



NSW Education Standards Authority

2019 HIGHER SCHOOL CERTIFICATE EXAMINATION

Software Design and Development

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- Write your Centre Number and Student Number at the top of page 13 and either pages 37 and 41 or pages 43 and 47

Total marks: 100**Section I – 20 marks** (pages 2–12)

- Attempt Questions 1–20
- Allow about 35 minutes for this section

Section II – 60 marks (pages 13–36)

- Attempt Questions 21–30
- Allow about 1 hour and 50 minutes for this section

Section III – 20 marks (pages 37–50)

- Attempt either Question 31 or Question 32
- Allow about 35 minutes for this section

Section I

20 marks

Attempt Questions 1–20

Allow about 35 minutes for this section

Use the multiple-choice answer sheet for Questions 1–20.

- 1** A developer uses existing modules of code to meet a client's needs quickly.
- Which development approach is being used?
- A. Agile
 - B. End user
 - C. Prototyping
 - D. Rapid application development
- 2** Which of the following best describes load testing?
- A. Testing every function of a system
 - B. Testing a system with large amounts of data
 - C. Testing a system with every transaction type
 - D. Testing of a system by different types of users
- 3** What is a benefit of outsourcing parts of a large software development project?
- A. It ensures protection of trade secrets.
 - B. It makes it easier to oversee work in progress.
 - C. It provides access to skilled personnel when needed.
 - D. It helps maintain the consistency of code and documentation.
- 4** What is the purpose of a post-implementation review?
- A. To check that the overall system functions correctly
 - B. To discuss the results of the acceptance testing process
 - C. To help evaluate the new system based on client feedback
 - D. To demonstrate the features of the new system to the client

5 Version control software, Gantt chart generators and test data generators are all examples of

- A. CASE tools.
- B. data modelling tools.
- C. project management tools.
- D. system documentation tools.

6 A program requires the use of three variables:

- Weekday (for example Monday, Wednesday)
- IsDayTime (for example Y, N)
- AverageTemp (for example 9.6).

Which of the following correctly shows how these variables are described in a data dictionary?

A.

<i>Data item</i>	<i>Data type</i>	<i>Size for storage</i>	<i>Example</i>
Weekday	string	9	Monday
IsDayTime	boolean	1	Y
AverageTemp	floating point	4	9.6

B.

<i>Data item</i>	<i>Data type</i>	<i>Size for storage</i>	<i>Example</i>
Weekday	string	7	Tuesday
IsDayTime	boolean	1	N
AverageTemp	integer	4	9.6

C.

<i>Data item</i>	<i>Data type</i>	<i>Size for storage</i>	<i>Example</i>
Weekday	string	6	Monday
IsDayTime	string	3	Yes
AverageTemp	integer	4	9.6

D.

<i>Data item</i>	<i>Data type</i>	<i>Size for storage</i>	<i>Example</i>
Weekday	string	9	Monday
IsDayTime	string	3	Yes
AverageTemp	floating point	3	9.6

Use the following information to answer Questions 7 and 8.

The following algorithm correctly searches an array for an item and outputs the position of that item in the array. Two pieces of code are missing, represented by (X) and (Y) below.

```
BEGIN
  Set LastIndex to the number of elements in Array
  Get SearchItem
  Found = FALSE
  Index = 1
  WHILE Found = FALSE AND Index < LastIndex + 1
    IF (X) THEN
      Found = TRUE
    ENDIF
    Increment Index
  ENDWHILE
  IF Found = TRUE THEN
    Display (Y)
  ENDIF
END
```

7 Which row of the table correctly identifies (X) and (Y)?

	(X)	(Y)
A.	Index = SearchItem	Index
B.	Index = SearchItem	Array(Index)
C.	Array(Index) = SearchItem	Index
D.	Array(Index) = SearchItem	Array(Index)

8 Which of the following variables is used as a flag in the algorithm?

- A. Found
- B. Index
- C. LastIndex
- D. SearchItem

9 Which row of the table contains correct statements about *interpretation* and *compilation*?

	<i>Interpretation</i>	<i>Compilation</i>
A.	The software is distributed in machine code format	A translator is required for the software to execute
B.	Debugging of the code is easier as syntax is checked line by line	A single version of the machine code can execute on all platforms
C.	The software potentially executes on any platform	The source code does not need to be distributed
D.	During syntax checking, all errors are displayed in a single list	The source code is not required for execution

10 Consider the following algorithm fragment.

```
REPEAT
  Whatever
UNTIL X > 5 OR Y = 8
```

Which of the following is equivalent to this fragment?

