



Surname _____

Other Names _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

A-level

COMPUTER SCIENCE

Paper 2

7517/2

Time allowed: 2 hours 30 minutes

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]



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.

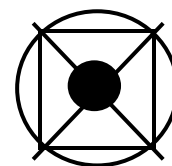
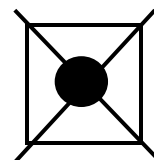
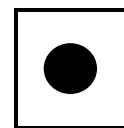
INFORMATION

- 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.

01.1

A bitmap image is 1000 pixels wide by 800 pixels high.

The image takes up 400 kB of storage space when represented as a bitmap, excluding metadata.

Calculate the maximum number of different colours that could appear in the image.

You should show your working. [3 marks]

Answer _____



0 1 . 2

The same image can also be represented using vector graphics.

The vector graphics representation of the image takes up 2 kB of storage space.

Explain why the amount of storage space taken up by the vector graphics representation of the image is significantly smaller than the space taken up by the bitmap representation. [3 marks]

[Turn over]





01.3

One advantage of vector graphics compared to bitmap graphics is that fewer bytes are used to represent an image.

State TWO other advantages of vector graphics compared with bitmap graphics. [2 marks]

Advantage 1 _____

Advantage 2 _____

[Turn over]

8



0 2

Describe what thin-client computing is AND explain TWO reasons why a thin-client system might be chosen in preference to a thick-client system. [3 marks]



3

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[Turn over]



03

A data communications system can transmit four different signals. Each different signal represents two bits of data.

03.1

Describe the exact relationship between the bit rate and the baud rate FOR THIS SYSTEM. [1 mark]

03.2

Describe the relationship between the bit rate of the system and the bandwidth of the transmission medium that the data is transmitted through. [1 mark]



03.3

The system uses serial transmission.

Describe the difference between the operation of serial and parallel transmission. [2 marks]

[Turn over]

4



| | |
|---|---|
| 0 | 4 |
|---|---|

FIGURE 1, provided in the separate insert, shows a circuit with inputs X0 to X2 and outputs Q0 to Q7

| | | | |
|---|---|---|---|
| 0 | 4 | . | 1 |
|---|---|---|---|

Write a Boolean expression to represent the output Q1 of the circuit in FIGURE 1, provided in the separate insert. [1 mark]

Q1 = _____



04.2

Complete the truth table below for the circuit in FIGURE 1. [3 marks]

| INPUTS | | | OUTPUTS | | | | | | | |
|--------|----|----|---------|----|----|----|----|----|----|----|
| X2 | X1 | X0 | Q0 | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 |
| 0 | 0 | 0 | | | | | | | | |
| 0 | 0 | 1 | | | | | | | | |
| 0 | 1 | 0 | | | | | | | | |
| 0 | 1 | 1 | | | | | | | | |
| 1 | 0 | 0 | | | | | | | | |
| 1 | 0 | 1 | | | | | | | | |
| 1 | 1 | 0 | | | | | | | | |
| 1 | 1 | 1 | | | | | | | | |

[Turn over]



04.3

Explain the purpose of the circuit in FIGURE 1, provided in the separate insert.

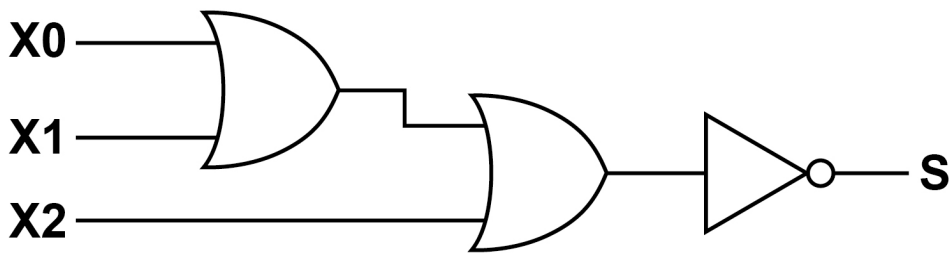
Considering the inputs and outputs of the circuit and consulting your answers to Question 04.1 and Question 04.2 may help you to do this. [2 marks]



| | | | |
|---|---|---|---|
| 0 | 4 | . | 4 |
|---|---|---|---|

The logic circuit in FIGURE 2 produces an output **S** that is equivalent to one of the outputs of the logic circuit in FIGURE 1, for the inputs **X0**, **X1** and **X2**.

