary value of this number. Show your working.

.....

.....

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.....

.....

.....[3]

(ii) Give the normalised binary pattern for +3.5. Show your working.

.....

.....

.....

.....

.....

.....[3]

(iii) Give the normalised binary pattern for –3.5. Show your working.

.....

.....

.....

.....

.....

.....[3]

The number of bits available to represent a real number is increased to 16.

(b) (i) If the system were to use the extra 4 bits for the mantissa, state what the effect would be on the numbers that can be represented.

.....

.....[1]

(ii) If the system were to use the extra 4 bits for the exponent instead, state what the effect would be on the numbers that can be represented.

.....

.....[1]

(c) A student enters the following expression into an interpreter:

```
OUTPUT (0.1 + 0.2)
```

The student is surprised to see the following output:

0.3000000000000001

Explain why this output has occurred.

.....

.....

.....

.....

.....

.....[3]

2 In this question, you are shown pseudocode in place of a real high-level language. A compiler uses a keyword table and a symbol table. Part of the keyword table is shown below.

- Tokens for keywords are shown in hexadecimal.
- All the keyword tokens are in the range 00 to 5F.

Keyword	Token
←	01
+	02
=	03
IF	4A
THEN	4B
ENDIF	4C
ELSE	4D
FOR	4E
STEP	4F
TO	50
INPUT	51
OUTPUT	52
ENDFOR	53

Entries in the symbol table are allocated tokens. These values start from 60 (hexadecimal).

Study the following piece of code:

```
Start ← 0.1
// Output values in loop
FOR Counter ← Start TO 10
    OUTPUT Counter + Start
ENDFOR
```

(a) Complete the symbol table below to show its contents after the lexical analysis stage.

Symbol	Token	
	Value	Type
Start	60	Variable
0.1	61	Constant

[3]

(b) Each cell below represents one byte of the output from the lexical analysis stage.

Using the keyword table and your answer to **part (a)** complete the output from the lexical analysis.

60	01												

[2]

(c) The compilation process has a number of stages. The output of the lexical analysis stage forms the input to the next stage.

(i) Name this stage.

.....[1]

(ii) State **two** tasks that occur at this stage.

.....

.....

.....

.....[2]

(d) The final stage of compilation is optimisation. There are a number of reasons for performing optimisation. One reason is to produce code that minimises the amount of memory used.

(i) State another reason for the optimisation of code.

.....[1]

(ii) What could a compiler do to optimise the following expression?

```
A ← B + 2 * 6
```

.....

.....

.....[1]

(iii) These lines of code are to be compiled:

```
X ← A + B
Y ← A + B + C
```

Following the syntax analysis stage, object code is generated. The equivalent code, in assembly language, is shown below:

```
LDD 436     //loads value A
ADD 437     //adds value B
STO 612     //stores result in X
LDD 436     //loads value A
ADD 437     //adds value B
ADD 438     //adds value C
STO 613     //stores result in Y
```

(iv) Rewrite the equivalent code, given above, following optimisation.

.....

.....

.....

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.....[3]

3 **(a)** Explain what is meant by circuit switching.

.....

.....

.....

.....[2]

(b) There are many applications in which digital data are transferred across a network. Video conferencing is one of these.

For this application, circuit switching is preferable to the use of packet switching.

Explain why this is so.

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.....[6]

(c) A web page is transferred from a web server to a home computer using the Internet.

Explain how the web page is transferred using packet switching.

.....

.....

.....

.....

.....

.....[3]

4 **(a)** Four descriptions and four types of computer architecture are shown below.

Draw a line to connect each description to the appropriate type of computer architecture.

Description	Computer architecture
A computer that does not have the ability for parallel processing.	SIMD
The processor has several ALUs. Each ALU executes the same instruction but on different data.	MISD
There are several processors. Each processor executes different instructions drawn from a common pool. Each processor operates on different data drawn from a common pool.	SISD
There is only one processor executing one set of instructions on a single set of data.	MIMD

[4]

(b) In a massively parallel computer explain what is meant by:

(i) Massive .....

.....

.....[1]

(ii) Parallel .....

.....

.....[1]

(c) There are both hardware and software issues that have to be considered for parallel processing to succeed.

Describe **one** hardware and **one** software issue.

Hardware .....

.....

.....

.....

Software .....

.....

.....

.....[4]

5 (a) (i) Complete the Boolean function that corresponds to the following truth table.

INPUT			OUTPUT
P	**Q**	**R**	**Z**
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

$Z = P \cdot \overline{Q} \cdot \overline{R} +$ .....[3]

The part to the right of the equals sign is known as the sum-of-products.

(ii) For the truth table above complete the Karnaugh Map (K-map).

		PQ			
		00	**01**	**11**	**10**
R	**0**				
	1				

[1]

The K-map can be used to simplify the function in **part(a)(i)**.

(iii) Draw loop(s) around appropriate groups of 1's to produce an optimal sum-of-products. [2]

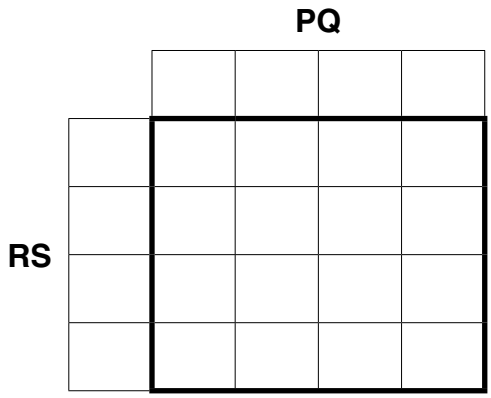
(iv) Using your answer to **part (a)(iii)**, write the simplified sum-of-products Boolean function.

Z = ...[1]

(b) The truth table for a logic circuit with four inputs is given below:

INPUT				OUTPUT
P	**Q**	**R**	**S**	**Z**
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1

(i) Complete the K-map corresponding to the truth table above.



[4]

(ii) Draw loop(s) around appropriate groups of 1's to produce an optimal sum-of-products. [2]

(iii) Using your answer to **part (b)(ii)**, write the simplified sum-of-products Boolean function.

Z = ...[2]

6 A number of processes are being executed in a computer.

A process can be in one of three states: running, ready or blocked.

(a) For each of the following, the process is moved from the first state to the second state. Describe the conditions that cause each of the following changes of state of a process:

From blocked to ready .....

.....

.....

.....

From running to ready .....

.....

.....

.....[4]

(b) Explain why a process cannot move directly from the ready state to the blocked state.

.....

.....

.....

.....

.....

.....[3]

(c) A process in the running state can change its state to something which is neither the ready state nor the blocked state.

(i) Name this state.

.....[1]

(ii) Identify when a process would enter this state.

.....[1]

(d) Explain the role of the low-level scheduler in a multiprogramming operating system.

.....

.....

.....

.....[2]

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Cambridge International **A Level**

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8788782541

COMPUTER SCIENCE **9608/31**

Paper 3 Advanced Theory **May/June 2016**

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

READ THESE INSTRUCTIONS FIRST

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You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

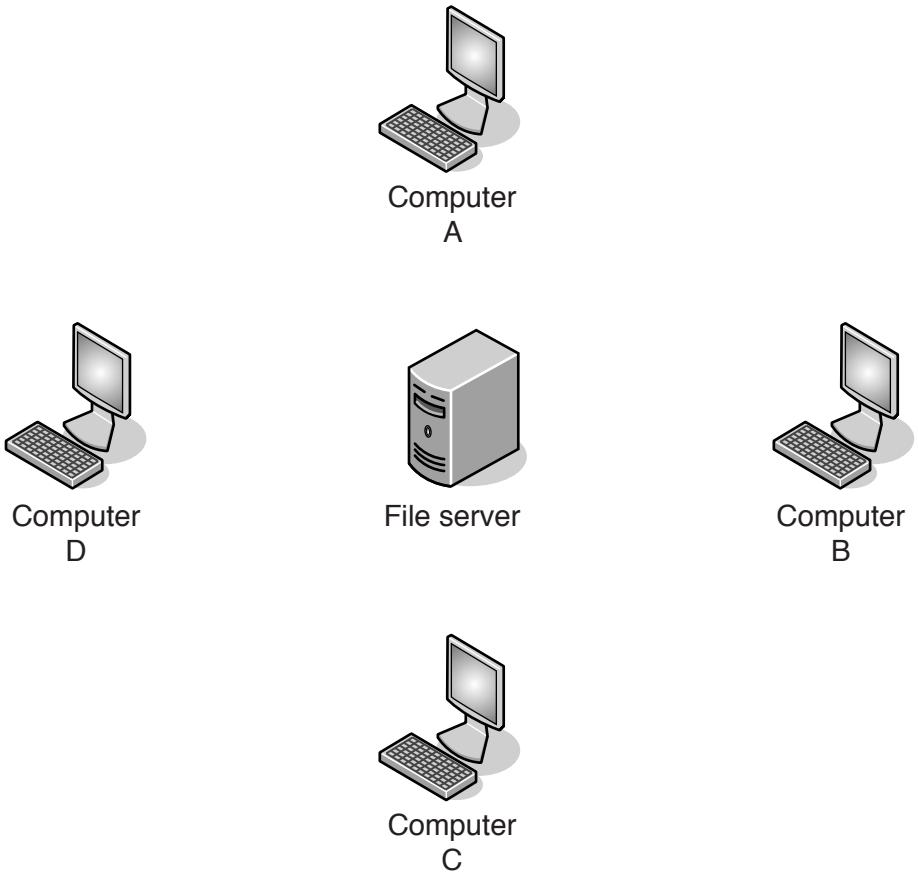
This document consists of **15** printed pages and **1** blank page.

CAMBRIDGE International Examinations

[Turn over

1 A Local Area Network (LAN) consists of four computers and one server. The LAN uses a bus topology.

(a) Complete the diagram below to show how the computers and the File server could be connected.



[2]

(b) Computer C sends a data packet to Computer A.

Three statements are given below.

Tick (✓) to show whether each statement is true or false.

Statement	True	False
Computer C uses the IP address of Computer A to indicate that the packet is for Computer A.		
Computer B can read the packet sent from Computer C to Computer A.		
The File server routes the packet to Computer A.		

[3]

(c) Computer A starts transmitting a packet to Computer C. At exactly the same time, the File server starts transmitting a packet to Computer D. This causes a problem.

(i) State the name given to this problem.

.....

.....[1]

(ii) Give **three** steps taken by both Computer A and the File server to allow them to transmit their packets successfully.

Step 1 .....

.....

Step 2 .....

.....

Step 3 .....

.....[3]

(d) Adding a switch to the LAN changes its topology. Explain how the use of a switch removes the problem identified in **part (c)(i)**.

.....

.....

.....

.....

.....

.....

.....

.....[4]

2 Digital certificates are used in Internet communications. A Certificate Authority (CA) is responsible for issuing digital certificates.

(a) Name **three** data items present in a digital certificate.

1 .....

2 .....

3 .....[3]

(b) The method of issuing a digital certificate is as follows:

1 A user starts an application for a digital certificate using their computer. On this computer a key pair is generated. This key pair consists of a public key and an associated private key.

2 The user submits the application to the CA. The generated ..... **(i)** ..... key and other application data are sent. The key and data are encrypted using the CA's ..... **(ii)** ..... key.

3 The CA creates a digital document containing all necessary data items and signs it using the CA's ..... **(iii)** ..... key.

4 The CA sends the digital certificate to the individual.

In the above method there are three missing words. Each missing word is either 'public' or 'private'.

State the correct word. Justify your choice.

(i) .....

Justification .....

.....[2]

(ii) .....

Justification .....

.....[2]

(iii) .....

Justification .....

.....[2]

(c) Alexa sends an email to Beena.

Alexa's email program:

- produces a message digest (hash)
- uses Alexa's private key to encrypt the message digest
- adds the encrypted message digest to the plain text of her message
- encrypts the whole message with Beena's public key
- sends the encrypted message with a copy of Alexa's digital certificate

Beena's email program decrypts the encrypted message using her private key.

(i) State the name given to the encrypted message digest.

.....[1]

(ii) Explain how Beena can be sure that she has received a message that is authentic (not corrupted or tampered with) and that it came from Alexa.

.....

.....

.....

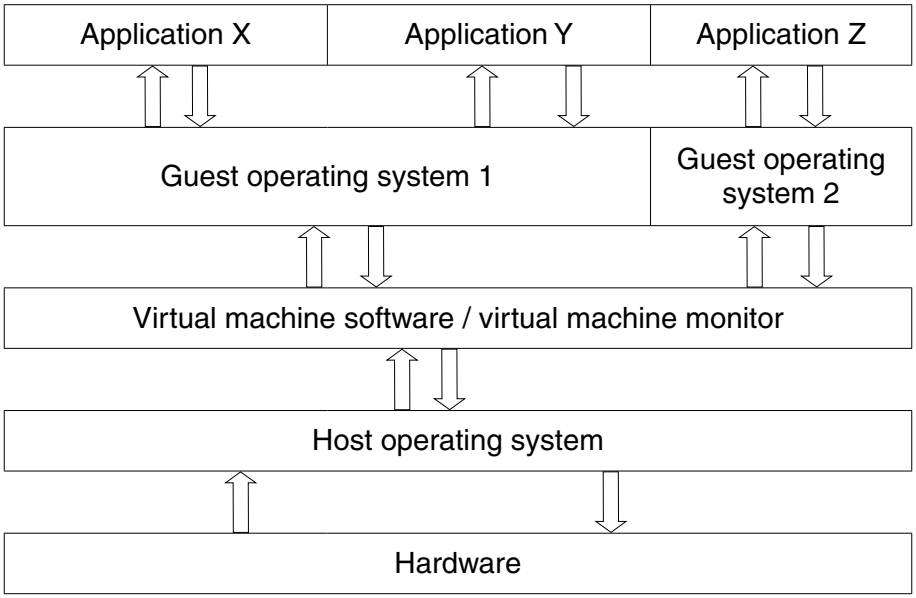
.....[2]

(iii) Name **two** uses where encrypted message digests are advisable.

1 .....

2 .....[2]

3 **(a)** The following diagram shows how applications X, Y and Z can run on a virtual machine system.



(i) The virtual machine software undertakes many tasks.

Describe **two** of these tasks.

Task 1 .....

.....

Task 2 .....

.....[2]

(ii) Explain the difference between a **guest operating system** and a **host operating system**.

.....

.....

.....

.....[2]

(b) A company uses a computer as a web server. The manufacturer will no longer support the computer's operating system (OS) in six months' time. The company will then need to decide on a replacement OS.

The company is also considering changing the web server software when the OS is changed.

Whenever any changes are made, it is important that the web server service is not disrupted.

In developing these changes, the company could use virtual machines.

(i) Describe **two** possible uses of virtual machines by the company.

Use 1 .....

.....

.....

.....

Use 2 .....

.....

.....

.....[4]

The web server often has to handle many simultaneous requests.

(ii) The company uses a virtual machine to test possible solutions to the changes that they will need to make.

Explain **one** limitation of this approach.

.....

.....

.....

.....[2]

4 **(a)** Three file organisation methods and two file access methods are shown below.

Draw lines to link each file organisation method to its appropriate file access method or methods.

File organisation method	File access method
serial	direct
sequential	sequential
random	

[4]

(b) A bank has a very large number of customers. The bank stores data for each customer. This includes:

- unique customer number
- personal data (name, address, telephone number)
- transactions

The bank computer system makes use of three files:

- A – a file that stores customer personal data. This file is used at the end of each month for the production of the monthly statement.
- B – a file that stores encrypted personal identification numbers (PINs) for customer bank cards. This file is accessed when the customer attempts to withdraw cash at a cash machine (ATM).
- C – a file that stores all customer transaction records for the current month. Every time the customer makes a transaction, a new record is created.

For each of the files A, B and C, state an appropriate method of organisation. Justify your choice.

(i) File A organisation .....

Justification .....

.....

.....

.....[3]

(ii) File B organisation .....

Justification .....

.....

.....

.....[3]

(iii) File C organisation .....

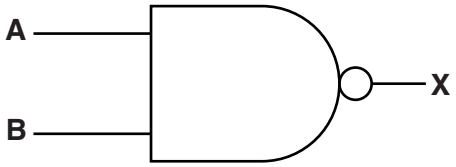
Justification .....

.....

.....

.....[3]

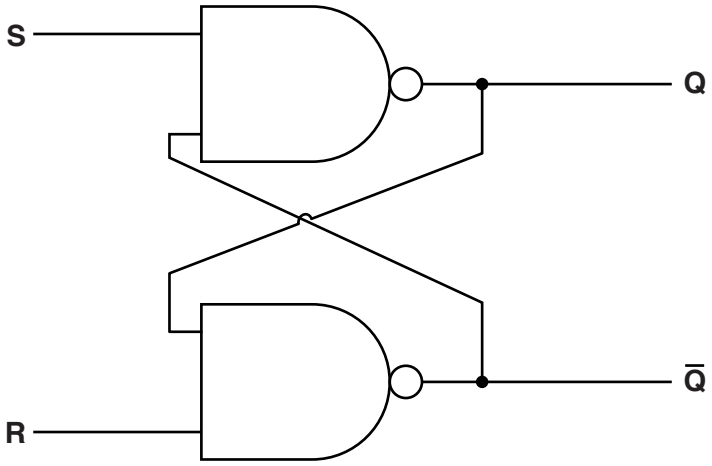
5 **(a)** Complete the truth table for this NAND gate:



A	B	X
0	0	
0	1	
1	0	
1	1	

[1]

A SR flip-flop is constructed using two NAND gates.



(b) **(i)** Complete the truth table for the SR flip-flop.

	S	R	Q	$\overline{Q}$
Initially	1	0	0	1
R changed to 1	1	1		
S changed to 0	0	1		
S changed to 1	1	1		
S and R changed to 0	0	0		

[4]

(ii) One of the combinations in the truth table should not be allowed to occur.

State the values of S and R that should not be allowed. Justify your choice.

S = ... R = ...

.....

.....

.....

.....[3]

Another type of flip-flop is the JK flip-flop.

(c) (i) Give one extra input present in the JK flip-flop.

.....

.....[1]

(ii) Give **one** advantage of the JK flip-flop.

.....

.....[1]

(d) Describe the role of flip-flops in a computer.

.....

.....

.....

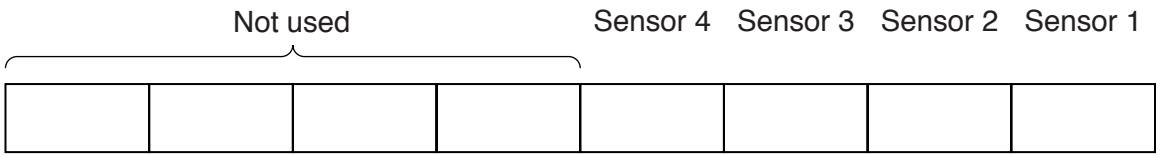
.....[2]

6 An intruder detection system for a large house has four sensors. An 8-bit memory location stores the output from each sensor in its own bit position.

The bit value for each sensor shows:

- 1 – the sensor has been triggered
- 0 – the sensor has not been triggered

The bit positions are used as follows:



The output from the intruder detection system is a loud alarm.

(a) (i) State the name of the type of system to which intruder detection systems belong.

.....[1]

(ii) Justify your answer to **part (i)**.

.....

.....[1]

(b) Name **two** sensors that could be used in this intruder detection system. Give a reason for your choice.

Sensor 1 .....

Reason .....

.....

Sensor 2 .....

Reason .....

.....[4]

The intruder system is set up so that the alarm will only sound if two or more sensors have been triggered.
An assembly language program has been written to process the contents of the memory location.

The table shows part of the instruction set for the processor used.

Instruction		Explanation
Op code	Operand	
LDD	<address>	Direct addressing. Load the contents of the given address to ACC
STO	<address>	Store the contents of ACC at the given address
INC	<register>	Add 1 to the contents of the register (ACC or IX)
ADD	<address>	Add the contents of the given address to the contents of ACC
AND	<address>	Bitwise AND operation of the contents of ACC with the contents of <address>
CMP	#n	Compare the contents of ACC with the number n
JMP	<address>	Jump to the given address
JPE	<address>	Following a compare instruction, jump to <address> if the compare was True
JGT	<address>	Following a compare instruction, jump to <address> if the content of ACC is greater than the number used in the compare instruction
END		End the program and return to the operating system

(c) Part of the assembly code is:

	Op code	Operand
SENSORS:		B00001010
COUNT:		0
VALUE:		1
LOOP:	LDD	SENSORS
	AND	VALUE
	CMP	#0
	JPE	ZERO
	LDD	COUNT
	INC	ACC
	STO	COUNT
ZERO:	LDD	VALUE
	CMP	#8
	JPE	EXIT
	ADD	VALUE
	STO	VALUE
	JMP	LOOP
EXIT:	LDD	COUNT
TEST:	CMP	…
	JGT	ALARM

(i) Dry run the assembly language code. Start at `LOOP` and finish when `EXIT` is reached.

BITREG	COUNT	VALUE	ACC
B00001010	0	1	

[4]

(ii) The operand for the instruction labelled `TEST` is missing.

State the missing operand.

.....[1]

(iii) The intruder detection system is improved and now has eight sensors.

One instruction in the assembly language code will need to be amended.

Identify this instruction .....

Write the amended instruction .....[2]

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Cambridge International **A Level**

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2155366653

COMPUTER SCIENCE **9608/31**

Paper 3 Advanced Theory **October/November 2016**

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

This document consists of **11** printed pages and **1** blank page.

DC (NF/AR) 116626/4

CAMBRIDGE International Examinations

[Turn over

1 In a particular computer system, real numbers are stored using floating-point representation with:

- 12 bits for the mantissa
- 4 bits for the exponent
- two's complement form for both mantissa and exponent

(a) Calculate the floating-point representation of +2.5 in this system. Show your working.

Mantissa **Exponent**

.....

.....

.....

.....

.....

..... [3]

(b) Calculate the floating-point representation of −2.5 in this system. Show your working.

Mantissa **Exponent**

.....

.....

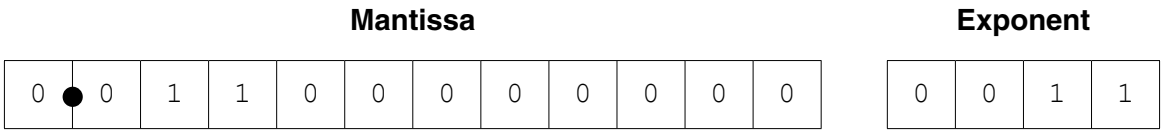
.....