- A. WHILE X > 5 AND Y = 8
 Whatever
 ENDWHILE
- B. WHILE X <= 5 AND Y <> 8
 Whatever
 ENDWHILE
- C. WHILE X <= 5 OR Y <> 8
 Whatever
 ENDWHILE
- D. WHILE X > 5 OR Y = 8
 Whatever
 ENDWHILE

11 Which installation method is best suited to the system upgrade required?

	<i>Method</i>	<i>Upgrade required</i>
A.	Pilot	Calculation of tax payable on goods, based on new laws
B.	Phased	Adding a new product to a supermarket
C.	Parallel	Updating a supermarket checkout system to produce redesigned receipts for customers
D.	Direct cut over	Calculation of tax for all NSW employees based on new government requirements

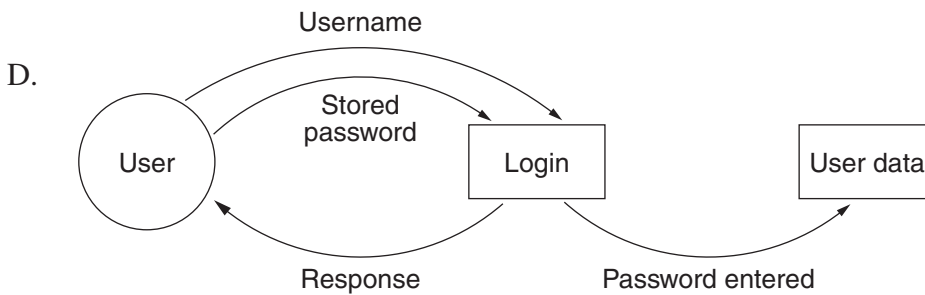
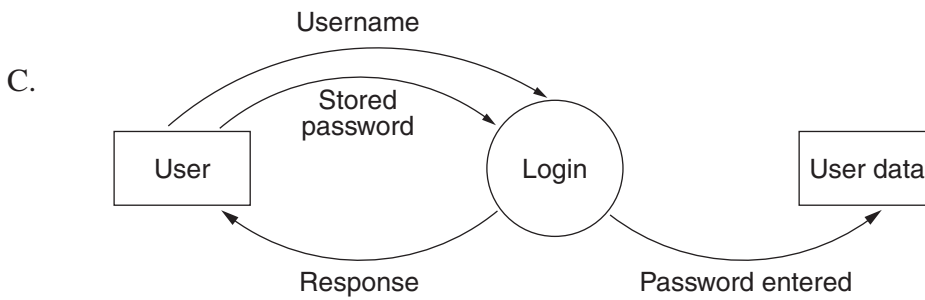
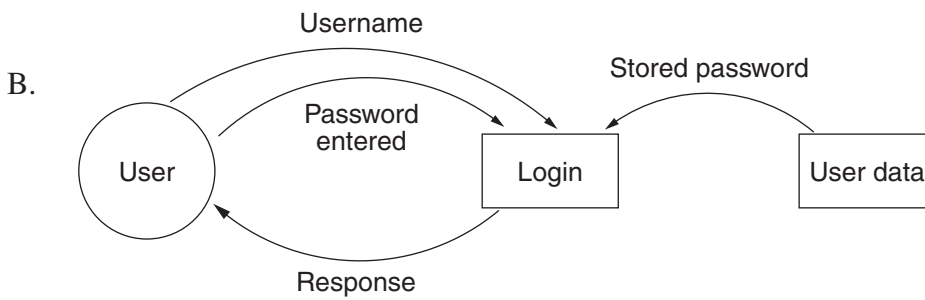
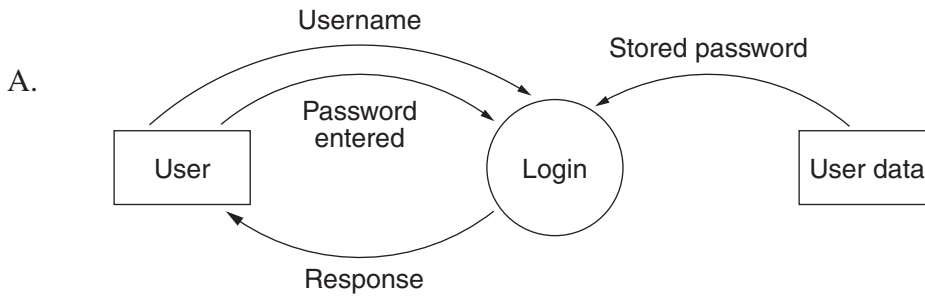
12 What happens during the 'fetch' step of the fetch–execute cycle?

- A. The program counter is incremented.
- B. A program is copied into the CPU for execution.
- C. Data needed to carry out an instruction in the CPU are moved from memory.
- D. An instruction is copied from memory and placed in the instruction register.

13 The IPO chart represents the procedure for enabling a user to login to a system.

<i>Input</i>	<i>Process</i>	<i>Output</i>
UserName PasswordEntered StoredPassword	Compare PasswordEntered with StoredPassword	'Login OK' 'Login failure'

Which of the following is a valid data flow diagram for this procedure?



- 14 A student designed an algorithm to determine entry costs into a show. She correctly designed the following set of concise, thorough and appropriate test data to test the algorithm.

2, 4, 10, 12, 20

Which of the following algorithms is she testing?

