AQA

Please write clearly in block capitals.

Centre number ☐☐☐☐☐   Candidate number ☐☐☐☐

Surname ____________________

Forename(s) ____________________

Candidate signature ____________________
I declare this is my own work.

AS
COMPUTER SCIENCE
Paper 2

Friday 22 May 2020   Morning   Time allowed: 1 hour 30 minutes

Materials
For this paper you must have:
- a calculator.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

Advice
- In some questions you are required to indicate your answer by completely shading a lozenge alongside the appropriate answer as shown. ●
- If you want to change your answer you must cross out your original answer as shown. ☒
- If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown. ⊗

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

Answer **all** questions in the spaces provided.

0 1 . 1 State the **decimal** equivalent of the hexadecimal number C57

[1 mark]

0 1 . 2 How many different values can be represented using two bytes?

[1 mark]

0 1 . 3 A data transmission system transmits one byte of data, using the majority voting system for error correction.

Figure 1 shows the bit pattern that was received.

Figure 1

`1`	`1`	`1`	`0`	`0`	`0`	`0`	`0`	`0`	`1`	`1`	`0`	`0`	`0`	`1`	`1`	`0`	`1`	`1`	`1`	`1`	`0`	`1`	`1`

Shade **one** lozenge to indicate the byte of data that the receiver will assume was sent.

[1 mark]

A `10010011` ○

B `10011011` ○

C `10010111` ○

D `10011110` ○

0 1 . 4 A check digit can be used to detect errors when data are entered or transmitted.

Explain what a check digit is and outline how the check digit is generated.

[2 marks]

5

0 2 . 1 **Figure 2** shows two unsigned binary integers.

Figure 2

0	0	1	0	1	1	0	1

0	0	0	0	0	1	0	1

What is the result **in binary** of multiplying the two numbers shown in **Figure 2**?

You **must** show all your working in binary.

[2 marks]

Answer

Question 2 continues on the next page

0 2 . 2 Convert the decimal number 6.34375 into an **unsigned fixed point binary number** using 8 bits with 5 bits after the binary point.

You may use the space below for working.

[2 marks]

Answer

		●					

0 3 . 1 A sound is being recorded from an analogue source using a sound card in a computer. The sound card contains an analogue to digital converter (ADC).

Describe the steps the ADC performs in this process.

[3 marks]

A sound has been recorded and takes up 34.56 megabytes (MB) of storage space. The sound lasts 360 seconds and was recorded with a sample resolution of 16 bits.

0 3 . 2 Calculate the sample rate used for the recording.

State your answer in samples per second (Hertz).

You should show your working.

[2 marks]

Answer ____________________

0 3 . 3 State Nyquist's theorem.

[2 marks]

7

Turn over for the next question

0 4 A student has attempted to calculate the minimum file size, in bytes, of a bitmapped image.

The bitmapped image is 10 pixels wide by 16 pixels high with 4 possible colours for each pixel.

The student calculates the answer to be 80 bytes by using the following method:

$$\frac{\text{number of pixels wide} \times \text{number of pixels high} \times \text{number of colours}}{\text{number of bits in a byte}}$$

Explain what the student has done wrong **and** state the correct minimum file size in bytes.

[2 marks]

What the student has done wrong ____________________

____

____

____

Correct minimum file size ____________________

____

2

0 5 . 1 Complete the truth table for A NAND B.

[1 mark]

A	**B**	**A NAND B**
0	0	
0	1	
1	0	
1	1	

0 5 . 2 A XOR B can be implemented as a logic circuit without using an XOR gate.

Using **only** AND, OR and NOT gates draw a circuit that will produce an output **Q** which is logically equivalent to **A XOR B**.

[3 marks]

0 5 . 3 Using the rules and identities of Boolean algebra, simplify the following Boolean expression.

$$\overline{\overline{A + B \cdot \overline{B}} + C \cdot A}$$

You **must** show your working.

[4 marks]

Answer

8

Turn over ►

0 6 . 1 The memory buffer register and the program counter are examples of registers.

What is a register?

[1 mark]

0 6 . 2 Describe the stored program concept.

[2 marks]

0 6 . 3 Some buses in a computer system have to be bidirectional, meaning data or instructions can travel both ways.

Explain why the data bus in a computer system must be bidirectional.

[2 marks]

Do not write outside the box

0 6 . 4 State **two** differences between how the Harvard and von Neumann architectures operate.

[2 marks]

Difference 1 ____

Difference 2 ____

Question 6 continues on the next page

Turn over ►

0 6 . 5 Describe **four** steps that a processor goes through during the fetch stage of the Fetch-Execute cycle.

You **must** explain the purpose of each step.