.....

.....

..... [3]

(c) Find the denary value for the following binary floating-point number. Show your working.



.....

.....

.....

.....

.....

..... [3]

(d) (i) State whether the floating-point number given in **part (c)** is normalised or not normalised.

..... [1]

(ii) Justify your answer given in **part (d)(i)**.

.....

..... [1]

(e) The system changes so that it now allocates 8 bits to both the mantissa and the exponent.

State **two** effects this has on the numbers that can be represented.

1 .....

.....

2 .....

..... [2]

2 There are four stages in the compilation of a program written in a high-level language.

(a) Four statements and four compilation stages are shown below.

Draw a line to link each statement to the correct compilation stage.

Statement	Compilation stage
This stage removes any comments in the program source code.	Lexical analysis
This stage could be ignored.	Syntax analysis
This stage checks the grammar of the program source code.	Code generation
This stage produces a tokenised version of the program source code.	Optimisation

[4]

(b) Write the Reverse Polish Notation (RPN) for the following expressions.

(i) `(A + B) * (C – D)`

..... [2]

(ii) `–A / B * 4 / (C – D)`

..... [3]

(c) An interpreter is executing a program. The program uses the variables `w`, `x`, `y` and `z`.

The program contains an expression written in infix form. The interpreter converts the infix expression to RPN. The RPN expression is:

```
x w z + y - *
```

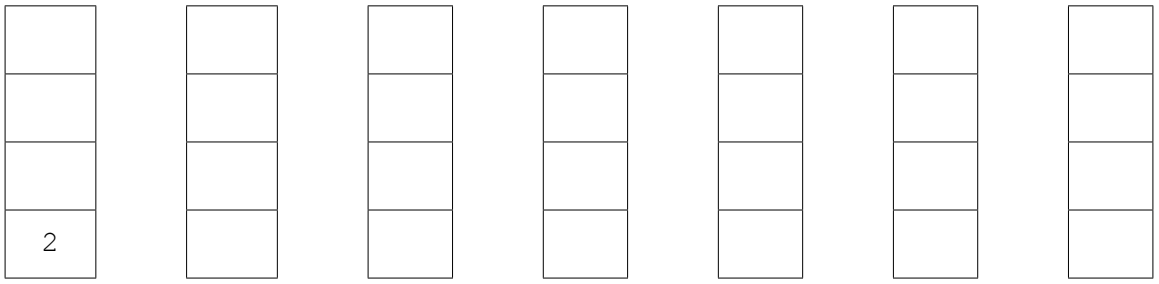
The interpreter evaluates this RPN expression using a stack.

The current values of the variables are:

```
w = 1   x = 2   y = 3   z = 4
```

(i) Show the changing contents of the stack as the interpreter evaluates the expression.

The first entry on the stack has been done for you.



[4]

(ii) Convert back to its original infix form, the RPN expression:

```
x w z + y - *
```

.....

..... [2]

(iii) Explain **one** advantage of using RPN for the evaluation of an expression.

.....

.....

.....

..... [2]

3 A computer operating system (OS) uses paging for memory management.

In paging:

- main memory is divided into equal-size blocks, called page frames
- each process that is executed is divided into blocks of the same size, called pages
- each process has a page table that is used to manage the pages of this process

The following table is the incomplete page table for a process X.

Page	Presence flag	Page frame address	Additional data
1	1	132	
2	1	245	
3	1	232	
4	0	0	
5	1	542	
6	0	0	
⌒	⌒	⌒	⌒
135	0	0	

When a particular page of the process is currently in main memory, the Presence flag entry in the page table is set to 1.

If the page is not currently present in memory, the Presence flag is set to 0.

(a) The page frame address entry for Page 2 is 245.

State what the value 245 could represent.

..... [1]

(b) Process X executes until the next instruction is the first instruction in Page 4. Page 4 is not currently in main memory.

State a hardware device that could be storing this page.

..... [1]

(c) When an instruction to be accessed is not present in main memory, its page must be loaded into a page frame. If all page frames are currently in use, the contents of a page frame will be overwritten with this new page.

The page that is to be replaced is determined by a page replacement algorithm.

One possible algorithm is to replace the page that has been resident in main memory for the longest time.

(i) Give the additional data that would need to be stored in the page table.

.....

..... [1]

(ii) Complete the table entries below to show what happens when Page 4 is swapped into main memory. Assume that Page 5 is the one to be replaced.

In the final column, give an example of the data you have identified in **part (c)(i)**.

Page	Presence flag	Page frame address	Additional data
4	.....	.....	.....

[3]

An alternative algorithm is to replace the page that has been used least.

(iii) Give the different additional data that the page table would now need to store.

.....

..... [1]

(iv) In the following table, complete the missing data to show what happens when Page 3 is swapped into main memory. Assume that Page 1 is the one to be replaced.

In the final column, give an example of the data you have identified in **part (c)(iii)**.

Page	Presence flag	Page frame address	Additional data
3	.....	.....	.....

[3]

(d) Explain why the algorithms given in **part (c)** may not be the best choice for efficient memory management.

Longest resident .....

.....

.....

.....

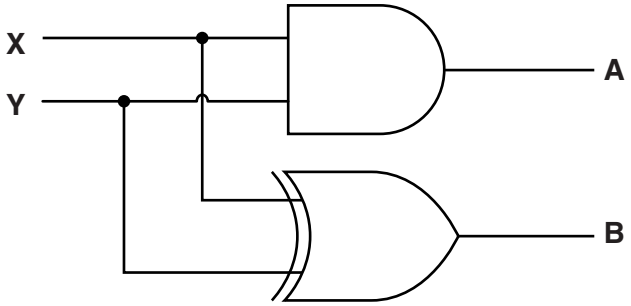
Least used .....

.....

.....

..... [4]

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



Input		Output	
X	**Y**	**A**	**B**
0	0		
0	1		
1	0		
1	1		

[2]

(ii) State the name given to this logic circuit.

..... [1]

(iii) Name the labels usually given to **A** and **B**.

Label **A** .....

Label **B** .....

Explain why your answers are more appropriate for the **A** and **B** labels.

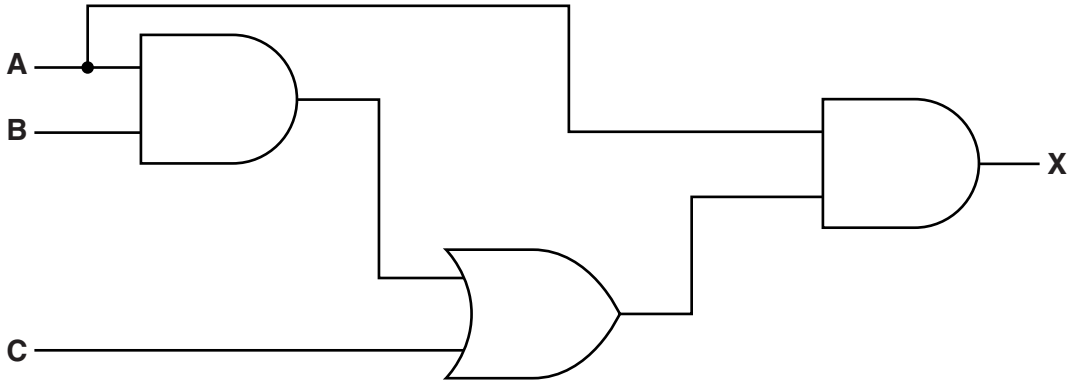
.....

.....

.....

..... [4]

(b) (i) Write the Boolean expression corresponding to the following logic circuit:



..... [2]

(ii) Use Boolean algebra to simplify the expression that you gave in **part (b)(i)**.

Show your working.

.....

.....

.....

.....

.....

..... [3]

5 The TCP/IP protocol suite can be viewed as a stack with four layers.

(a) (i) Complete the stack by inserting the names of the three missing layers.

[3]

(ii) State how each layer of the stack is implemented.

..... [1]

(b) A computer is currently running two processes:

- Process 1 is downloading a web page.
- Process 2 is downloading an email.

(i) Describe **two** tasks that the Transport layer performs to ensure that the incoming data is downloaded correctly.

1 .....

.....

.....

.....

2 .....

.....

.....

..... [4]

(ii) Name a protocol that will be used by Process 1.

..... [1]

(iii) Name a protocol that will be used by Process 2.

..... [1]

6 **(a)** The table below gives descriptions of three types of malware.

Description	Term
Malware that attaches itself to another program.	
Malware that redirects the web browser to a fake website.	
Email that encourages the receiver to access a website and give their banking details.	

Complete the table by adding the correct terms. [3]

(b) Ben wants to send a highly confidential email to Mariah so that only she can read it. Plain text and cipher text will be used in this communication.

(i) Explain the terms plain text and cipher text.

Plain text .....

.....

Cipher text .....

..... [2]

(ii) Explain how the use of asymmetric key cryptography ensures that only Mariah can read the email.

.....

.....

.....

.....

.....

.....

.....

..... [4]

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Cambridge International A Level

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

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COMPUTER SCIENCE **9608/32**

Paper 3 Advanced Theory **October/November 2016**

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

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At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

This document consists of **12** printed pages.

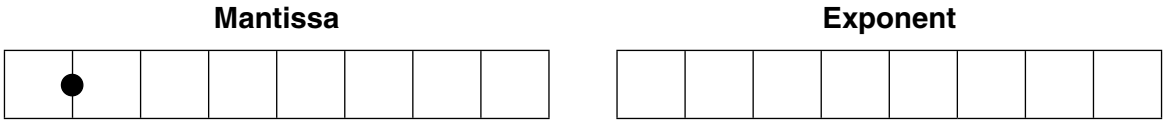
CAMBRIDGE International Examinations

[Turn over

1 In a particular computer system, real numbers are stored using floating-point representation with:

- 8 bits for the mantissa
- 8 bits for the exponent
- two's complement form for both mantissa and exponent

(a) Calculate the floating point representation of +3.5 in this system. Show your working.



.....

.....

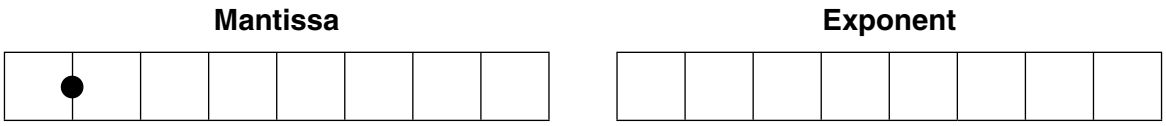
.....

.....

.....

..... [3]

(b) Calculate the floating-point representation of –3.5 in this system. Show your working.



.....

.....

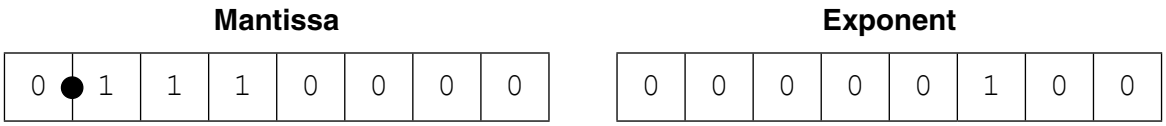
.....

.....

.....

..... [3]

(c) Find the denary value for the following binary floating-point number. Show your working.



.....

.....

.....

.....

.....

..... [3]

(d) (i) State whether the floating-point number given in **part (c)** is normalised or not normalised.

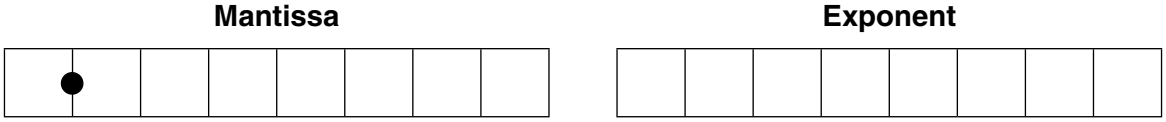
..... [1]

(ii) Justify your answer given in **part (d)(i)**.

.....

..... [1]

(e) Give the binary two's complement pattern for the negative number with the largest magnitude.



[2]

2 There are four stages in the compilation of a program written in a high-level language.

(a) Four statements and four compilation stages are shown below.

Draw a line to link each statement to the correct compilation stage.

Statement	Compilation stage
This stage can improve the time taken to execute the statement: `x = y + 0`	Lexical analysis
This stage produces object code.	Syntax analysis
This stage makes use of tree data structures.	Code generation
This stage enters symbols in the symbol table.	Optimisation

[4]

(b) Write the Reverse Polish Notation (RPN) for the following expression.

```
P + Q - R / S
```

..... [2]

(c) An interpreter is executing a program. The program uses the variables `a`, `b`, `c` and `d`.

The program contains an expression written in infix form. The interpreter converts the infix expression to RPN. The RPN expression is:

```
b a * c d a + + -
```

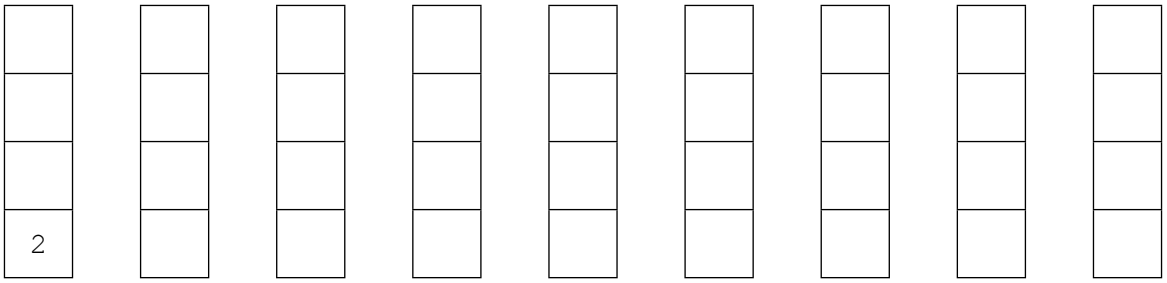
The interpreter evaluates this RPN expression using a stack.

The current values of the variables are:

```
a = 2   b = 2   c = 1   d = 3
```

(i) Show the changing contents of the stack as the interpreter evaluates the expression.

The first entry on the stack has been done for you.



[4]

(ii) Convert back to its original infix form, the RPN expression:

```
b a * c d a + + -
```

.....

..... [2]

(iii) One advantage of using RPN is that the evaluation of an expression does not require rules of precedence.

Explain this statement.

.....

.....

.....

..... [2]

3 A computer operating system (OS) uses paging for memory management.

In paging:

- main memory is divided into equal-size blocks, called page frames
- each process that is executed is divided into blocks of the same size, called pages
- each process has a page table that is used to manage the pages of this process

The following table is the incomplete page table for a process, Y.

Page	Presence flag	Page frame address	Additional data
1	1	221	
2	1	222	
3	0	0	
4	0	0	
5	1	542	
6	0	0	
⌒	⌒	⌒	⌒
249	0	0	

(a) State **two** facts about Page 5.

1 .....

.....

2 .....

..... [2]

(b) Process Y executes the last instruction in Page 5. This instruction is not a branch instruction.

(i) Explain the problem that now arises in the continued execution of process Y.

.....

.....

.....

.....

.....

..... [2]

(ii) Explain how interrupts help to solve the problem that you explained in **part (b)(i)**.

.....

.....

.....

.....

.....

..... [3]

(c) When the next instruction is not present in main memory, the OS must load its page into a page frame. If all page frames are currently in use, the OS overwrites the contents of a page frame with the required page.

The page that is to be replaced is determined by a page replacement algorithm.

One possible algorithm is to replace the page which has been in memory the shortest amount of time.

(i) Give the additional data that would need to be stored in the page table.

.....

..... [1]

(ii) Complete the table entry below to show what happens when Page 6 is swapped into main memory. Include the data you have identified in **part (c)(i)** in the final column. Assume that Page 1 is the one to be replaced.

In the final column, give an example of the data you have identified in **part (c)(i)**.

Page	Presence flag	Page frame address	Additional data
6	……	……..……	……

[3]

Process Y contains instructions that result in the execution of a loop, a very large number of times. All instructions within the loop are in Page 1.

The loop contains a call to a procedure whose instructions are all in Page 3.

All page frames are currently in use. Page 1 is the page that has been in memory for the shortest time.

(iii) Explain what happens to Page 1 and Page 3, each time the loop is executed.

.....

.....

.....

.....

.....

..... [3]

(iv) Name the condition described in **part (c)(iii)**.

..... [1]

4 Both clients and servers use the Secure Socket Layer (SSL) protocol and its successor, the Transport Layer Security (TLS) protocol.

(a) (i) What is a protocol?

.....

.....

.....

..... [2]

(ii) Name the client application used in this context.

..... [1]

(iii) Name the server used in this context.

..... [1]

(iv) Identify **two** problems that the SSL and TLS protocols can help to overcome.

1 .....

2 ..... [2]

(b) Before any application data is transferred between the client and the server, a handshake process takes place. Part of this process is to agree the security parameters to be used.

Describe **two** of these security parameters.

1 .....

.....

.....

.....

2 .....

.....

.....

..... [4]

(c) Name **two** applications of computer systems where it would be appropriate to use the SSL or TLS protocol. These applications should be different from the ones you named in **part (a)(ii)** and **part (a)(iii)**.

1 .....

.....

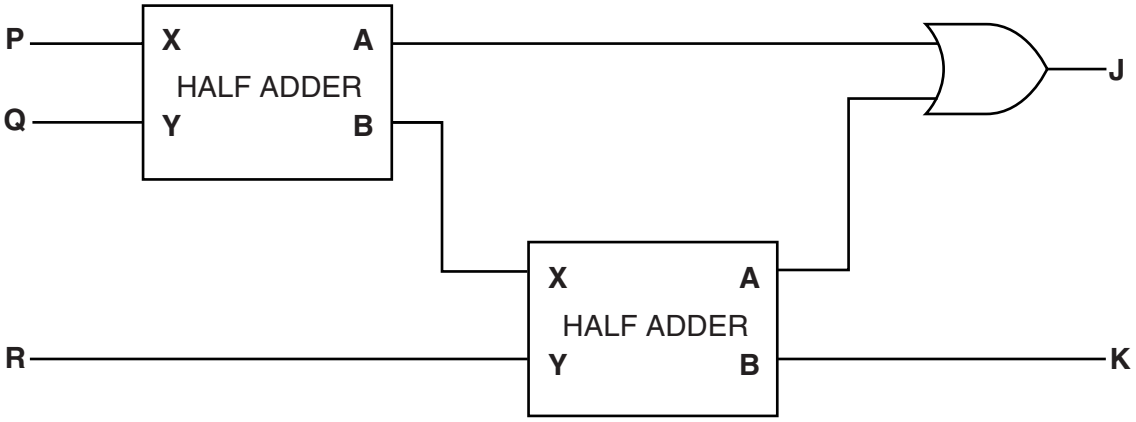
2 .....

..... [2]

5 (a) (i) A half adder is a logic circuit with the following truth table.

Input		Output	
X	**Y**	**A**	**B**
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

The following logic circuit is constructed.



Complete the following truth table for this logic circuit.

Input			Working space	Output	
P	**Q**	**R**		**J**	**K**
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

[2]

(ii) State the name given to this logic circuit.

..... [1]

(iii) Name the labels usually given to **J** and **K**.

Label **J** .....

Label **K** .....

Explain why your answers are appropriate labels for these outputs.

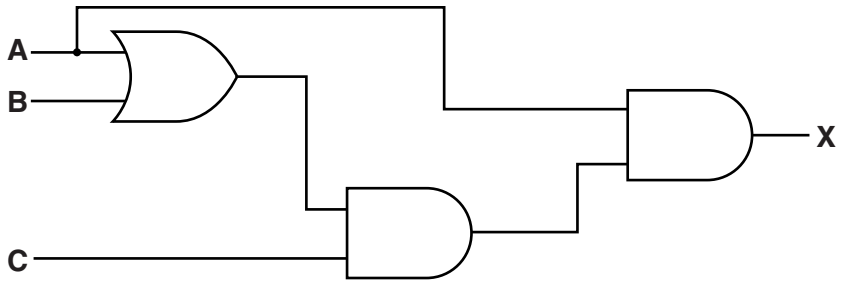
.....

.....

.....

..... [4]

(b) (i) Write down the Boolean expression corresponding to the following logic circuit:



..... [2]

(ii) Use Boolean algebra to simplify the expression given in **part (b)(i)**.

Show your working.

.....

.....

.....

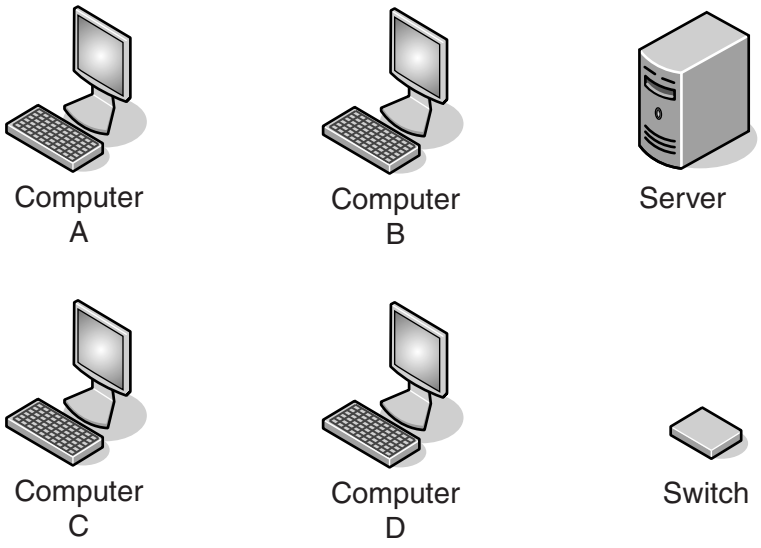
.....

.....

..... [4]

6 A Local Area Network (LAN) consists of four computers, one server and a switch. The LAN uses a star topology.

(a) Complete the diagram below to show how to connect the devices.



[2]

(b) The LAN uses packets to transfer data between devices.

Three statements are given below.

Tick (✓) to show whether each statement is true or false.

Statement	True	False
All packets must be routed via the server.		
Computer B can read a copy of the packet sent from the Server to Computer A.		
No collisions are possible.		

[3]

(c) In the same building as this star network, there is another star network.

(i) Name the device needed to connect the two networks together.

..... [1]

(ii) Explain how the device in **part (c)(i)** decides whether to transfer a packet from one network to the other.