- A. BEGIN
 Get age
 CASEWHERE age is
 Less than 4 : Display "Free entry"
 From 4 to 12 : Display "Half Price"
 Over 12 : Display "Full Price"
 ENDCASE
END
- B. BEGIN
 Get age
 CASEWHERE age is
 Less than 4 : Display "Free entry"
 Over 12 : Display "Full Price"
 Over 65 : Display "Pension Rate"
 ENDCASE
END
- C. BEGIN
 Get age
 CASEWHERE age is
 Less than 4 : Display "Free entry"
 From 4 to 12 : Display "Half Price"
 From 13 to 65 : Display "Full Price"
 OTHERWISE : Display "Pension Rate"
 ENDCASE
END
- D. BEGIN
 Get age
 CASEWHERE age is
 Equals 4 : Display "Free entry"
 Less than 12 : Display "Half Price"
 21 and over : Display "Adult Price"
 OTHERWISE : Display "Full Price"
 ENDCASE
END

15 Which row of the table correctly describes features of a sequential file and a relative file?

	<i>Sequential</i>	<i>Relative</i>
A.	Records can only be read in the order they were written	The first field in each record is the key field
B.	Once opened, records can be read and written to the file	Uses an EOF marker to signify the end of the file
C.	Can be opened in 'append' mode	Allows update of an existing record in place
D.	Individual records can be read or written in any order	Uses a numeric key to access a specific record

16 Consider the following code.

```
BEGIN main
  Y is global
  X = 10
  Y = 20
  change
  print X,Y
END main
```

```
BEGIN change
  X is local
  X = 15
  Y = 25
END change
```

What is the output produced?

- A. 10, 20
- B. 10, 25
- C. 15, 20
- D. 15, 25

- 17 A system requires users to enter a valid ID which must start with an N or an E. The following instructions are displayed.

First type N or E
Then type # followed by a code and then another #
The code must start with two or three letters followed by at least two digits.

Which of the following is the correct EBNF definition for a valid ID based on these instructions?

You may assume that Letter and Digit are already defined.

- A. ID = [N|E] #<Code>#
Code = <LetterPart><NumberPart>
LetterPart = <Letter><Letter>{<Letter>}
NumberPart = <Digit><Digit>[<Digit>]
- B. ID = [N|E] #<Code>#
Code = <LetterPart><NumberPart>
LetterPart = <Letter><Letter>[<Letter>]
NumberPart = <Digit>{<Digit>}
- C. ID = (N|E) #<Code>#
Code = <LetterPart><NumberPart>
LetterPart = <Letter><Letter>{<Letter>}
NumberPart = <Digit><Digit>[<Digit>]
- D. ID = (N|E) #<Code>#
Code = <LetterPart><NumberPart>
LetterPart = <Letter><Letter>[<Letter>]
NumberPart = <Digit><Digit>{<Digit>}

- 18 RND(N) produces a random integer between 1 and N, inclusive.

Which of the following would always produce a random integer between 11 and 30, inclusive?

- A. $X = \text{RND}(30) - 11$
- B. $X = \text{RND}(20) + 10$
- C. $X = \text{RND}(30) - \text{RND}(10)$
- D. $X = \text{RND}(10) + \text{RND}(20)$

19 The input data for a program needs to be a single uppercase letter.

Which of the following would ensure that data accepted for processing are always valid?

- A. input X
IF length of X = 1 THEN
 IF X is lowercase THEN
 input X
 END IF
END IF
- B. valid = FALSE
REPEAT
 input X
 IF length of X = 1 AND X is uppercase THEN
 valid = TRUE
 END IF
UNTIL valid = TRUE
- C. valid = TRUE
REPEAT
 input X
 IF length of X > 1 OR X is lowercase THEN
 valid = FALSE
 END IF
UNTIL valid = TRUE
- D. valid = TRUE
WHILE valid = FALSE
 input X
 IF length of X = 1 AND X is uppercase THEN
 valid = TRUE
 END IF
ENDWHILE

- 20 This array has been partially sorted using an insertion sort with some passes already completed.

2	1	7	5	3	4	6	8
---	---	---	---	---	---	---	---

Which of the following is a possible result of the next pass?

A.

1	2	5	3	4	6	7	8
---	---	---	---	---	---	---	---

B.

2	1	6	3	4	5	7	8
---	---	---	---	---	---	---	---

C.

2	1	7	3	4	5	6	8
---	---	---	---	---	---	---	---

D.

1	2	3	4	6	5	7	8
---	---	---	---	---	---	---	---

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Centre Number

Software Design and Development

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Student Number

Section II Answer Booklet

60 marks

Attempt Questions 21–30

Allow about 1 hour and 50 minutes for this section

Instructions

- Write your Centre Number and Student Number at the top of this page.
- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
- If you include diagrams in your answer, ensure that they are clearly labelled.
- Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering.

Please turn over

Question 21 (3 marks)

Describe what a developer needs to consider when developing interfaces for software to be used on modern devices with small touchscreens.

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Question 22 (3 marks)

Identify TWO advantages and TWO disadvantages to users if a particular software development company is dominant in the software marketplace.

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Question 23 (12 marks)

- (a) Outline ONE similarity and ONE difference between an array and a record. 2

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- (b) A university is planning to use a web-based form to collect data from its students.

The table shows examples of the data required.

