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

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	
11	
TOTAL	

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

0 1 . 1 Describe the difference between natural numbers and integers.

In your answer, give **one** example of a number that is an integer but not a natural number.

[2 marks]

0 1 . 2 Describe what it means for a number to be irrational.

In your answer, give **one** example of an irrational number.

[2 marks]

Do not write outside the box

0 1 . 3 Shade **one** lozenge in the **Counting** column to indicate which set of numbers is most suitable for counting and **one** lozenge in the **Measuring** column to indicate which set of numbers is most suitable for measuring real-world quantities.

[2 marks]

		Counting	Measuring
A	Integer	⬭	⬭
B	Natural	⬭	⬭
C	Rational	⬭	⬭
D	Real	⬭	⬭

6

0 2 . 1 Convert the decimal number 177 to unsigned binary using 8 bits.

[1 mark]

0 2 . 2 Convert the decimal number 193 to hexadecimal.

[1 mark]

2

Turn over for the next question

Do not write outside the box

0 3 . 1 State, **in decimal**, the lowest and highest values that could be represented in unsigned binary when using 16 bits.

[2 marks]

Lowest _____

Highest _____

0 3 . 2 **Figure 1** and **Figure 2** show the bit patterns of two **unsigned binary integers**.

Figure 1

0	0	0	1	0	1	0	1

Figure 2

0	0	0	0	0	1	1	1

Calculate the result of multiplying these two numbers together using **binary multiplication**.

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

[2 marks]

Answer _____

4

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0 4 . 1 ASCII is one character coding system.

Explain the term 'character code'.

[1 mark]

0 4 . 2 Explain why Unicode was introduced as an alternative to ASCII.

[2 marks]

Question 4 continues on the next page

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Figure 3 shows a 7-bit ASCII character code. The character code is to be sent across a network using a parity system.

Figure 3

0	0	1	0	1	1	1

0 4 . 3 Describe how the parity bit would be generated for the character code in **Figure 3** using even parity.

[2 marks]

0 4 . 4 Write the parity bit below to complete the byte that will be sent using even parity.

[1 mark]

	0	0	1	0	1	1	1

Do not write outside the box

0 4 . 5 The bit pattern 1000001 represents the character 'A' in 7-bit ASCII. Other characters follow on from this in sequence. For example, the bit pattern 1000100 represents the character 'D'.

The bit pattern 1000100 1000001 1000010 represents 'DAB' in 7-bit ASCII.

What bit pattern results from encrypting the string 'DAB' using a Vernam cipher with the key 'EGG'?

You **must** show your working.

[3 marks]

9

Turn over for the next question

Do not write outside the box

0 5 . 1 Describe the difference between analogue and digital data.

[2 marks]

0 5 . 2 Describe the steps that an analogue to digital converter (ADC) carries out when converting a sound signal.

[3 marks]

5

0 6 . 1 Define the term 'software'.

[1 mark]

Do not write outside the box

0 6 . 2 Translators are one type of system software.

Give **two** other types of system software.

[2 marks]

Type 1 _____

_____

_____

Type 2 _____

_____

_____

0 6 . 3 Some compilers translate source code into an intermediate language rather than producing an executable file. Bytecode is one example of an intermediate language.

Explain how intermediate language code is used after it has been generated.

[2 marks]

_____

_____

_____

_____

_____

_____

0 6 . 4 Give **one** reason why some compilers produce their final output in an intermediate language instead of machine code.

[1 mark]

_____

_____

_____

6

Turn over for the next question

Do not write outside the box

0 7 . 1 State which logic gate has the truth table shown in **Figure 4**.

[1 mark]

Figure 4

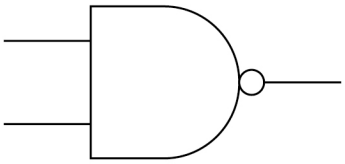
A	B	Q
0	0	1
0	1	0
1	0	0
1	1	0

Answer _____

0 7 . 2 State the logic gate that is represented by the symbol shown in **Figure 5**.

[1 mark]