.....

.....

.....

..... [2]

Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

5224848084

COMPUTER SCIENCE **9608/31**

Paper 3 Advanced Theory **May/June 2017**

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

READ THESE INSTRUCTIONS FIRST

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Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

This document consists of **16** printed pages.

CAMBRIDGE International Examinations

1 **(a)** Consider the following user-defined data type:

```
TYPE LibraryBookRecord
   DECLARE ISBN      : INTEGER
   DECLARE Title     : STRING
ENDTYPE
```

(i) Write a pseudocode statement to declare a variable, `Book`, of type `LibraryBookRecord`.

.....[1]

(ii) Write a pseudocode statement that assigns 'Dune' to the `Title` of `Book`.

.....[1]

(b) The user-defined data type `LibraryBookRecord` needs to be modified by adding the following fields:

- a field called `Genre` which can take two values, fiction or non-fiction
- a field called `NumberOfLoans` which can be an integer value in the range 1 to 99

Write the updated version of `LibraryBookRecord`.

.....

.....

.....

.....

.....

.....

.....[3]

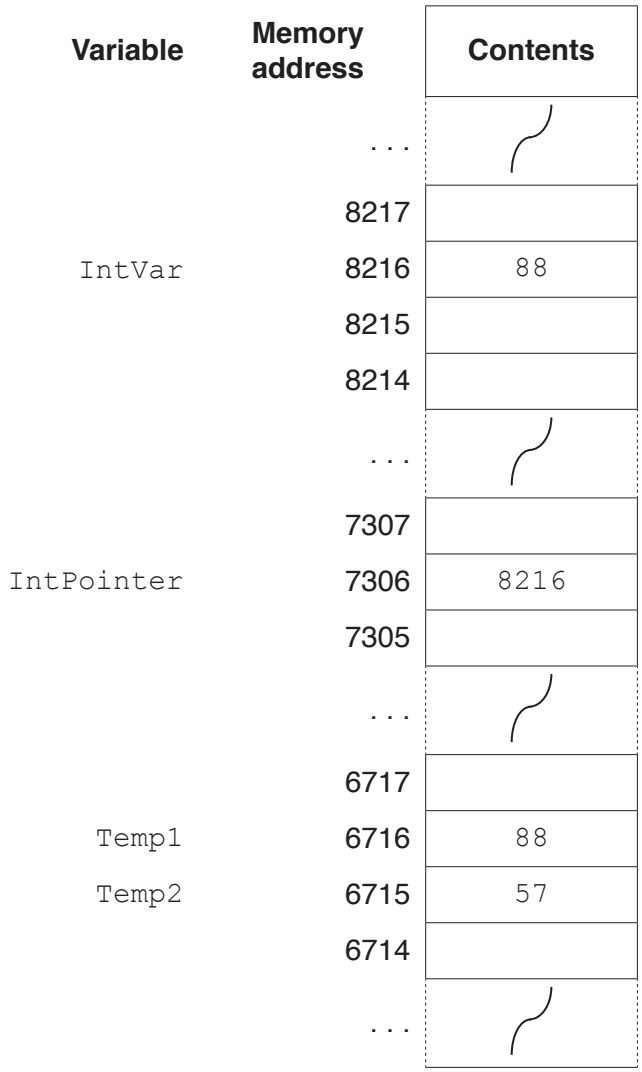
(c) A pointer is a variable that stores the address of a variable of a particular type.

Consider the code on page 3, which uses the following identifiers:

Identifier	Data type	Description
`IntPointer`	`^INTEGER`	pointer to an integer
`IntVar`	`INTEGER`	an integer variable
`Temp1`	`INTEGER`	an integer variable
`Temp2`	`INTEGER`	an integer variable

```
IntVar ← 57            // assigns the value 57 to the integer
                       // variable IntVar
IntPointer ← @IntVar   // assigns to IntPointer the address of the
                       // integer variable IntVar
Temp2 ← IntPointer^    // assigns to variable Temp2 the value at an
                       // address pointed at by IntPointer
IntPointer^ ← Temp1    // assigns the value in the variable Temp1 to
                       // the memory location pointed at by IntPointer
```

The four assignment statements are executed. The diagram shows the memory contents after execution.



Use the diagram to state the current values of the following expressions:

(i) `@Temp2` .....[1]

(ii) `IntPointer` .....[1]

(iii) `IntPointer^` .....[1]

(iv) `IntPointer^ = Temp2 + 6` .....[1]

(d) Write pseudocode statements that will achieve the following:

(i) Assign the value `22` to the variable `Temp2`.

.....[1]

(ii) Place the address of `Temp1` in `IntPointer`.

.....[1]

(iii) Copy the value in `Temp2` into the memory location currently pointed at by `IntPointer`.

.....[1]

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

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

	Description	Term	
(i)	A standalone piece of malicious software that can replicate itself using a network.	.....	[1]
(ii)	Use email to attempt to obtain an individual's confidential data.	.....	[1]
(iii)	....	Virus	[2]

(b) State **two** vulnerabilities that the malware in **part (a)(i)** or **part (a)(iii)** can exploit.

Vulnerability 1 .....

.....

Vulnerability 2 .....

.....

[2]

Question 2 continues on the next page.

(c) Anna has to send an email to Bob containing confidential information. Bob and Anna have never sent emails to each other before.

Bob and Anna both have public and private keys.

The first step is for Anna to request that Bob sends her one of his keys.

(i) State the key that Bob sends. .....[1]

(ii) Explain how Anna can be sure that it is Bob who has sent the key.

.....

.....

.....

.....[2]

(iii) Anna has received the key from Bob.

The following incomplete table shows the sequence of actions between Anna and Bob to communicate the confidential information.

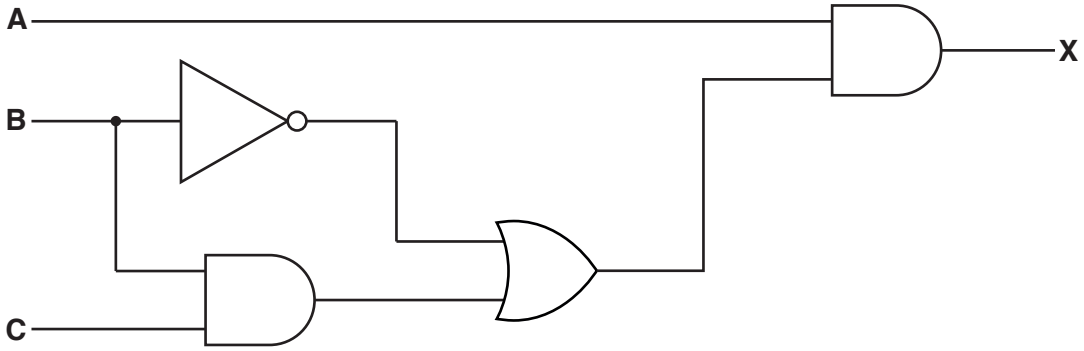
Complete the table.

The person performing the action	What that person does
Anna	Requests Bob's <answer to **part (c)(i)**> key.
Bob	.....
Anna	.....
Anna	Sends the email to Bob.
Bob	....

[4]

Question 3 begins on page 8.

3 Consider the following logic circuit, which contains a redundant logic gate.



(a) Write the Boolean algebraic expression corresponding to this logic circuit.

X = ...[3]

(b) Complete the truth table for this logic circuit.

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

[2]

(c) **(i)** Complete the Karnaugh Map (K-map) for the truth table in **part (b)**.

		AB			
		00	**01**	**11**	**10**
C	**0**				
	1				

[1]

The K-map can be used to simplify the expression in **part (a)**.

(ii) Draw loop(s) around appropriate groups to produce an optimal sum-of-products. [2]

(iii) Write a simplified sum-of-products expression, using your answer to **part (ii)**.

X = ...[2]

(d) One Boolean identity is:

$$A + \overline{A}.B = A + B$$

Simplify the expression for X in **part (a)** to the expression for X in **part (c)(iii)**. You should use the given identity.

.....

.....

.....

.....[2]

4 A bank has 95 000 customers. Each customer has a unique ID.

When a customer uses an Automated Teller Machine (ATM) to obtain cash, their current balance is checked. The balance is stored in a file which has the following fields:

- the customer ID (6-digit number in the range 100000 to 999999)
- an encrypted PIN
- the current balance

The file can store a maximum of 100 000 records.

(a) Give a reason why a random organisation would be appropriate for this file.

.....

.....[1]

(b) An algorithm for inserting a new record in this file uses the following hash function:

```
RecordKey ← CustomerID MOD 100000
```

where `RecordKey` is the record position in the file.

(i) Complete the table to show the values generated by the hash function for the given customer IDs.

CustomerID	RecordKey
802139	2139
700004	
689998	
102139	

[1]

(ii) State the range of possible values for `RecordKey`.

Minimum value of `RecordKey`: .....

Maximum value of `RecordKey`: .....

[2]

(iii) A procedure is written to insert a new record into the file.

Complete the algorithm for this procedure.

```
PROCEDURE InsertRecord(CustomerID : INTEGER)
   RecordKey ← CustomerID MOD 100000
   Success ← FALSE
   // Find position for new record and insert it
   REPEAT
      IF record at position RecordKey is .....................
         THEN
            Insert new record at position RecordKey
            Success ← TRUE
         ELSE
            IF RecordKey = .....................
               THEN
                  RecordKey ← .....................
               ELSE
                  RecordKey ← ..................... + 1
            ENDIF
      ENDIF
   UNTIL Success = TRUE
ENDPROCEDURE
```

[4]

(c) (i) Explain why an encrypted version of the PIN is stored in the file.

.....

.....

.....

.....[2]

(ii) A customer attempts to withdraw cash from an ATM. An algorithm is used to check if the customer has entered the correct PIN.

Complete the algorithm.

```
1. Customer ID is read from card.

2. Customer enters PIN.

3. Customer PIN is .....

4. .....

5. Customer record is located in file.

6. .....

7. If match then transaction can proceed.
```

[3]

5 **(a)** A web browser is used to request and display a page stored on an internet web server.

Explain how each of the following items is used in this event.

(i) Packet: .....

.....

.....

.....[2]

(ii) Router: .....

.....

.....

.....[2]

(iii) TCP/IP: .....

.....

.....

.....[2]

(b) The Internet can be used for video conferencing. Data can be transmitted over the Internet using either packet switching or circuit switching.

(i) State **two** problems that could arise if video conferencing were to use packet switching.

Problem 1 .....

.....

Problem 2 .....

.....

[2]

(ii) Explain what is meant by **circuit switching**.

.....

.....

.....

.....[2]

(iii) Explain how the use of circuit switching overcomes the problems you have identified in **part (i)**.

.....

.....

.....

.....

.....

.....[3]

6 A computer system is used to manage some of the functions in a vehicle. The vehicle has a number of sensors and actuators. One sensor is used to monitor the moisture on the screen. If the moisture exceeds a pre-set value, the windscreen wiper motor turns on automatically.

The software used in the computer system is dedicated to the sensor management functions. When the system starts, the software runs some initial tasks. It then loops continuously until the system is switched off.

(a) (i) State the name given to the type of system described.

.....[1]

(ii) Explain your answer to **part (i)**.

.....

.....[1]

(b) Within the software loop, the value of each sensor is read in turn. The value read from the sensor is then processed.

State **two** drawbacks with this method of reading and processing sensor data.

Drawback 1 .....

.....

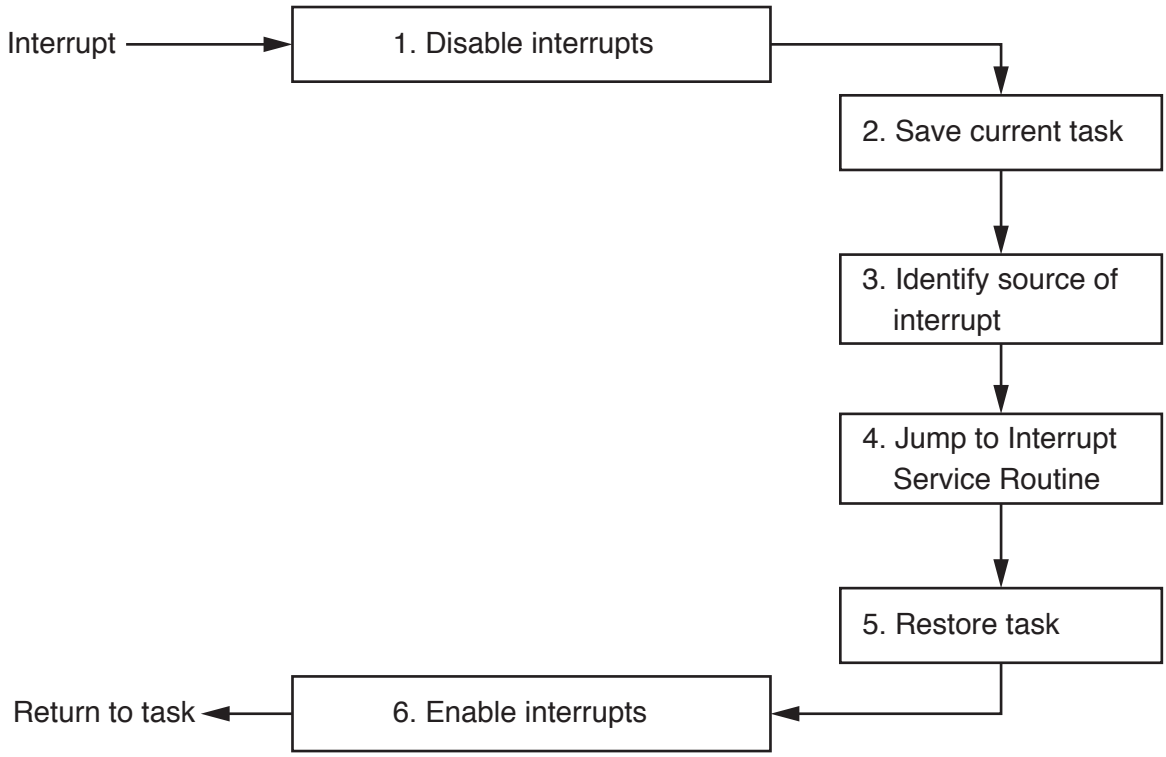
Drawback 2 .....

.....

[2]

(c) An alternative method of reading and processing sensor data is to use interrupts. Each sensor is connected so that it can send an interrupt signal to the processor if its value changes.

On receipt of an interrupt signal, the processor carries out a number of steps as shown in the following diagram.



(i) State the purpose of step 1.

.....

.....

.....[1]

(ii) State the purpose of step 6.

.....

.....

.....[1]

(iii) Explain how the current task is saved in step 2.

.....

.....

.....

.....[2]

(iv) State **two** benefits of using interrupts to read and process the sensor data.

Benefit 1 .....

.....

Benefit 2 .....

.....

[2]

(v) The interrupt handler in step 3 has to test each bit of a 16-bit register to discover the source of the interrupt.

The contents of the 16-bit register are loaded into the 16-bit accumulator:

Accumulator

Bit:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	0	0	0	0	1	0	1	0	1	0	1	0	0	0

An instruction is required to achieve the following:

- If bit 9 is zero, set the accumulator to zero.
- If bit 9 is one, set the accumulator to a non-zero value.

Write this instruction using an appropriate bitwise operation.

.....[2]

Cambridge International AS & A Level

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

COMPUTER SCIENCE **9608/32**

Paper 3 Advanced Theory **May/June 2017**

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

This document consists of **14** printed pages and **2** blank pages.

CAMBRIDGE International Examinations

[Turn over

1 **(a)** Consider the following pseudocode user-defined data type:

```
TYPE MyContactDetail
   DECLARE Name        : STRING
   DECLARE HouseNumber : INTEGER
ENDTYPE
```

(i) Write a pseudocode statement to declare a variable, `NewFriend`, of type `MyContactDetail`.

.....[1]

(ii) Write a pseudocode statement that assigns 129 to the `HouseNumber` of `NewFriend`.

.....[1]

(b) The user-defined data type `MyContactDetail` needs to be modified by:

- adding a field called `Area` which can take three values, uptown, downtown or midtown
- amending the field `HouseNumber` so that house numbers can only be in the range 1 to 499.

Write the updated version of `MyContactDetail`.

.....

.....

.....

.....

.....

.....

.....[3]

(c) A pointer is a variable that stores the address of a variable of a particular type.

Consider the pseudocode on page 3, which uses the following identifiers:

Identifier	Data type	Description
`IPointer`	`^INTEGER`	pointer to an integer
`Sum`	`INTEGER`	an integer variable
`MyInt1`	`INTEGER`	an integer variable
`MyInt2`	`INTEGER`	an integer variable

```
Sum ← 91              // assigns the value 91 to the integer variable Sum
IPointer ← @Sum       // assigns to IPointer the address of the
                      // integer variable Sum
MyInt1 ← IPointer^    // assigns to variable MyInt1 the value at an
                      // address pointed at by IPointer
IPointer^ ← MyInt2    // assigns the value in the variable MyInt2 to
                      // the memory location pointed at by IPointer
```

The four assignment statements are executed. The diagram shows the memory contents after execution.

Variable	Memory Address	Contents
	...	
	5848	
	5847	
IPointer	5846	4402
	5845	
	...	
	4403	
Sum	4402	33
	4401	
	...	
	3428	
MyInt1	3427	91
MyInt2	3426	33
	3425	
	...	

Use the diagram to state the current values of the following expressions:

(i) `IPointer` .....[1]

(ii) `IPointer^` .....[1]

(iii) `@MyInt1` .....[1]

(iv) `IPointer^ = MyInt2` .....[1]

(d) Write pseudocode statements that will achieve the following:

(i) Place the address of `MyInt2` in `IPointer`.

.....[1]

(ii) Assign the value `33` to the variable `MyInt1`.

.....[1]

(iii) Copy the value in `MyInt2` into the memory location currently pointed at by `IPointer`.

.....[1]

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

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

	Description	Term	
(i)	Malicious code is installed on a personal computer so that the user is misdirected to a fraudulent web site without their knowledge.	.....	[1]
(ii)	An attempt to acquire sensitive information, often for malicious reasons, by trying to deceive the user through the contents of an email.	.....	[1]
(iii)	....	Worm	[2]

(b) State **two** vulnerabilities that the malware in **part (a)(i)** or **part (a)(ii)** can exploit.

Vulnerability 1 .....

.....

Vulnerability 2 .....

.....

[2]

(c) Digital certificates are used in internet communications. A Certificate Authority (CA) is responsible for issuing a digital certificate.

The digital certificate contains a digital signature produced by the CA.

(i) Name **three** additional data items present in a digital certificate.

1 .....

2 .....

3 .....
[3]

(ii) Describe how the digital signature is produced by the CA.

.....

.....

.....

.....

.....

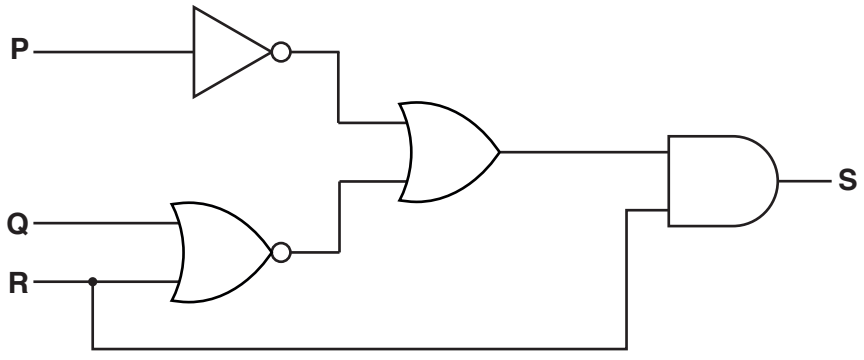
.....[3]

(iii) Give the reason for including a digital signature in the digital certificate.

.....

.....[1]

3 A logic circuit is shown:



(a) Write the Boolean algebraic expression corresponding to this logic circuit:

S = ...[4]

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

P	Q	R	Working space	S
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

[2]

(c) **(i)** Complete the Karnaugh Map (K-map) for the truth table in **part (b)**.

		PQ			
		00	**01**	**11**	**10**
R	**0**				
	1				

[1]

The K-map can be used to simplify the function in **part (a)**.

(ii) Draw loop(s) around appropriate groups to produce an optimal sum-of-products. [1]

(iii) Write a simplified sum-of-products expression, using your answer to **part (ii)**.

S = ...[1]

(d) One Boolean identity is:

$$(A + B) \,.\, C = A \,.\, C + B \,.\, C$$

Simplify the expression for S in **part (a)** to the expression for S in **part (c)(iii)**.

You should use the given identity and De Morgan's Laws.

.....

.....

.....

.....

.....

.....

.....

.....[3]

4 **(a)** Three file organisation methods and two file access methods are shown below.

Draw lines to link each file organisation method to its appropriate file access method(s).

File organisation method	File access method
random	sequential
serial	direct
sequential	

[4]

(b) An energy company supplies electricity to a large number of customers. Each customer has a meter that records the amount of electricity used. Customers submit meter readings using their online account.

The company's computer system stores data about its customers.

This data includes:

- account number
- personal data (name, address, telephone number)
- meter readings
- username and encrypted password.

The computer system uses three files:

File	Content	Use
A	Account number and meter readings for the current month.	Each time a customer submits their reading, a new record is added to the file.
B	Customer's personal data.	At the end of the month to create a statement that shows the electricity supplied and the total cost.
C	Usernames and encrypted passwords.	When customers log in to their accounts to submit meter readings.

For each of the files A, B and C, state an appropriate file organisation method for the use given in the table.

All three file organisation methods must be different.

Justify your choice.

(i) File A organisation .....

Justification .....

.....

.....

.....[3]

(ii) File B organisation .....

Justification .....

.....

.....

.....[3]

(iii) File C organisation .....

Justification .....

.....

.....

.....[3]

5 The TCP/IP protocol suite can be viewed as a stack with four layers.

(a) Complete the stack by inserting the names of the three missing layers.

Application layer

[3]

(b) BitTorrent is a protocol used at the Application layer for the exchange of data.

(i) State the network model used with this protocol.

.....[1]

(ii) State the use of BitTorrent.

.....[1]

(iii) Explain how the exchange of data is achieved using BitTorrent.

.....

.....

.....

.....

.....

.....

.....

.....[4]

(c) State **two** additional protocols that are also used at the Application layer for the exchange of data.

For each protocol, give an example of an appropriate exchange of data.

Protocol 1 .....

