Centre Number

Student Number

2024 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 this page and either page 41 or page 49

Total marks: 100

Section I – 20 marks (pages 2–13)
- Attempt Questions 1–20
- Allow about 35 minutes for this section

Section II – 60 marks (pages 17–39)
- Attempt Questions 21–30
- Allow about 1 hour and 50 minutes for this section

Section III – 20 marks (pages 41–56)
- 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   Which of the following is covered by a software licence?

    A.   The data types used by the software

    B.   The security of the data in the system

    C.   The ease of use of the interface by users

    D.   The number of users running the software

2   A software solution is to be developed by a team, initially with a small number of features. More features will be added over the life of the project in response to user feedback.

Which development approach would be most suitable for this software solution?

    A.   RAD

    B.   Agile

    C.   End-user

    D.   Prototyping

3   A new system is being implemented. The old system will be kept running until all problems with the new system are resolved.

Which installation method is being used?

    A.   Pilot

    B.   Phased

    C.   Parallel

    D.   Direct cut over

4 A software developer uses artificial intelligence software to generate code for a software solution.

Which of the following is the developer using?

A. Piloting

B. A compiler

C. Outsourcing

D. A CASE tool

5 Which of the following describes data that would best be stored in an array of floating point/real numbers?

A. Dice rolls that are randomly generated for a game

B. The average daily temperature for each day in 2024

C. Product codes that need to be sorted alphabetically for display

D. Attendance data for a school indicating whether each student was absent or present

6 Company *A* and company *B* have made an agreement that company *B*'s internet browser will be the default browser for company *A*'s operating system.

Legal action is being considered against both companies due to the nature of this agreement.

Which statement best describes the relevant issue here?

A. It is a software market issue because the companies are minimising competition.

B. It is a copyright issue because both companies can claim intellectual property for their software.

C. It is a project management issue because the browser and the operating system must be made compatible with each other.

D. It is an ergonomic issue because of potentially inconsistent interface design between the browser and the operating system.

7 Consider the following code fragment.

```
Get Age
CASEWHERE Age IS
        < 12              :  Price = 5
        >= 12 AND < 60  :  Price = 10
        >= 60            :  Price = 8
ENDCASE
```

Initially 6, 20, 60 were used as test data.

Which of the following additional test data sets is the most useful for fully testing the code?

A.   11, 13

B.   11, 61

C.   12, 13

D.   12, 61

Use the following interface design to answer Questions 8–9.
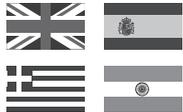
The interface has a number of features identified as ①, ②, ③, ④ and ⑤.

As a user types the letters of their suburb (feature ②), an updated list of possible suburbs is displayed for the user to select from.

8 Which row of the table correctly identifies the most suitable way to store the data captured through the identified features?

	Homeowner ③	NumPeopleStaying ④	Language ⑤
A.	Boolean	Integer	Integer
B.	String	Floating point/real	Image
C.	String	Integer	Integer
D.	Boolean	Floating point/real	Image

9 By using appropriate interface design features, a developer can address issues such as inclusivity, ergonomics, privacy and data validation.

Which row correctly matches specific interface features with the relevant issues they are designed to address?

	Feature	*Issue*		*Feature*	*Issue*
A.	①	Inclusivity		②	Validation
B.	②	Ergonomics		⑤	Inclusivity
C.	③	Privacy		①	Ergonomics
D.	⑤	Validation		③	Privacy

