

# Candidate Marks Report

*Series : 6 2018*

This candidate's script has been assessed using On-Screen Marking. The marks are therefore not shown on the script itself, but are summarised in the table below.

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Centre No :	Assessment Code :	H446
Candidate No :	Component Code :	01
Candidate Name :		

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Total Marks :

In the table below 'Total Mark' records the mark scored by this candidate.  
'Max Mark' records the Maximum Mark available for the question.

Answer all the questions.

1 A digital coffee making machine has a CPU that uses the Little Man Computer Instruction Set.

(a) Little Man Computer operates on a computer system based on the Von Neumann Architecture.

(i) State **two** features of the Von Neumann architecture.

1 Instructions and data have a shared memory

Space

2 Instructions and data are stored in the same

format

[2]

(ii) Describe **one** feature, **not** part of the standard Von Neumann Architecture, which contemporary CPUs may have in order to improve performance.

Pipelining improves performance. This can be

seen in the fetch, decode, execute cycle, where

each step is performed concurrently, whereas in

the von neumann architecture they are done in

sequence

[2]

(b) Part of the coffee making machine's code asks the user to press a button to select strength. The code outputs 1 which will switch on a green light to indicate a valid selection or outputs 0 to indicate an invalid selection.

The code is shown below:

	INP	
	STA	entry
	LDA	max
	SUB	entry
	BRP	accept
	LDA	redLight
	BRA	printAndEnd
accept	LDA	greenLight
printAndEnd	OUT	
	HLT	
greenLight	DAT	1
redLight	DAT	0
max	DAT	5
entry	DAT	

Fig. 1



- (i) Tick the appropriate boxes below to indicate which inputs will result in a green light (i.e. code outputs 1) and which with a red light.

Input	Green Light	Red Light
1	✓	
2	✓	
3	✓	
4	✓	
5	✓	
6		✓
7		✓
8		✓
9		✓

[2]

- (ii) Explain which registers and buses are used, and the values they store/carry, when the line LDA redLight is executed (after it has been fetched and decoded). You should assume the address redLight refers to memory location 11.

When LDA redLight is run, the data location of redLight (in this case 11) is loaded into the Memory Address Register. The ~~value~~ location in the MAR is then sent down the address bus into memory. The value in data location 11 (which is 0) is sent along the data bus, into the Memory Data Register, where it is then loaded into the accumulator for use

[6]



- (iii) Write code in a high-level language or pseudocode that has the same functionality as the code in Fig. 1.

```

i = int(input("Enter a value"))
IF i <= 5
    Print("1")
ELSE
    Print("0")
ENDIF

```

[3]

- (iv)\* Discuss the differences between assembly code and high-level languages. You should refer to:

- the advantages and disadvantages of writing programs in assembly code rather than a high-level language
- when each approach might be used
- why the coffee machine was programmed in assembly code.

Assembly code is code closer to what the CPU can interpret. Each line relates to a single machine code instruction that the CPU can process.

Assembly code can be quicker to run, as there is no need for compilation or interpretation. Programs written in assembly code are generally smaller in size compared to high level languages as instructions take up less memory.

However, assembly code can be longer and more complicated to write, as there are less instructions when compared to a high level language.

High level languages could be used in game development for example, where an assembly language would be used in a smaller <sup>embedded</sup> system. It is suitable for a coffee machine as the code is simple and small, making it easier to store and reducing the memory <sup>and cost</sup>. [9]



2 A software company decides to build an operating system for OCR smart watches.

(a) Memory management is one of the functions of an operating system.

(i) List **three** functions, other than memory management, of an operating system.

- 1 Providing a platform for applications/utility
- 2 Managing device drivers and connections with other devices or peripherals
- 3 providing security

[3]

Part of a computer's memory is represented below (Fig. 2). The operating system divides the memory into equally sized chunks.