<i>ID</i>	<i>Surname</i>	<i>Given names</i>	<i>Date of birth</i>	<i>Email address</i>	<i>Gender</i>	<i>Full/part time</i>	<i>Faculty</i>
1425613	Jones	Brian John	01/04/1989	bjones@...	M	F	Maths
2562731	Frith	Chris	25/12/2001	cfrith@...	O	P	English
3413465	Alba	Senoria Jane	30/06/1999	salba@...	F	F	Science
...

Gender must be M, F or O (other/undisclosed).

Students can apply to study either full-time (F) or part-time (P).

There are twelve faculties at the university. Each student can be enrolled in one faculty only.

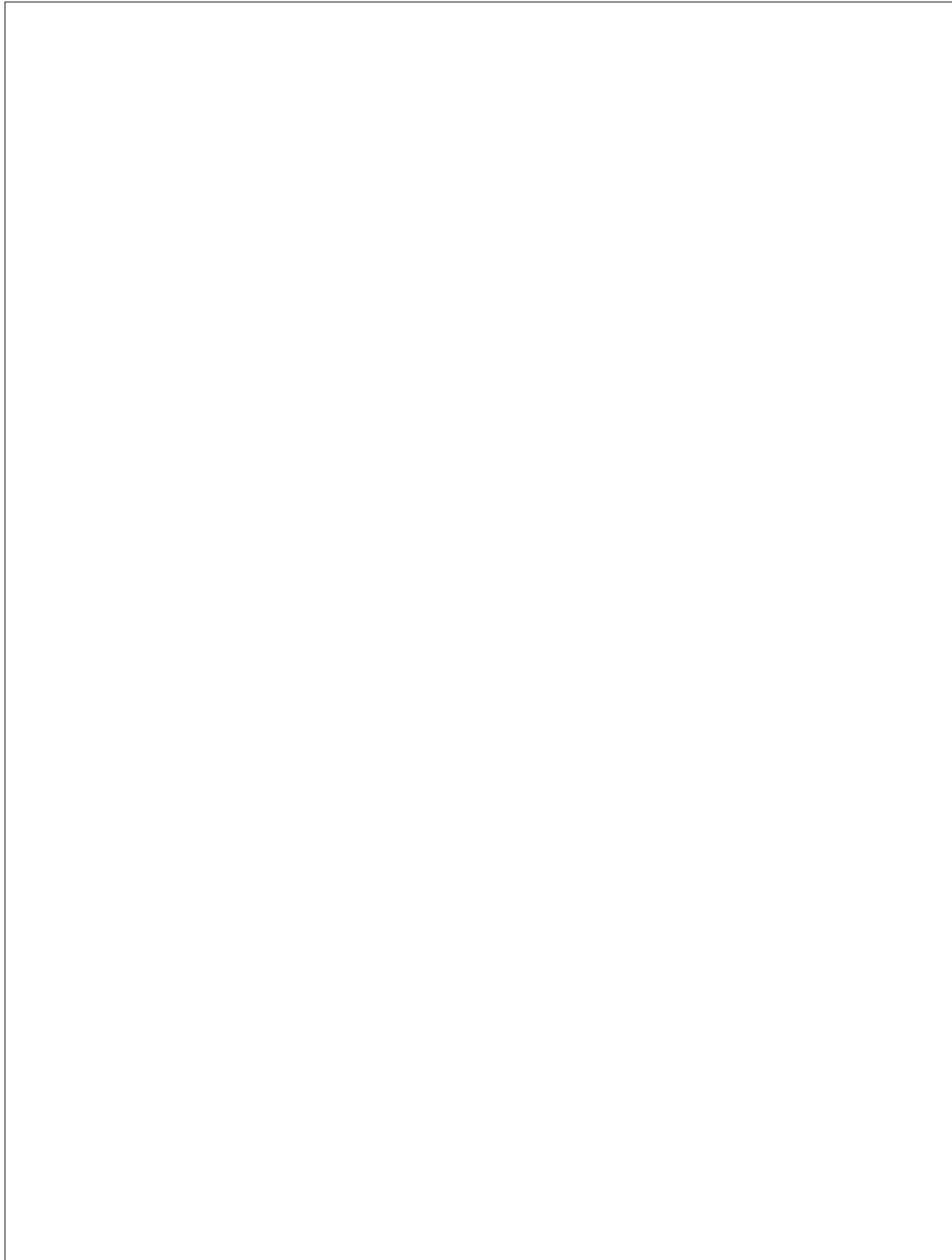
The student ID is automatically generated.

Question 23 continues on page 17

Question 23 (continued)

- (i) Design the web-based form using the fields specified in the table. Clearly label all screen elements that enable validation.

