AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname ____________________

Forename(s) ____________________

Candidate signature ____________________
I declare this is my own work.

A-level
COMPUTER SCIENCE
Paper 2

Wednesday 18 June 2025 Morning Time allowed: 2 hours 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 100.

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	
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11	
12	
13	
14	
TOTAL	

J U N 2 5 7 5 1 7 2 0 1

IB/G/Jun25/G4006/E6

7517/2

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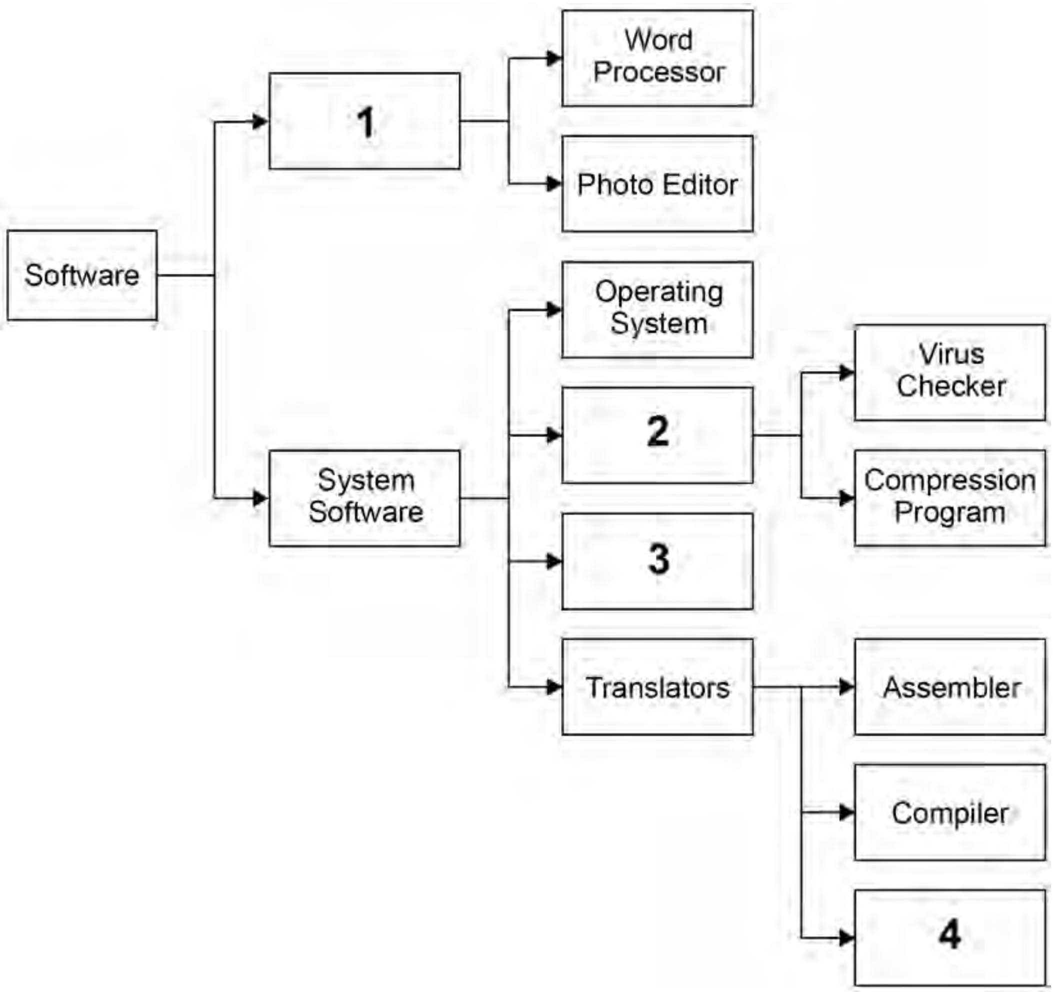
Answer **all** questions.

0 1 . 1 **Figure 1** shows the classification of various types of software and some examples of these types.

Figure 1



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Complete **Table 1** by naming the correct types of software that should be placed at positions **1** to **4** in **Figure 1**.