Example .....

.....

Protocol 2 .....

Example .....

.....

[4]

6 A large office building has many floors. On each floor there are security sensors and security cameras. There is the same number of sensors on each floor. The building has a single security room.

The images from the security cameras are output on monitors (one monitor for each floor) placed in the security room.

The data from the sensors are read and processed by a computer system. Sensor readings and warning messages can be displayed on the monitors.

(a) (i) State the name given to the type of system described.

.....[1]

(ii) Explain your answer to **part (i)**.

.....

.....[1]

(iii) State **two** sensors that could be used in this system.

Sensor 1 .....

Sensor 2 .....
[2]

(b) A software routine:

- checks the readings from the sensors
- outputs readings and warning messages to the monitors
- loops continuously.

The routine uses the following pseudocode variables:

Identifier	Data type	Description
`FloorCounter`	`INTEGER`	Loop counter for number of floors
`SensorCounter`	`INTEGER`	Loop counter for number of sensors
`NumberOfFloors`	`INTEGER`	Stores the number of floors
`NumberOfSensors`	`INTEGER`	Stores the number of sensors
`ForEver`	`BOOLEAN`	Stores value that ensures continuous loop

(i) Complete the following pseudocode algorithm for the routine.

```
01 ForEver ← .....
02 REPEAT
03   FOR FloorCounter ← 1 TO NumberOfFloors
04     FOR SensorCounter ← 1 TO .....
05       READ Sensor(SensorCounter)on Floor(FloorCounter)
06       IF Sensor value outside range
07          THEN
08             OUTPUT "Problem on Floor ", FloorCounter
09       ENDIF
10     ENDFOR
11   ENDFOR
12   //
13   // Delay loop
14   // Delay loop
15   //
16 UNTIL .....
```

[3]

(ii) A delay needs to be introduced before the loop is processed again.

Write a `FOR` loop, in pseudocode, to replace lines `13` and `14`.

.....

.....[1]

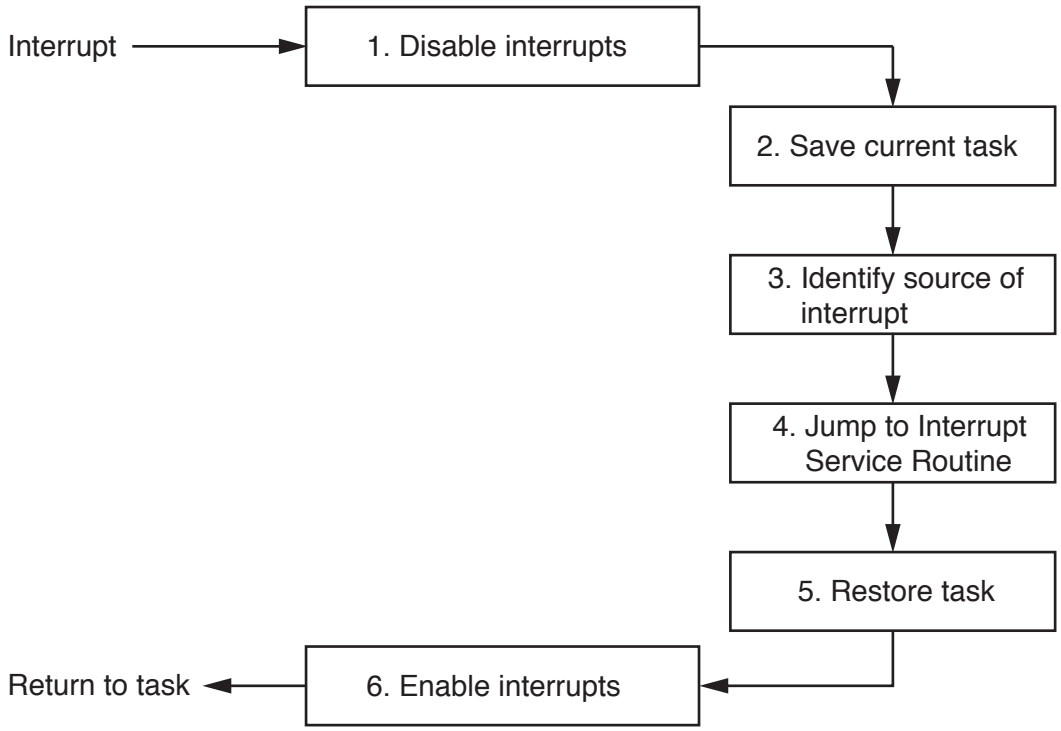
(iii) Give a reason for this delay in the system.

.....

.....[1]

(c) An alternative method of reading and processing sensor data is to use interrupts. Each sensor is connected so that it can send an interrupt signal to the processor if its value changes.

On receipt of an interrupt signal, the processor carries out a number of steps as shown in the following diagram.



(i) State the purpose of step 3.

.....

.....[1]

(ii) Explain what happens at step 4.

.....

.....

.....

.....[2]

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Cambridge International AS & A Level

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CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

COMPUTER SCIENCE **9608/31**

Paper 3 Advanced Theory **October/November 2017**

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

This document consists of **16** printed pages.

CAMBRIDGE International Examinations

[Turn over

1 A Local Area Network (LAN) consists of three computers, one server and a switch. The LAN uses a star topology.

(a) Complete the following diagram to show how the computers, the server and the switch could be connected.

[1]

(b) There are four statements in the following table. For each statement, place a tick (✓) in the appropriate column to indicate whether it is true or false.

Statement	True	False
The server can send packets to Computer B and Computer C at the same time.		
The network software on each computer needs to include collision detection and avoidance.		
Computer B can read a packet sent from the server to Computer C.		
Computer A can send a packet to Computer B and at the same time the server can be sending a packet to Computer C.		

[4]

(c) The LAN shown in **part (a)** will be connected to the Internet.

(i) A router will be attached to one of the devices on the LAN.

State the device used. Give a reason for your choice.

Device .....

Reason .....

.....

..... [2]

(ii) Explain why a router is required.

.....

.....

.....

..... [2]

(iii) After the router has been connected, Computer A sends several packets to an internet web server.

Explain how the packets are transmitted from the router to the web server.

.....

.....

.....

.....

.....

..... [3]

2 **(a)** The following diagram shows four descriptions and four types of computer architecture.

Draw lines to connect each description to the appropriate computer architecture.

Description	Computer architecture
Most parallel computer systems use this architecture.	SIMD
Widely used to process 3D graphics in video games.	MIMD
A microprocessor is used to control a washing machine.	MISD
There are a number of processing units. Each processing unit executes the same instruction but on different data.	SISD

[4]

(b) A computer has a single processor that contains four processing units.

Explain why this is **not** an example of a massively parallel computer.

.....

.....

.....

..... [2]

(c) An application has previously executed on a single computer. The application will be transferred onto a massively parallel computer.

The program code used in the application will need to be updated to ensure that the power of the massively parallel computer is fully used.

Explain what changes will be required to the program code.

.....

.....

.....

..... [2]

(d) Explain **one** of the hardware issues that will have to be overcome if a massively parallel computer is to function successfully.

.....

.....

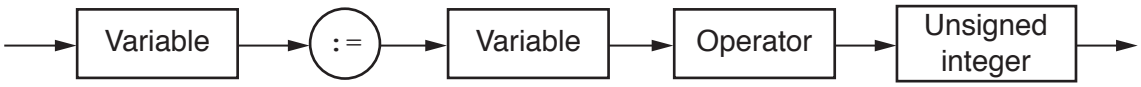
.....

..... [2]

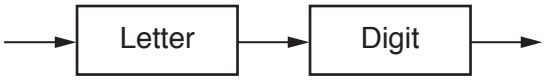
3 The following syntax diagrams for a particular programming language show the syntax of:

- an assignment statement
- a variable
- an unsigned integer
- a letter
- an operator
- a digit.

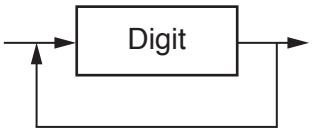
Assignment statement



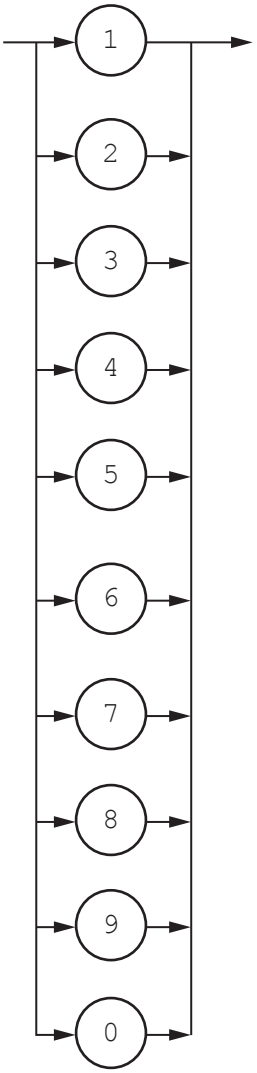
Variable



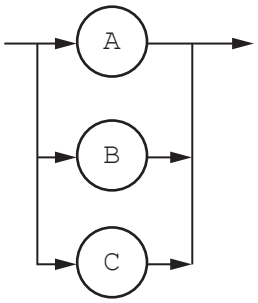
Unsigned integer



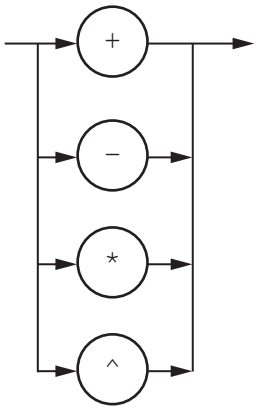
Digit



Letter



Operator



(a) The following assignment statements are invalid.

Give the reason in each case.

(i) `C2 = C3 + 123`

Reason: .....

..... [1]

(ii) `A3 := B1 - B2`

Reason: .....

..... [1]

(iii) `A32 := A2 * 7`

Reason: .....

..... [1]

(b) Complete the Backus-Naur Form (BNF) for the syntax diagrams shown.

`<digit>` has been done for you.

`<assignment_statement> ::=`

.....

`<variable> ::=`

.....

`<unsigned_integer> ::=`

.....

`<digit> ::= 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0`

`<letter> ::=`

.....

`<operator> ::=`

.....

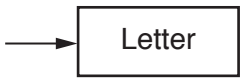
[6]

(c) The definition of <variable> is changed to allow:

- one or two letters and
- zero, one or two digits.

Draw an updated version of the syntax diagram for <variable>.

Variable



[2]

(d) The definition of <assignment_statement> is altered so that its syntax has <unsigned_integer> replaced by <real>.

A real is defined to be:

- at least one digit before a decimal point
- a decimal point
- at least one digit after a decimal point.

Give the BNF for the revised <assignment_statement> and <real>.

<assignment_statement> ::= .....

.....

<real> ::= .....

.....

[2]

4 The Secure Socket Layer (SSL) protocol and its successor, the Transport Layer Security (TLS) protocol, are used in Internet communications between clients and servers.

(a) (i) Define the term **protocol**.

.....

.....

.....

..... [2]

(ii) Explain the purpose of the TLS protocol.

.....

.....

.....

.....

.....

..... [3]

(b) A handshake process has to take place before any exchange of data using the TLS protocol. The handshake process establishes details about how the exchange of data will occur. Digital certificates and keys are used.

The handshake process starts with:

- the client sending some communication data to the server
- the client asking the server to identify itself
- the server sending its digital certificate including the public key.

Describe, in outline, the other steps in the handshake process.

.....

.....

.....

.....

.....

..... [3]

(c) Give **two** applications where it would be appropriate to use the TLS protocol.

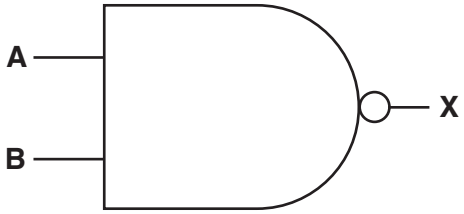
1 .....

.....

2 .....

.....
[2]

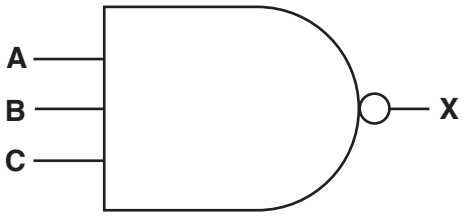
5 (a) (i) Complete the truth table for this 2-input NAND gate:



A	B	X
0	0	
0	1	
1	0	
1	1	

[1]

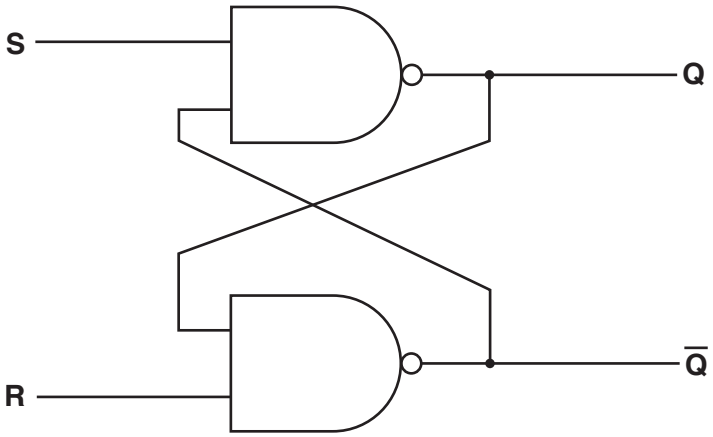
(ii) Complete the truth table for this 3-input NAND gate:



A	B	C	X
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

[1]

(b) A SR flip-flop is constructed using two NAND gates.



(i) Complete the truth table for the SR flip-flop:

	S	R	Q	$\overline{Q}$
Initially	1	0	0	1
R changed to 1	1	1		
S changed to 0	0	1		
S changed to 1	1	1		
S and R changed to 0	0	0	1	1

[3]

(ii) The final row in the table in **part b(i)** shows that the output for both **Q** and $\overline{\mathbf{Q}}$ is 1.

Explain why this is a problem.

.....

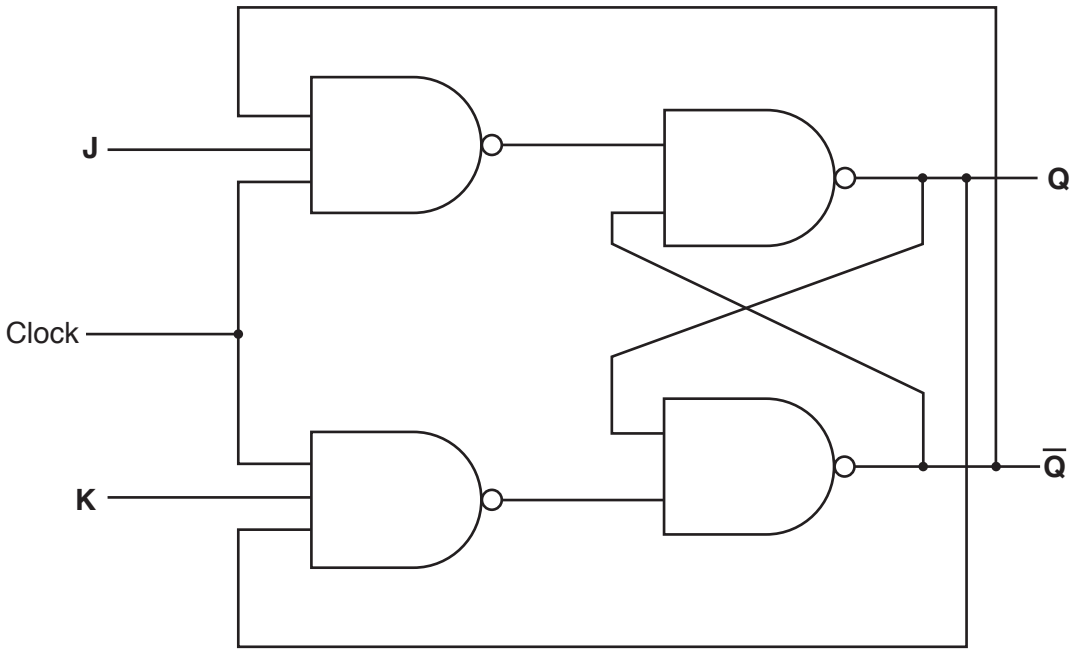
.....

.....

..... [2]

(c) Another type of flip-flop is the JK flip-flop.

A JK flip-flop is constructed as follows:



(i) Complete this truth table for the JK flip-flop.

J	K	Clock	Working space	Initial values		Final values	
				Q	$\overline{Q}$	Q	$\overline{Q}$
0	0	1		1	0	1	0
0	0	1		0	1	0	1
0	1	1		1	0	0	1
0	1	1		0	1	0	1
1	0	1		1	0		
1	0	1		0	1		
1	1	1		1	0		
1	1	1		0	1		

[4]

(ii) Explain why the JK flip-flop is an improvement on the SR flip-flop.

.....

.....

.....

..... [2]

(d) Explain the role of flip-flops in a computer.

.....

.....

.....

..... [2]

6 A large warehouse stores goods that must be kept above a temperature of 15 degrees Celsius. The warehouse has six temperature sensors which are each placed at a different location in the warehouse.

A computer system is programmed to turn on appropriate heaters when one of the sensors is below the minimum temperature.

(a) (i) State the name given to the type of system described.

..... [1]

(ii) Justify your answer to **part (i)**.

.....

..... [1]

(b) Sensors and heaters are two types of device used in this system.

State **two** other devices that are used. Justify your choice.

Device 1 .....

Justification .....

.....

Device 2 .....

Justification .....

.....

[4]

(c) The computer system stores the temperature readings for the six sensors in six 8-bit memory locations.

Six of the bits in an 8-bit register, `LOWREG`, are used to indicate whether a particular reading is below the minimum temperature. A value of `1` means the reading is below the minimum temperature.

For example:

This pattern of bits in `LOWREG` shows that sensor 5, sensor 4 and sensor 1 have readings below the minimum temperature.

		6	5	4	3	2	1
Not used	Not used	0	1	1	0	0	1

The following table shows part of the instruction set for a processor which has one general purpose register, the Accumulator (ACC), and an Index Register (IX).

Instruction		**Explanation**
Op code	**Operand**	
`LDD`	`<address>`	Direct addressing. Load the contents of the given address to ACC.
`LDR`	`#n`	Immediate addressing. Load the number n to IX.
`LDX`	`<address>`	Indexed addressing. Form the address from <address> + the contents of the index register. Copy the contents of this calculated address to ACC.
`STO`	`<address>`	Store the contents of ACC at the given address.
`INC`	`<register>`	Add 1 to the contents of the register (ACC or IX).
`ADD`	`<address>`	Add the contents of the given address to the ACC.
`OR`	`<address>`	Bitwise OR operation of the contents of ACC with the contents of address.
`CMP`	`#n`	Compare the contents of ACC with number n.
`CMP`	`<address>`	Compare the contents of ACC with the contents of <address>.
`JMP`	`<address>`	Jump to the given address.
`JPE`	`<address>`	Following a compare instruction, jump to <address> if the compare was True.
`JGE`	`<address>`	Following a compare instruction, jump to <address> if the content of ACC is greater than or equal to the number used in the compare instruction.

Question 6(c) continues on the next page.

14

Part of the assembly language code for updating `LOWREG` is:

Label	Op code	Operand
LOWTEMP:		15
LOWREG:		B00000000
COUNTER:		1
START:	LDR	#0
LOOP:	LDX	8000
	CMP	LOWTEMP
	JGE	TEMPOK
	LDD	LOWREG
	OR	COUNTER
	STO	LOWREG
TEMPOK:	LDD	COUNTER
Q1:	CMP	#32
	JPE	HEATON
	ADD	COUNTER
	STO	COUNTER
	INC	IX
	JMP	LOOP
HEATON:	LDD	LOWREG
		

(i) The code uses six memory locations to store the temperature readings. It stores readings for sensors 1 to 6 at addresses `8000` to `8005`.

At a particular time, the memory locations store the following data.

8000	8001	8002	8003	8004	8005
17	14	15	15	16	14

Dry run the assembly language code starting at `START` and finishing when the loop has been processed twice.

LOWTEMP	LOWREG	COUNTER	ACC	IX
15	B00000000	1		

[4]

(ii) Explain why the operand of the instruction labelled `Q1` has the value 32.

.....

.....

.....

..... [2]

(iii) The code beginning at the instruction labelled `HEATON` must make the system turn on the heaters in those areas that are below the minimum temperature.

Describe what this code will have to do.

.....

.....

.....

.....

.....

..... [3]

Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0586807379

COMPUTER SCIENCE **9608/32**

Paper 3 Advanced Theory **October/November 2017**

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

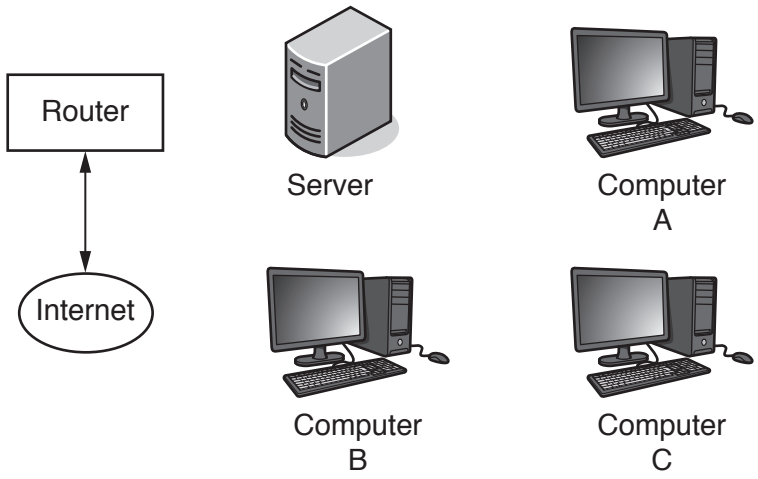
This document consists of **15** printed pages and **1** blank page.

CAMBRIDGE International Examinations

[Turn over

1 A Local Area Network (LAN) consists of three computers, one server and a router connected to the Internet. The LAN uses a bus topology.

(a) Complete the following diagram to show how the computers, the server and the router could be connected.



[2]

(b) There are four statements in the following table. For each statement, place a tick (✓) in the appropriate column to indicate whether it is true or false.

Statement	True	False
The server can send packets to Computer B and the router at the same time.		
Computer C uses the IP address of a web server to send a request for a web page on the web server.		
Computer B can read a packet sent from Computer A to Computer C.		
The server can read all incoming packets from the Internet.		