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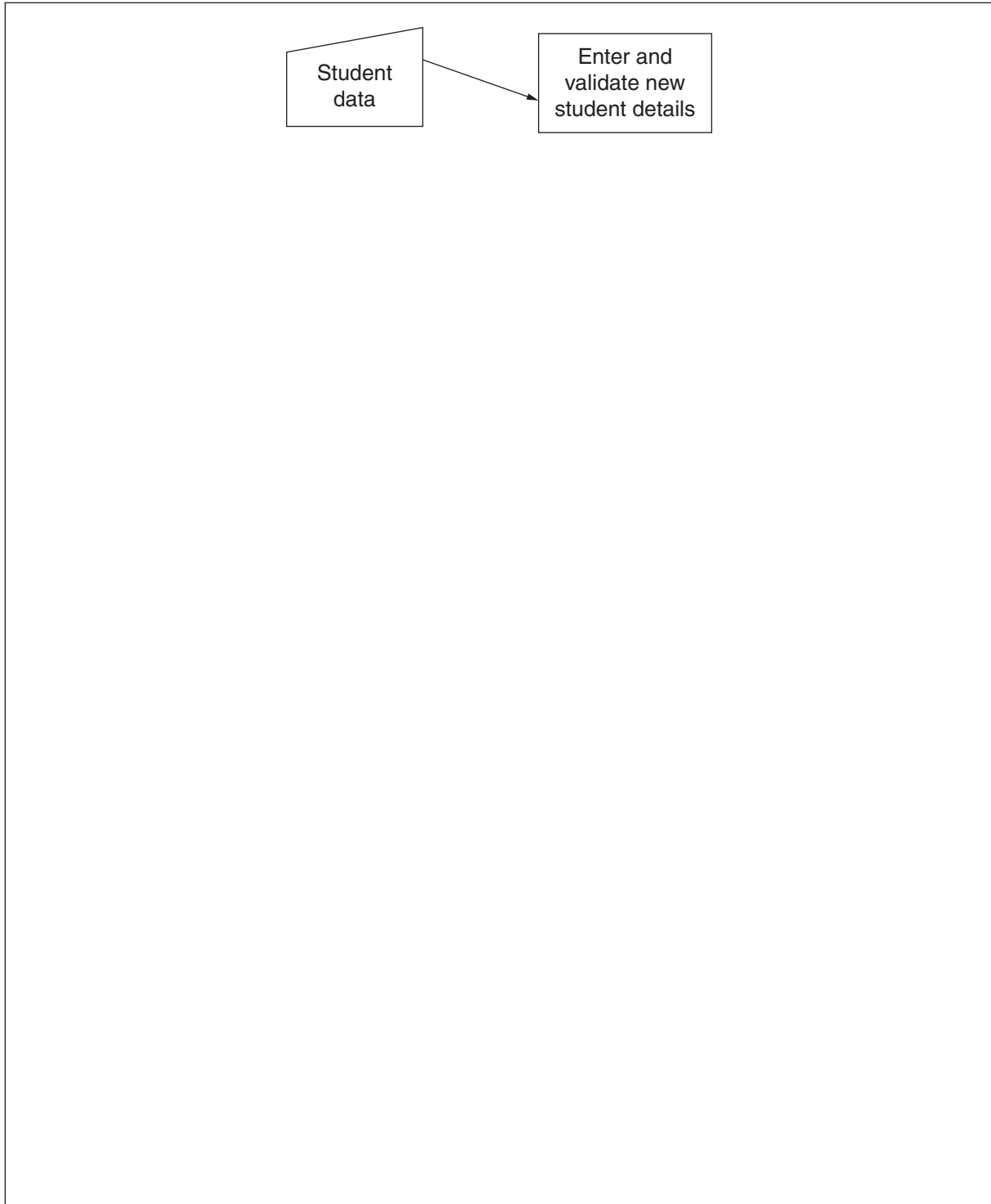
Question 23 continues on page 18

Question 23 (continued)

- (ii) Student data collected using the web-based form will be saved to local hard drive storage as well as to a cloud-based backup. An email is sent to each student confirming application details. At the end of the application process a report is printed for each faculty.

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Complete the system flowchart to represent this process.



Do NOT write in this area.

Question 23 continues on page 19

Question 23 (continued)

- (iii) Over 20 000 students are expected to enrol. There are occasions when the student records need to be searched. Searches could be based on different criteria each time.

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Explain when a linear search might be appropriate and when a binary search might be appropriate for searching the records.

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End of Question 23

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Question 24 (5 marks)

Consider the following code which prints a sequence of numbers with a common difference between them, such as 3, 6, 9.

```
1 X = 1
2 Get Y
3 REPEAT
4     Z = Y
5     IF X < 7 THEN
6         X = X + 1
7         IF X < 8 THEN
8             Print X * Z
9         END IF
10    END IF
11    X = X + 1
12 UNTIL X > 8
13 Print "Done"
```

(a) Perform a desk check on this code, with $Y = 2$.

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Question 24 continues on page 21

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Question 24 (continued)

- (b) The logic of the code on the previous page is correct.

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Explain how the code can be simplified by removing some lines and modifying others, and still produce the same output. Refer to line numbers in your answer. There is no need to rewrite the complete code.

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End of Question 24

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Question 25 (10 marks)

A team is planning to develop a new social-networking application that allows users to share photos and videos, and message each other. The team expects that, after the initial implementation, the application will need many changes to remain competitive.