[2 marks]

Table 1

Number	**Correct label**
1	
2	
3	
4	

0 1 . 2 One function of the operating system is to allocate I/O devices to competing processes.

Describe **two other** functions of an operating system.

[2 marks]

Function 1 ____

____

____

Function 2 ____

____

____

Question 1 continues on the next page

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0 1 . 3 Software can be developed using a low-level language or a high-level language.

Describe the advantages of writing programs using a high-level language.

[4 marks]

8

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0 2 . 1 A sound file, produced by sampling sound, requires 1.5 megabytes of storage space.

The sound file has a duration of 50 seconds and was recorded at a sample rate of 20 000 samples per second (Hertz).

Calculate the sample resolution that was used when the sound was sampled.

[2 marks]

Answer ______________________ bits

0 2 . 2 Describe the principles of operation of an analogue to digital converter (ADC).

[2 marks]

Turn over ►

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0 2 . 3 Explain **one** reason why a digital sound file that has been recorded using sampling may not accurately represent the original analogue signal produced by the microphone.

[2 marks]

0 2 . 4 One advantage of representing a piece of music using MIDI instead of as sampled sound is that the file produced requires less storage space.

Explain why.

[2 marks]

8

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0 3 . 1 Describe the principles of operation of an optical disk.

In your response, you should cover how data is represented on a disk and how the data would be read.

[6 marks]

Turn over ►

Do not write outside the box

0 3 . 2 State **two** reasons why most modern computers do not have an optical disk drive.
[2 marks]

Reason 1 ____

____

____

Reason 2 ____

____

____

8

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0 4 It is difficult to write and enforce laws relating to the use of computers.

Explain why.

[3 marks]

3

Turn over for the next question

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0 5 Explain why a client-server network would be more suitable for use in a school than a peer-to-peer network.

[3 marks]

3

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Turn over for the next question

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0 6 A school uses a relational database to store information about merits that are given to students. A merit is an award made for outstanding work or conduct.

At the end of each term, prizes are awarded to the students who achieve the most merits.

The database contains the four relations shown in **Figure 2**.

Figure 2

Student(<u>StudentID</u>, FirstName, LastName, YearGroup, House)

Teacher(<u>TeacherID</u>, FirstName, LastName)

Merit(<u>MeritID</u>, StudentID, TeacherID, DateAwarded, Reason)

Term(<u>TermName, TermYear</u>, StartDate, EndDate)

The Student relation stores information about the students who attend the school. An example of the data stored about a student is:

StudentID	**FirstName**	**LastName**	**YearGroup**	**House**
20965	Sophie	Latham	12	Kitchener

The Teacher relation stores information about the teachers who work at the school and who award merits to students.

The Merit relation stores information about the merits that teachers have awarded to students, when they were awarded and for what reason.

The Term relation stores information about the dates of each term. An example of the data stored about a term is:

TermName	**TermYear**	**StartDate**	**EndDate**
Autumn	2024	04/09/2024	20/12/2024

The StudentID, TeacherID, MeritID, YearGroup and TermYear attributes are all numeric values.

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0 6 . 1 When the Merit relation was first designed, it did not contain the MeritID field. Instead, the values in the StudentID, TeacherID and DateAwarded attributes were used together as a composite entity identifier.

Describe the limitation that would have occurred if the entity identifier for the Merit relation consisted of the StudentID, TeacherID and DateAwarded attributes.

[1 mark]

0 6 . 2 The diagram below shows three of the entities from the school merit database.

Draw the relationships that exist between the three entities shown on the diagram.

You **must** clearly show the degree of each relationship.