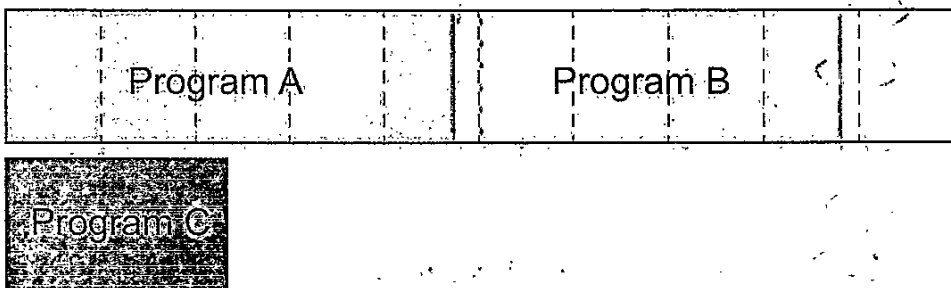


Fig. 2

(ii) State the name of the type of memory management used in Fig. 2.

Paging

[1]

(iii) The operating system needs to load program C into memory but there is not enough space. Describe how the operating system would use virtual memory to load program C.

A program not in use (either A or B), would be sent to virtual memory, and stored there until needed. C would then be able to be loaded as memory has been cleared in RAM. If the program in virtual memory is needed, ~~the~~ another program will be sent to virtual memory, and the needed program ~~is~~ restored to RAM.

[3]



- (b) The company sets up a website to promote the watch. Part of the website is shown below. The sentence 'Download The Factsheet' is a hyperlink to the file factsheet.pdf which is stored in the same folder as the HTML file for the webpage.

## Features

The new OCR Smart Watch:

1. Uses the CB2 RISC processor for long battery life
2. Stores up to 20hrs of music
3. Tracks fitness

Download The Factsheet

- (i) Write the HTML to produce the extract from the webpage above. You can assume it will be placed within the <body> tags of a pre-existing page. You do **not** need to specify the font.

```
<h1><b>Features</b></h1>
<ol> The new OCR smart watch
<li> uses the CB2 RISC processor for long battery life </li>
<li> stores up to 20hrs of music </li>
<li> tracks fitness </li>
</ol>
<a href="factsheet.pdf">Download the factsheet </a>
```

[5]



- (ii) Explain what happens when a search engine indexes the page. You do not need to discuss ranking.

When a webpage is indexed, a crawler travels through the page, indexing the words in the page before following all the links on the page. Any meta data is also indexed. The results of the index is stored to allow for easy web searching when a keyword is entered into the web browser [3]

- (iii) Explain why using a RISC processor rather than a CISC processor is likely to result in increased battery life.

RISC only needs one clock cycle per instruction, and has a lowered energy consumption, thus increasing battery life. CISC takes multiple cycles per instruction, and has an increased energy consumption, thus lowering battery life. [3]



- 3 An airport holds details of flights in a database using the table `Flight`. An extract of the table is shown below.

<u>FlightID</u>	<u>FlightNumber</u>	<u>DestinationCode</u>	<u>DestinationName</u>	<u>DepartureDate</u>	<u>DepartureTime</u>
1355	OC0089	JFK	John F. Kennedy	03/07/18	09:50
1453	CS1573	LHR	Heathrow	03/07/18	10:30
1921	OC7750	JFK	John F. Kennedy	04/07/18	08:30
1331	AM0045	YHZ	Halifax	04/07/18	14:25
1592	HB0326	RTM	Rotterdam	04/07/18	19:10
1659	CS0123	LHR	Heathrow	04/07/18	07:20

- (a) Describe what the SQL statement below does.

```
SELECT FlightNumber FROM Flight WHERE DestinationCode='JFK'
```

.....  
 Selects a row in the 'FlightNumber' column, in the  
 'Flight' table, where the destination code is  
 'JFK'  
 .....  
 ..... [2]

The airport cancels all its flights to Heathrow on 4<sup>th</sup> July 2018.

- (b) The SQL statement below shows all the data for flights going to Halifax. Rewrite it so it instead removes all flights to Heathrow on 4<sup>th</sup> July 2018.

```
SELECT * FROM Flight WHERE DestinationName='Halifax'
```

.....  
~~SELECT~~ DELETE \* FROM 'Flight'  
 WHERE DestinationName = 'Heathrow'  
 AND DepartureDate = '04/07/18'  
 .....  
 .....  
 ..... [3]





(c) Tables often have primary and secondary keys.