Figure 5



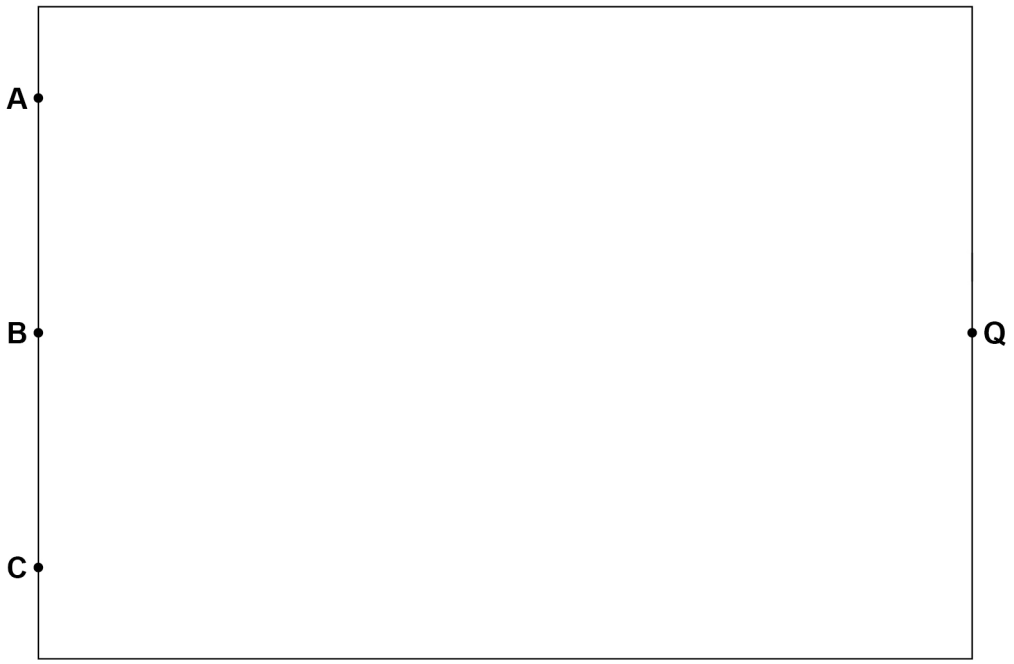
Answer _____

Do not write outside the box

0 7 . 3 Draw the logic circuit for the following Boolean expression.

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

[2 marks]



0 7 . 4 Complete the truth table below.

A	B	$\overline{B}$	$(A + \overline{B})$	$(A + \overline{B}) \cdot B$
0	0			
0	1			
1	0			
1	1			

Using the final column, give a simplified Boolean expression for

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

[3 marks]

Answer _____

Question 7 continues on the next page

Turn over ►

Do not write outside the box

0 7 . 5 Using the rules and identities of Boolean algebra, simplify the following Boolean expression.

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

[4 marks]

Answer

11

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0 8 . 1 The fetch-execute cycle involves the Current Instruction Register (CIR), Control Unit, Memory Address Register (MAR), Memory Buffer Register (MBR) and Program Counter (PC).

Figure 6 lists four events that can take place during one cycle of the fetch-execute cycle. The events are labelled **A** to **D**.

Some events that take place during the fetch-execute cycle are not listed.

Put these events in the order they would occur in the fetch-execute cycle when an ADD instruction is executed.

Write the numbers 1 to 4 beside each description in **Figure 6** to indicate the order in which the events occur. The number 1 should be used to indicate the event that would happen first.

[3 marks]

Figure 6

	Description	**Order (1 to 4)**
A	The contents of the MBR are copied to the CIR.	
B	The contents of the PC are copied to the MAR.	
C	The Control Unit decodes the contents of the CIR.	
D	The result of the calculation is stored.	

0 8 . 2 Describe the role of main memory in the execution of computer programs.

[2 marks]

Question 8 continues on the next page

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0 8 . 3 State the name of the processor component that is responsible for performing mathematical operations such as addition and multiplication.

[1 mark]

0 8 . 4 Explain why increasing the data bus width can lead to improvements in processor performance.

[1 mark]

0 8 . 5 Identify the bus that would need to be changed **and** state the change needed so that the maximum amount of memory addressable by the processor would be doubled.

[2 marks]

Bus to change _____

Change needed _____

9

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Table 1 shows the standard AQA assembly language instruction set that should be used to answer question **0 9 . 1** and question **0 9 . 2**

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

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0 9 . 1 Shade **one** lozenge to show which of the assembly instructions in **Figure 7** uses immediate addressing.

[1 mark]

Figure 7

	Instruction	Immediate Addressing
A	`LDR R3, 42`	⬭
B	`MOV R3, #42`	⬭
C	`STR R3, 101`	⬭
D	`SUB R3, R2, R1`	⬭

0 9 . 2 A computer program is required that will multiply the value stored in `X` by 2 if it is less than 50 and leave it unchanged if it is 50 or more.

The algorithm for this task can be written in pseudocode as:

```
IF X < 50 THEN
  X ← X * 2
ENDIF
```

Write an assembly language program using the AQA assembly language instruction set shown in **Table 1** to carry out this task.

At the start, the value of `X` is stored in memory location 101

[4 marks]

5

Turn over ►

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1 0 . 1 Describe the purpose of start and stop bits in asynchronous data transfer.

[2 marks]

Purpose of start bit _____

Purpose of stop bit _____

1 0 . 2 Protocols are used in computer networking.

Define the term 'protocol'.

[1 mark]

1 0 . 3 Users of a computer network will experience latency.

Define the term 'latency'.

[1 mark]

1 0 . 4 Explain how a physical star topology can behave logically as a bus network.

[2 marks]

6

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1 1 An international technology company produces a smart speaker for use in homes. The smart speaker can be controlled by a user providing voice commands, which means the device must always be listening for audio input. The company stores audio recordings of each user to analyse when improving its voice recognition algorithms. The audio recordings are compressed using lossy compression and then sent over the Internet to be stored at the company's headquarters.

Discuss a range of ethical, legal and cultural issues that are raised by the company storing the audio captured by its smart speakers **and** justify why the company might use lossy compression.

You will be assessed on your ability to follow a line of reasoning to produce a coherent, relevant and structured response.

[12 marks]

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END OF QUESTIONS

12

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