[1 mark]

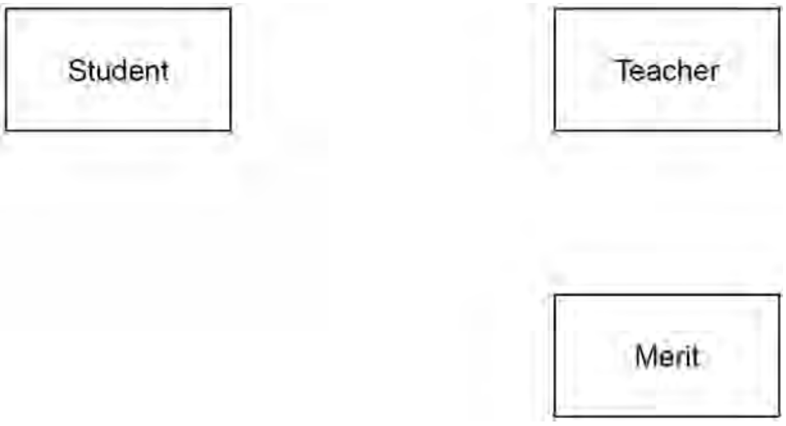

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Figure 2 is repeated below to help you answer Questions **06.3** and **06.4** without having to turn back in the question paper.

Figure 2 (repeated)

Student(StudentID, FirstName, LastName, YearGroup, House)

Teacher(TeacherID, FirstName, LastName)

Merit(MeritID, StudentID, TeacherID, DateAwarded, Reason)

Term(TermName, TermYear, StartDate, EndDate)

0 6 . 3 A new student has joined the school. The student is called Ethan Smith and their year group is 7. They are placed in Hulme house and given the StudentID number 17423.

Write SQL code to add the student's details to the Student table.

[2 marks]

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0 6 . 4 At the end of the Spring term of 2025, the school needed to identify the students who achieved merits during the term, so that prizes could be awarded to them.

The dates of the term are stored in the Term table.

Write a query that will list all the merits that were awarded during the term.

For each merit on the list, the first name and last name of the student awarded the merit should be included, together with the reason the merit was awarded.

The merits should appear on the list in order of the StudentID of the students that they were awarded to, with merits for the student with the lowest StudentID at the start of the list.

[6 marks]

Question 6 continues on the next page

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0 6 . 5 The merits database can be accessed on any computer within the school.

It is possible that two users might try to edit the same record simultaneously.

Describe how two users trying to edit the same record could cause a problem if the database system did not implement a method to manage concurrent access.

[2 marks]

12

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0 7 . 1 State the stored program concept.

[2 marks]

0 7 . 2 Describe the roles of the following **three** components of a processor.

[6 marks]

Control unit

General purpose registers

Status register

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A particular processor represents machine code instructions in 32 bits.

The number of bits allocated to the opcode varies depending upon the operation that the instruction represents. The remaining bits are allocated to the operands. An instruction can have between zero and three operands.

Figure 3 shows the format of an ADD instruction in assembly language and machine code.

Figure 3

ADD Instruction: `ADD R2, R5, #17`

Opcode												Operands																			
Basic Machine Operation											M	Operand A				Operand B				Operand C											
1	1	1	0	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	1

- **Operand A** and **Operand B** are register numbers.
- The bit labelled **M** in **Opcode** indicates the addressing mode to use for **Operand C**.
- **Operand C** can refer to either a register number or a numeric value, depending upon the addressing mode that is being used.

0 7 . 3 All of the processor's general purpose registers can be referenced using each of the operands in the ADD instruction in **Figure 3**.

Calculate the maximum number of general purpose registers that the processor could have.

[1 mark]

____

____

Answer ______________________

Do not write outside the box

0 7 . 4 When the immediate addressing mode is used:

- the value in **Operand C** in **Figure 3** represents a numeric value that will be processed by the ADD instruction
- the value in **Operand C** is represented as a **two's complement binary integer**.

In **decimal**, calculate the range of numbers that **Operand C** can represent.

[1 mark]

Most positive ____________ Most negative ____________

10

Turn over for the next question

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0 8 The Internet Protocol version 4 (IPv4) addressing system does not provide enough unique addresses for every device that is connected to the Internet.

This is being addressed in the long term by the replacement of IPv4 with IPv6.

In the short term, the use of public and private IP addresses, NAT and DHCP is helping to deal with this problem.

Explain:

- why IPv4 does not provide enough unique addresses and how IPv6 will overcome this problem
- the difference between a public (routable) and a private (non-routable) IP address
- how NAT works and how it helps to deal with this problem
- how DHCP works and how it helps to deal with this problem.