(i) State why DestinationCode would **not** be a suitable primary key for the Flight table.

Different flights can go to the same destination, & a primary key should be unique [1]

(ii) State why DestinationCode would be a suitable secondary key for the Flight table.

Allows for the table to be quickly searched or indexed based on where the flight is going [1]

(d) The airline wishes to ensure the database is normalised.

(i) Describe why the database can be considered to be in First Normal Form.

The database can be considered in 1NF as it has a clear primary key, and each cell only has one data item in it. [2]

(ii) Describe why the database can be considered to be in Second Normal Form.

There are no many to many relationships present. [2]

(iii) Describe why the database can **not** be considered to be in Third Normal form.

Some columns, such as destination name, are not dependant on the primary key, and should be moved into a separate table [2]



- (e) The airport wishes to allow airlines to be able to access the data it has on flights via the internet.

Describe **one** format or method the airport could use to provide the data to the airlines so they can use it in their own applications.

.....

.....

.....

..... [2]



4 The internet can be considered an example of a WAN.

(a) Describe what is meant by the term 'WAN'.

A wide area network is a network that covers a large area, not just a single building.

[2]

(b) The internet uses a set of protocols referred to as the TCP/IP stack. The TCP/IP stack consists of four different layers, each with its own set of protocols.

(i) Explain why protocols are important on a network.

Protocols allow for <sup>different</sup> devices and networks to share data between each other by keeping consistent standards. This ensures data can be read and sent across a range of devices.

[2]

(ii) State the name of the four layers of the TCP/IP stack.

- 1 Application
- 2 Transport
- 3 Internet
- 4 Link

[4]



- 5 A software company is producing software that allows users with severe mobility issues to input data into a computer.

The software flashes up letters on the screen one at a time. The user sends a signal to the computer when the letter they want appears on the screen.

- (a) State the name of an input device and describe how it could be used by a user with very limited mobility in their hands and arms to send a signal to the computer.

Device name: ..... A Mouse .....

How it would be used: ..... the user would press on the  
Mouse button to send the signal to the  
Computer .....

[2]



- (b) Rather than displaying the whole alphabet, once the first letter has been entered, the program only shows letters that could be possible according to words in its dictionary. All possible words are stored in a tree data structure.

The program is tested on a sample dictionary of four words, represented as a tree in Fig. 3:

BARON  
BATHS  
BELOW  
BELTS

- (i) Annotate Fig. 3 to show how the word BELTS would be removed from the tree. [2]  
(ii) Annotate Fig. 3 to show how the words BEACH and BONE would be added to the tree. [2]