(a) Justify a software development approach for this project.

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(b) Describe various ways in which the team can evaluate the application once it has been implemented.

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Question 25 continues on page 23

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Question 25 (continued)

- (c) Justify a variety of ways in which the team could ensure ease of future maintenance of the code for this evolving social-networking application.

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End of Question 25

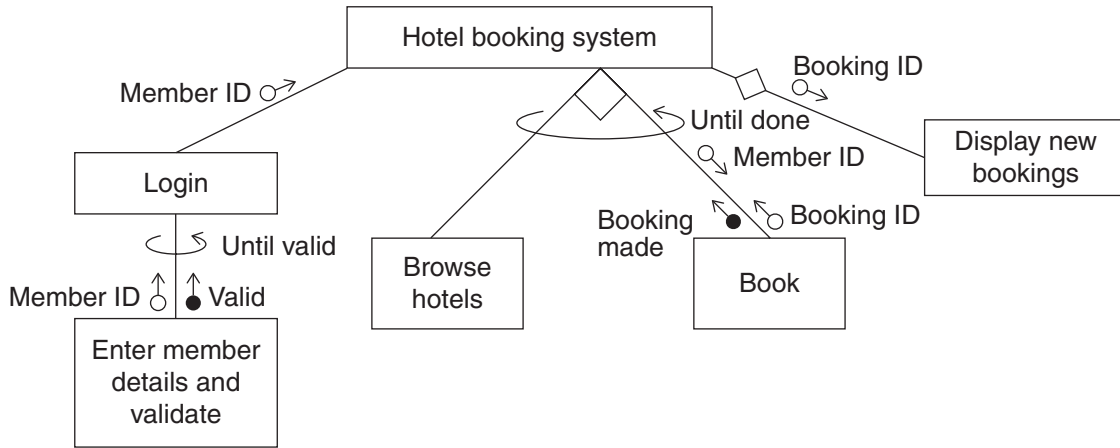
- 23 -

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Question 26 (4 marks)

The structure chart documents a hotel booking system.

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Describe the system in words, making reference to the meaning of each symbol used.

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Question 27 (9 marks)

A travel company that specialises in tours for disabled people has employed a developer to upgrade its system so that tours can be booked and paid for online. The current system uses an unusual mix of hardware and software.

- (a) Justify **THREE** considerations for the developer when designing the upgrade for this system. **3**

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- (b) Outline **THREE** factors that should be taken into account by the developer when choosing a programming language to implement this upgrade. **3**

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Question 27 continues on page 27

Question 27 (continued)

- (c) Explain ONE advantage and ONE disadvantage of a single person developing the system upgrade.

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End of Question 27

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Question 28 (4 marks)

An algorithm is required to encrypt a string of characters and display the encrypted string. The following library routines can be used in the algorithm.

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Length(string1) provides the number of characters in string1

Each of the following routines returns a single string. The original string remains unchanged.

Flip (string1)	creates a new string with the order of the characters in string1 reversed
Middle (string1, n)	copies the middle n characters from string1
Left (string1, n)	copies n characters from the beginning of string1
Right (string1, n)	copies n characters from the end of string1
Append (string1, string2)	creates a new string with string2 added after string1

For example, the following code will display riahc, chair

```
Word = "chair"  
Print Flip (Word)  
Print Word
```

The original unencrypted string

- is at least 16 characters long
- has an even number of characters.

The string is to be encrypted as follows:

Step 1. Take the middle 10 characters and reverse them.

Step 2. From the original unencrypted string:

- Extract the characters up to (but not including) the middle 10 characters
- Reverse these, and add them to the front of the string generated in step 1.

Step 3. From the original unencrypted string:

- Extract all of the characters after the middle 10 characters
- Reverse these, and add them to the end of the string generated in step 2.

For example, "computersaregreat!" will encrypt to "pmocrgerasretultae".

Question 28 continues on page 29

Question 29 (5 marks)

A student wrote the following subroutine using a particular programming language. The subroutine is intended to sort the elements of an array called Friends into ascending alphabetical order.

```
10 Start SortFriends
20     Set Num to length(Friends) 'REM Num = the number of elements in the array
30     Set Swapped to False
40     Loopwhile Swapped = True
50         For Count = 1 to Num - 1
60             If Friends(Count) > Friends(Count + 1)
70                 Set Temp to Friends(Count)
80                 Set Friends(Count) to Friends(Count + 1)
90                 Set Friends(Count + 1) to Temp
100                Set Swapped to True
110            Endif
120        Next Count
130        Increment Num
140    Endloop
150    For ListCount = 1 to Num
160        Display Friends(ListCount)
170    Next ListCount
180 End SortFriends
```

- (a) When the subroutine is executed, the output is not as expected. 3

Describe TWO methods that can be used to identify the errors in this subroutine. Refer to line numbers in your answer.

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Question 29 continues on page 31

Question 29 (continued)

- (b) Identify and justify the changes to the subroutine required so that the correct output is achieved. In your answer you may refer to line numbers. 2

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End of Question 29

Do NOT write in this area.