[12 marks]

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12

Turn over ►

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0 9 **Figure 4** shows a logic circuit. The circuit has seven inputs and two outputs. The inputs $\mathbf{B_6}$ to $\mathbf{B_0}$ represent the ASCII code of a character, where $\mathbf{B_6}$ is the most significant bit and $\mathbf{B_0}$ is the least significant bit. The circuit outputs are $\mathbf{Q_1}$ and $\mathbf{Q_2}$. The outputs of six of the gates in the circuit have been labelled **U**, **V**, **W**, **X**, **Y** and **Z**.

Figure 4

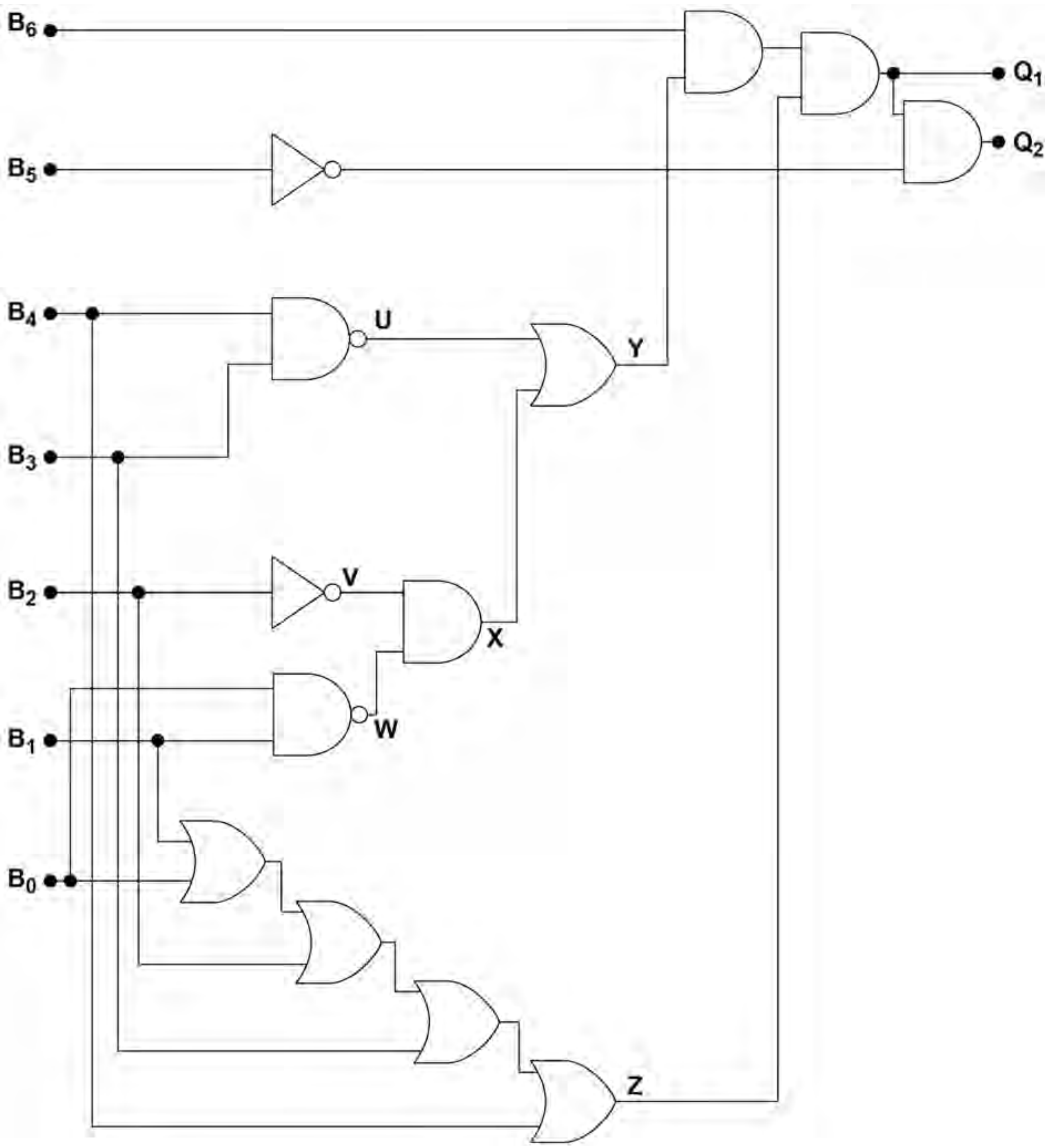

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Figure 5 shows the ASCII code for printable characters.