FIGURE 2



Which output (**Q0** to **Q7**) from FIGURE 1 is the output **S** from the circuit in FIGURE 2 equivalent to? [1 mark]

[Turn over]

| |
|---|
| |
| 7 |



| | |
|---|---|
| 0 | 5 |
|---|---|

A sports centre uses a relational database to store information about its facilities (such as the swimming pool) and the bookings that have been made to use them.

FIGURE 3, provided in the separate insert, shows the structure of the relations in the database.

- The Facility relation stores the different facilities available at the sports centre. Each one is identified by a unique number and has a brief description. For example, the facility with FacilityID 1 has the description ‘Outdoor Pitch A’. PricePerHour is the price of hiring a facility for 1 hour. For example, the facility with FacilityID 1 has a price per hour of £17.50.**
- The FacilityForSport relation identifies which facilities are suitable for which sports. For example, the facility with FacilityID 1 is suitable for football, rugby and hockey and would therefore require three separate records in this relation.**
- The Booking relation stores the bookings that have been made. Bookings must start and end either on the hour, at quarter past, half past or quarter to the hour. A customer can make bookings for more than one facility for the same time. For example, a badminton club secretary might book both of the indoor sports halls for the same time. However, each facility can only be booked by one customer at any one time.**



- The Customer relation stores the details of customers who have made bookings.

05.1

The entity identifier (primary key) for the Booking relation is a composite entity identifier, consisting of these three attributes:

FacilityID, BookingDate, StartTime

An alternative entity identifier could have been chosen, composed of different attributes.

Shade ONE lozenge to indicate which of the following groups of attributes would form a valid alternative entity identifier for the Booking relation. [1 mark]

BookingDate, StartTime, EndTime

FacilityID, BookingDate, EndTime

FacilityID, StartTime, CustomerID

FacilityID, BookingDate, EndTime, Sport

[Turn over]



05.2

A different design was originally proposed for the database. This design did not have the Customer relation and had the following design for the Booking relation:

Booking(FacilityID, BookingDate, StartTime, EndTime, Forename, Surname, EmailAddress)

Explain why this alternative design would have been rejected in favour of the design in FIGURE 3, provided in the separate insert. [2 marks]

[Turn over]



05.3

Complete the following SQL statement to create the Facility relation specified in FIGURE 3, including the primary key. [3 marks]

```
CREATE TABLE Facility ( _____  
_____  
_____  
_____  
_____  
_____  
_____  
_____  
_____  
_____  
_____  
_____  
_____  
_____  
_____  
_____  
_____  
_____  
_____  
_____  
_____  
_____ )
```



Use **FIGURE 3**, provided in the separate insert, to help you answer **Question 5.4**

05.4

A customer wants to book a facility that is suitable for playing basketball on the 15/06/2021 between 14:15 and 16:15

As part of the booking process, a query is needed to list all the existing bookings that would overlap with the new booking.

Write a query that will list all the bookings for facilities that are suitable for playing basketball and which would overlap with the booking that the customer wants to make.

For each booking which would overlap with the new booking only the FacilityID, StartTime and EndTime fields should be listed. [7 marks]

[Turn over]



TABLE 1 is provided in the separate insert. It is included so that you can answer Question 06.1

06

FIGURE 4, provided in the separate 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 in the separate insert.

The program takes its input values from registers R1 and R2 and stores its output in registers R0 and R1

06.1

Complete the trace table below to show the results of executing the program in FIGURE 4 when the initial values in registers R1 and R2 are 34 and 6

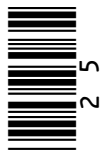
Each register can hold a 16-bit value.

