AQA

Surname _____

Forename(s) _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

A-level

COMPUTER SCIENCE

Paper 2

7517/2

Tuesday 18 June 2024 **Afternoon**

Time allowed: 2 hours 30 minutes

At the top of the page, write your surname and forename(s), your centre number, your candidate number and add your signature.

[Turn over]

J U N 2 4 7 5 1 7 2 0 1

MATERIALS

For this paper you must have:

- **a calculator**
- **an insert.**

INSTRUCTIONS

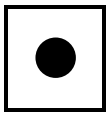
- **Use black ink or black ball-point pen.**
- **Answer ALL questions.**
- **You must answer the questions in the spaces provided. Do not write on blank pages.**
- **If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).**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

INFORMATION

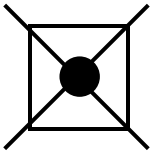
- **The marks for questions are shown in brackets.**
- **The maximum mark for this paper is 100.**

ADVICE

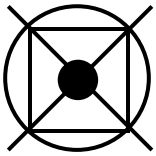
- **In some questions you are required to indicate your answer by completely shading a lozenge alongside the appropriate answer as shown.**



- **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.**



DO NOT TURN OVER UNTIL TOLD TO DO SO

Answer ALL questions.

0 1

Anti-virus software and user training are measures that can be used to reduce the threat posed by viruses.

Describe FOUR OTHER measures that can be used to reduce the threat posed by viruses. [4 marks]

4

0 2 . 1

A digital camera takes photographs that are 4000 pixels wide by 3000 pixels tall and can contain up to 16 777 216 different colours.

Calculate the size of one image in megabytes.
[2 marks]

Answer _____ **megabytes**

0 2 . 2

How many images, taken using the camera referred to in Question 02.1, could be stored on a 256 gigabyte memory card?

You should assume that all of the storage space on the memory card is available to store image data.

Round your answer down to the nearest whole number. [1 mark]

Answer _____

[Turn over]

When a digital camera takes a photograph, an array of photosensors produces analogue voltages representing the amount of light falling on each photosensor. An analogue-to-digital converter then converts these analogue voltages into digital values. These digital values are used to create the pixel data for the bitmap image.

0 2 . 3

Explain why the voltages produced by the photosensors are considered to be analogue AND why the pixel data is considered to be digital. [2 marks]

[Turn over]

An image is 20 pixels wide by 30 pixels tall. The colour of each pixel is represented using one byte.

Here is a row of data from the original image. The colour of each of the 20 pixels is shown as a decimal value, with commas used to separate the data for the different pixels:

24, 24, 24, 253, 254, 255, 76, 76, 76, 80, 82, 0, 0, 9, 223, 223, 224, 220, 76, 76

The image is to be compressed using Run Length Encoding (RLE). The RLE method used will:

- represent the length of a run using one byte
- represent a colour using one byte.

In decimal, the RLE for the colour of the first four pixels would be:

3, 24, 1, 253

0 2 . 4

Calculate how much memory the row of pixels will take up before AND after it has been encoded using RLE. [1 mark]

Memory before RLE (bytes) _____

_____

_____

_____

Memory after RLE (bytes) _____

_____

_____

_____

[Turn over]

0 2 . 5

Comment on the effectiveness of the use of RLE to encode the row of pixels in Question 02.4, on page 11, AND explain why this is the case. [1 mark]

7

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[Turn over]

0 3

FIGURE 1, provided on page 2 of the insert, shows the organisation of part of a simple computer system.

0 3 . 1

State the name of the bus labelled X in FIGURE 1.
[1 mark]

0 3 . 2

The data bus inside the computer uses synchronous parallel data transmission.

Describe what synchronous transmission is. [1 mark]

[Turn over]

0 3 . 3

Peripherals, such as a keyboard or printer, are connected to the computer using a USB (Universal Serial Bus) connection. USB uses synchronous serial data transmission.