[4]

(c) The user on Computer A and the user on Computer B are both using the Internet at the same time. On a few occasions, Computer A and Computer B start transmitting packets to the router at exactly the same time. This causes a problem called a collision.

(i) Explain what is meant by a **collision** in this context.

.....

.....

.....

.....[2]

(ii) As a result of the collision, both Computer A and Computer B stop transmitting.

Computer A must carry out a number of steps to ensure the successful transmission of its packet.

Give **two** of the steps.

Step 1 .....

Step 2 .....
[2]

(d) The LAN topology is redesigned.

(i) Describe the changes that could be made to the LAN topology to overcome the problem identified in **part (c)**.

.....

.....

.....

.....[2]

(ii) Explain how the redesign has overcome the problem.

.....

.....

.....

.....[2]

2 **(a)** The following diagram shows four descriptions and two types of processor.

Draw lines to connect each description to the appropriate type of processor.

Description	Type of processor
It has a simplified set of instructions.	
Emphasis is on the hardware rather than the software.	CISC
It makes extensive use of general purpose registers.	RISC
Many instruction formats are available.	

[4]

(b) In a RISC processor, instructions are processed using pipelining.

(i) Explain what is meant by **pipelining**.

.....

.....

.....

.....[2]

(ii) The following table shows the five stages that occur when instructions are fetched and executed. The table also shows a number of time intervals.

Two instructions, D followed by E, are fetched and executed. The 'E' in the incomplete table shows that instruction E has been fetched in time interval 2.

Complete each row of the table.

	Time interval							
Stage	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Fetch instruction		E						
Read registers and decode instruction								
Execute instruction								
Access operand in memory								
Write result to register								

[3]

(c) The instruction set for a RISC processor that allows pipelining includes the following instruction.

Instruction		Explanation
Op code	**Operands**	
ADD	<dest>, <op1>, <op2>	Add the integers in registers op1 and op2. Place the result in register dest.

A program contains the following three instructions.

```
ADD r3, r2, r1

ADD r5, r4, r3

ADD r10, r9, r8
```

(i) Explain why pipelining fails for the first two instructions.

.....

.....

.....

.....[2]

(ii) The instructions were produced by a compiler after translation of a high-level language program.

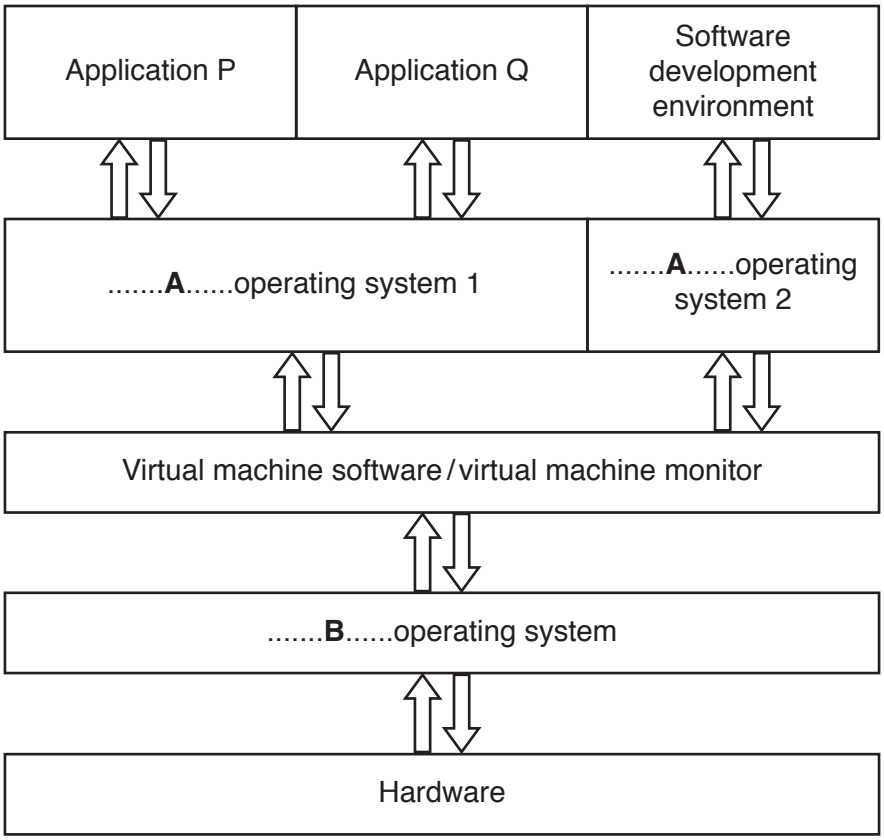
The compiler is not capable of code optimisation.

State how the code from the compiler could have been optimised to overcome the problem in **part (c)(i)**.

.....

.....[1]

3 **(a)** This diagram shows how applications P, Q and a software development environment can be run on a virtual machine system.



(i) State the operating systems labelled **A** and **B** in the diagram.

A .....

B .....
[2]

(ii) Application P is executing and requests data from a file.

Describe what happens after .....**A**.....operating system 1 has received the data request from the application.

.....

.....

.....

.....

.....

.....[3]

(b) A software development company uses virtual machines to produce software.

(i) State **one** benefit to the company.

.....

.....[1]

(ii) Explain **two** limitations of this approach.

Limitation 1 .....

.....

.....

.....

Limitation 2 .....

.....

.....

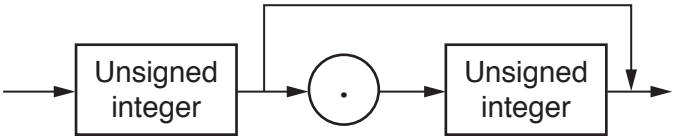
.....

[4]

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

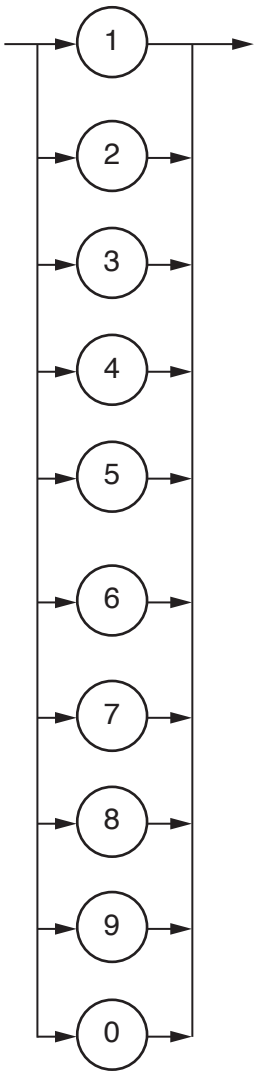
- an unsigned number
- an unsigned integer
- a digit.

Unsigned number



Unsigned integer

Digit



(a) (i) Explain why 32 is a valid unsigned integer.

.....

.....

.....

.....[2]

(ii) Explain why 32.5 is a valid unsigned number.

.....

.....

.....

.....[2]

(b) Complete the Backus-Naur Form (BNF) for the syntax diagrams shown.

<unsigned_number> ::= .....

.....

<unsigned_integer> ::= .....

.....

<digit> ::= .....

.....

[5]

The format of an unsigned number is amended to include numbers with possible exponents.

If an unsigned number has an exponent, then the exponent part:

- will start with an 'E'
- be followed by an optional '+' or '–' sign
- and be completed by an unsigned integer.

Examples of unsigned numbers with exponents include: 3E2, 3E+3, 3E–32, 3.45E–2

(c) **(i)** Redraw the syntax diagram for unsigned number to include numbers that might have exponents.

[4]

(ii) Use your syntax diagram from **part (c)(i)** to write the BNF for an unsigned number to include numbers with exponents.

<unsigned_number> ::= .....

.....

.....

.....

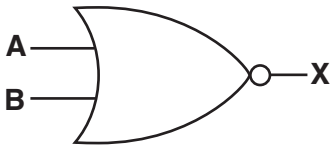
.....

.....

.....

.....[4]

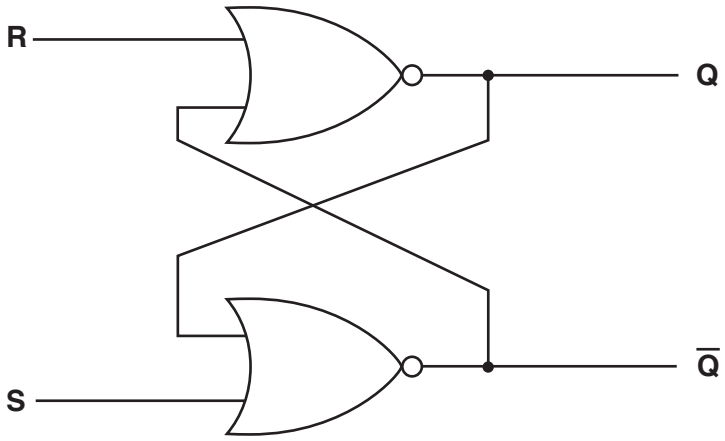
5 **(a)** Complete the truth table for this NOR gate:



A	B	X
0	0	
0	1	
1	0	
1	1	

[1]

A SR flip-flop is constructed using two NOR gates.



(b) Complete the truth table for the SR flip-flop:

	S	R	Q	$\overline{Q}$
Initially	1	0	1	0
S changed to 0	0	0		
R changed to 1	0	1		
R changed to 0	0	0		
S and R changed to 1	1	1		

[4]

Another type of flip-flop is the JK flip-flop. The JK flip-flop is an improvement on the SR flip-flop.

(c) (i) The JK flip-flop has three inputs. Two of the inputs are the Set (J) and the Reset (K).

State the third input.

.....[1]

(ii) There are **two** problems with the SR flip-flop that the JK flip-flop overcomes.

State each problem and state why it does not occur for the JK flip-flop.

Problem 1 .....

.....

.....

.....

Problem 2 .....

.....

.....

.....

[4]

6 The environment in a very large greenhouse is managed by a computer system. The system uses a number of different sensors that include temperature sensors. In addition, the system controls a number of heaters, windows and sprinklers.

(a) State **one** other type of sensor that could be used with this system.

Justify your choice.

Sensor .....

Justification .....

.....

[2]

(b) Describe why feedback is important in this system.

.....

.....

.....

.....

.....

.....[3]

(c) **(i)** The system makes use of a number of parameters. These parameters are used in the code that runs the system.

State **one** of the parameters used in controlling the temperature in the greenhouse.

.....[1]

(ii) Explain how the parameter identified in **part (c)(i)** is used in the feedback process.

.....

.....

.....

.....[2]

(d) There are eight temperature sensors numbered 1 to 8. Readings from these sensors are stored in four 16-bit memory locations. The memory locations have addresses from `4000` to `4003`. Each memory location stores two sensor readings as two unsigned binary integers.

Sensor 1 reading is stored in bits 8 to 15 of address `4000`; Sensor 2 reading is stored in bits 0 to 7 of address `4000` and so on. The diagram shows that the current sensor 1 reading has a value of 97.

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
4000	0	1	1	0	0	0	0	1	0	0	1	1	1	0	0	1
4001	1	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0
4002	0	0	0	1	0	1	0	0	0	0	0	0	1	1	0	1
4003	1	0	0	0	0	0	1	0	1	1	0	0	0	1	0	1

(i) Give the denary value of the current reading for Sensor 5.

.....

.....

.....

.....[1]

(ii) The following table shows part of the instruction set for a processor. The processor has one general purpose register, the Accumulator (ACC).

Instruction		Explanation
Op code	**Operand**	
LDD	<address>	Direct addressing. Load the contents of the location at the given address to ACC.
AND	#n	Bitwise AND operation of the contents of ACC with the operand.
AND	<address>	Bitwise AND operation of the contents of ACC with the contents of <address>.
XOR	#n	Bitwise XOR operation of the contents of ACC with the operand.
XOR	<address>	Bitwise XOR operation of the contents of ACC with the contents of <address>.
OR	#n	Bitwise OR operation of the contents of ACC with the operand.
OR	<address>	Bitwise OR operation of the contents of ACC with the contents of <address>. <address> can be an absolute address or a symbolic address.
LSL	#n	Bits in ACC are shifted n places to the left. Zeros are introduced on the right hand end.
LSR	#n	Bits in ACC are shifted n places to the right. Zeros are introduced on the left hand end.

The reading for Sensor 5 is used in a calculation. The calculation is carried out by two assembly language instructions.

The first instruction loads the contents of the 16-bit location that contains the value for Sensor 5.

The second instruction moves the bits in Sensor 5 so that the 16-bit value is the value of Sensor 5.

Complete the two instructions in the following code. Use the instruction set provided.

```
LDD ..... // load the contents of the 16-bit location
          containing the value for Sensor 5 into the
          Accumulator

..... // move the bits in the Accumulator so that the
      Accumulator stores the value of Sensor 5 as an
      unsigned 16-bit binary integer
```

[3]

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Cambridge International AS & A Level

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Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

COMPUTER SCIENCE **9608/31**

Paper 3 Advanced Theory **May/June 2018**

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs or rough working.
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DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

This document consists of **15** printed pages and **1** blank page.

CAMBRIDGE International Examinations

[Turn over

1 In a computer system, real numbers are stored using normalised floating-point representation with:

- 12 bits for the mantissa
- 4 bits for the exponent
- Two's complement form for both mantissa and exponent.

(a) Find the denary value for the following binary floating-point number.

Mantissa

1	0	1	1	1	0	0	1	1	0	1	0

Exponent

0	1	0	1

Show your working.

Working .....

.....

.....

.....

.....

Answer .....

[3]

(b) Calculate the normalised floating-point representation of 5.25 in this system. Show your working.

Working .....

.....

.....

.....

.....

.....

Mantissa

Exponent

[3]

(c) The size of the mantissa is decreased and the size of the exponent is increased.

State how this affects the range and precision of the numbers that the computer system can represent.

.....

.....

.....

.....[2]

2 A programmer uses non-composite and composite data types to create a program.

(a) Define the term **non-composite data type**.

.....

.....[1]

(b) Describe **two** different non-composite data types.

Data type 1 .....

Description .....

.....

.....

Data type 2 .....

Description .....

.....

.....

[4]

(c) Define the term **composite data type**.

.....

.....[1]

(d) Describe **two** different composite data types.

Data type 1 .....

Description .....

.....

.....

Data type 2 .....

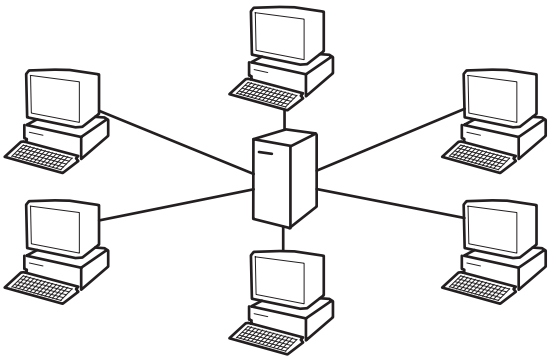
Description .....

.....

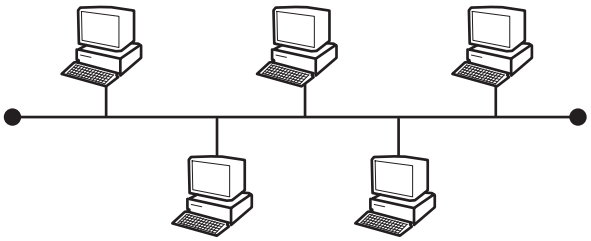
.....

[4]

3 Star and bus are two types of topology that can be used in a Local Area Network (LAN).



Star topology



Bus topology

(a) (i) State **one** benefit and **one** drawback of the star topology.

Benefit .....

.....

Drawback .....

.....

[2]

(ii) State **one** benefit and **one** drawback of the bus topology.

Benefit .....

.....

Drawback .....

.....

[2]

(b) The sequence of steps 1 to 7 describes what happens when the LAN transmits data from Computer X to Computer Y using circuit switching. Four statements (4 to 7) are missing from the sequence.

A	Computer X sends the data.
B	The sender signals node to deallocate resources.
C	Computer Y sends a receipt signal.
D	If available, Computer X sets up path between nodes.

Write **one** letter (**A** to **D**) in the appropriate space to complete the sequence.

1 Computer X sends a connection request to Computer Y.

2 Computer Y sends ready or busy signal.

3 If busy, Computer X waits and then resends the connection request to Computer Y.

4 ……

5 ……

6 ……

7 ……

[3]

(c) **(i)** Protocols are essential for successful transmission of data over a network. The TCP/IP protocol suite operates on many layers.

State the appropriate layer for each protocol in the following table.

Protocol	Layer
TCP	
IP	
SMTP	

[3]

(ii) Peer-to-peer (P2P) file sharing uses the BitTorrent protocol.

Explain how the BitTorrent protocol allows files to be shared.

.....

.....

.....

.....

.....

.....[3]

Question 4 begins on the next page.

4 **(a)** A Boolean expression produces the following truth table.

INPUT			OUTPUT
A	**B**	**C**	**X**
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

(i) Write the Boolean expression for the truth table as a sum-of-products.

X = ...[2]

(ii) Complete the Karnaugh Map (K-map) for the truth table in **part (a)(i)**.

		AB			
		00	**01**	**11**	**10**
C	**0**				
	1				

[1]

The K-map can be used to simplify the function in **part (a)(i)**.

(iii) Draw loop(s) around appropriate group(s) of 1s to produce an optimal sum-of-products for the table in **part (a)(ii)**. [2]

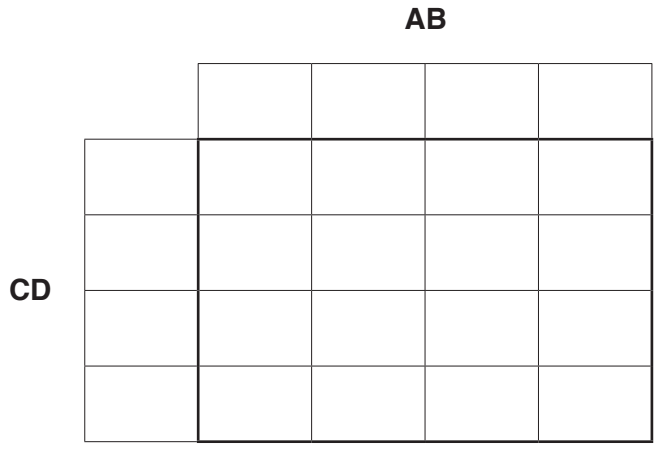
(iv) Write the simplified sum-of-products expression for your answer to **part (a)(iii)**.

X = ...[2]

(b) A logic circuit with four inputs produces the following truth table.

INPUT				OUTPUT
A	**B**	**C**	**D**	**X**
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	1
1	1	1	0	0
1	1	1	1	0

(i) Complete the K-map that corresponds to the truth table.



[4]

(ii) Draw loop(s) around appropriate group(s) of 1s to produce an optimal sum-of-products for the table in **part (b)(i)**. [2]

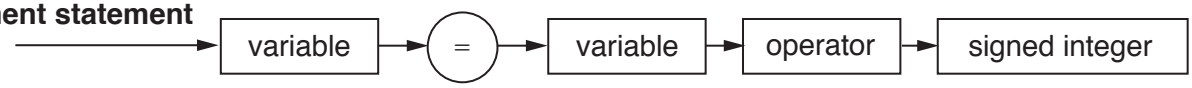
(iii) Write the simplified sum-of-products expression for your answer to **part (b)(ii)**.

X = ...[2]

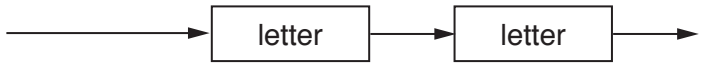
5 The following syntax diagrams show the syntax of:

- an assignment statement
- a variable
- a signed integer
- a letter
- a digit
- an operator

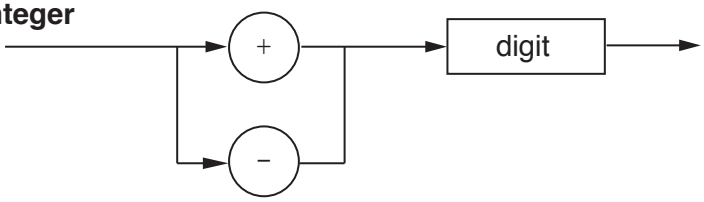
assignment statement



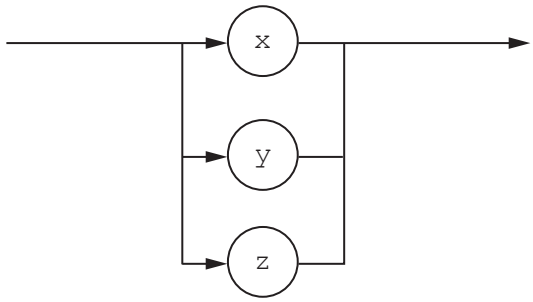
variable



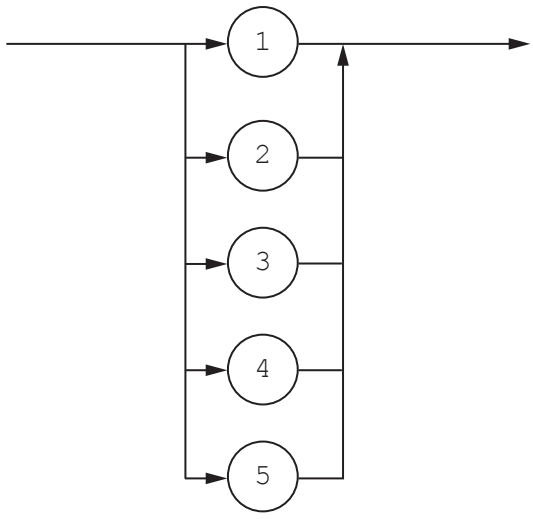
signed integer



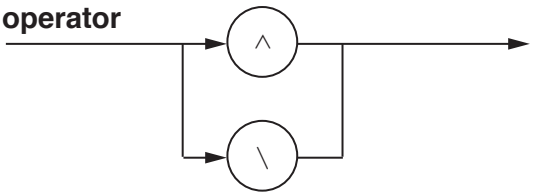
letter



digit



operator



(a) The following assignment statements are invalid.

Give the reason in each case.

(i) `xy = xy ^ c4`

Reason .....

.....[1]

(ii) `zy = zy \ 10`

Reason .....

.....[1]

(iii) `yy := xz ^ - 6`

Reason .....