Use the following information to answer Questions 10–11.
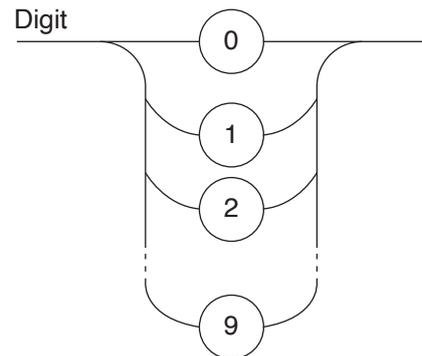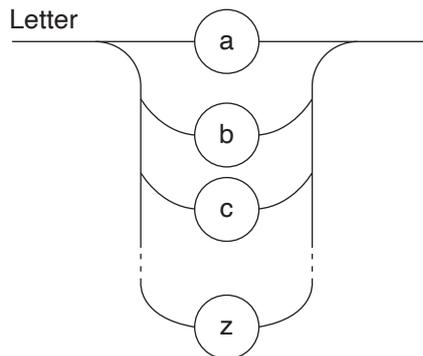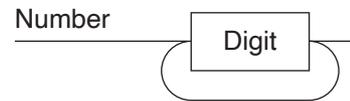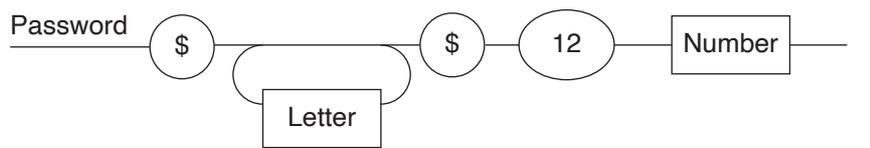
10   Which of the following is a correct Password using this definition?

A. abc12

B. aab120

C. $ab12$12

D. $help$help$123

11 Which of the following EBNF definitions is logically equivalent to the railroad diagram provided?

A. Password =${<Letter>}$12<Number>
    Letter = [a|b|c|...|z]
    Number = <Digit>{<Digit>}
    Digit = 0, 1, 2, ... , 9

B. Password = ${<Letter>}$12<Number>
    Letter = [a|b|c|...|z]
    Number = <Digit>[<Digit>]
    Digit = 0|1|2|3| ... |9

C. Password = <Letter>12<Number>
    Letter = ${a|b|c|...|z}$
    Number = <Digit>{<Digit>}
    Digit = 0|1|2| ... |9

D. Password = {Letter}12{Number}
    Letter = a|b|c|...|z
    Number = Digit{Digit}
    Digit = 1|2|3| ... |9

12 An array called List contains the following data.

index	1	2	3	4
List(index)	X	A	W	C

Consider the following code fragment.

```
Temp = List(1)
List(4) = List(1)
List(1) = Temp
FOR index = 1 to 4
        Display List(index)
NEXT index
```

What is the output produced by the code?

A. A, C, W, X

B. C, A, W, C

C. C, A, W, X

D. X, A, W, X

Use the following information to answer Questions 13–14.

SUB and SAVE are two instructions available for a central processing unit.

SUB A, B, C   subtracts the contents of Register B from the contents of Register A and places the result in Register C.

SAVE X, Y   stores a copy of the contents of Register X in memory location Y.

Consider the following fragment of code.

SUB R3, R1, R2

SAVE R2, N3

13   Before execution of the code fragment, the registers contain the following values.

Register	Contents
R1	7
R2	9
R3	15

What will be the contents of N3 after execution of the code fragment?

A.   2

B.   6

C.   8

D.   9

14   Which of the following is performing the function of an accumulator in this code?

A.   N3

B.   R1

C.   R2

D.   R3

15 The array Fruit contains the following data.

Index	Fruit(Index)
1	Banana
2	Apple
3	Mandarin
4	Peach
5	Apricot
6	Mandarin

Consider the following code fragment.

```
BEGIN SEARCH
        Index = 1
        Found = 0
        Input SearchItem
        WHILE Found = 0 AND Index <= 6
                IF Fruit (Index) = SearchItem THEN
                        Print Index
                        Found = Found + 1
                ENDIF
                Index = Index + 1
        END WHILE
END SEARCH
```

What is the output if the data entered is Mandarin?

A. 2, 3

B. 3

C. 3, 6

D. 6

16   Consider the following structure chart.
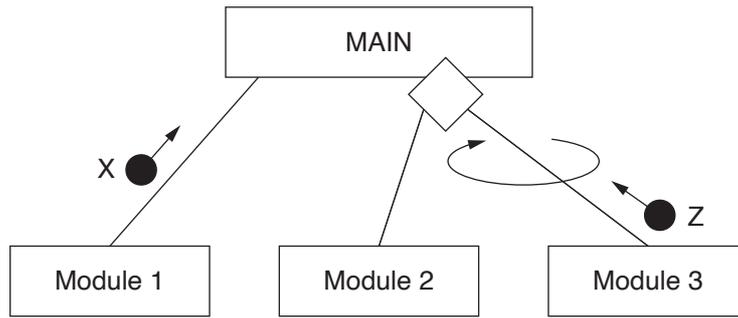
Which of the following flowcharts matches the logic in the MAIN module?