Figure 5

ASCII code		ASCII code		ASCII code		ASCII code	
Char	**Binary**	**Char**	**Binary**	**Char**	**Binary**	**Char**	**Binary**
SP	0100000	8	0111000	P	1010000	h	1101000
!	0100001	9	0111001	Q	1010001	i	1101001
"	0100010	:	0111010	R	1010010	j	1101010
#	0100011	;	0111011	S	1010011	k	1101011
$	0100100	<	0111100	T	1010100	l	1101100
%	0100101	=	0111101	U	1010101	m	1101101
&	0100110	>	0111110	V	1010110	n	1101110
'	0100111	?	0111111	W	1010111	o	1101111
(	0101000	@	1000000	X	1011000	p	1110000
)	0101001	A	1000001	Y	1011001	q	1110001
*	0101010	B	1000010	Z	1011010	r	1110010
+	0101011	C	1000011	[	1011011	s	1110011
,	0101100	D	1000100	\	1011100	t	1110100
-	0101101	E	1000101	]	1011101	u	1110101
.	0101110	F	1000110	^	1011110	v	1110110
/	0101111	G	1000111	_	1011111	w	1110111
0	0110000	H	1001000	`	1100000	x	1111000
1	0110001	I	1001001	a	1100001	y	1111001
2	0110010	J	1001010	b	1100010	z	1111010
3	0110011	K	1001011	c	1100011	{	1111011
4	0110100	L	1001100	d	1100100	|	1111100
5	0110101	M	1001101	e	1100101	}	1111101
6	0110110	N	1001110	f	1100110	~	1111110
7	0110111	O	1001111	g	1100111		

0 9 . 1 Complete the truth table below for the input of the ASCII codes of the characters `*` `@` `F` `W` `\` and `f` into the logic circuit shown in **Figure 4**.

[4 marks]

		Inputs												Outputs		
Char	**Binary**	B_6	B_5	B_4	B_3	B_2	B_1	B_0	**U**	**V**	**W**	**X**	**Y**	**Z**	Q_1	Q_2
*	0101010	0	1	0	1	0	1	0								
@	1000000	1	0	0	0	0	0	0								
F	1000110	1	0	0	0	1	1	0								
W	1010111	1	0	1	0	1	1	1								
\	1011100	1	0	1	1	1	0	0								
f	1100110	1	1	0	0	1	1	0								