.....[1]

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

`<assignment statement> ::=`

.....

`<variable> ::=`

.....

`<signed integer> ::=`

.....

`<operator> ::=`

.....
[4]

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

`<variable> ::=`

.....[2]

6 A company specialises in educational software.

(a) The company is concerned that malware might disrupt their business.

(i) Add appropriate descriptions and terms in the table.

	Description	Term
A	Redirection to a bogus website that appears to be legitimate to gain confidential data.	.....
B	Use email to attempt to gain a user's confidential data.	.....
C	....	**Spyware**
D	....	**Worm**

[4]

(ii) A member of staff is using the Internet to carry out research. They are worried about the threat from terms **A** and **B**.

Identify **one** solution to the each of the threats.

Term **A** .....

.....

Term **B** .....

.....

[2]

(b) A customer downloads a new educational software package from the company.

Explain how the customer's and the company's computers use a hashing algorithm to assure the customer that:

- the software has come from the company (is authentic) and
- no one has altered it.

.....

.....

.....

.....

.....

.....

.....

.....[4]

7 A museum stores antique items that need to be kept at constant temperature.

The museum is not sure about the actual temperatures. The museum installs some equipment. This records the temperatures every hour and ensures the temperature stays within a set range.

(a) Identify the type of system described.

.....[1]

(b) The system has a temperature sensor.

Identify **two** other items of hardware that the museum can use for the type of system identified.

Describe the purpose of each item.

Item 1 .....

Purpose .....

.....

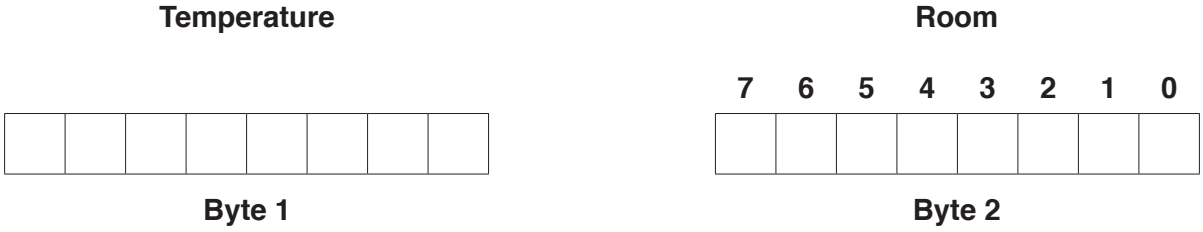
Item 2 .....

Purpose .....

.....
[4]

(c) The equipment records the temperature in all seven rooms in the museum.

Each recording is stored as two successive bytes in memory. The format is as shown.



The room is indicated by the setting of one of the bits in **Byte 2** to 1. For example, room 7 is indicated by setting bit 7 to 1.

Bit 0 of **Byte 2** is a flag:

- The flag's initial value is zero.
- When the reading has been processed, the flag's value is set to 1.

Byte 1 contains the temperature reading as an unsigned integer.

One reading returns the following binary data.

Temperature

1	0	1	1	0	0	1	1

Byte 1

Room

7	6	5	4	3	2	1	0
0	0	1	0	0	0	0	1

Byte 2

(i) Analyse the data contained in the two bytes.

.....

.....

.....

.....

.....[3]

(ii) The system receives a temperature reading of 238 from room number 4.

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

Byte 1

7	6	5	4	3	2	1	0

Byte 2

[2]

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Cambridge International AS & A Level

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3020014690

COMPUTER SCIENCE **9608/32**

Paper 3 Advanced Theory **May/June 2018**

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

This document consists of **12** printed pages.

CAMBRIDGE International Examinations

[Turn over

1 Data types can be defined in a programming language.

The data type, `StudentRecord`, is defined by the code:

```
TYPE StudentRecord
   DECLARE StudentID        : INTEGER
   DECLARE StudentFirstName : STRING
   DECLARE StudentSurname   : STRING
   DECLARE StudentDOB       : DATE
   DECLARE StudentCourse    : ARRAY[1:10] OF STRING
ENDTYPE
```

A variable, `CollegeStudent`, is declared with the code:

```
DECLARE CollegeStudent : StudentRecord
```

(a) Write a pseudocode statement to assign 6539 to the `StudentID` of `CollegeStudent`.

.....[1]

(b) The type definition for `StudentRecord` is changed.

(i) Students can take six courses from: Computer Science, Engineering, Science, Maths, Physics, Chemistry, Music, Drama and English Language.

Rewrite **one** line from the type definition of `StudentRecord` to implement the change.

`DECLARE` .....

.....

.....

.....[2]

(ii) The values for the field `StudentID` must be between `1` and `8000` inclusive.

Rewrite **one** line from the type definition of `StudentRecord` to implement the change.

`DECLARE` .....[1]

(c) A programmer is asked to write a program to process the assessment data for each student. Students sit one exam in every course they take.

A composite data type, `StudentAssessment`, needs to be defined with the following three fields.

- a student assessment code (a unique code of three letters and two digits)
- the marks for the six exams
- the average mark of the six exams

(i) Write **pseudocode** to define the data type `StudentAssessment`.

.....

.....

.....

.....

.....

.....[4]

(ii) Data about all students and their assessments are stored in a file that uses random organisation. The `StudentID` is used as the key field.

The program allows a user to enter data for a new student.

Explain how the program adds the new data to the file.

.....

.....

.....

.....

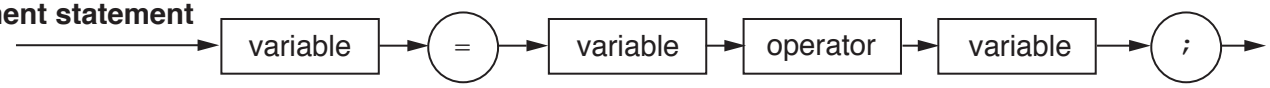
.....

.....[3]

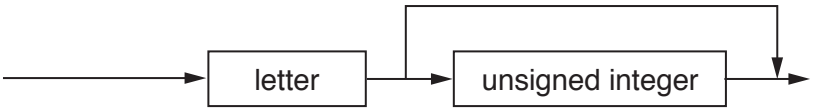
2 The following syntax diagrams show the syntax of:

- an assignment statement
- a variable
- an unsigned integer
- a letter
- a digit
- an operator

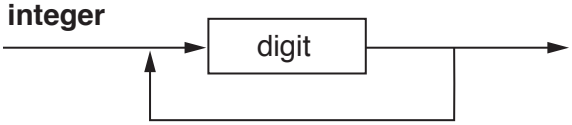
assignment statement



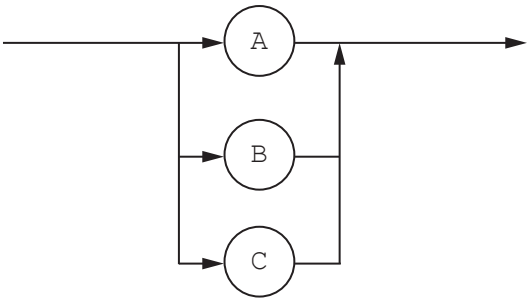
variable



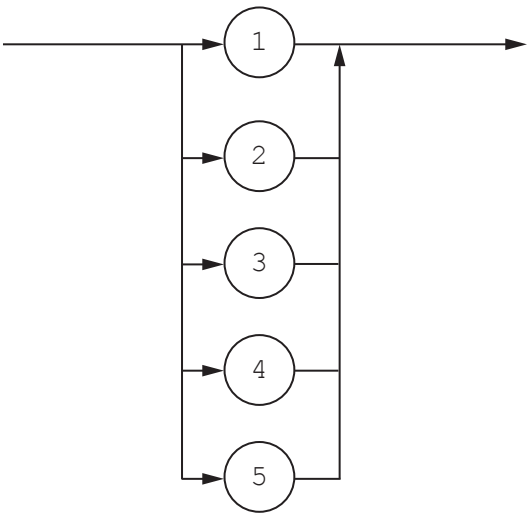
unsigned integer



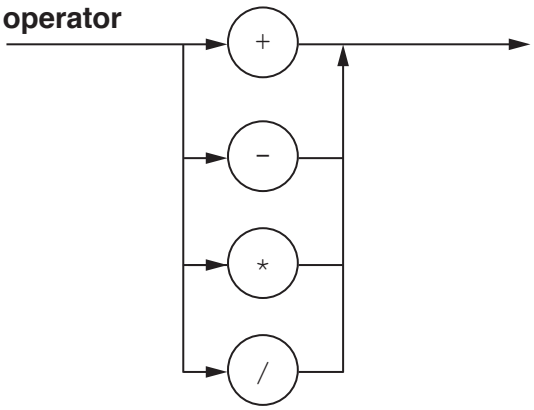
letter



digit



operator



(a) The following assignment statements are invalid.

Give the reason in each case.

(i) `A = B + 5;`

Reason .....

.....[1]

(ii) `A = B - D;`

Reason .....

.....[1]

(iii) `C4 = B2 - A1 + C3;`

Reason .....

.....[1]

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

<assignment statement> ::=

.....

<variable> ::=

.....

<unsigned integer> ::=

.....

<operator> ::=

.....
[6]

(c) The syntax of **variable** is changed to allow one or more letters followed by an unsigned integer.

Draw a syntax diagram for the new syntax of the variable.

[3]

3 In a computer system, real numbers are stored using normalised-floating point representation with:

- 8 bits for the mantissa
- 4 bits for the exponent
- two's complement form for both mantissa and exponent.

(a) Calculate the normalised floating-point representation of + 21.75 in this system. Show your working.

Working .....

.....

.....

.....

.....

.....

Mantissa								Exponent			

[3]

(b) Find the denary value for the following binary floating-point number.

Mantissa							
1	0	1	1	0	0	0	0

Exponent			
1	1	1	0

Show your working.

Working .....

.....

.....

.....

.....

Answer .....

[3]

4 The TCP/IP protocol suite is used on the Internet.

(a) The table has statements about transmitting data across the Internet.

Put a tick (✓) in each row to identify whether the responsibility belongs to TCP or IP.

Responsibility	TCP	IP
Correct routing		
Host to host communication		
Communication between networks		
Retransmitting missing packets		
Reassembling packets into the correct order		

[5]

(b) Identify **two** other internet protocols. State a use for each protocol.

Protocol 1 .....

.....

Use .....

.....

Protocol 2 .....

.....

Use .....

.....
[4]

(c) State the name of the TCP/IP layer that uses IP addresses.

.....[1]

(d) Emails are transmitted across the Internet using packet switching and routing tables.

(i) Give **four** items of data in an IP data packet.

1 .....

2 .....

3 .....

4 .....
[4]

(ii) Describe **two** benefits of using packet switching.

Benefit 1 .....

.....

.....

.....

Benefit 2 .....

.....

.....

.....
[4]

(iii) Give **two** items of data stored in a routing table.

1 .....

2 .....
[2]

5 Katarina works for a company specialising in the sale of computer parts and accessories. She works in the London office and her colleague Lucy works in the Hong Kong office. Katarina emails confidential information to Lucy so that only Lucy can read the information.

(a) Explain how public and private keys are used to ensure that only Lucy has a readable copy of the confidential information.

.....

.....

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.....

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.....

.....

.....[4]

(b) Julio is buying items from the online shop. He already has an account with the shop.

Explain how the use of Secure Socket Layer (SSL) or Transport Layer Security (TLS) helps to keep Julio's confidential information secure.

.....

.....

.....

.....

.....

.....[3]

(c) The manager of the company is concerned about the threat of malware.

State **three** vulnerabilities that a malware can exploit.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

6 **(a)** There are five scenarios on the left and two types of system on the right.

Draw a line to link each scenario to its correct type of system.

Scenario	System
Car speed display	
Aeroplane autopilot	Control
Rollercoaster	Monitoring
Recording the rainfall at a weather station	
Robot loading a part onto a conveyor belt	

[2]

(b) Mary has six fish tanks. The temperature of the water in each tank needs to be within a specific range.

Identify **three** items of hardware that Mary can add to her tanks to help maintain the temperature. Describe the purpose of each item.

Item 1 .....

Purpose .....

.....

Item 2 .....

Purpose .....

.....

Item 3 .....

Purpose .....

.....

[6]

(c) A temperature reading is taken from each tank once per minute. The temperature reading is stored as two successive bytes. The format is shown:

Fish tank

7	6	5	4	3	2	1	0

Byte 1

Temperature reading

Byte 2

The fish tank number is indicated by setting one of the bits in **Byte 1** to 1. For example, fish tank number 5 is indicated by setting bit 5 to 1.

Bit 7 of **Byte 1** is a flag:

- the flag's initial value is zero
- when the reading has been processed, the flag's value is set to 1

Bit 0 of **Byte 1** is unused.

Byte 2 contains the temperature reading as a two's complement integer.

(i) After a temperature reading has been taken, the bytes contain the following data.

7	6	5	4	3	2	1	0
0	0	0	0	1	0	0	0

Byte 1

0	0	0	0	1	0	1	1

Byte 2

Analyse the data contained in the two bytes.

.....

.....

.....

.....

.....

.....[3]

(ii) The system receives a temperature reading of –2 from fish tank number 4.

Complete the bytes to show the values for this reading after it has been processed.

7	6	5	4	3	2	1	0

Byte 1

Byte 2

[2]

(d) A hardware device to affect the temperature of each tank is on or off depending on the value of a bit in memory location `6753`.

If bit 4 is 1, then the hardware device in fish tank 4 is on.

Write **assembly language** instructions to set bit 4 of memory location `6753` to 1 without changing any other bits. Use the instruction set provided.

.....

.....

.....

.....[3]

Instruction set

Instruction		Explanation
Op code	**Operand**	
`LDD`	`<address>`	Direct addressing. Load the contents of the location at the given address to ACC.
`STO`	`<address>`	Store the contents of ACC at the given address.
`AND`	`#n`	Bitwise AND operation of the contents of ACC with the operand.
`AND`	`<address>`	Bitwise AND operation of the contents of ACC with the contents of <address>.
`XOR`	`#n`	Bitwise XOR operation of the contents of ACC with the operand.
`OR`	`#n`	Bitwise OR operation of the contents of ACC with the operand.
`OR`	`<address>`	Bitwise OR operation of the contents of ACC with the contents of <address>. <address> can be an absolute address or a symbolic address.

Cambridge International AS & A Level

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CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

COMPUTER SCIENCE **9608/31**

Paper 3 Advanced Theory **October/November 2018**

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

This document consists of **14** printed pages and **2** blank pages.

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[Turn over

Question 1 begins on the next page.

1 Consider the following user-defined data type.

```
TYPE Book
     DECLARE ISBN     : INTEGER
     DECLARE Author   : STRING
     DECLARE Title    : STRING
     DECLARE Supplier : (Amazone, Stones, Smiths, Blackwalls, Greens,
                         Coals, Boarders)
ENDTYPE
```

(a) Name the data type of `Book`.

.....[1]

(b) Name the non-composite data type used in the `Supplier` declaration.

.....[1]

(c) **(i)** Write a pseudocode statement to declare a variable, `BestSeller`, of type `Book`.

.....[1]

(ii) Write a pseudocode statement to assign "`John Williams`" to the author of `BestSeller`.

.....[1]

2 **(a)** A computer system stores real numbers using floating-point representation. The floating-point numbers have:

- eight bits for the mantissa
- four bits for the exponent.

The mantissa and exponent are both in two's complement form.

(i) Calculate the denary value of the following floating-point number.

Mantissa								Exponent			
0	0	1	1	1	0	0	0	0	1	1	1

Show your working.

Working .....

.....

.....

.....

.....

Answer .....

[3]

(ii) State how you know the floating-point number in **part (a)(i)** is not normalised.

.....

.....[1]

(iii) Normalise the floating-point number in **part (a)(i)**.

Mantissa								Exponent			

[2]

(b) **(i)** Write the largest positive number that this system can represent as a normalised floating-point number in this format.

Mantissa								Exponent			

[2]

(ii) Write the smallest positive number that can be stored as a normalised floating-point number in this format.

Mantissa								Exponent			

[2]

(c) The number of bits available to represent a real number is increased to 16.

State the effect this has on the numbers that can be represented, if the additional four bits are used in the:

(i) mantissa .....

.....[1]

(ii) exponent .....

.....[1]

(d) A student enters the following code into an interpreter.

```
X = 0.1
Y = 0.2
Z = 0.3
OUTPUT (X + Y + Z)
```

The student is surprised to see the output:

```
0.6000000000000001
```

Explain why this is output.

.....

.....

.....

.....

.....

.....[3]

3 A local college has CSMA/CD in operation on its Local Area Network (LAN).

(a) One function of CSMA/CD is to monitor traffic on the network.

State **two** other tasks performed by CSMA/CD.

1 .....

2 .....

[2]

(b) The network uses the TCP/IP protocol to transfer files across the network.

(i) State **three** functions of the **TCP** part of this protocol.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

(ii) State **two** functions of the **IP** part of this protocol.

1 .....

2 .....

[2]

(iii) Identify **one** other common protocol that could be used to transfer files across the college network.

.....[1]

(c) Protocols are essential for successful transmission of data over a network. The TCP/IP protocol suite operates on many layers.

Give an appropriate protocol for each layer in the table.

Layer	Protocol
Application	
Transport	
Internet	

[3]

(d) The TCP/IP protocol is used to send an email message from one node on a LAN to a node on a different LAN.

State the steps that take place when the email message is sent and received.

.....

.....

.....

.....

.....

.....

.....

.....[4]

4 **(a)** A Boolean expression corresponds to the following truth table.

INPUT			OUTPUT
A	**B**	**C**	**X**
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

(i) Write the Boolean expression for the truth table by applying the sum-of-products.

X = ...[2]

(ii) Complete the Karnaugh Map (K-map) for the truth table.

		AB			
		00	**01**	**11**	**10**
C	**0**				
	1				

[1]

(iii) The K-map can be used to simplify the expression in **part (a)(i)**.

Draw loop(s) around appropriate groups of 1s in the table in **part (a)(ii)** to produce an optimal sum-of-products. [3]

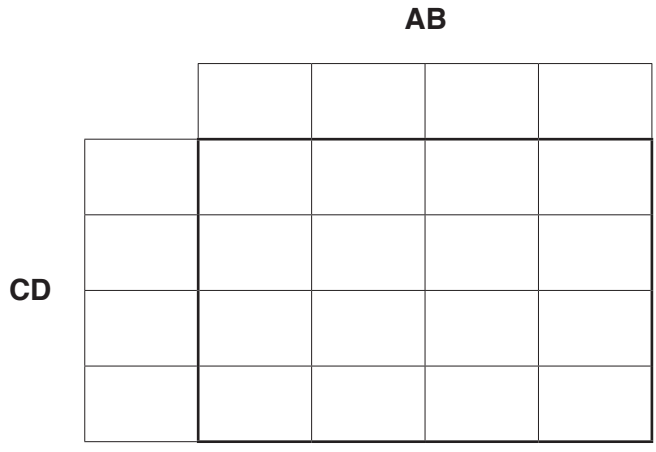
(iv) Write the simplified sum-of-products expression for your answer to **part (a)(iii)**.

X = ...[3]

(b) A logic circuit with four inputs produces the following truth table.

INPUT				OUTPUT
A	**B**	**C**	**D**	**X**
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

(i) Complete the K-map that corresponds to the truth table.



[4]

(ii) Draw loop(s) around appropriate groups of 1s in the table in **part (b)(i)** to produce an optimal sum-of-products. [2]

(iii) Write the simplified sum-of-products expression for your answer to **part (b)(ii)**.

X = ...[2]

5 A computer process can be in one of three states: running, ready or blocked.

(a) Explain how the processes are affected when the following events take place.

(i) The running process needs to read a file from a disk.

.....

.....

.....

.....[2]

(ii) The running process uses up its time slice.

.....

.....

.....

.....[2]

(b) (i) State the conditions that are necessary for a process to move from the ready to the running state.

.....

.....

.....

.....[2]

(ii) State the conditions that are necessary for a process to move from the blocked to the ready state.

.....

.....

.....

.....[2]

(c) Give **three** reasons why process scheduling is needed.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

6 The compilation process has a number of stages. The first stage is lexical analysis.

A compiler uses a keyword table and a symbol table. Part of the keyword table is shown.

- Tokens for keywords are shown in hexadecimal.
- All of the keyword tokens are in the range `00` – `5F`.

Keyword	Token
←	01
*	02
=	03
IF	4A
THEN	4B
ENDIF	4C
ELSE	4D
FOR	4E
STEP	4F
TO	50
INPUT	51
OUTPUT	52
ENDFOR	53

Entries in the symbol table are allocated tokens. These values start from 60 (hexadecimal).

Study the following code.

```
Start ← 1
INPUT Number
// Output values in a loop
FOR Counter ← Start TO 12
    OUTPUT Number * Counter
ENDFOR
```

(a) Complete the symbol table to show its contents after the lexical analysis stage.

Symbol	Token	
	Value	Type
`Start`	`60`	Variable
`1`	`61`	Constant

[3]

(b) The output from the lexical analysis stage is stored in the following table. Each cell stores one byte of the output.

Complete the output from the lexical analysis stage. Use the keyword table and your answer to **part (a)**.

`60`	`01`														

[2]

(c) The output of the lexical analysis stage is the input to the syntax analysis stage.

Identify **two** tasks in syntax analysis.

1 .....

.....

2 .....

.....

[2]

(d) The final stage of compilation is optimisation.

(i) Code optimisation produces code that minimises the amount of memory used.

Give **one** additional reason why code optimisation is performed.

.....

.....[1]

(ii) A student uses the compiler to compile some different code.

After the syntax analysis stage is complete, the compiler generates object code.

The following lines of code are compiled.

```
X ← A + B
Y ← A + B + C
Z ← A + B + C + D
```

The compilation produces the following assembly language code.

```
LDD 236     //     loads value A to accumulator
ADD 237     //     adds value B to accumulator
STO 512     //     stores accumulator in X
LDD 236     //     loads value A to accumulator
ADD 237     //     adds value B to accumulator
ADD 238     //     adds value C to accumulator
STO 513     //     stores accumulator in Y
LDD 236     //     loads value A to accumulator
ADD 237     //     adds value B to accumulator
ADD 238     //     adds value C to accumulator
ADD 239     //     adds value D to accumulator
STO 514     //     stores accumulator in Z
```

Rewrite the assembly language code after it has been optimised.

.....

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.....