Question 30 (5 marks)

In a game, players are identified by a 3-digit number and are awarded scores. The results have been stored in a 2-dimensional array called `First`, sorted by player number. The scores need to be transferred to a different 2-dimensional array called `Second`, so that all scores for a particular player are in a single row.

Each player can have a maximum of 10 scores. You may assume there are always 50 scores stored in the first array.

Sample contents for the two arrays are shown.

First

231	5
231	2
231	6
231	3
654	1
654	4
777	2
...	...

In this example,
 $\text{First}(3,2) = 6$

Second

231	5	2	6	3						
654	1	4								
777	2									
...										

Question 30 continues on page 33

Section II extra writing space

If you use this space, clearly indicate which question you are answering.

A large rectangular area with 25 horizontal lines for writing, intended for answers to questions in Section II.

Do NOT write in this area.



Section II extra writing space

If you use this space, clearly indicate which question you are answering.

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Centre Number

Software Design and Development

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Student Number

Section III

20 marks

Attempt either Question 31 or Question 32

Allow about 35 minutes for this section

Answer the question in the spaces provided. These spaces provide guidance for the expected length of response.

If you include diagrams in your answer, ensure that they are clearly labelled.

Question 31 — Programming Paradigms (20 marks)

- (a) Explain ONE benefit of using the object oriented paradigm with respect to software maintenance. **2**

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Question 31 continues on page 38

Question 31 (continued)

- (b) The following fragment of code is from a theatre booking system. The system allows tickets to be sold for a variety of events at a number of different theatres. In the future, the developers are hoping to incorporate changes to the ticketing system, such as allowing a greater variety of discount types.

```
10  class TICKET {
20      private –
30          Ticket_no: integer
40          Event_id: string
50          Date_of_event: date
60          Theatre_id: string
70          Basic_cost: float
80          Event_name: string
90      public –
100         GetEvent_name()
110             RETURN Event_name
120         END GetEvent_name
130 }
140 class TICKETTYPE {
150     is a TICKET
160     private –
170         Type_of_ticket: string
180         Discount: real
190         Evidence_sighted: Boolean    ‘REM For example, set to TRUE if driver
                                         licence is seen
200     public –
210         GetDiscount()
220             RETURN Discount
230         END GetDiscount
240         GetEvent_name()
250             RETURN Event_name, Type_of_ticket
260         END GetEvent_name
270 }
```

Question 31 continues on page 39



Question 31 (continued)

- (i) Distinguish between *inheritance* and *polymorphism*. Support your answer with specific examples from this system. 4

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- (ii) A discount can only be provided if relevant evidence is sighted. 2

Write the code to achieve this. Include line numbers to show where the code is to be added.

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Question 31 continues on page 40





Question 31 (continued)

(c) A medical diagnosis system has been developed using the logic paradigm. Doctors can enter a range of symptoms into the system, for example temperature, rash, pain. The system produces a diagnosis, for example ‘90% chance that the patient has measles’. The system also accepts direct entry of digital images such as X-rays, scans and photos to assist in arriving at a diagnosis.

(i) Define the following logic paradigm concepts. Include a relevant example of each from this system: 3

- a fact
- a rule
- a query.

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(ii) Describe how pattern matching can be used in this system. 3

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Question 31 continues on page 41



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Student Number

Section III (continued)

Question 31 (continued)

- (d) There are a number of driverless car systems being developed, in which cars travel from one place to another without a driver being required. The car is controlled by software. **3**

Describe how artificial intelligence (AI) can be used in such systems.

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Question 31 continues on page 42

Question 31 (continued)

- (e) Does the imperative paradigm still have a role to play in the development of software today? Justify your answer. **3**

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End of Question 31

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Centre Number

Software Design and Development

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Student Number

Section III (continued)

Do NOT attempt Question 32 if you have already attempted Question 31.

Question 32 — The Interrelationship between Software and Hardware (20 marks)

- (a) Perform the following binary addition. Clearly show all carry bits used. 2

$$\begin{array}{r}
 1\ 0\ 1\ 1 \\
 0\ 1\ 1\ 1 \\
 +0\ 0\ 1\ 1 \\
 \hline
 \\
 \hline
 \end{array}$$

- (b) Outline how the binary arithmetic processes of subtraction, division and multiplication can be achieved with a combination of adding, shifting and flipping bits. 3

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Question 32 continues on page 44



Question 32 (continued)

(c) Consider the following 32 bits of data.

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0000 0011 0100 0011 0110 0001 0111 0100

The data can be interpreted in many ways, including:

- Cat
- 54747508
- 5.741722×10^{-37} .

With reference to the binary representation of data, explain how these THREE interpretations are possible. There is no need to perform calculations.