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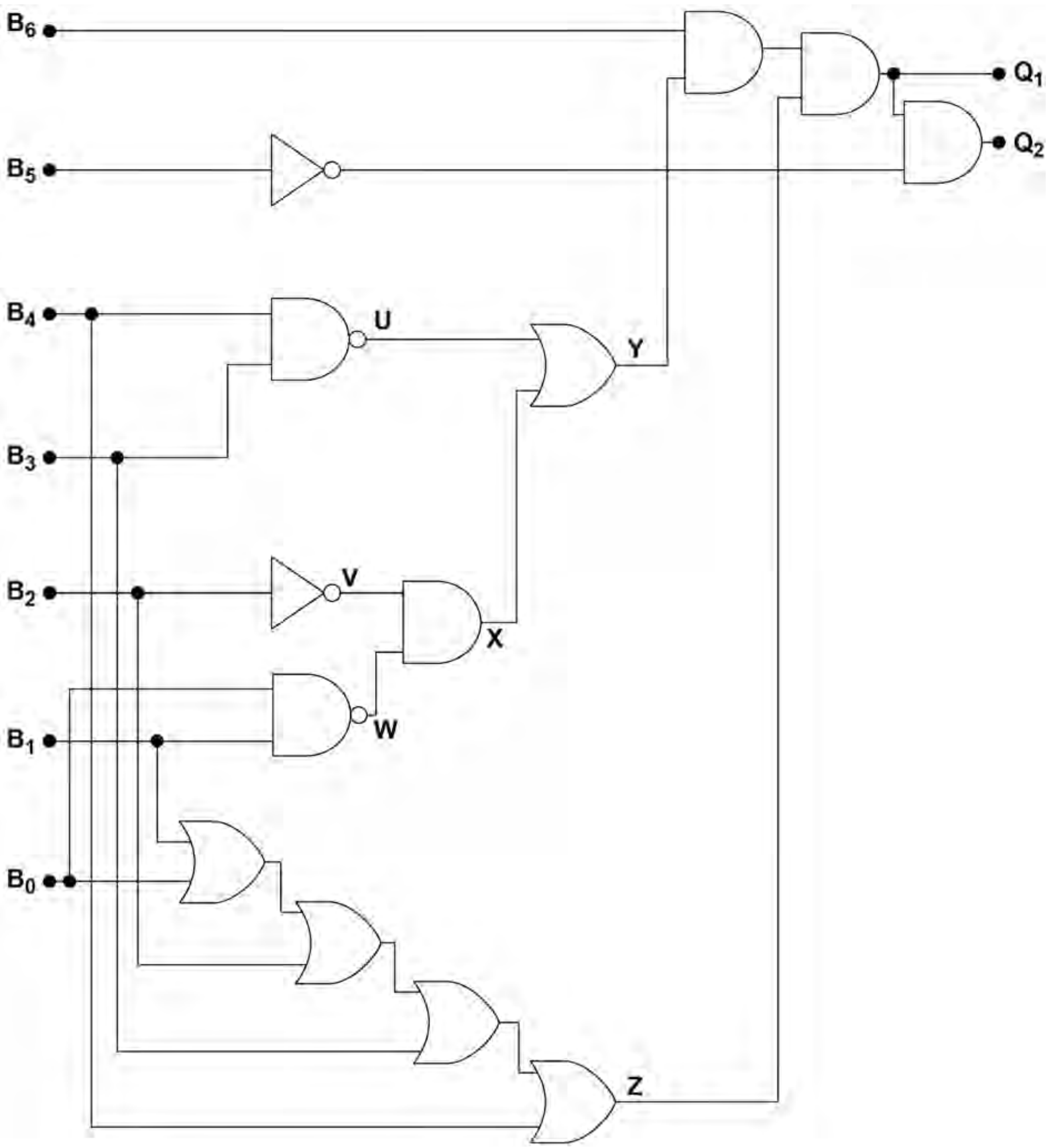
Figure 4 is repeated below to help you answer Questions **09.2** and **09.3** without having to turn back in the question paper.

Figure 4 (repeated)



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0 9 . 2 Describe the purpose of the outputs $\mathbf{Q_1}$ and $\mathbf{Q_2}$ of the circuit in **Figure 4**.

[2 marks]

$\mathbf{Q_1}$ ____

____

$\mathbf{Q_2}$ ____

____

0 9 . 3 Shade **one** lozenge to indicate which of the Boolean equations correctly represents the output $\mathbf{Q_1}$ in **Figure 4**.

[1 mark]

A $Q_1 = B_6 \cdot (\overline{B_4 \cdot B_3} + \overline{B_2} \cdot \overline{B_1 \cdot B_0}) \cdot (B_4 + B_3 + B_2 + B_1 + B_0) \cdot \overline{B_5}$ ⬭

B $Q_1 = B_6 \cdot (\overline{B_4} \cdot \overline{B_3} + \overline{B_2} \cdot \overline{B_1} \cdot \overline{B_0}) \cdot (B_4 + B_3 + B_2 + B_1 + B_0)$ ⬭

C $Q_1 = B_6 \cdot (\overline{B_4 \cdot B_3} + \overline{B_2} \cdot \overline{B_1 \cdot B_0}) \cdot (B_4 + B_3 + B_2 + B_1 + B_0)$ ⬭

D $Q_1 = B_6 \cdot \overline{B_4 \cdot B_3} + \overline{B_2} \cdot \overline{B_1 \cdot B_0} \cdot (B_4 + B_3 + B_2 + B_1 + B_0)$ ⬭

E $Q_1 = B_6 + (\overline{B_4 + B_3} \cdot \overline{B_2} + \overline{B_1 + B_0}) + (B_4 \cdot B_3 \cdot B_2 \cdot B_1 \cdot B_0)$ ⬭

7

Turn over for the next question

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1 0 . 1 State **two** reasons why data is often compressed.