Explain why serial transmission has been chosen to communicate with peripherals connected to the computer AND why parallel transmission is used by the data bus inside the computer. [3 marks]

[Turn over]

0 3 . 4

The USB interface inside the computer is an example of an I/O controller.

Describe the role of an I/O controller. [2 marks]

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[Turn over]

0 3 . 5

The computer's address bus uses 36 wires/lines and each main memory location can hold a 16-bit data value.

In gibibytes, express the maximum amount of main memory that could be installed in the computer, assuming that the CPU could access all of the memory using the address bus.

You should show your working. [2 marks]

Answer _____ gibibytes

0 3 . 6

State an example of how the control bus is used when the processor stores data into main memory. [1 mark]

10

0 4 . 1

Shade the lozenges next to ALL of the TRUE statements about representing numbers using fixed and floating point representations. [2 marks]

○ **A A processor can usually carry out calculations on fixed point numbers more quickly than calculations on floating point numbers.**

○ **B Fixed point numbers represent data using a mantissa and an exponent.**

○ **C In a given number of bits, a fixed point system can represent positive numbers that are closer to zero than a floating point system can.**

○ **D In a given number of bits, a fixed point system can represent some numbers more precisely than a floating point system.**

○ **E In a given number of bits, a floating point system can represent a bigger range of numbers than a fixed point system.**

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[Turn over]

Questions 04.2, 04.3 and 04.4 use a NORMALISED floating point representation with an 8-BIT MANTISSA and a 4-BIT EXPONENT, both stored using TWO'S COMPLEMENT.

0 4 . 2

FIGURE 2, provided on page 3 of the insert, shows a floating point representation of a number:

Calculate the decimal equivalent of the number in FIGURE 2.

You should show your working. [2 marks]

Answer _____

[Turn over]

Questions 04.2, 04.3 and 04.4 use a NORMALISED floating point representation with an 8-BIT MANTISSA and a 4-BIT EXPONENT, both stored using TWO'S COMPLEMENT.

0 4 . 3

The decimal number 12.765625 (which can also be expressed as $12\frac{49}{64}$) cannot be represented exactly in this floating point system.

Write the closest possible normalised representation of this number in the boxes on the opposite page.

You should show your working. [3 marks]

Answer

Mantissa

Exponent

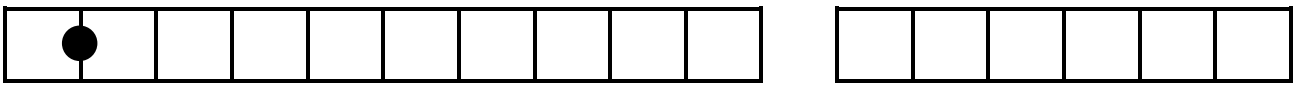
[Turn over]

0 4 . 4

What is the smallest number of bits that would need to be ADDED TO the mantissa so that the decimal number 12.765625 could be represented exactly? [1 mark]

0 4 . 5

A different system uses a NORMALISED floating point representation with a 10-BIT MANTISSA and a 6-BIT EXPONENT, both stored using TWO'S COMPLEMENT.



Mantissa **Exponent**

In DECIMAL, what is the most negative number that this system could represent?

You should show your working. [2 marks]

Most negative number _____

[Turn over]

10

0 5 . 1

A company uses a file server that stores files on magnetic hard disk drives. These files can be accessed by other computers through a network.

Describe:

- **how the data for a file would be stored on a magnetic hard disk AND read from it by the file server**
- **how the individual layers of the TCP/IP stack in the file server would be used to transmit the file onto the network.**

In your response, you do NOT need to describe how the file would be transmitted across the network or how the TCP/IP stack would be used in the computer that has requested the file. You only need to write about how the data would be put onto the network by the file server. [12 marks]

[Turn over]

[Turn over]

0 5 . 2

The company needs to purchase a second file server.