[8 marks]

15

Turn over for the next question

Table 1 shows the standard AQA assembly language instruction set that should be used to answer question part **0 7 . 1**

Table 1 – standard AQA assembly language instruction set

`LDR Rd, <memory ref>`	Load the value stored in the memory location specified by `<memory ref>` into register `d`.
`STR Rd, <memory ref>`	Store the value that is in register `d` into the memory location specified by `<memory ref>`.
`ADD Rd, Rn, <operand2>`	Add the value specified in `<operand2>` to the value in register `n` and store the result in register `d`.
`SUB Rd, Rn, <operand2>`	Subtract the value specified by `<operand2>` from the value in register `n` and store the result in register `d`.
`MOV Rd, <operand2>`	Copy the value specified by `<operand2>` into register `d`.
`CMP Rn, <operand2>`	Compare the value stored in register `n` with the value specified by `<operand2>`.
`B <label>`	Always branch to the instruction at position `<label>` in the program.
`B<condition> <label>`	Branch to the instruction at position `<label>` if the last comparison met the criterion specified by `<condition>`. Possible values for `<condition>` and their meanings are: `EQ`: equal to `NE`: not equal to `GT`: greater than `LT`: less than
`AND Rd, Rn, <operand2>`	Perform a bitwise logical AND operation between the value in register `n` and the value specified by `<operand2>` and store the result in register `d`.
`ORR Rd, Rn, <operand2>`	Perform a bitwise logical OR operation between the value in register `n` and the value specified by `<operand2>` and store the result in register `d`.
`EOR Rd, Rn, <operand2>`	Perform a bitwise logical XOR (exclusive or) operation between the value in register `n` and the value specified by `<operand2>` and store the result in register `d`.
`MVN Rd, <operand2>`	Perform a bitwise logical NOT operation on the value specified by `<operand2>` and store the result in register `d`.
`LSL Rd, Rn, <operand2>`	Logically shift left the value stored in register `n` by the number of bits specified by `<operand2>` and store the result in register `d`.
`LSR Rd, Rn, <operand2>`	Logically shift right the value stored in register `n` by the number of bits specified by `<operand2>` and store the result in register `d`.
`HALT`	Stops the execution of the program.

Labels: A label is placed in the code by writing an identifier followed by a colon (:). To refer to a label the identifier of the label is placed after the branch instruction.

Interpretation of `<operand2>`

`<operand2>` can be interpreted in two different ways, depending on whether the first character is a `#` or an `R`:

- `#` – use the decimal value specified after the `#`, eg `#25` means use the decimal value 25
- `Rm` – use the value stored in register `m`, eg `R6` means use the value stored in register 6

The available general purpose registers that the programmer can use are numbered 0–12

0 7 . 1 Write an assembly language program to encrypt a single character using the Caesar cipher. The character to be encrypted is represented using a character set consisting of 26 characters with character codes 0–25. The output of the process should be the character code of the encrypted character.

The assembly language instruction set that you should use to write the program is listed in **Table 1**.

Table 2 shows the character codes and the characters they represent.

Table 2

Code	Character
0	A
1	B
2	C
3	D
4	E
5	F
6	G
7	H
8	I

Code	Character
9	J
10	K
11	L
12	M
13	N
14	O
15	P
16	Q
17	R

Code	Character
18	S
19	T
20	U
21	V
22	W
23	X
24	Y
25	Z

- Memory location 100 contains the character code to be encrypted, which is in the range 0–25
- Memory location 101 contains an integer key to be used for encryption, which is in the range 0–25
- The program should store the character code of the encrypted character in memory location 102

[4 marks]

0 7 . 2 An instruction uses immediate addressing.

What is immediate addressing?

[1 mark]

0 7 . 3 Another method of encryption is the Vernam cipher.

Explain why, under the correct conditions, the Vernam cipher is perfectly secure.

[1 mark]

6

0 8 The managers of a care home expect all of their residents to wear a Personal Emergency Response System (PERS) device. This is a device which residents wear around their neck and has a button that can be used to summon help should they feel unwell or require assistance.

A company has developed a life-blogging device. Like the PERS device it is worn around the neck. The life-blogging device monitors bodily signs such as blood pressure and heart rate as well as recording audio and video. The data collected are sent to a server and all of the data collected on the server can be accessed via a website.

The care home managers are considering using the life-blogging system instead of PERS so that the staff can monitor the residents' data. The life-blogging system will allow the care home to respond more quickly to an emergency situation and deal with situations where the resident is not capable of pushing a button. The managers are considering not telling the residents about the new device as they think it may confuse them.

0 8 . 1 Discuss any moral, ethical, legal and cultural issues that the care home managers should consider before introducing the new life-blogging devices.

[9 marks]

Turn over ►

0 8 . 2 The life-blogging device contains a solid-state disk (SSD). It stores its data on this in addition to uploading the data to a server.

Explain **two** reasons why an SSD is a better choice than a magnetic hard disk for this application.

[4 marks]

Reason 1 ____

Reason 2 ____

13

0 9 . 1 State **one** reason why a user might choose to compress an image file.

[1 mark]

0 9 . 2 Describe **one** advantage of lossless compression over lossy compression.

[1 mark]

0 9 . 3 Explain how data can be compressed using dictionary-based compression.

[3 marks]

5

Turn over for the next question

1 0 . 1 Explain the operation of a logical bus network topology.

[3 marks]

1 0 . 2 Explain how it is possible for the bit rate of a communications channel to be higher than its baud rate.

[1 mark]

1 0 . 3 A data transmission system uses even parity. Data are transmitted in bytes, with each byte containing seven data bits and one parity bit.

Explain how the receiver will perform error detection on a received byte.

[2 marks]

1 0 . 4 State **two** advantages of serial data transmission over parallel data transmission and explain how these are achieved.

[4 marks]

Advantage 1

How achieved

Advantage 2

How achieved

10

END OF QUESTIONS

Question number	**Additional page, if required. Write the question numbers in the left-hand margin.**

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