[2 marks]

Reason 1 ____________________

Reason 2 ____________________

1 0 . 2 Two different methods of compressing data are run length encoding (RLE) and dictionary-based methods.

Explain why RLE is more suitable for compressing images and dictionary-based methods are more suitable for compressing text.

[2 marks]

4

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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1 1

The Fibonacci sequence is a number sequence in which the first two numbers are both 1 and every other number in the sequence is the sum of the previous two numbers. The first ten values in the Fibonacci sequence are:

1, 1, 2, 3, 5, 8, 13, 21, 34, 55

Figure 6 shows a function written in a functional programming language to calculate the *n*th term in the Fibonacci sequence.

Figure 6

```
fibonacci 1 = 1
fibonacci 2 = 1
fibonacci n = fibonacci (n - 1) + fibonacci (n - 2)
```

1 1 . 1 Shade **all** of the lozenges for the statements that are **true** about the `fibonacci` function in **Figure 6**.

[1 mark]

A The function has one argument. ⬭

B The function is a first-class object. ⬭

C The function outputs a list. ⬭

D The function uses a higher-order function. ⬭

1 1 . 2 Shade **one** lozenge to indicate the function type of the `fibonacci` function in **Figure 6**.

[1 mark]

A $\mathbb{N} \to \mathbb{N}$ ⬭

B $\mathbb{Q} \to \mathbb{Z}$ ⬭

C $\mathbb{R} \to \mathbb{Z}$ ⬭

D $\mathbb{Z} \to \mathbb{N}$ ⬭

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1 1 . 3 Explain why the recursive method used by the code in **Figure 6** is **not** an efficient method of calculating the *n*th term in the Fibonacci sequence.

[2 marks]

1 1 . 4 Describe what partial function application is.

[2 marks]

6

Turn over for the next question

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1 2 A computer represents numbers using a **normalised** floating point representation with an **8-bit mantissa** and a **6-bit exponent**, both stored using **two's complement**, as shown in **Figure 7**.

Five different bit patterns that are stored in this computer's memory are listed in **Figure 7** and are labelled with the letters **A** to **E**. Four of the bit patterns are valid normalised floating point numbers and one is not.

Figure 7

	Mantissa	Exponent
A	0 ● 1 0 0 0 0 0 0	1 0 0 0 0 0
B	1 ● 0 0 0 0 0 0 0	1 0 0 0 0 0
C	0 ● 0 1 1 1 1 1 1	1 1 1 1 1 1
D	1 ● 0 0 0 0 0 0 0	0 1 1 1 1 1
E	0 ● 1 1 1 1 1 1 1	0 1 1 1 1 1

1 2 . 1 Shade **one** lozenge to indicate which bit pattern (**A**–**E**) in **Figure 7** does not represent a normalised value.

[1 mark]

A ⬭ **B** ⬭ **C** ⬭ **D** ⬭ **E** ⬭

1 2 . 2 Shade **one** lozenge to indicate which bit pattern (**A**–**E**) in **Figure 7** shows the most negative normalised value that can be represented.

[1 mark]

A ⬭ **B** ⬭ **C** ⬭ **D** ⬭ **E** ⬭

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12.3 State **one** reason why values stored using a floating point representation are usually normalised.

[1 mark]

Question parts **12.4** and **12.5** use a **normalised** floating point representation with an **8-bit mantissa** and a **6-bit exponent**, both stored using **two's complement**.

12.4 **Figure 8** shows a floating point representation of a number:

Figure 8

Mantissa

1	. 0	1	0	1	0	0	0

Exponent

1	1	1	1	0	0

Calculate the decimal equivalent of the number in **Figure 8**.

Express your answer to at least four decimal places or as a fraction.