.....[5]

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Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

7825200973

COMPUTER SCIENCE **9608/32**

Paper 3 Advanced Theory **October/November 2018**

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

This document consists of **13** printed pages and **3** blank pages.

DC (RW/CT) 150986/3

CAMBRIDGE International Examinations

[Turn over

1 **(a)** A computer system uses floating-point representation to store real numbers. The floating-point numbers have:

- 8 bits for the mantissa
- 8 bits for the exponent

The mantissa and exponent are both in two's complement form.

(i) Calculate the denary value of the following floating-point number. It is **not** in normalised form.

Mantissa								Exponent							
0	0	1	0	1	0	1	0	0	0	0	0	0	1	0	1

Show your working.

Working .....

.....

.....

.....

.....

Answer .....

[3]

(ii) Convert the denary number +7.5 into a normalised floating-point number.

Show your working.

Mantissa								Exponent							

Working .....

.....

.....

.....

.....

[3]

(iii) Convert the denary number –7.5 into a normalised floating-point number.

Show your working.

Mantissa								Exponent							

Working .....

.....

.....

.....

.....

[3]

(b) A normalised floating-point number is shown.

Mantissa								Exponent							
0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1

(i) State the significance of this binary number.

.....

.....[1]

(ii) State what will happen if a positive number is added to this number.

.....

.....[1]

2 **(a)** A network can be set up using a star topology.

Give **three** features of a star topology.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

(b) **(i)** Describe what is meant by **circuit switching**.

.....

.....

.....

.....[2]

(ii) The table shows statements that relate to circuit switching, packet switching or both.

Tick (✓) **one or more** boxes in each row to show whether the statement applies to circuit switching, packet switching or both.

Statements	Circuit switching	Packet switching
Shares bandwidth		
Data may arrive out of order		
Data can be corrupted		
Data are less likely to get lost		

[4]

3 **(a)** Consider the following Boolean expression.

$$A \,.\, \overline{B} \,.\, \overline{C} + A \,.\, B \,.\, \overline{C} + A \,.\, B \,.\, C$$

Use Boolean algebra to simplify the expression.

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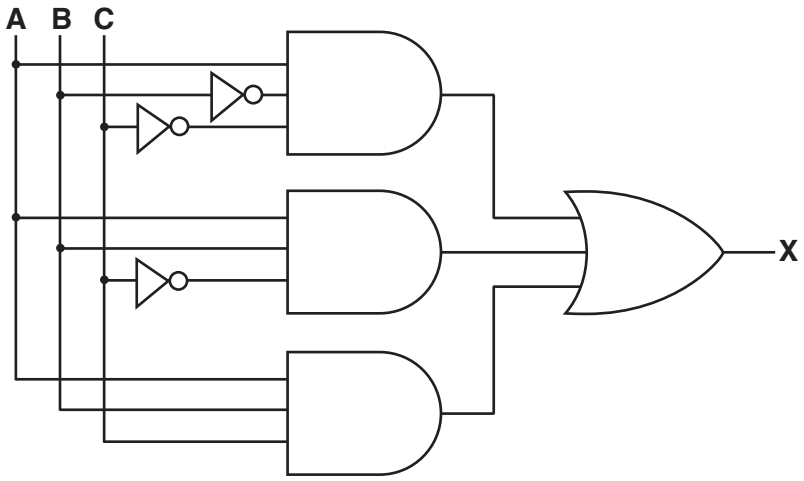
.....[4]

(b) (i) Complete the truth table for the following logic circuit.



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

[2]

(ii) Complete the Karnaugh Map (K-map) for the truth table in **part (b)(i)**.

		AB			
		00	01	11	10
C	0				
	1				

[1]

(iii) Draw loops around appropriate groups of 1s in the table in **part (b)(ii)** to produce an optimal sum-of-products. [2]

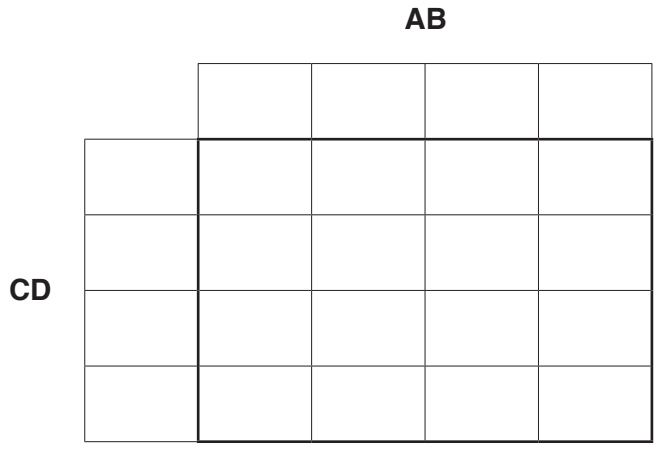
(iv) Using your answer to **part (b)(iii)**, write a simplified sum-of-products Boolean expression.

X = ...[2]

(c) The truth table for a logic circuit with four inputs is shown.

INPUT				OUTPUT
A	**B**	**C**	**D**	**X**
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

(i) Complete the K-map for the truth table in **part (c)**.



[4]

(ii) Draw loops around appropriate groups of 1s in the table in **part (c)(i)** to produce an optimal sum-of-products. [2]

(iii) Using your answer to **part (c)(ii)**, write a simplified sum-of-products Boolean expression.

X = ...[2]

4 A compiler uses a keyword table and a symbol table. Part of the keyword table is shown.

- Tokens for keywords are shown in hexadecimal.
- All of the keyword tokens are in the range `00 – 5F`.

Keyword	Token
←	01
+	02
=	03
IF	4A
THEN	4B
ENDIF	4C
ELSE	4D
FOR	4E
STEP	4F
TO	50
INPUT	51
OUTPUT	52
ENDFOR	53

Entries in the symbol table are allocated tokens. These values start from `60` (hexadecimal).

Study the following code.

```
INPUT Number1
INPUT Number2
INPUT Answer
IF Answer = Number1 + Number2
   THEN
      OUTPUT 10
   ELSE
      OUTPUT 0
ENDIF
```

(a) Complete the symbol table to show its contents after the lexical analysis stage.

Symbol	Token	
	Value	Type
Number1	60	Variable
Number2	61	Variable

[3]

(b) The output from the lexical analysis stage is stored in the following table. Each cell stores one byte of the output.

Complete the output from the lexical analysis. Use the keyword table and your answer to **part (a)**.

51	60																	

[2]

(c) A student uses the compiler to compile some different code.

After the syntax analysis is complete, the compiler generates object code.

The following line of code is compiled: `X ← A + B + C – D`

The compilation produces the following assembly language code.

```
LDD 236      // loads value A into accumulator
ADD 237      // adds value B to accumulator
ADD 238      // adds value C to accumulator
STO 540      // stores accumulator in temporary location
LDD 540      // loads value from temporary location into accumulator
SUB 239      // subtracts value D from accumulator
STO 235      // stores accumulator in X
```

(i) Identify the final stage in the compilation process that follows this code generation stage.

.....[1]

(ii) Rewrite the equivalent code following the final stage.

.....

.....

.....

.....

.....

.....

.....

.....[3]

(iii) State **two** benefits of the process that is carried out in the final stage.

Benefit 1 .....

.....

Benefit 2 .....

.....

[2]

(d) An interpreter is executing a program. The program uses the variables `a`, `b`, `c` and `d`.

The program contains an expression that is written in infix form. The interpreter converts the infix expression to RPN.

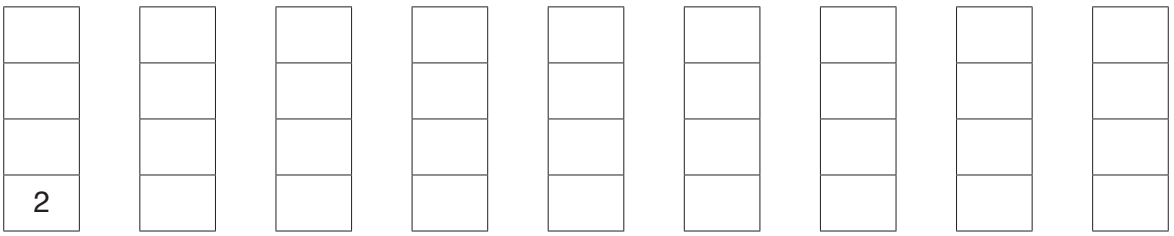
The RPN expression is: `b a c + * d + 2 -`

The interpreter evaluates this RPN expression using a stack.

The current values are: `a = 1` `b = 2` `c = 2` `d = 3`

Show the changing contents of the stack as the interpreter evaluates the expression.

The first entry on the stack has been done for you.



[4]

5 **(a)** Most desktop or laptop computers use CISC (Complex Instruction Set Computing) architecture. Most smartphones and tablets use RISC (Reduced Instruction Set Computing).

State **four** features that are different for the CISC and RISC architectures.

1 .....

.....

2 .....

.....

3 .....

.....

4 .....

.....

[4]

(b) In a RISC processor, four instructions (**A**, **B**, **C**, **D**) are processed using pipelining.

The following table shows five stages that take place when instructions are fetched and executed. In time interval **1**, instruction **A** has been fetched.

(i) In the table, write the instruction labels (**A**, **B**, **C**, **D**) in the correct time interval for each stage. Each operation only takes one time interval.

Stage	Time interval								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Fetch instruction	**A**								
Decode instruction									
Execute instruction									
Access operand in memory									
Write result to register									

[3]

(ii) When completed, the table in **part (b)(i)** shows how pipelining allows instructions to be carried out more rapidly. Each time interval represents one clock cycle.

Calculate how many clock cycles are saved by using pipelining in the example in **part (b)(i)**.

Show your working.

Working .....

.....

.....

Answer .....

[3]

(c) The table shows four statements about computer architecture.

Put a tick (✓) in each row to identify the computer architecture associated with each statement.

Statement	Architecture		
	SIMD	**MIMD**	**SISD**
Each processor executes a different instruction			
There is only one processor			
Each processor executes the same instruction input using data available in the dedicated memory			
Each processor typically has its own partition within a shared memory			

[4]

6 **(a)** The following table shows descriptions and terms relating to data transmission security.

Add appropriate descriptions and terms to complete the table.

	Description	**Term**
A	The result of encryption that is transmitted to the recipient.	.....
B	The type of cryptography used where different keys are used; one for encryption and one for decryption.	.....
C	....	**Digital certificate**
D	....	**Private key**

[4]

(b) The sequence of steps 1 to 7 describes what happens when setting up a secure connection using Secure Socket Layer (SSL).

Four statements are missing from the sequence.

A	If the browser trusts the certificate, it creates, encrypts and sends the server a symmetric session key using the server's public key.
B	Server sends the browser an acknowledgement, encrypted with the session key.
C	Server sends a copy of its SSL Certificate and its public key.
D	Server decrypts the symmetric session key using its private key.

Write **one** letter (**A** to **D**) in the appropriate space to complete the sequence.

1. Browser requests that the server identifies itself.
2. ……
3. Browser checks the certificate against a list of trusted Certificate Authorities.
4. ……
5. ……
6. ……
7. Server and browser now encrypt all transmitted data with the session key.

[3]

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Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1261665674

COMPUTER SCIENCE **9608/31**

Paper 3 Advanced Theory **May/June 2019**

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

READ THESE INSTRUCTIONS FIRST

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DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

This document consists of **13** printed pages and **3** blank pages.

DC (LK) 179424

Cambridge Assessment International Education

[Turn over

1 In a computer system, real numbers are stored using normalised floating-point representation with:

- twelve bits for the mantissa
- four bits for the exponent.

The mantissa and exponent are both in two's complement form.

(a) Calculate the denary value for the following binary floating-point number.

Show your working.

Mantissa												Exponent			
1	0	0	1	0	1	1	1	0	0	1	1	0	1	1	1

Working .....

.....

.....

.....

.....

Answer .....

[3]

(b) Calculate the normalised floating-point representation of +1.5625 in this system.

Show your working.

Working .....

.....

.....

.....

.....

.....

Mantissa												Exponent			

[3]

(c) **(i)** Write the largest positive number that can be stored as a normalised floating-point number using this format.

Mantissa												Exponent			

[2]

(ii) Write the smallest non-zero positive number that can be stored as a normalised floating-point number using this format.

Mantissa												Exponent			

[2]

(d) The developer of a new programming language decides that all real numbers will now be stored using 20-bit normalised floating-point representation. She must decide how many bits to use for the mantissa and how many bits for the exponent.

Explain the trade-off between using either a large number of bits for the mantissa, or a large number of bits for the exponent.

.....

.....

.....

.....

.....

..... [3]

2 Cables connect the computers in a university admissions department in a star topology. The server room contains the server and printer for the employees to use. The department has three employees. Each employee has a computer connected to the star network.

(a) (i) Draw a diagram to show this topology.

[3]

(ii) Explain the benefits to the admissions department of using a star topology.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(b) Each department of the university has its own network. All the department networks connect to the university's main Local Area Network (LAN). The LAN has a bus topology and uses the CSMA/CD protocol.

Describe the CSMA/CD protocol.

.....

.....

.....

.....

.....

.....

..... [3]

(c) Explain how the following devices are used to support the university LAN.

(i) Router .....

.....

.....

..... [2]

(ii) Network Interface Card (NIC) .....

.....

.....

..... [2]

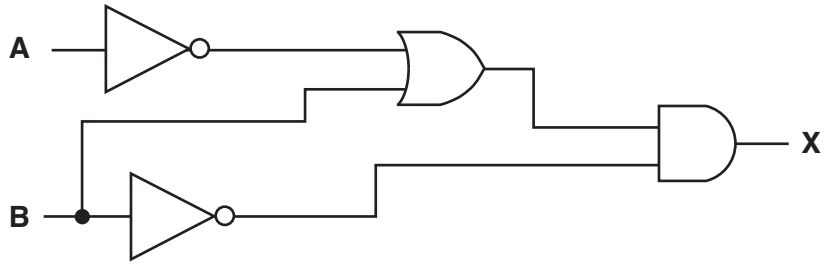
(iii) Wireless Access Point .....

.....

.....

..... [2]

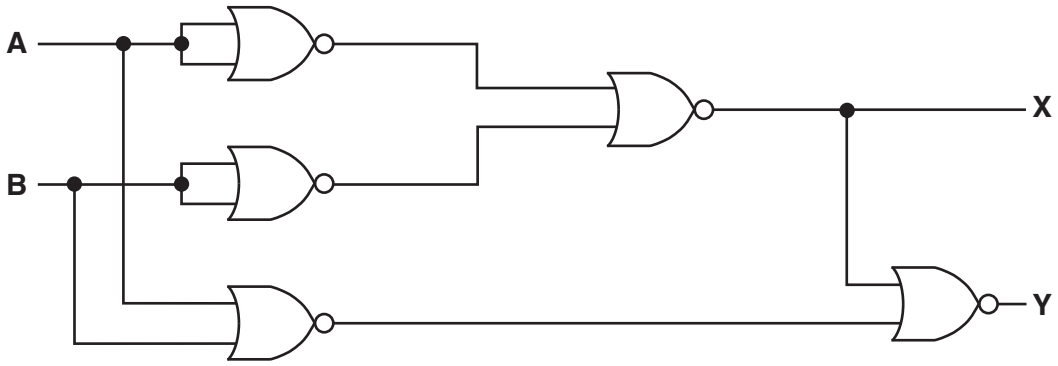
3 **(a)** The following logic circuit can be simplified to use only one gate.



Give the name of this single gate.

..... [1]

(b) **(i)** Complete the truth table for the logic circuit.



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

[2]

(ii) Give the name of the logic circuit that has this truth table.

..... [1]

(iii) Give the uses for outputs **X** and **Y**.

X .....

Y .....

[2]

(c) Consider the following Boolean algebraic expression:

$$\overline{A} \,.\, \overline{B} \,.\, \overline{C} \,.\, \overline{D} + \overline{A} \,.\, \overline{B} \,.\, \overline{C} \,.\, D + \overline{A} \,.\, \overline{B} \,.\, C \,.\, D + \overline{A} \,.\, \overline{B} \,.\, C \,.\, \overline{D} + \overline{A} \,.\, B \,.\, \overline{C} \,.\, \overline{D}$$

Use Boolean algebra to simplify the expression. Show your working.

Working .....

.....

.....

.....

.....

.....

.....

.....

.....

Simplified expression ..... [5]

4 A compiler uses a keyword table and a symbol table. Part of the keyword table is shown.

- Tokens for keywords are shown in hexadecimal.
- All of the keyword tokens are in the range 00 – 5F.

Keyword	Token
←	01
+	02
=	03
<>	04
IF	4A
THEN	4B
ENDIF	4C
ELSE	4D
REPEAT	4E
UNTIL	4F
TO	50
INPUT	51
OUTPUT	52
ENDFOR	53

Entries in the symbol table are allocated tokens. These values start from 60 (hexadecimal).

Study the following piece of pseudocode.

```
Counter ← 0
INPUT Password
REPEAT
   IF Password <> "Cambridge"
      THEN
         INPUT Password
   ENDIF
   Counter ← Counter + 1
UNTIL Password = "Cambridge"
OUTPUT Counter
```

(a) Complete the symbol table to show its contents after the lexical analysis stage.

Symbol	Token	
	Value	Type
Counter	60	Variable

[3]

(b) The output from the lexical analysis stage is stored in the following table. Each cell stores one byte of the output.

Complete the output from the lexical analysis using the keyword table **and** your answer to **part (a)**.

60	01																						

[2]

(c) The following table shows assembly language instructions for a processor which has one general purpose register, the Accumulator (ACC).

Instruction		Explanation
Op code	**Operand**	
LDD	<address>	Direct addressing. Load the contents of the location at the given address to ACC
ADD	<address>	Add the contents of the given address to the ACC
STO	<address>	Store the contents of ACC at the given address

After the syntax analysis is completed successfully, the compiler generates object code.

The following lines of high level language code are compiled.

```
X = X + Y
Z = Z + X
```

The compilation produces the assembly language code as follows:

```
LDD 236
ADD 237
STO 236
LDD 238
ADD 236
STO 238
```

(i) The final stage in the compilation process that follows this code generation stage is code optimisation.

Rewrite the equivalent code after optimisation.

.....

.....

.....

.....

.....

..... [3]

(ii) Explain why code optimisation is necessary.

.....

.....

.....

..... [2]

5 **(a)** Wiktor is an employee of a travel agent. He uses asymmetric encryption to send confidential information to his manager.

Fill in the spaces with an appropriate term to complete the descriptions.

Asymmetric encryption uses different ……. for encrypting and decrypting data. When Wiktor sends a message to his manager, the message is encrypted into ……. using his manager's ……. key. When the manager receives the message, it is decrypted using her ……. key.

When the manager replies, the message is encrypted using Wiktor's ……. key, and when Wiktor receives the message, it is decrypted into ……. using his ……. key. [5]

(b) When customers pay for their travel booking online, a secure connection is established using Secure Socket Layer (SSL).

Explain how the customer's browser and the server used to collect the payment will establish a secure connection.

.....

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..... [6]

(c) The manager is concerned about the threat of malware to the company computer systems.

Name **two** types of malware. State what the company should do to help prevent the effect of the malware.

The two methods of prevention must be different.

Malware type 1 .....

Prevention .....

.....

Malware type 2 .....

Prevention .....

.....

[4]

6 Monitoring and control systems have many different applications.

(a) Explain the importance of feedback in a control system.

.....

.....

.....

.....

.....

..... [3]

(b) An indoor swimming pool is to be kept at a constant temperature of 28 degrees.

Describe the use of feedback in this control system.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(c) Give **one** example of a monitoring system. Explain why this is a monitoring system.

Monitoring system .....

.....

Explanation .....

.....

.....

.....

[3]

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Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

COMPUTER SCIENCE **9608/32**

Paper 3 Advanced Theory **May/June 2019**

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

READ THESE INSTRUCTIONS FIRST

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You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

This document consists of **11** printed pages and **1** blank page.

Cambridge Assessment International Education

[Turn over

1 **(a)** A computer stores real numbers using floating-point representation. The floating-point numbers have:

- eight bits for the mantissa
- four bits for the exponent.

The mantissa and exponent are both stored in two's complement format.

(i) Calculate the denary value of the following floating-point number.

Show your working.

Mantissa								Exponent			
0	0	1	1	0	1	1	1	0	1	0	1

Working .....

.....

.....

.....

.....

Answer .....

[3]

(ii) State why the floating-point number in **part (a)(i)** is **not** normalised.

.....

..... [1]

(iii) Give the floating-point number in **part (a)(i)** in normalised two's complement format.

Mantissa								Exponent			

[2]

(b) (i) Convert the denary number +11.625 into a normalised floating-point number.

Show your working.

Working .....

.....

.....

.....

.....

.....

Mantissa **Exponent**

[3]

(ii) Convert the denary number –11.625 into a normalised floating-point number.

Show your working.

Working .....

.....

.....

.....

.....

.....

Mantissa **Exponent**

[3]

(c) A student enters the following into an interpreter:

```
OUTPUT(0.2 * 0.4)
```

The student is surprised to see that the interpreter outputs the following:

```
0.08000000000000002
```

Explain why the interpreter outputs this value.

.....

.....

.....

.....

.....

..... [3]

2 Packet switching can be used to transmit data across the Internet.

Packet switching is not always the most appropriate method of transferring data.

(a) Name an alternative method of transferring data across the Internet.

..... [1]

(b) Give an example of a situation where the method you identified in **part (a)** is more appropriate.

Justify your choice.

Example .....

.....

Justification .....

.....

.....

.....

[3]

3 **(a)** A Boolean algebraic expression produces the following truth table.

INPUT			OUTPUT
A	**B**	**C**	**X**
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

(i) Complete the Karnaugh Map (K-map) for the truth table.

		AB			
		00	**01**	**11**	**10**
C	**0**				
	1				

[1]

The K-map can be used to simplify the expression that produced the truth table in **part (a)**.