It is considering whether to purchase a file server with magnetic hard disk drives installed or a file server with solid-state disks (SSDs) instead. Each of the file servers has the same total storage capacity.

State ONE ADVANTAGE and ONE DISADVANTAGE of purchasing the file server that uses SSDs. [2 marks]

Advantage _____

_____

_____

_____

Disadvantage _____

_____

_____

_____

14

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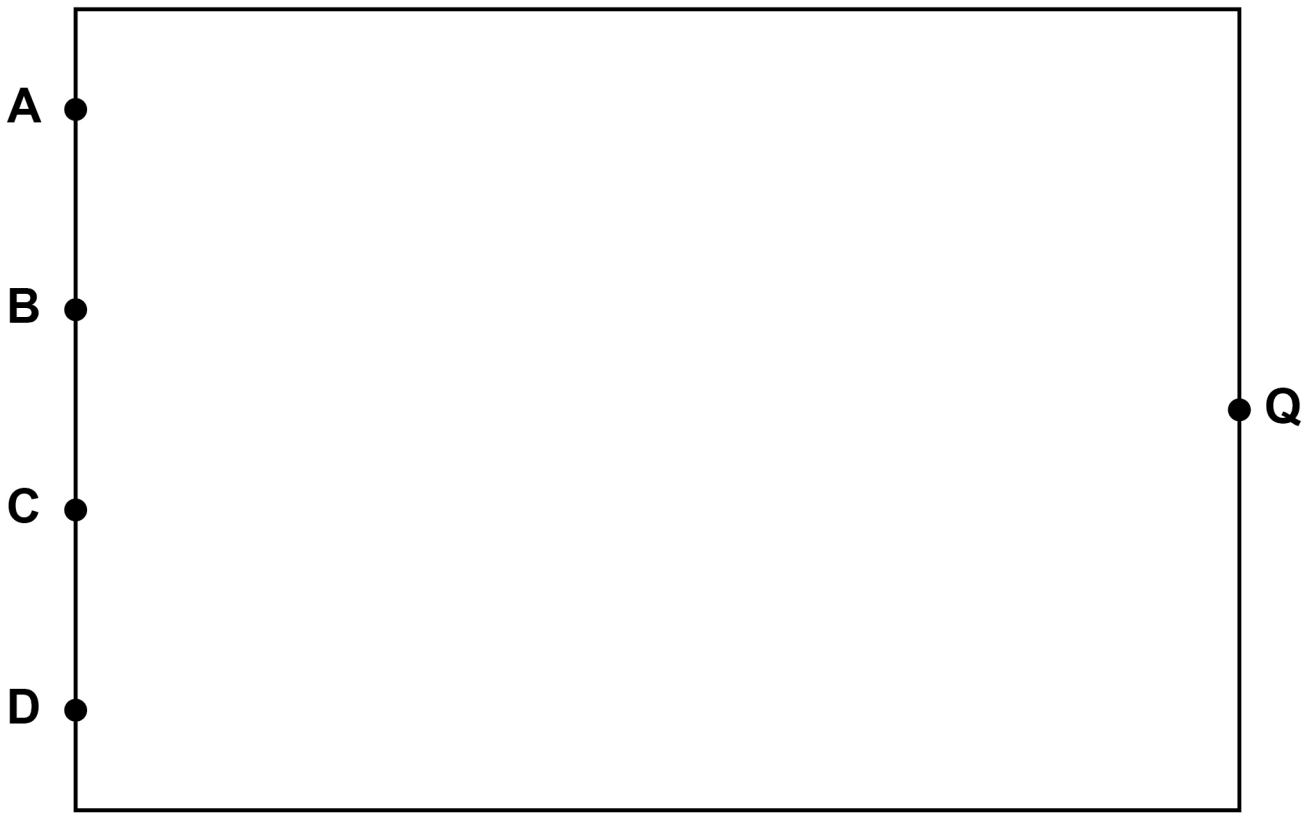
[Turn over]

0 6 . 1

Draw a logic circuit for the Boolean expression:

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

Do NOT simplify the expression. [4 marks]



0 6 . 2

A flip-flop is a component that can be incorporated into a logic circuit. FIGURE 3, provided on page 3 of the insert, shows a diagram of an edge-triggered D-type flip-flop.

