![AQA logo]

AS
COMPUTER SCIENCE

Paper 2

Tuesday 14 June 2016   Afternoon   Time allowed: 1 hour 30 minutes

Materials
You will need no other materials.
You may use 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.
* 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 may be required to indicate your answer by shading a lozenge. If you wish to change your answer, make sure that the incorrect answer is clearly crossed through with an x.

There are no questions printed on this page

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

0 1   **Table 1** shows four values.

Table 1

A	$\sqrt{2}$
B	$(-9)^2$
C	-4
D	0.5

0 1 . 1   Shade in **one** lozenge to indicate which of the values represented by the letters **A**–**D** in **Table 1** is a natural number.

A ⬭   B ⬭   C ⬭   D ⬭

[1 mark]

0 1 . 2   Shade in **one** lozenge to indicate which of the values represented by the letters **A**–**D** in **Table 1** is an irrational number.

A ⬭   B ⬭   C ⬭   D ⬭

[1 mark]

0 1 . 3   Shade in **one** lozenge to indicate which of the values represented by the letters **A**–**D** in **Table 1** is an integer but **not** a natural number.

A ⬭   B ⬭   C ⬭   D ⬭

[1 mark]

Turn over for the next question

3

0 2 **Figure 1** contains a bit pattern.

Figure 1

0	0	1	1	1	0	0	1

0 2 . 1 What is the hexadecimal equivalent of the bit pattern shown in **Figure 1**?

[1 mark]

_____

_____

_____

0 2 . 2 Why do programmers often use hexadecimal instead of binary to represent bit patterns?

[1 mark]

_____

_____

_____

0 2 . 3 What is the decimal equivalent of the bit pattern shown in **Figure 1** if it represents an **unsigned fixed-point binary** value with four bits before the binary point and four bits after the binary point?

[2 marks]

_____

_____

_____

_____

0 2 . 4 What is the decimal equivalent of the bit pattern shown in **Figure 1** if it represents a **two's complement binary integer**?

[1 mark]

0 2 . 5 The ASCII code for the numeric character "0" is 48_{10}; other numeric characters follow on from this in sequence.

What character is represented by the bit pattern in **Figure 1** if it is an ASCII code?

[1 mark]

0 2 . 6 Parity bits are often used to detect errors during data transmission. If the most significant bit in the bit pattern in **Figure 1** (the leftmost bit) is a parity bit, explain how the value of this was calculated by the sending device before the byte was transmitted. You should assume that the even parity system is being used.

[2 marks]

Question 2 continues on the next page

Turn over ▶

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0 2 . 7 Majority voting is an alternative to using parity bits. Explain how the majority voting system works in the context of data transmission.

[2 marks]

_____

_____

_____

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_____

_____

10

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

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

You **must** show your working.

[4 marks]

Answer _____

4

Turn over for the next question

0 4

0 4 . **1**   Assembly language is considered to be a low-level language. Which other type of language is also considered to be a low-level language?

[1 mark]

_____

Table 2 shows the standard AQA assembly language instruction set that should be used to answer question parts **0 4** . **2** and **0 4** . **3**

Table 2 – standard AQA assembly language instruction set

Instruction	Description
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 to 12.

The AND instruction can be used to help identify if a particular bit in a register contains a 1. The instruction AND R3, R1, #8 will perform the logical bitwise AND operation between the contents of register R1 and the bit pattern 0000 1000 and store the result in register R3. If register R1 has a 1 in bit 3 then the bit pattern for the decimal number 8 will be stored in register R3, otherwise the bit pattern for the decimal number 0 will be stored in register R3.

Figure 2 and **Figure 3** show examples of this.