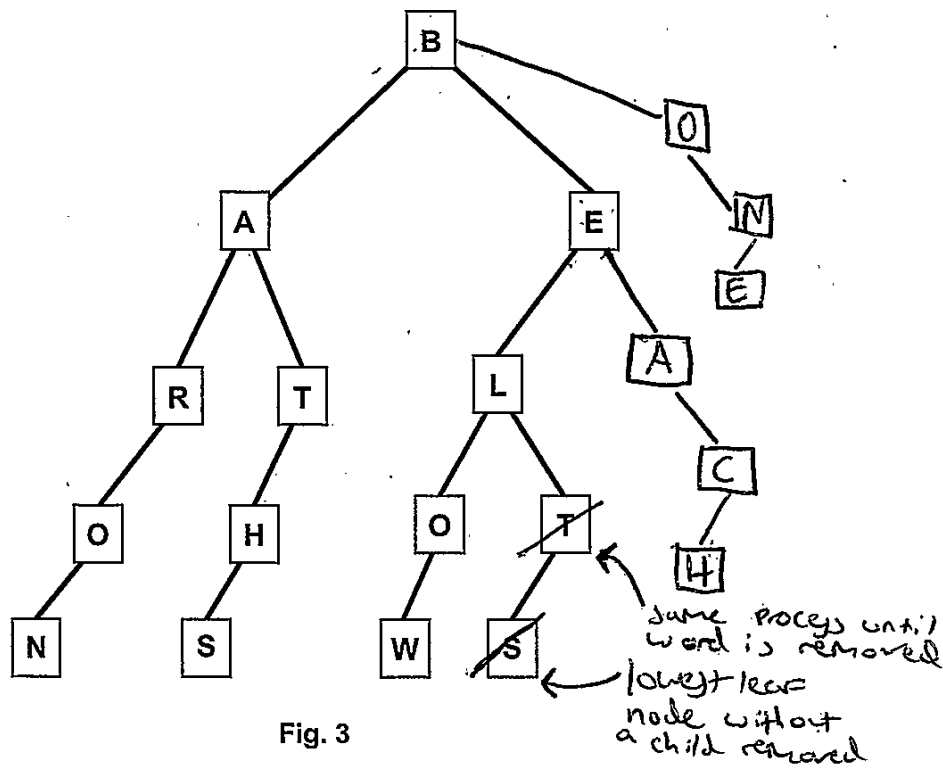


Fig. 3

- (c) The developer decides she wants to make the software program open source.

Explain the benefits to the users of the software being open source.

Open source programs allow users to access the source code, allowing them to modify the system to suit their specific needs

[2]



6\* "Technology is changing too quickly for the law to keep up."

Discuss to what extent you agree with the statement above. In your discussion you should explain which laws regulate the use of technology and how advancements in technology have made the laws difficult to enforce/implement.

To an extent I agree with the statement.

While there are laws in place to protect users,

modern advancements have made it hard to properly enforce laws.

For example, the computer misuse act is designed to protect users from unauthorized access, however modern proxy and masking software, as well as developments in hacking, have made it harder to protect users, as well as find <sup>and</sup> ~~the~~ apprehend ~~and~~ perpetrators.\*

With modern social media and technology, the data protection act is also becoming harder to uphold. As seen recently with Facebook, companies can take, process and sell <sup>private</sup> data such as messages and search history, as well as personal information, to countries and agencies without adequate data protection laws, without the government or the users themselves being aware. ~~The~~ tracking what companies keep and do has become ~~extremely~~ extremely hard, and often <sup>by the time they are caught,</sup> the damage has already been done.

\* Modern proxy, ~~and~~ firewalls and the availability of ~~strong~~ strong encryption has also made it harder for the Regulation of Investigatory Powers Act to be upheld, as often ~~the~~ users' ~~data's~~ history and communications are encrypted to a high degree, keeping criminal activity [12] hidden.



7 A taxi firm is investigating replacing its drivers with self-driving cars.

(a) Explain why the self-driving system will use a real-time operating system.

Real time operating systems can react in a very short time (a fraction of a second). This is necessary in a high speed driving scenario where the system will have to react to stimuli such as obstacles, turnings and other cars quickly to avoid crashing. [3]



- (b) The code for the self-driving system has been written using an object-oriented programming language.

It recognises obstacles in the road and then classifies them.  
The class for Obstacle is shown below.

```
public class Obstacle
    private moving //Boolean value
    private distance //Real number given in metres
    private direction //Integer given as between 1 and 360 degrees

    public procedure new(givenMoving, givenDistance, givenDirection)
        moving=givenMoving
        distance=givenDistance
        direction=givenDirection
    endprocedure

    public procedure updateDistance(givenDistance)
        distance=givenDistance
    endprocedure

endclass
```

- (i) Write a line of code to create an object called bollard of type Obstacle which is not moving and is 7.8 metres away in a direction of 8 degrees.

~~new Obstacle~~  
.....  
new Obstacle = bollard (0, 7.8, 8); ..... [2]

- (ii) Describe an example of encapsulation in the class definition code above.

Encapsulation means that only given methods have access  
to private attribute. For example the attribute distance  
is private, and so can only be edited by  
the given method updateDistance. .... [2]

- (iii) Describe the advantages of using encapsulation.