Explain how the output Q will be affected when a pulse is received on the CLOCK input. [1 mark]

[Turn over]

0 6 . 3

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

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

You MUST show your working. [4 marks]

Working _____

Answer _____

[Turn over]

9

0 7

A student has a Local Area Network (LAN) in her house. She uses one of the computers on the LAN as a web server to host a website for a club that she is a member of.

FIGURE 4 shows the Uniform Resource Locator (URL) of a page on the website.

FIGURE 4

`http://www.loveapug.org.uk/pictures/cutepugs.html`

0 7 . 1

State the protocol and domain name used in the URL in FIGURE 4. [1 mark]

Protocol _____

Domain name _____

0 7 . 2

Describe how domain names are organised. [2 marks]

[Turn over]

0 7 . 3

Explain the service provided by Internet registries AND why they are needed. [2 marks]

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[Turn over]

FIGURE 5, provided on page 4 of the insert, shows a diagram of the LAN in the student's house. The LAN connects three computers, including the web server, to the Internet via a router.

The router's public IP address is 186.7.2.31. The non-routable IP addresses of each of the computers on the LAN is shown in FIGURE 5.

The router uses Network Address Translation (NAT) because the computers on the LAN, including the web server, have non-routable IP addresses.

The router also incorporates a switch and a DHCP server.

0 7 . 4

Explain how a computer located outside the LAN can access the web server, despite the fact that the web server is identified by a non-routable IP address.
[3 marks]

[Turn over]

0 7 . 5

Explain why it might be undesirable to allow the network settings of the web server to be configured by a DHCP server. [1 mark]

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[Turn over]

0 7 . 6

The student uses the computer with IP address 192.168.0.4 to download a file from an FTP server on the Internet using the File Transfer Protocol (FTP).

Describe how NAT will be used in this process, to handle both the outgoing request and the returned data. [4 marks]

[Turn over]

0 7 . 7

The replacement of IPv4 with IPv6 would mean that NAT is no longer necessary.

Explain why this is the case. [1 mark]

0 7 . 8

The web server and the web browser on a client computer use the Websocket protocol when they communicate with each other.

Shade ONE lozenge to indicate which of these statements about the Websocket protocol is true.
[1 mark]

○ **A All messages sent using the protocol encode data using XML.**

○ **B All messages sent using the protocol have a digital signature.**

○ **C Messages sent using the protocol can only originate from the web server.**

○ **D The protocol establishes a full-duplex communication channel.**

○ **E The protocol operates at the network layer of the TCP/IP stack.**

15

0 8

A shop that sells items through a website uses a relational database to store information about the products that it sells and the sales that it has made.

FIGURE 6, provided on page 5 of the insert, shows the structure of the relations in the database.

- **The Product relation stores information about the products that the shop sells and who supplies them. Each type of product is identified by a unique number and has a brief description. For example, ProductID 1 has the Description 'A4 Ring Binder – Purple'. The QuantityInStock indicates how many of the product the shop currently has in stock.**
- **The Sale and SaleLine relations are used to record the details of the sale of products to a customer. Each sale is identified by a unique SaleID, which is a number.**
- **The Customer relation stores the details of customers who have registered on the website so that they can purchase products. Each customer is identified by a unique CustomerID, which is a number.**
- **The Supplier relation records the details of companies who supply the products to the shop. Each supplier is identified by a unique SupplierID, which is a number.**

0 8 . 1

Shade ONE lozenge to indicate which of the listed assumptions has been made when the database was designed. [1 mark]

○ **A A customer cannot be added to the database until a sale has been made to them.**