Figure 2 – Example when bit 3 of R1 contains a 1

Bit	7	6	5	4	3	2	1	0
R1	0	1	0	0	1	1	1	0

Result of

```
        0  1  0  0  1  1  1  0
   AND  0  0  0  0  1  0  0  0
```

is

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

So R3 will now contain

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

Figure 3 – Example when bit 3 of R1 contains a 0

Bit	7	6	5	4	3	2	1	0
R1	0	1	0	0	0	1	1	0

Result of

```
        0  1  0  0  0  1  1  0
   AND  0  0  0  0  1  0  0  0
```

is

```
        0  0  0  0  0  0  0  0
```

So R3 will now contain

```
        0  0  0  0  0  0  0  0
```

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0 4 . 2 All even numbers are represented by bit patterns ending with a `0`; all odd numbers are represented by bit patterns ending with a `1`.

Complete the assembly language instruction below to help identify if register `R1` contains an odd number, storing the result of this operation in register `R3`.

[1 mark]

AND R3, R1, _____

Question 4 continues on the next page

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0 4 . 3 **Figure 4** shows a block of code, written in a high-level language, that is used to find out if the number stored in the variable A is even. If the value is even then the number 69_{10} is stored in the variable B, otherwise the number 79_{10} is stored in the variable B.

Figure 4

```
IF IsEven(A)
    THEN B ← 69
    ELSE B ← 79
ENDIF
```

Write a sequence of assembly language instructions that would perform the same operations as the high-level language code in **Figure 4**.

Assume that register R1 currently stores the value associated with A, that register R2 stores the value currently associated with B and that register R3 is available for general use, if necessary.

Your answer to question **0 4 . 2** can be reused as part of your answer to this question.

[6 marks]

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0 4 . 4 Shade in **one** lozenge to indicate which addressing mode is being used with the second operand in the assembly language instruction `MOV R2, #0`.

[1 mark]

| Direct | ○ | | Immediate | ○ |

0 4 . 5 Explain what a register is.

[1 mark]

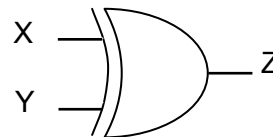_____

_____

_____

10

0 5

0 5 . 1 What is the name of the logic gate represented by the truth table and symbol shown in **Figure 5**?

[1 mark]

Figure 5

X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	0

Question 5 continues on the next page

Turn over ▶

Figure 6 shows a logic circuit that might be found inside a processor.

Figure 6

| 0 | 5 | . | 2 | The value at **M** (indicated by the arrow in **Figure 6**) is represented by the following Boolean expression.

$$1 . \overline{C}$$

Simplify this Boolean expression.

[1 mark]

| 0 | 5 | . | 3 |

The output **T** (in **Figure 6**) is represented by the following Boolean expression.

$$1 \oplus \overline{C}$$

Simplify this Boolean expression.

[1 mark]

| 0 | 5 | . | 4 |

Complete the missing cells in **Table 3**.

[3 marks]

Table 3 – Four rows of the truth table for the circuit in Figure 6

Inputs			Outputs		
C	B	A	T	S	R
0	0	0	0	0	0
0	0	1			
0	1	0			
0	1	1	0	1	0

| 0 | 5 | . | 5 |

The logic circuit shown in **Figure 6** obtains the two's complement of a 3-bit binary number. Explain how this circuit could be used by a processor when subtracting one 3-bit binary number from another.

[1 mark]

Question 5 continues on the next page

Turn over ▶

0 5 . 6 The circuit in **Figure 6** can be simplified so that it uses fewer logic gates but still has the same functionality. Changing the design of the circuits used in a processor can improve processor performance. Increasing the number of cores can also improve processor performance.

State **three** other factors that can improve processor performance. For each factor, explain how it will improve processor performance.

[6 marks]