Allows the user to set conditions and control  
how an attribute is changed. This can prevent  
an attribute being changed accidentally or to  
an invalid value, ~~and~~ and can protect against  
malicious alterations. .... [2]





- (c) The self-driving program recognises people as a special type of obstacle and the class Person should inherit the methods and attributes of Obstacle. People are treated like other obstacles except:
- when the updateDistance method is called, if the person is more than 2 metres away but is 5 metres (or less) away, the method Controls.beepHorn() is called.
  - when the person is 2 metres away (or closer), the method Controls.applyBrakes() is called as well as Controls.beepHorn().

Complete the class Person.

class Person inherits Obstacle

public procedure updateDistance(givenDistance)

IF givenDistance > 2 AND givenDistance ≤ 5  
Controls.beepHorn()

ELSE IF givenDistance ≤ 2  
Controls.beepHorn()

Controls.~~beepHorn~~applyBrakes()

ENDIF

distance=givenDistance

endprocedure

endclass

[5]

- (d) Give one advantage and one disadvantage to the customers of the taxi using self-driving cars rather than drivers.

Advantage

Allows for quicker reaction to obstacles compared  
to humans

Disadvantage

Can raise ethical questions regarding the best outcome  
in a situation involving human life



- 8 A student writes a program to apply a symmetric encryption algorithm to work on messages of up to 25 ASCII characters.

(a) Describe what is meant by the term 'ASCII'.

ASCII is a character set used by computers to represent letters and special characters, by giving each character a unique 8 bit binary value.

[2]

The encryption algorithm works in the following way.

A message of up to 25 characters (spaces and punctuation are not included) is placed in a 5×5 array. Any leftover spaces are filled with random letters. The message I LOVE COMPUTER SCIENCE becomes:

I	L	O	V	E
C	O	M	P	U
T	E	R	S	C
I	E	N	C	E
T	O	W	R	M

The key is a sequence of ten numbers.

In this example we will use 1 2 3 4 5 1 2 3 4 5. The first 5 numbers state how many spaces the rows 0 to 4 must be rotated right.

A key with the first 5 digits 1 2 3 4 5 would result in

E	I	L	O	V
P	U	C	O	M
R	S	C	T	E
E	N	C	E	I
T	O	W	R	M

The next 5 digits state how many spaces down the columns 0 to 4 should be rotated.

Applying the last 5 digits 1 2 3 4 5 to the grid above would give

T	N	C	O	V
E	O	C	T	M
P	I	W	E	E
R	U	L	R	I
E	S	C	O	M



Part of the pseudocode for the algorithm is written below.

```

global array grid[5,5]
addMessage()
// letters and random letters have been entered
// into the 2D array, grid

for i = 0 to 4
    x = getNextDigitInKey() → Gets key
    shiftRow(i,x)
next i

for i = 0 to 4
    x = getNextDigitInKey()
    shiftColumn(i,x)
next i

//Now reassemble array back into string.

```

(b) Show the result of running the algorithm on the grid and key below.

[2]

**KEY:** 3 3 3 3 1 1 1 1 1

T	O	P	S	E
C	R	E	T	M
E	S	S	A	G
E	Y	R	P	L
U	O	G	G	Q

Grid after only the rows are shifted:

P	S	E	T	E
E	T	M	C	R
S	A	G	E	S
R	P	L	E	Y
G	G	Q	U	O

Grid after columns have also been shifted:

G	G	Q	U	O
P	S	E	T	E
E	T	M	C	R
S	A	G	E	S
R	P	L	E	Y



(c) Write the procedure shiftRow.

New Procedure shiftRow(i, x)

~~For counter = 0 to x~~ Counter = 0

For counter = 0 to x

i = i + 1

END For

End Procedure

[4]



(d)\* Modern encryption is much stronger than the method described in the first part of this question.

Discuss the impact of modern encryption on society. You should refer to:

- The importance of asymmetric encryption and how it differs from symmetric encryption.
- Different circumstances in which symmetric and asymmetric encryption may be used.

A symmetric encryption differs from asymmetric encryption as it uses two keys. Each user will have a public and a private key. The sender will encrypt the message with the receiver's public key, and the receiver will unlock it with a private key only they have access to. This is safer as there is no chance of the key being intercepted or the encryption process being reversed.