You may find it easier to understand the operation of the program if you write the contents of the registers out in both binary and decimal.

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



| R0 | R1 | R2 | R3 | R4 |
|----|--------------------|----------------|----|----|
| | 100010 (34) | 110 (6) | | |
| | | | | |
| | | | | |
| | | | | |
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[Turn over]

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06.2

The initial values for the program (its inputs) are stored in R1 and R2 and the final values stored in R0 and R1 are its outputs.

By considering the inputs and the outputs in your trace table for Question 06.1, describe the purpose of the program. [2 marks]

[Turn over]

8



07.1

Explain why a laser printer with a built-in wireless network adapter is likely to be a suitable choice of printer for a small office. [3 marks]



07.2

**Describe the principles of operation of a laser printer.
[6 marks]**

[Turn over]



| | |
|---|---|
| 0 | 8 |
|---|---|

Use binary addition in 8-bit two's complement to perform the subtraction:

$$18 - 72$$

You **MUST** show both your working and your final answer in binary. [2 marks]

[Turn over]

| |
|---|
| — |
| 2 |



| | |
|---|---|
| 0 | 9 |
|---|---|

Big Data is an important application area for modern computer science.

- **Describe what Big Data is, using examples to illustrate your description.**
- **Explain some of the challenges that Big Data brings with it and the approaches that can be taken to overcome these, in relation to programming and hardware.**
- **Consider some of the ethical and legal issues that might arise in applications that store data, particularly data about people.**

[12 marks]



[Turn over]





Lined writing area consisting of 20 horizontal lines.

[Turn over]





[Turn over]