A.

B.

C.

D.

17 Consider the following code fragment.

```
BEGIN
        OPEN FileName for input
        ItemName = "XXX"
        READ ItemName from FileName
        WHILE ItemName is not equal to "XXX"
                ProcessItem
                READ ItemName from FileName
                CLOSE FileName
        ENDWHILE
END
```

Which type of error will result when this code is executed after successful compilation?

A.   Syntax

B.   Runtime

C.   Overflow

D.   Type mismatch
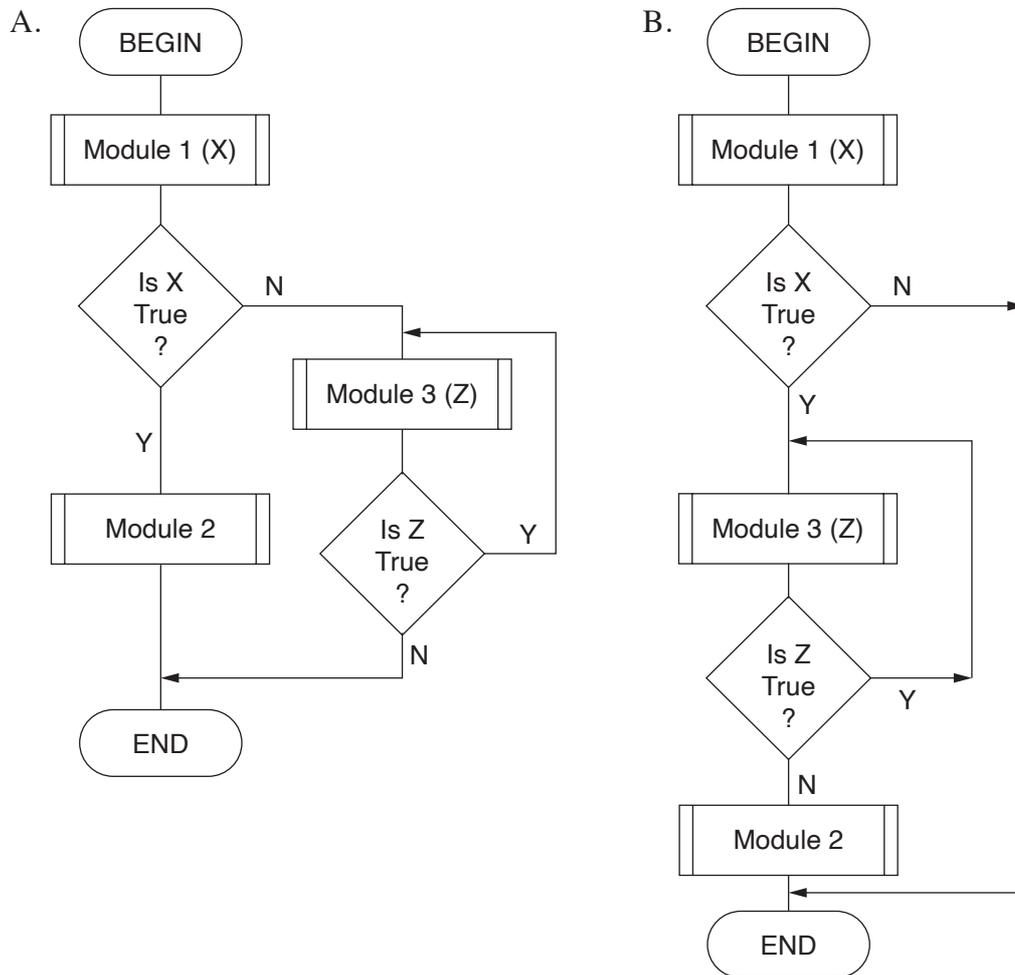
18 A program is written using a higher-level language.

Which of the following shows the correct sequence of processes that need to occur for the program to run?

A.   Token generation, parsing, compilation, execution, linking

B.   Syntactical analysis, compilation, storing, parsing, execution

C.   Syntactical analysis, parsing, linking, code generation, execution

D.   Token generation, syntactical analysis, code generation, linking, execution

19 The following array is to be sorted in ascending order, starting the sort process from the left.

| 14 | 16 | 18 | 24 | 20 | 22 | 26 |

Which row of the table correctly matches a sort method with the minimum number of passes required, before the elements of this array are in the correct order?