You should show your working.

[2 marks]

Answer ____________________

Question 12 continues on the next page

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Question parts **12.4** and **12.5** use a **normalised** floating point representation with an **8-bit mantissa** and a **6-bit exponent**, both stored using **two's complement**.

1 2 . 5 The decimal value 43 057 152 cannot be represented exactly using this floating point system.

Write the closest possible normalised floating point representation of the decimal value 43 057 152 in the boxes below.

You should show your working.

[3 marks]

Answer

	•						

Mantissa

Exponent

1 2 . 6 Calculate the **relative error** that occurred when you represented 43 057 152 as closely as possible in question part **12.5**.

You should show your working.

Express your answer as a percentage to at least four decimal places.

[1 mark]

Answer ____________________

9

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1 3 Using the rules of Boolean algebra, simplify the following Boolean expression.

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

You **must** show your working.

[4 marks]

Working

Answer

4

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1 4 An assembly language program is used to control the operation of a robot.

The program uses the AQA assembly language instruction set in **Table 3** on page 36.

The value in memory location 100 is used to read input from the robot's sensors and to provide output to the robot's motors. The memory location can hold an 8-bit value.

Figure 9 shows an example 8-bit value in memory location 100.

Figure 9

Outputs			**Inputs**				
B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0
1	1	0	1	0	0	1	0

The purpose of each bit is:

- B_7 – Controls the motor that drives the robot's left wheel.
- B_6 – Controls the motor that drives the robot's right wheel.
- B_5 – Controls the motor that drives the robot's accessory arm.
- B_4 – Represents the input from an ultrasonic sensor.
- B_3 – Represents the input from a light sensor.
- B_2 – Represents the input from touch sensor **X**.
- B_1 – Represents the input from touch sensor **Y**.
- B_0 – Represents the input from touch sensor **Z**.

Writing a value of `1` to one of the bits B_7 to B_5 will cause the motor controlled by the bit to turn on. The motor will remain on until a `0` is written to the bit.

Reading a value of `1` from bits B_4 to B_0 indicates that the sensor associated with the bit has been activated. Reading a value of `0` indicates that the sensor has not been activated.

For example, the value `11010010` in memory location 100 in **Figure 9** indicates that the robot is driving forward, as both the left and right motors are on, and that the ultrasonic sensor and touch sensor **Y** have been activated.

The current state of the inputs can be determined by reading the value from memory location 100. When a value is written to memory location 100, only the values in bits B_7 to B_5 change.

The program in **Table 2** is used to make the robot carry out a task. The program has been split into six sections.

Complete the **Purpose** column of **Table 2** to explain the effect of the code in sections **2** to **6** on the robot. In your response, where appropriate, you should include the effect of the sensor inputs on the robot's actions.

[6 marks]

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Table 2

Section	Code	Purpose

1	`LDR R0, 100`
	`ORR R0, R0, #192`
	`STR R0, 100`
		Make the robot drive forwards.

2	`loop1:`
	`LDR R0, 100`
	`AND R1, R0, #7`
	`CMP R1, #0`
	`BEQ loop1`	

3	`LDR R0, 100`
	`AND R0, R0, #63`
	`STR R0, 100`	

4	`LDR R0, 100`
	`MOV R2, #0`
	`MOV R3, #0`
	`loop2:`
	`AND R1, R0, #1`
	`CMP R1, #0`
	`BEQ skip`
	`ADD R2, R2, #1`
	`skip:`
	`ADD R3, R3, #1`
	`LSR R0, R0, #1`
	`CMP R3, #3`
	`BNE loop2`
	`CMP R2, #2`
	`BEQ active`
	`HALT`	

5	`active:`
	`LDR R0, 100`
	`ORR R0, R0, #32`
	`STR R0, 100`	

6	`loop3:`
	`LDR R0, 100`
	`AND R1, R0, #8`
	`CMP R1, #0`
	`BEQ loop3`
	`AND R0, R0, #223`
	`STR R0, 100`
	`HALT`	

Complete rows 2 to 6 in the Purpose column

6

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Table 3 – 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

END OF QUESTIONS

There are no questions printed on this page

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