| |
|----|
| |
| 12 |



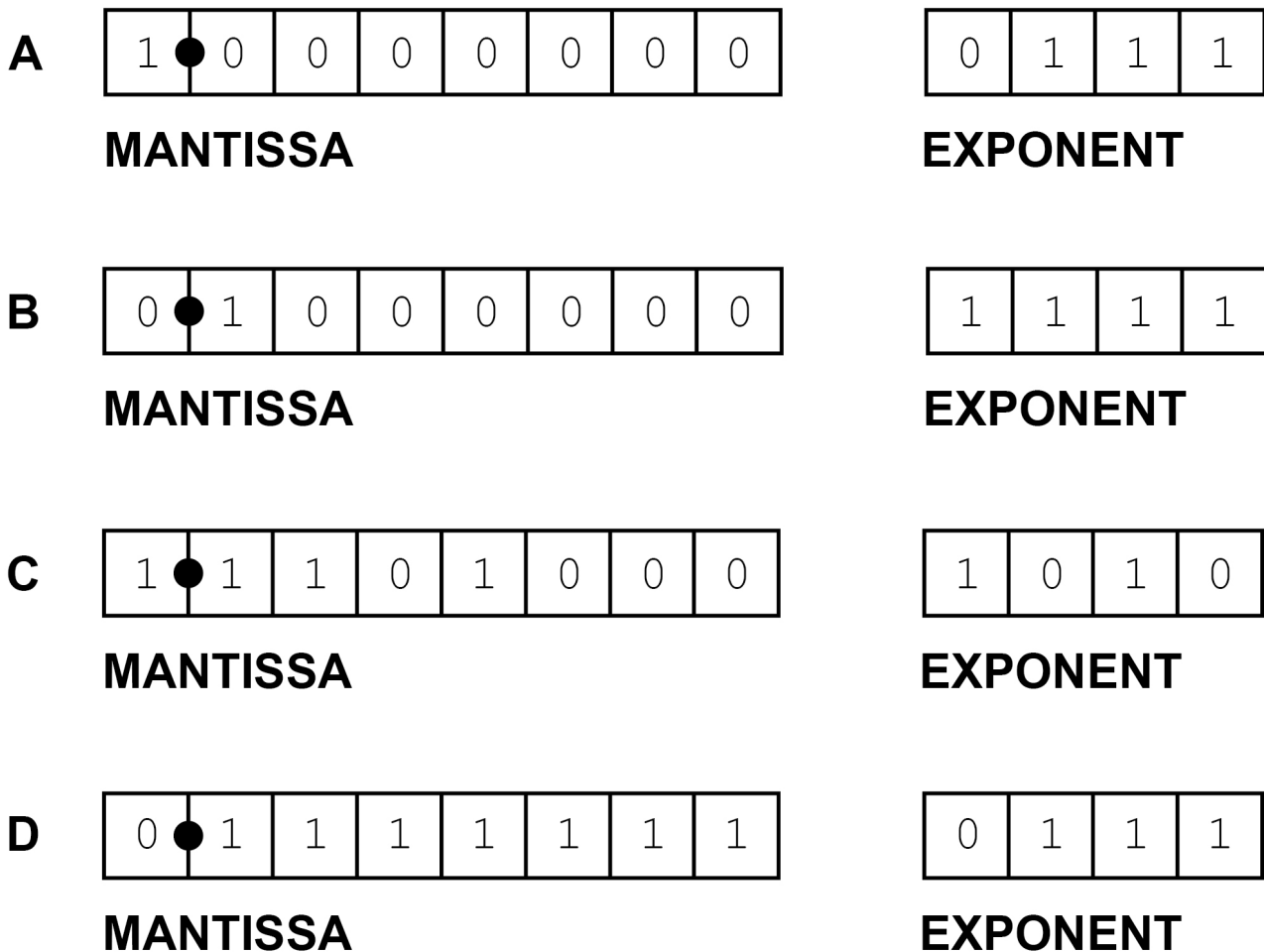
| | |
|---|---|
| 1 | 0 |
|---|---|

A particular computer uses a **NORMALISED** floating point representation with an 8-bit mantissa and a 4-bit exponent, both stored using **TWO'S COMPLEMENT**.

| | | | |
|---|---|---|---|
| 1 | 0 | . | 1 |
|---|---|---|---|

Four-bit patterns that are stored in this computer's memory are listed in **FIGURE 5** and are labelled with the letters **A** to **D**. Three of the bit patterns are valid normalised floating point numbers and one is not.

FIGURE 5



Complete TABLE 2 below. In the CORRECT LETTER (A–D) column write the appropriate letter from A to D to indicate which bit pattern in FIGURE 5 is an example of the type of value described in the VALUE DESCRIPTION column.

Do NOT use the same letter more than once. [3 marks]

TABLE 2

| VALUE DESCRIPTION | CORRECT LETTER (A–D) |
|---|----------------------|
| A negative value that is valid in the representation. | |
| The largest positive value that can be represented in the system. | |
| A value that is not valid in the representation because it is not normalised. | |

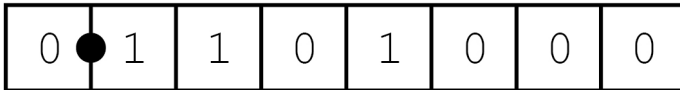
[Turn over]



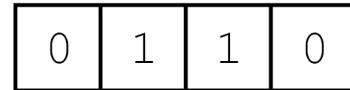
| | | | |
|---|---|---|---|
| 1 | 0 | . | 2 |
|---|---|---|---|

FIGURE 6 shows a floating point representation of a number:

FIGURE 6



MANTISSA



EXPONENT

Calculate the decimal equivalent of the number.

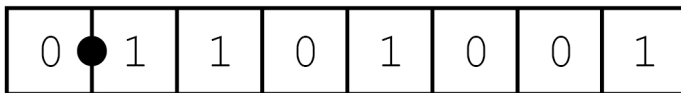
You should show your working. [2 marks]

Answer _____

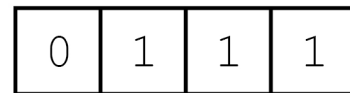


In this floating point system, the closest possible representation of the decimal number 104.7 is shown in FIGURE 7.