Asymmetric encryption can be much less safe, ~~as~~ symmetric encryption is generally used in important files or data such as passwords in a business or government setting.

Asymmetric encryption has made sure vital ~~connections~~ connections are safe and secure, preventing data breaches and hacks in classified documents.

[9]



9 (a) Demonstrate how the bytes below are added together. Show your working.

$$\begin{array}{r}
 01101010 \\
 00111111+ \\
 \hline
 10101001 \\
 \phantom{10101001} + \\
 \phantom{10101001} 0 \\
 \hline
 = 10101001
 \end{array}$$

[2]

(b) Demonstrate how the bottom byte below is subtracted from the top byte. Show your working.

$$\begin{array}{r}
 \overset{x}{0} \overset{x}{0} \\
 \cancel{1} \cancel{1} 001111 \\
 00111001 - \\
 \hline
 00110110 \\
 \hline
 = 00110110
 \end{array}$$

[2]

(c) Convert the binary number shown below to hexadecimal.

0011	1011	1000	0111
3	7	0	F

0123456789ABCDEF

= 370F

[2]

(d) The number below is represented in floating point format with a 5-bit mantissa in two's complement followed by a 3-bit exponent in two's complement. Calculate the denary value of the number, showing your working.

01001<sup>421</sup>010      exponent = FZ      ~~10~~

$0.\overset{t}{1}0001$

= 010.01 8421.  $\frac{1}{2} \frac{1}{4} \frac{1}{8} \frac{1}{16}$

0010.0100

2              .25

= 2.25

[3]



- (e) The numbers below are represented in floating point format with a 5-bit mantissa in two's complement followed by a 4-bit exponent in two's complement. Normalise the numbers shown below, showing your working.

00011 0010

$$\underbrace{0.0011}_{\text{5-bit mantissa}} \underbrace{0010}_{\text{4-bit exponent}}$$

<sup>2</sup>

$$= 000.1100 = \text{Positive so should start with 0.1}$$

$$= 0.1000 0000$$

[2]

11100 0110

$$\underbrace{1.1100000110}_{\text{5-bit mantissa}}$$

<sup>6</sup>

$$= \text{Negative so should start with 1.0}$$

$$= 1.0000 0100$$

[2]

- (f) Show the byte below after having an AND applied with the masking byte.

Byte	1	0	1	1	1	0	0	1
AND	1	1	1	1	1	1	1	1
Result	1	0	1	1	1	0	0	1

[1]

- (g) Show the byte below after having an OR applied with the masking byte.

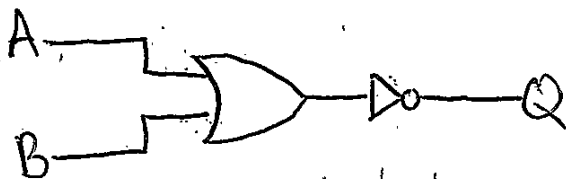
Byte	1	0	1	1	1	0	0	1
OR	1	1	1	1	1	1	1	1
Result	1	1	1	1	1	1	1	1

[1]



10 (a) Draw a logic gate diagram to represent the Boolean expression:

$$Q \equiv \neg(A \vee B)$$



[2]

(b) Find the Boolean expression represented in the Karnaugh Map below. Show your working.

		AB			
		00	01	11	10
CD	00	1	1	1	1
	01	0	0	1	1
	11	0	0	0	1
	10	0	0	0	1

Handwritten annotations: A '2' is written next to the top row (CD=00). A '3' is written next to the rightmost column (AB=10). The rightmost column is circled.

$$1 = \neg A \wedge \neg B \wedge \neg C \wedge D$$

$$2 = A \wedge (A \vee B) \wedge (\neg C \wedge D) \wedge (\neg C \wedge D)$$

$$3 = A \wedge \neg B \wedge C \vee (C \wedge D)$$

[5]

END OF QUESTION PAPER

# OCR

Oxford Cambridge and RSA

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