(ii) Draw loops around appropriate groups of 1s in the K-map to produce an optimal sum-of-products. [2]

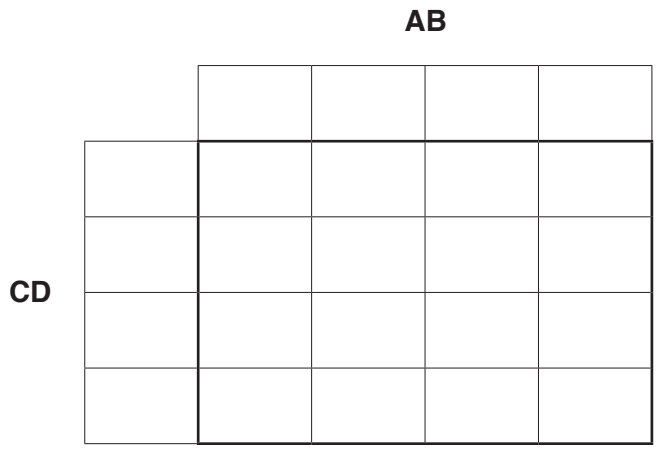
(iii) Write the simplified sum-of-products Boolean expression for the truth table.

X = ... [2]

(b) A logic circuit with four inputs produces the following truth table.

INPUT				OUTPUT
A	**B**	**C**	**D**	**X**
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	1
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	1
1	1	1	0	0
1	1	1	1	0

(i) Complete the K-map for the truth table.



[4]

(ii) Draw loops around appropriate groups of 1s in the K-map to produce an optimal sum-of-products. [2]

(iii) Write the simplified sum-of-products Boolean algebraic expression for the truth table.

X = ... [2]

4 **(a)** Describe the main steps in the evaluation of a Reverse Polish Notation (RPN) expression using a stack.

.....

.....

.....

.....

.....

.....

.....

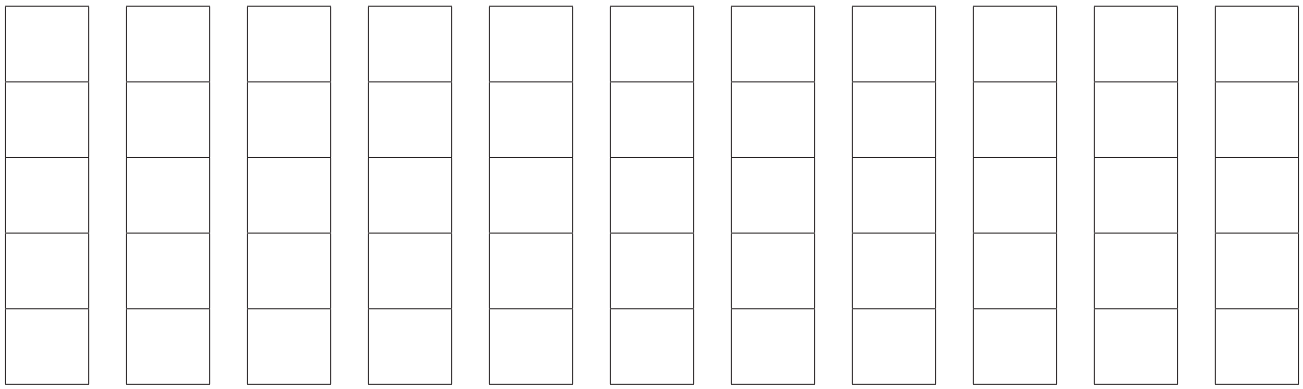
..... [4]

(b) The infix expression `8 * (5 - 2) - 30 / (2 * 3)` converts to:

`8 5 2 - * 30 2 3 * / -`

in Reverse Polish Notation (RPN).

Show the changing contents of the stack as this RPN expression is evaluated.



[4]

5 Sanjeet is a member of the public, and he wants to send a private message to a government department.

(a) Explain how asymmetric encryption is used to ensure that the message remains private.

.....

.....

.....

..... [2]

(b) When the government department replies to Sanjeet, it needs to send a verified message.

Explain how asymmetric encryption can be used to ensure that it is a verified message.

.....

.....

.....

.....

.....

..... [2]

(c) The government's computer systems are vulnerable to malware.

(i) Describe **two** vulnerabilities that malware can exploit in computer systems.

1 .....

.....

.....

.....

2 .....

.....

.....

.....

[4]

(ii) Identify **one** method that can be used to restrict the effect of malware.

.....

..... [1]

6 A company sells plant watering systems that automatically turn on water sprinklers when the soil becomes too dry.

The plant watering system has a processor and connecting cables.

Identify **two** other hardware devices that are required in this system. State the purpose of each device.

Device 1 .....

Purpose .....

.....

Device 2 .....

Purpose .....

.....

[4]

7 **(a)** RISC (Reduced Instruction Set Computing) and CISC (Complex Instruction Set Computing) are two types of processor.

Tick (✓) **one** box in each row to show if the statement applies to RISC or CISC processors.

Statement	RISC	CISC
Larger instruction set		
Variable length instructions		
Smaller number of instruction formats		
Pipelining is easier		
Microprogrammed control unit		
Multi-cycle instructions		

[3]

(b) In parallel processing, a computer can have multiple processors running in parallel.

(i) State the **four** basic computer architectures used in parallel processing.

1 .....

2 .....

3 .....

4 .....

[4]

(ii) Describe what is meant by a **massively parallel computer**.

.....

.....

.....

.....

.....

..... [3]

8 **(a)** A computer process can be in one of three states.

Identify **and** describe **two** of these states.

State 1 .....

Description .....

.....

.....

State 2 .....

Description .....

.....

.....

[6]

(b) One of the main tasks of an operating system is resource management.

Describe how an operating system can maximise the use of resources.

Primary memory .....

.....

.....

.....

.....

.....

Disk .....

.....

.....

.....

.....

.....

[6]

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Cambridge International AS & A Level

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CANDIDATE NAME

CENTRE NUMBER

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COMPUTER SCIENCE **9608/31**

Paper 3 Advanced Theory **October/November 2019**

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

No calculators allowed.

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
No marks will be awarded for using brand names of software packages or hardware.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The maximum number of marks is 75.

This document consists of **13** printed pages and **3** blank pages.

Cambridge Assessment International Education

[Turn over

1 Real numbers are stored using floating-point representation in a computer system.

This representation uses:

- 8 bits for the mantissa, followed by
- 4 bits for the exponent.

Two's complement form is used for both the mantissa and the exponent.

(a) (i) A real number is stored as a 12-bit normalised binary number as follows:

Mantissa								Exponent			
0	1	0	1	0	0	1	0	0	0	1	0

Calculate the denary value for this binary number. Show your working.

Working .....

.....

.....

Denary value .....

[3]

(ii) Calculate the normalised binary number for –3.75. Show your working.

Mantissa								Exponent			

Working .....

.....

.....

.....

[3]

(b) The number of bits available to represent a real number is increased to 16.

State the effect of increasing the size of the exponent by 4 bits.

.....

..... [1]

(c) State why some binary representations can lead to rounding errors.

.....

..... [1]

(d) Complete the following descriptions by inserting the **two** missing terms.

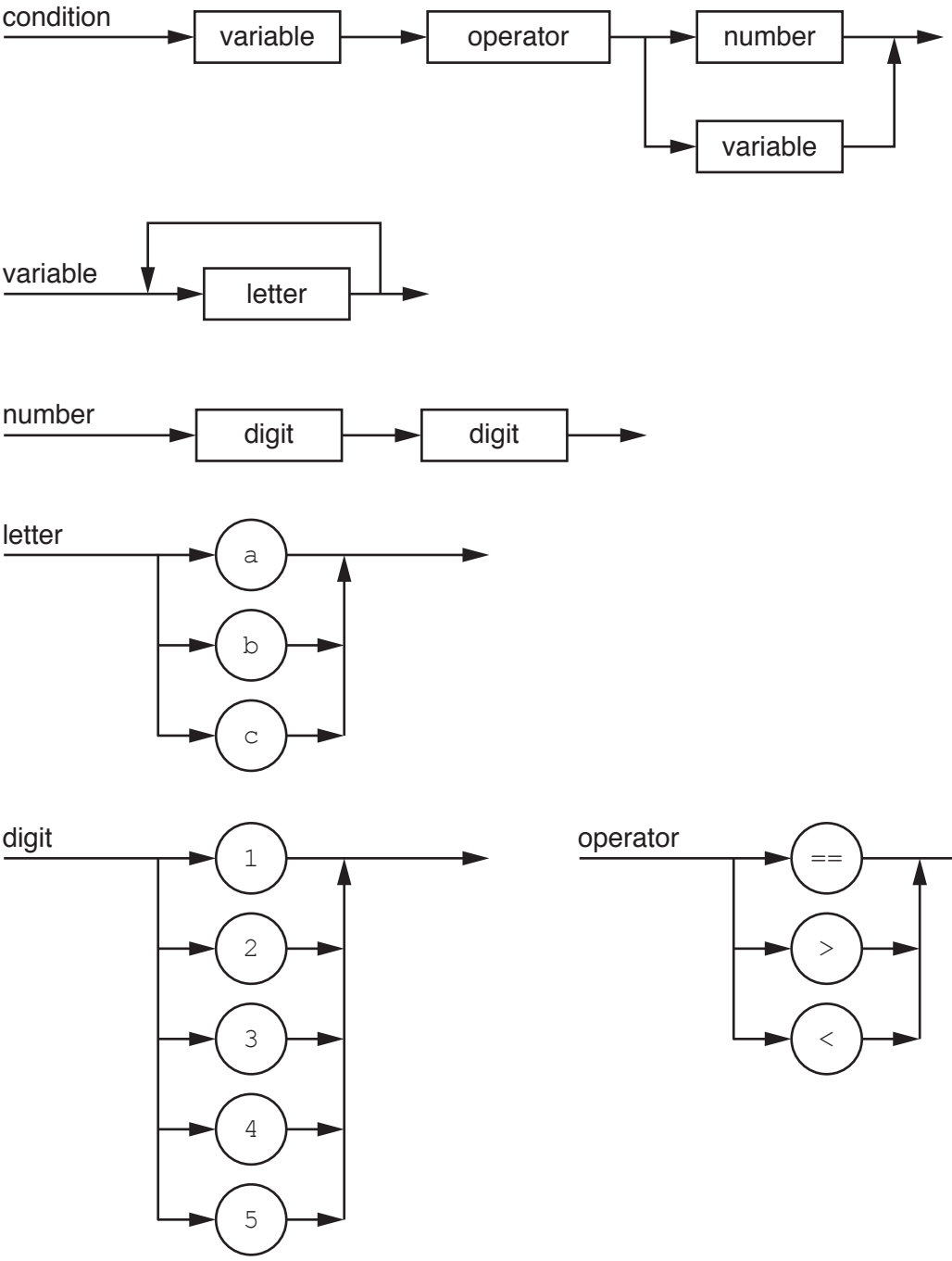
..... can occur in the exponent of a floating-point number, when the exponent has become too large to be represented using the number of bits available.

A calculation results in a number so small that it cannot be represented by the number of bits available. This is called ..... .

[2]

2 The following syntax diagrams for a programming language show the syntax of:

- a condition
- a variable
- a number
- a letter
- a digit
- an operator



(a) The following conditions are invalid.

Give the reason in each case.

(i) `35 > 24`

Reason .....

..... [1]

(ii) `abc := cba`

Reason .....

..... [1]

(iii) `bc < 49`

Reason .....

..... [1]

(b) Complete the Backus-Naur Form (BNF) for the syntax diagram.

<operator> ::= .....

.....

<number> ::= .....

.....

<variable> ::= .....

.....

<condition> ::= .....

.....

[6]

3 Protocols are essential for communication between computers.

(a) Explain why protocols are essential for communication between computers.

.....

.....

.....

.....

..... [2]

(b) A protocol used in bus networks is CSMA/CD.

Explain what is meant by **CSMA/CD**.

.....

.....

.....

.....

.....

.....

.....

..... [4]

4 A Boolean expression produces the following truth table.

INPUT			OUTPUT
A	**B**	**C**	**X**
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

(a) Write the Boolean expression for the truth table as a sum-of-products.

X = ... [2]

(b) Complete the Karnaugh Map (K-map) for the truth table above.

		AB			
		00	**01**	**11**	**10**
C	**0**				
	1				

[1]

The K-map can be used to simplify the expression in **part (a)**.

(c) Draw loops around appropriate groups in the K-map in **part (b)** to produce an optimal sum-of-products. [2]

(d) Write, using your answer to **part (c)**, a simplified sum-of-products expression for the truth table.

X = ... [2]

5 **(a)** Explain why user-defined data types are necessary.

.....

.....

.....

..... [2]

(b) An organisation stores data about its employees.

- Employee ID is a five-digit number, for example, 01234.
- Employee name is a string, for example, 'Kiri Moana'.
- Department is one of three values: Sales, Technical, Customer services.
- Salary is an integer value in the range 25 000 to 150 000.

(i) Complete the following **pseudocode** definition of a user-defined data type to store the employee data.

```
TYPE Employee

  DECLARE EmployeeID   :  .....
  DECLARE EmployeeName :  STRING
  DECLARE Department   :  ( .....
                             .....)
  DECLARE Salary       :  25000..150000
```

.....

[4]

(ii) Write a **pseudocode** statement to declare a variable, `NewEmployee` of data type `Employee`.

.....

..... [1]

(iii) Write a **pseudocode** statement that assigns `02244` to the `EmployeeID` of `NewEmployee`.

.....

..... [1]

(iv) `Employee` is an example of a record that is a composite data type.

State **two** other composite data types.

1 .....

2 .....

[2]

6 **(a)** An operating system (OS) uses a memory management technique called paging.

Explain what is meant by the following terms.

Page .....

.....

.....

Page frame .....

.....

.....

Page table .....

.....

..... [3]

(b) Explain why an operating system needs to use scheduling algorithms.

.....

.....

.....

.....

.....

..... [3]

(c) State what is meant by an **interrupt**.

.....

..... [1]

(d) For a computer system using multi-programming, the low-level scheduler decides which process will get next use of the processor.

One algorithm could be a round-robin, which means every process gets use of the processor in sequence for a fixed amount of time (time-slice).

For a round-robin algorithm, five processes are currently loaded and get the use of the processor in the sequence:

JOB21 – JOBSS – JOBPT – JOB32 – JOB42, then return to JOB21

Process JOB32 has just completed its time-slice.

The following paragraph describes what happens next. Complete the paragraph by inserting the missing processes.

Interrupt received from the low-level scheduler. Save all register contents for

..... .

Copy the saved registers for ..... to the CPU.

The processor will now process ..... .

[3]

7 **(a)** Identify the **four** layers of the TCP/IP protocol suite.

1 .....

2 .....

3 .....

4 .....

[4]

(b) The TCP/IP protocol suite is responsible for transmitting data across the Internet using packet switching.

(i) Explain why packet switching is used when sending data across the Internet.

.....

.....

.....

..... [2]

(ii) Each packet requires a header.

Describe the purpose of a packet header.

.....

.....

.....

..... [2]

(iii) Identify **three** items that should be contained in a packet header.

Item 1 .....

.....

Item 2 .....

.....

Item 3 .....

.....

[3]

8 Digital certificates are used in internet communications. A Certificate Authority (CA) is responsible for issuing a digital certificate.

(a) Identify **two** data items present in a digital certificate.

1 .....

2 .....

[2]

(b) The following paragraph describes how a digital signature is produced. Complete the paragraph by inserting an appropriate term in each space.

A ..... algorithm is used to generate a message digest from the plain text message. The message digest is ..... with the sender's ..... .

[3]

9 **(a)** The following incomplete table shows descriptions relating to computer architectures.

Complete the table by inserting the appropriate terms.

	Description	Term
A	• There are several processors. • Each processor executes different sets of instructions on one set of data at the same time.	.....
B	• The processor has several ALUs. • Each ALU executes the same set of instructions on different sets of data at the same time.	.....
C	• There is only one processor. • The processor executes one set of instructions on one set of data.	.....
D	• There are several processors. • Each processor executes a different set of instructions. • Each processor operates on different sets of data.	.....

[4]

(b) State **three** characteristics of massively parallel computers.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

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CANDIDATE NAME

CENTRE NUMBER

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COMPUTER SCIENCE **9608/32**

Paper 3 Advanced Theory **October/November 2019**

1 hour 30 minutes

Candidates answer on the Question Paper.

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The maximum number of marks is 75.

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[Turn over

1 **(a)** The following incomplete table shows descriptions relating to the security of data transmission.

Complete the table with the appropriate terms.

	Description	Term
A	The original data to be transmitted as a message	.....
B	An electronic document from a trusted authority that ensures authentication	.....
C	An encryption method produced by a trusted authority that can be used by anyone	.....

[3]

(b) **(i)** Explain the purpose of a digital signature.

.....

.....

.....

..... [2]

(ii) Describe how a digital signature is produced for transmission with the message.

.....

.....

.....

.....

.....

.....

..... [3]

2 **(a)** A Boolean expression produces the following truth table.

INPUT			OUTPUT
A	**B**	**C**	**X**
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

(i) Write the Boolean expression for the truth table by applying the sum-of-products.

X = ...

..... [3]

(ii) Complete the Karnaugh Map (K-map) for the truth table in **part (a)**.

		AB			
		00	**01**	**11**	**10**
C	**0**				
	1				

[1]

The K-map can be used to simplify the function in **part (a)(i)**.

(iii) Draw loop(s) around appropriate groups in the table in **part (a)(ii)**, to produce an optimal sum-of-products. [2]

(iv) Write, using your answer to **part (a)(iii)**, a simplified Boolean expression for your Karnaugh map.

X = ... [2]

(b) Simplify the following expression using De Morgan's laws. Show your working.

$$\overline{(\overline{W} + X) \bullet (Y + \overline{Z})}$$

.....

.....

.....

.....

.....

..... [3]

3 A computing department in a school has a Local Area Network (LAN) with a bus topology.

(a) A description of sending a message on a bus network is given.

Complete the following description by inserting an appropriate term in each space.

Computer 1 and Computer 2 are on the same bus network. Computer 1 sends a message to Computer 2. Before the message is sent, it is split into ..... .

Computer 1 needs to check that the ..... is free, before sending the message, otherwise a ..... will occur that will be managed by the ..... protocol.

[4]

(b) The computing department's LAN needs to connect to the Internet.

Explain how each device is used in the operation of the bus network.

Router .....

.....

.....

.....

Network Interface Card (NIC) .....

.....

.....

.....

[4]

(c) The computing department's network is being adapted to allow students to connect wireless devices.

(i) Identify **two** types of hardware components the computing department will need to allow wireless connection.

1 .....

2 .....
[2]

(ii) Describe how the wireless connection sends and receives data.

.....

.....

.....

.....

.....

.....

.....

..... [4]

4 Physical memory is managed using virtual memory and paging.

(a) Describe what is meant by **virtual memory**.

.....

.....

.....

..... [2]

(b) **(i)** Explain how paging is used to manage virtual memory.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(ii) Give a suitable page replacement algorithm for this process.

..... [1]

(iii) One drawback of using virtual memory is disk thrashing.

Describe what is meant by the term **disk thrashing**.

.....

.....

.....

..... [2]

5 A weather station uses monitoring and control systems.

(a) Describe the difference between a monitoring system and a control system.

.....

.....

.....

..... [2]

(b) **(i)** The weather station records how the outside temperature changes over a period of time. The system will read the temperature once every hour, over a period of 100 days.

The temperature readings are automatically stored in a file. No other data are stored.

Explain why the weather station has decided to use serial organisation for the file.

.....

.....

.....

..... [2]

(ii) Serial files can be accessed using sequential access.

Explain how sequential access could be used for the temperature readings file.

.....

.....

.....

..... [2]

(iii) Name **and** describe a method of file organisation other than serial or sequential.

Method .....

Description .....

.....

.....

.....

.....

.....

[4]

6 **(a)** State what is meant by a **user-defined data type**.

.....

..... [2]

(b) A pseudocode declaration for a user-defined data type for the months of the year is as follows:

```
TYPE
  DECLARE Months: (January, February, March, April, May, June, July,
                   August, September, October, November, December)
ENDTYPE
```

(i) Identify this type of user-defined data type.

.....

..... [1]

(ii) Write a **pseudocode** statement to declare a variable `CurrentMonth` of data type `Months`.

.....

..... [1]

(iii) Write a **pseudocode** statement to assign the value `August` to the variable `CurrentMonth`.

.....

..... [1]

7 The following are the first few lines of a source code program written in a high-level language. The source code program is to be translated by the language compiler.

```
// program written on 15 June 2019

DECLARE IsFound : Boolean;
DECLARE NoOfChildren : Integer;
DECLARE Count : Integer;
Constant TaxRate = 15;

// start of main program
For Count = 1 to 50
…
…
…
```

(a) During the lexical analysis stage, the compiler will use a keyword table and a symbol table.

(i) Identify **two** types of data in the keyword table.

Type 1 .....

Type 2 .....
[2]

(ii) Identify **two** types of data in the symbol table.

Type 1 .....

Type 2 .....
[2]

(iii) Explain how the contents of the keyword and symbol tables are used to translate the source code program.

.....

.....

.....

..... [2]

(iv) State **one** additional task completed at the lexical analysis stage that does not involve the use of a keyword or a symbol table.

.....

..... [1]

(b) The final stage of compilation can be code optimisation.

Explain why code is optimised.

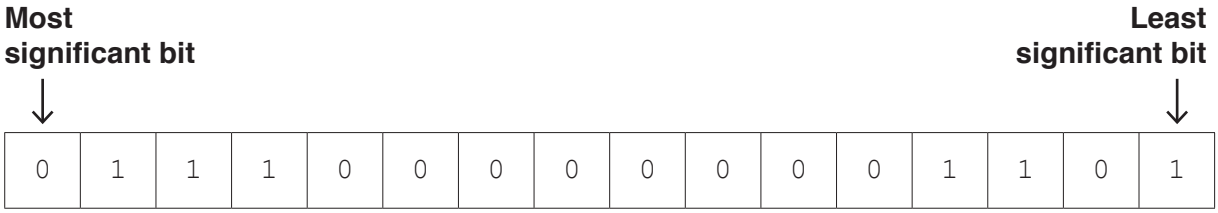
.....

.....

.....

..... [2]

8 **(a)** The following 16-bit binary pattern represents a floating-point number stored in two's complement form. The twelve most significant bits are used for the mantissa and the four least significant bits are used for the exponent.



(i) Identify the binary value of the exponent.

..... [1]

(ii) Identify the binary value of the mantissa.

..... [1]

(iii) State whether the number stored is positive or negative. Justify your choice.

Positive or negative .....

Justification .....

.....

.....

[2]

(iv) Convert the binary floating-point number in **part (a)** into denary. Show your working.

Working .....

.....

.....

.....

.....

Denary value .....

[3]

(b) The number of bits used for the exponent is increased to eight, and the number of bits used for the mantissa is decreased to eight.

State the effects of this change.

.....

.....

.....

..... [2]

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