FIGURE 7



MANTISSA



EXPONENT

By converting this number back to decimal it can be seen that the actual value stored is 105

1 0 . 3

Calculate the ABSOLUTE ERROR that has occurred when representing 104.7 in FIGURE 7. [1 mark]

Answer _____

[Turn over]



REPEAT OF FIGURE 7

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 0 | ● | 1 | 1 | 0 | 1 | 0 | 0 | 1 |
|---|---|---|---|---|---|---|---|---|

MANTISSA

| | | | |
|---|---|---|---|
| 0 | 1 | 1 | 1 |
|---|---|---|---|

EXPONENT

| | | | |
|---|---|---|---|
| 1 | 0 | . | 4 |
|---|---|---|---|

Calculate the **RELATIVE ERROR** that has occurred when representing 104.7 in FIGURE 7.

Express your answer as a percentage to two decimal places. [1 mark]

Answer _____



| | | | |
|---|---|---|---|
| 1 | 0 | . | 5 |
|---|---|---|---|

Explain why the relative error is usually considered to be a more important measure of error than the absolute error. [1 mark]

[Turn over]

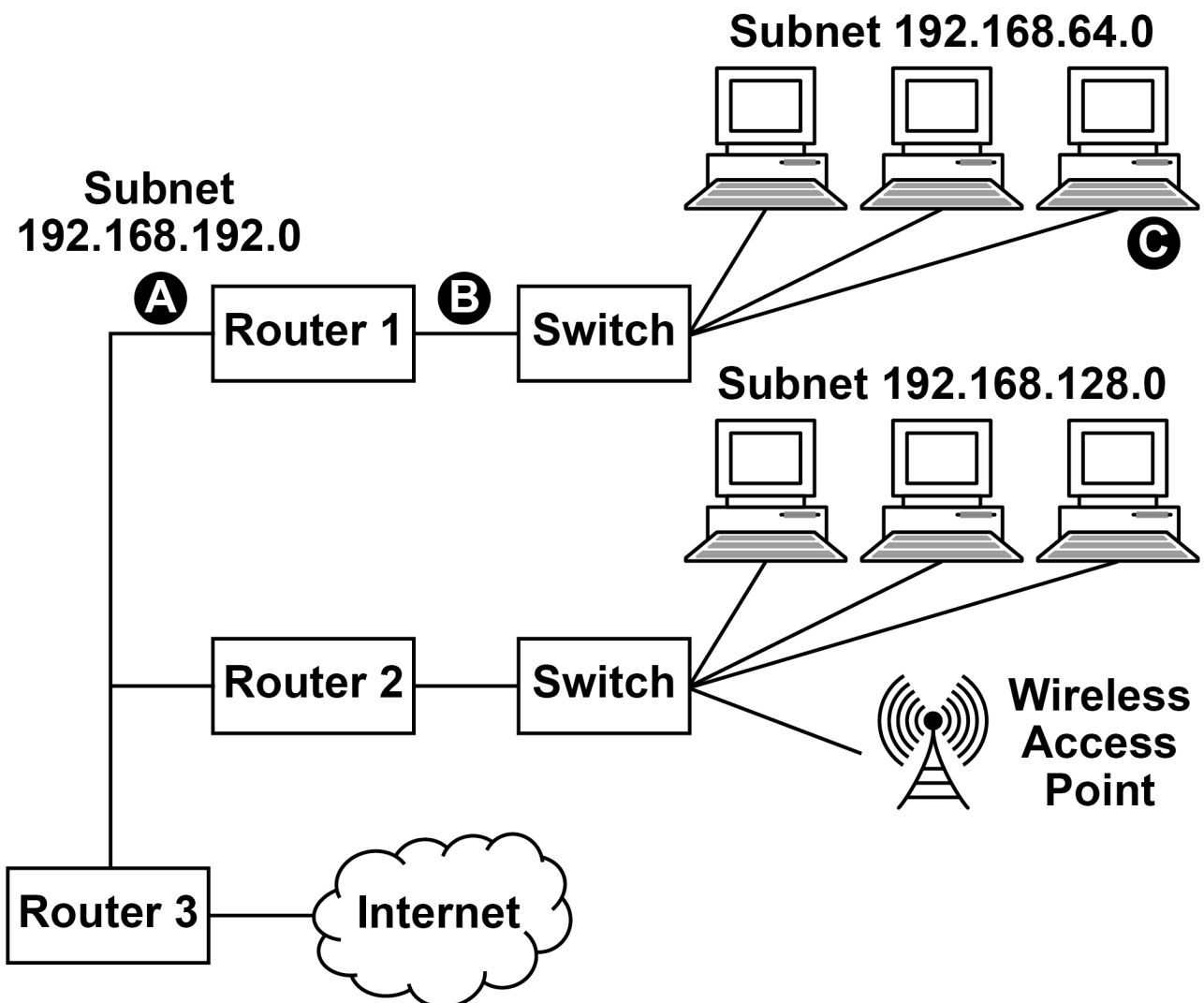
| |
|---|
| |
| 8 |



11

FIGURE 8 shows a computer network. The devices connected to the network are identified using IPv4 addresses. When assigning IP addresses, 20 bits have been allocated to the Network IDs (also known as Subnet IDs or subnet addresses) and 12 bits have been allocated to the Host IDs.

FIGURE 8



| | | | |
|---|---|---|---|
| 1 | 1 | . | 1 |
|---|---|---|---|

**State suitable IP addresses for:
[3 marks]**

The Router 1 port labelled **A** _____

The Router 1 port labelled **B** _____

The computer labelled **C** _____

[Turn over]



11.2

Shade **ONE** lozenge to indicate which of the following four subnet masks is the one that has been assigned to the devices connected to the network in **FIGURE 8**, on page 44. [1 mark]

A 255.255.0.0**B 255.255.15.0****C 255.255.240.0****D 255.255.255.0****11.3**

The devices on the network in **FIGURE 8** use IPv4.

State **ONE** reason why IPv6 has been introduced to replace IPv4. [1 mark]



11.4