○ **B Each product is only supplied by one supplier.**

○ **C Each supplier only supplies one product.**

○ **D Only one sale can be made to a customer on a particular date.**

○ **E Two different products cannot be purchased as part of the same sale.**

[Turn over]

When a sale is made to a customer, three changes need to be made to the data in the database:

- **a new record is created in the Sale table**
- **a new record is created in the SaleLine table for each different product that is part of the sale**
- **the records in the Product table are updated to reduce the QuantityInStock by the purchased quantity for each type of product that has been sold.**

A sale is made on the 29/09/2024 to the Customer with CustomerID 48. The sale is for 3 of the products with ProductID 1. The sale is to be given the SaleID 4072.

0 8 . 2

Write an SQL query that will create the new record for sale 4072 in the Sale table. [2 marks]

[Turn over]

0 8 . 3

Write an SQL query that will update the QuantityInStock of the product with ProductID 1 when this sale is made. The value 3 should be subtracted from the current quantity in stock. [3 marks]

0 8 . 4

The database system can be accessed by many users simultaneously.

Describe how timestamp ordering can be used to manage concurrent access to a database. [3 marks]

[Turn over]

0 8 . 5

The database described in FIGURE 6, provided on page 5 of the insert, is fully normalised.

Describe TWO problems that can occur with databases that are NOT fully normalised. [2 marks]

Problem 1 _____

Problem 2

[Turn over]

11

0 9

Algorithms and artificial intelligence are being increasingly used to assist with the diagnosis of medical conditions. For example, algorithms based on artificial intelligence can diagnose some medical conditions from X-ray images.

Discuss some of the moral, ethical and legal issues that might arise as a result of using computer systems to assist with diagnosing medical conditions.

In your answer you will be assessed on your ability to follow a line of reasoning to produce a coherent, relevant and structured response. [6 marks]

[Turn over]

[Turn over]

6

TABLE 1 is provided on pages 6–9 of the insert. The table is included so that you can answer Question 10.1

1 0

FIGURE 7, provided on pages 10 and 11 of the insert, shows an assembly language program which has been written using the AQA assembly language instruction set. The instruction set is explained in TABLE 1, provided on pages 6–9 of the insert.

1 0 . 1

Complete the trace table, on the opposite page, to show the results of executing the program in FIGURE 7, provided in the separate insert, when the initial value in memory location `130` is 83

Each register can hold an 8-bit value.

You may find it easier to understand the operation of the program if you write the contents of memory location `130` and register `R1` out in both binary and decimal.

You may not need to use all the rows in the table.
[6 marks]

Memory Location 130	R1	R2	R3	R4
83 (01010011)				

[Turn over]

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1 0 . 2

The value in memory location `130` before the program is executed is the program's input and the value stored in memory location `130` when the program finishes executing is its output.

By considering your trace table for Question 10.1, on page 67, and the assembly language code in FIGURE 7, provided on pages 10 and 11 of the insert, describe the purpose of the program. [2 marks]

1 0 . 3

Describe TWO advantages of writing programs in assembly language over writing programs using a high-level language. [2 marks]

Advantage 1 _____

_____

_____

_____

Advantage 2 _____

_____

_____

_____

1 0 . 4

Some high-level languages are described as being imperative.

Explain what imperative means in this context. [1 mark]

11

1 1 . 1

A functional programming function `f` has the function type:

$f: \mathbb{N} \longrightarrow \mathbb{R}$

Describe the co-domain of the function `f`. [1 mark]

1 1 . 2

Describe TWO features of functional programming languages that make it easier to write code that can be distributed to run across multiple servers. [2 marks]

Feature 1 _____

Feature 2 _____

END OF QUESTIONS

3

Additional page, if required.

Write the question numbers in the left-hand margin.

Additional page, if required.

Write the question numbers in the left-hand margin.

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For Examiner's Use	
Question	Mark
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