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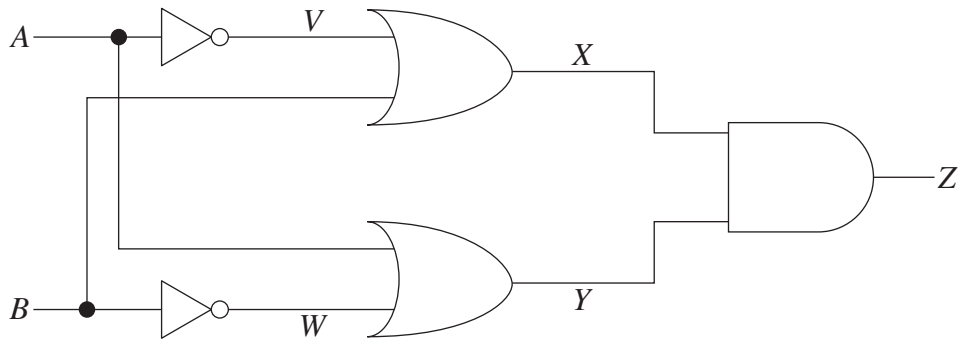
Question 32 continues on page 45



Question 32 (continued)

(d) Consider the following logic circuit.

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Draw a circuit that is logically equivalent to the circuit provided, but which uses the fewest number of gates possible. Support your answer with a relevant truth table.

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Question 32 continues on page 47



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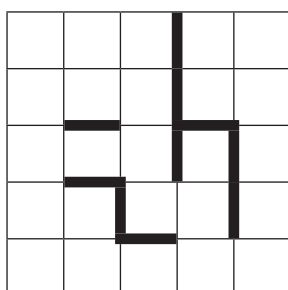
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Section III (continued)

Question 32 (continued)

- (e) A developer is designing a system to explore and map a maze using a drone. The maze is constructed of paths using a grid of 2 metre by 2 metre squares. Each square can be bounded by walls on up to three of its sides.

A sample maze is shown.



The drone has 4 sensors that sense the distance to the nearest wall to its left, right, in front and behind. It has one motor which can drive the drone forward, backward, left or right.

Data streams are sent between the drone and a computer that controls the drone.

The drone starts in the centre of a 2 metre square and always moves to the centre of another square. After each move there is communication between the drone and the computer.

Question 32 continues on page 48

Question 32 (continued)

The structure of the data stream sent from the drone to the computer is shown in Table 1.

Table 1

<i>Component</i>	<i>Number of bits</i>	<i>Description</i>
Start bit	1	Always 1
Left	4	Distance from the nearest wall to its left, measured in metres
Right	4	Distance from the nearest wall to its right, measured in metres
In front	4	Distance from the nearest wall in front of it, measured in metres
Behind	4	Distance from the nearest wall behind it, measured in metres
Stop bit	1	Always 1

Note: If the distance to the nearest wall is 15 metres or greater, or no wall is sensed, the value is set to 1111.

- (i) The drone has just moved to a position where it is 3 metres away from a wall to its left, 3 metres away from a wall to its right, and is 5 metres away from the wall in front of it. The nearest wall to the rear of the drone is 21 metres away. 2

Construct the data stream that would be sent from the drone to the computer.

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- (ii) The structure of the data stream sent from the computer to the drone is shown in Table 2. 3

Table 2

<i>Component</i>	<i>Number of bits</i>	<i>Description</i>
Start bit	1	Always 1
Motor status	1	0 – motor off 1 – motor on
Direction	2	00 – backwards 01 – right 10 – left 11 – forwards
Stop bit	1	Always 1

Question 32 continues on page 49

Question 32 (continued)

The drone (▲) starts in the position shown in the diagram below.

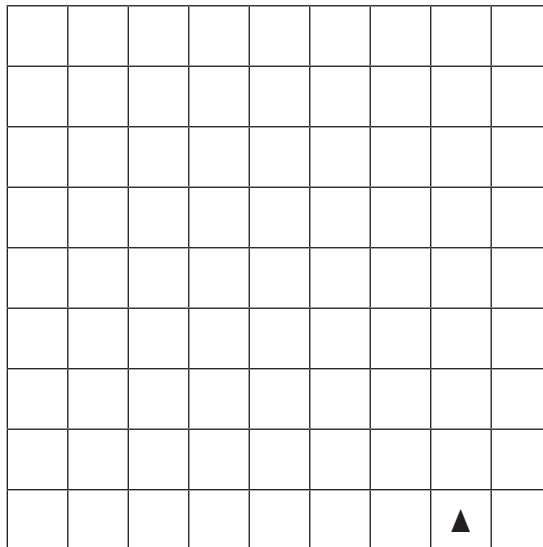
If the motor is turned on, the drone will move 2 metres in the direction specified in the data stream from the computer, moving to the centre of the next square.

Note that the drone is always in a horizontal position and always faces the same direction.

The following communications occur between the drone and the computer:

From the drone:	1 0001 0001 1111 1111 1
From the computer:	1 1 11 1
From the drone:	1 0011 0001 1101 1111 1
From the computer:	1 1 10 1
From the drone:	1 0001 0011 0011 0001 1
From the computer:	1 1 11 1
From the drone:	1 0111 0001 0001 0011 1

Draw the movement of the drone within the diagram, showing all known walls.



Question 32 continues on page 50



Question 32 (continued)

- (iii) Explain the required changes to the drone and the data streams to enable the drone to explore and map a 3-dimensional maze.

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