State the name of the physical topology used in subnet 192.168.64.0 in FIGURE 8. [1 mark]

[Turn over]



11.5

Laptop computers and other devices can connect to the network via the wireless access point. The wireless connection uses the CSMA/CA protocol with Request to Send/Clear to Send (RTS/CTS).

A laptop connected to the wireless access point has data to send to another computer.

Explain how the CSMA/CA protocol with RTS/CTS will be used during this transmission. [6 marks]



| | |
|---|---|
| 1 | 2 |
|---|---|

**Describe how MIDI is used to represent digital music.
[2 marks]**

| |
|---|
| — |
| 2 |



13.1

Describe the difference between application software and system software. [2 marks]

[Turn over]



| | | | |
|---|---|---|---|
| 1 | 3 | . | 2 |
|---|---|---|---|

Utilities are a type of system software.

Describe what utilities are AND include an example of a utility in your answer. [2 marks]

| |
|----------|
| — |
| 4 |



| | | | |
|---|---|---|---|
| 1 | 4 | . | 1 |
|---|---|---|---|

Shade **ONE** lozenge to indicate which of these statements about a computer that uses the stored program concept is **FALSE**. [1 mark]

A Instructions are fetched and executed in sequence.

B The computer can only be used with one program.

C The data is stored in the main memory.

D The program is stored in the main memory.

[Turn over]



14.3

One method that can be used to improve the performance of a processor is to increase the amount of cache memory.

Describe:

- what cache memory is
- what cache memory is used for
- how increasing the amount of cache memory can improve the performance of a processor.

[4 marks]

[Turn over]



Additional page, if required.

Write the question numbers in the left-hand margin.



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| For Examiner's Use | |
|--------------------|------|
| Question | Mark |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| 14 | |
| TOTAL | |

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