Factor: _____

How improves: _____
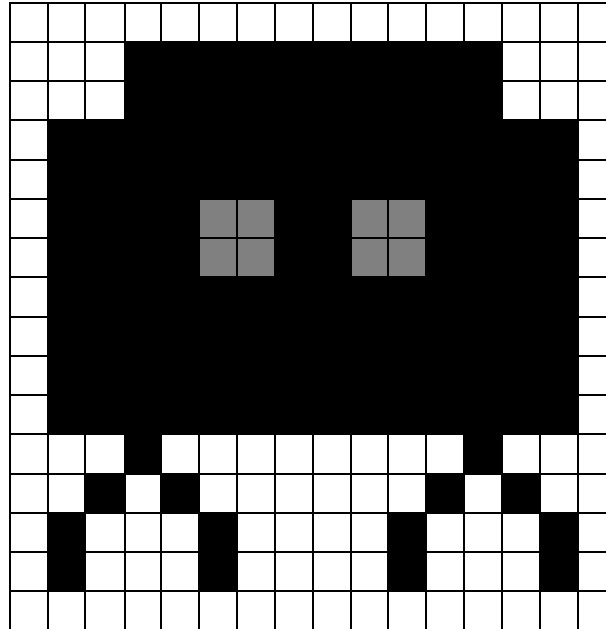
_____

_____

Factor: _____

How improves: _____

_____

_____

Factor: _____

How improves: _____

_____

_____

13

Turn over for the next question

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0 6 Digital images are often represented using a bitmap. **Figure 7** shows a 16x16 bitmap image that is to be used as a character in a computer game.

Figure 7

0 6 . 1 What is the minimum file size in **bytes** of the image shown in **Figure 7** when it is represented using a bitmap?

You may get some marks for your working even if your answer is incorrect.

[3 marks]

Answer _____

IB/M/Jun16/7516/2

0 6 . 2 Explain why the actual file size for the image will be larger than the minimum file size calculated for your answer for **0 6 . 1**

[1 mark]

0 6 . 3 If the number of colours used in the image in **Figure 7** were increased by two, what is the minimum number of extra bits that would be needed to represent each pixel?

[1 mark]

0 6 . 4 Image files are often compressed so that they take up less storage space. Describe how **run length encoding** (**RLE**) could be used to compress the image shown in **Figure 7**.

[2 marks]

7

Turn over ▶

0 7 A school has installed a wireless network with multiple wireless access points.

0 7 . 1 What hardware component is needed for each device that is going to be connected to the wireless network?

[1 mark]

A student is trying to use his own mobile device on the school network. He has all the necessary hardware and software, all the hardware devices are working correctly and he knows the correct SSID and WPA2 key for the school network. However, he is still not able to connect to the wireless network.

0 7 . 2 Describe a security measure, other than logging in, that the school might have put in place that is preventing this student from connecting his own mobile device to the network.

[3 marks]

0 7 . 3 Explain why preventing students from using their own mobile devices on the wireless network is likely to improve the performance of the school network.

[2 marks]

0 7 . 4 Explain the role of a Service Set Identifier (SSID) in wireless networking.

[2 marks]

_____

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0 7 . 5 WPA2 is an example of a protocol. Explain what is meant by the term protocol.

[2 marks]

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Turn over for the next question

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0 8 The organisers of a marathon race have installed checkpoints at regular intervals along the course. The time at which each competitor passes a checkpoint is recorded.

0 8 . 1 Three input devices that could be used at each checkpoint to capture data automatically as competitors pass by are:

- barcode reader
- digital camera
- RFID reader.

The race organisers decide to use RFID readers. Evaluate the suitability of all three devices **and** explain why RFID is the most appropriate choice.

[6 marks]

The computer used by the race organisers has a built-in magnetic hard disk drive, a built-in solid-state disk and an optical disk drive.

0 8 . 2 State **two** reasons why the computer has a magnetic hard disk and a solid-state drive instead of using only solid-state storage.

[2 marks]

Reason 1:

Reason 2:

0 8 . 3 State **two** hardware components of a solid-state drive.

[2 marks]

Component 1:

Component 2:

10

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0 9

0 9 . 1 Some high-level languages are imperative. Explain the term imperative.

[2 marks]

0 9 . 2 Explain the advantages and disadvantages of programming using imperative high-level languages compared with low-level languages.

[4 marks]

IB/M/Jun16/7516/2

0 9 . 3 A program written in a high-level language needs to be translated using either a compiler or an interpreter before it can be executed. Describe **two** differences between a compiler and an interpreter.

[2 marks]

Difference 1: _____

_____

_____

_____

Difference 2: _____

_____

_____

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8

END OF QUESTIONS

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