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

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

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]

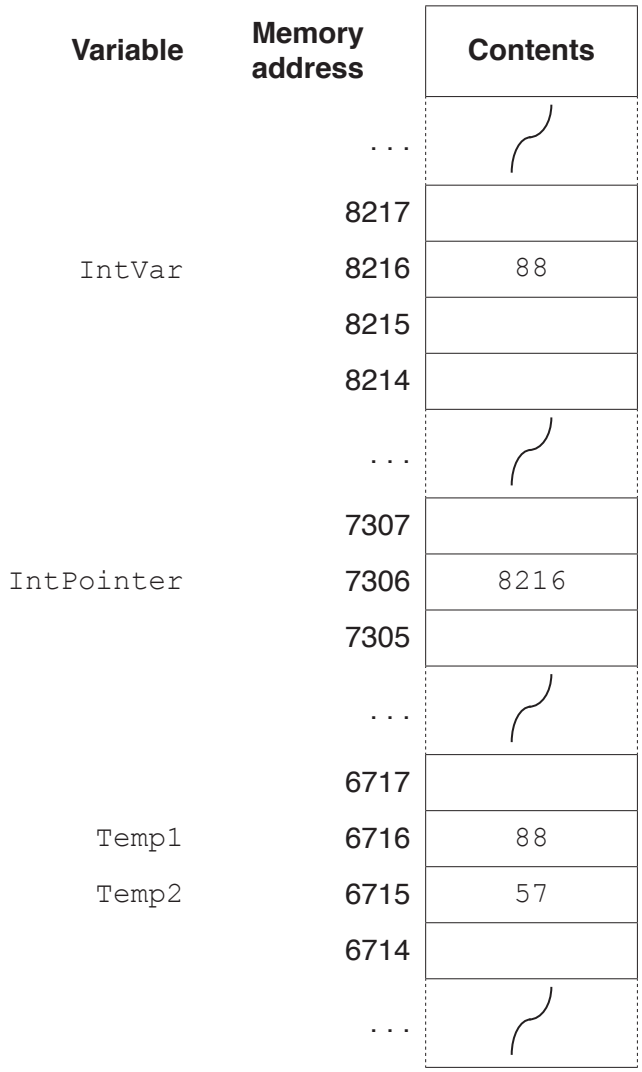
(c) A pointer is a variable that stores the address of a variable of a particular type.

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.

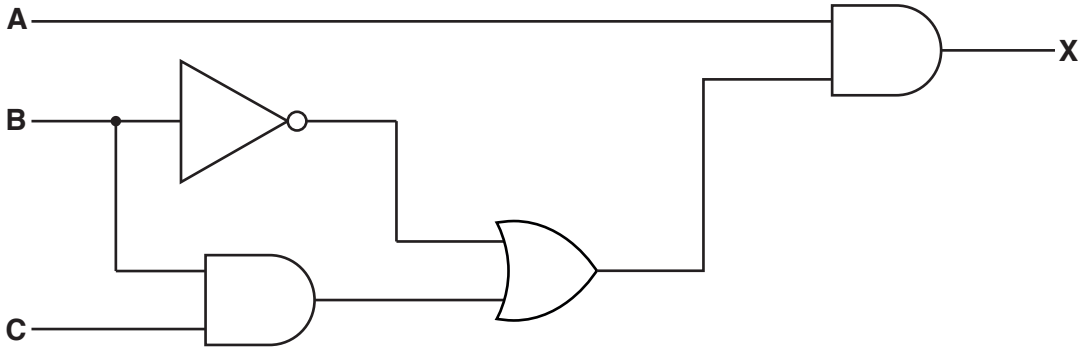
Complete the table.

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 .....

.....

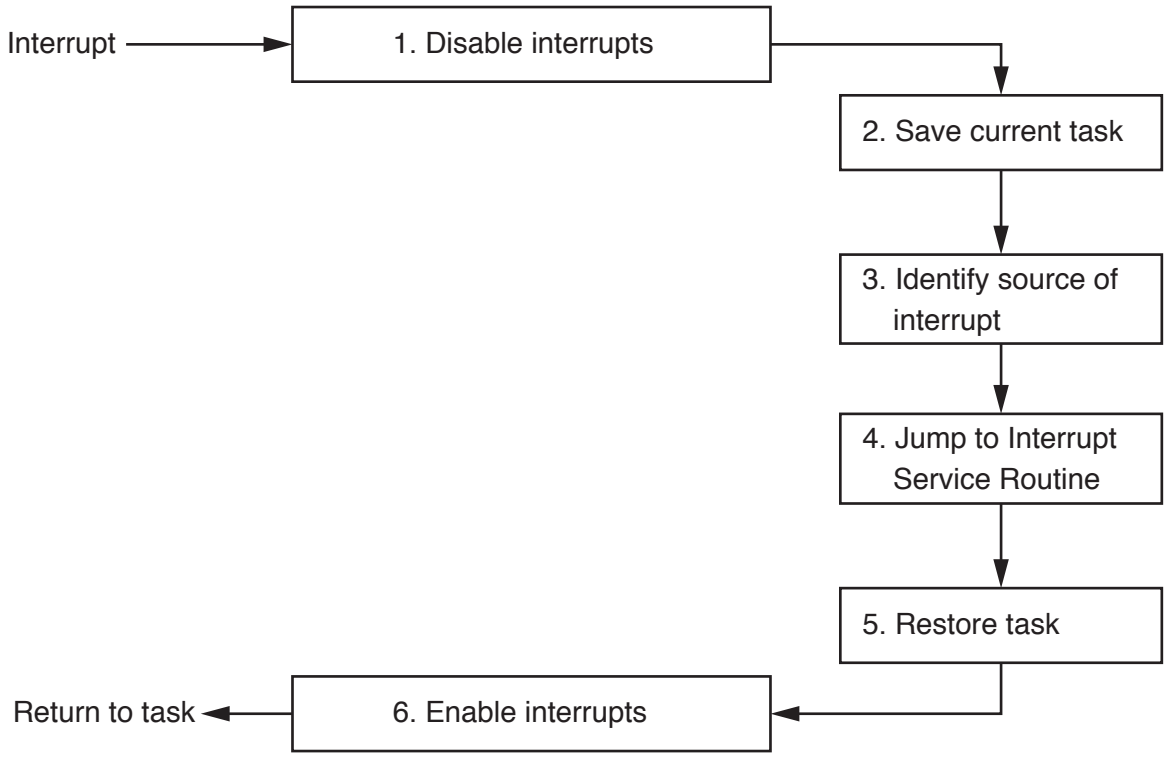
Drawback 2 .....

.....

[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]