	Method	*Minimum number of passes*
A.	Insertion	5
B.	Insertion	3
C.	Selection	3
D.	Selection	2

20 In a system, products are identified by a 5-character product code.

Which of the following subroutines always returns a valid product code?

NOTE: LEN() returns the number of characters in a string.

A.
```
BEGIN GetValidCode
        valid = FALSE
        input code
        WHILE valid = FALSE
                IF LEN(code) = 5 THEN
                        valid = TRUE
                ENDIF
                input code
        ENDWHILE
        return code
END GetValidCode
```

B.
```
BEGIN GetValidCode
        valid = FALSE
        REPEAT
                input code
                IF LEN(code) <> 5 THEN
                        valid = FALSE
                ENDIF
        UNTIL valid = TRUE
        return code
END GetValidCode
```

C.
```
BEGIN GetValidCode
        valid = FALSE
        REPEAT
                input code
                IF LEN(code) = 5 THEN
                        valid = TRUE
                ENDIF
        UNTIL valid = TRUE
        return code
END GetValidCode
```

D.
```
BEGIN GetValidCode
        valid = FALSE
        WHILE valid = FALSE
                input code
                IF LEN(code) <> 5 THEN
                        valid = FALSE
                ELSE
                        valid = TRUE
                ENDIF
        ENDWHILE
        return valid
END GetValidCode
```

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Software Design and Development

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 (6 marks)

An online application is required by the end of the school year to provide school students with information about travel opportunities. It will provide images and video clips, and will be produced by a team of developers.

(a) Outline TWO benefits of using a team of developers to develop this application. **3**

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(b) Describe how a Gantt chart could be used to manage the development of this application. **3**

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Question 22 (11 marks)

A shopkeeper employs a developer to create a website to enable customers to buy items online.

(a)   Why is it important for the developer to consult the shopkeeper at the start of the development process?   **2**

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(b)   Distinguish between user documentation and technical documentation for this website.   **3**

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Question 22 (continued)

(c) Complete the partial data dictionary for this website. **3**

Data item	Data type	Storage size bits/bytes	Description	Examples
Surname	String	40 bytes	Surname of customer	Faruga
ItemName		20 bytes	Name of item	2 L skim milk
Quantity			Number of items	4
Order			Details of items in the order	Dozen eggs 1 $5.00 Flour 1 kg 2 $2.00 2 L skim milk 4 $3.50
TotalCost		4 bytes	Total amount due	
Paid?			Has payment been made?	

Question 22 continues on page 21

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Question 22 (continued)

(d)   Recommend TWO ways that the developer can test this website prior to   **3**
      implementation.

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End of Question 22

Please turn over

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Question 23 (6 marks)

The following algorithm was written to find the average mark and the maximum mark in a school assessment. The assessment marks are stored in a sequential file called MarksData.

```
10      BEGIN Analysis
20            Max = 100
30            Num_Students = 0
40            Open MarksData for input
50            Read Mark from MarksData
60            WHILE NOT EOF
70                  IF Mark > Max THEN
80                        Max = Mark
90                  ENDIF
100                 Add 1 to Num_Students
110                 Average = Mark/Num_Students
120                 Read Mark from MarksData
130           END WHILE
140           Display Max, Average
150           Close MarksData
160     END Analysis
```

The algorithm does not produce the expected output.

The file MarksData contains the values:
    20
    60
    30
    40

Question 23 continues on page 23

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(a) Complete a desk check for this algorithm using the values stored in MarksData.   **3**

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(b) Suggest how the algorithm can be modified so that it achieves the correct   **3**
output. You may refer to line numbers in your response.

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End of Question 23

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Question 24 (10 marks)

In some areas, drivers need to use an app on their phone to pay for parking.

This app allows the driver to:
- create an account using their car registration number and banking details
- start and end each parking session by pressing START and END buttons
- pay for parking using the stored banking details.

For each parking session, the app records the start and end times, calculates the cost of parking, accepts payment and stores the details remotely.

The cost of parking is calculated using the hourly rate and the time spent. The hourly rate is determined by the location of the car.

(a)   Construct an IPO diagram for the module that calculates the cost of parking.   **3**

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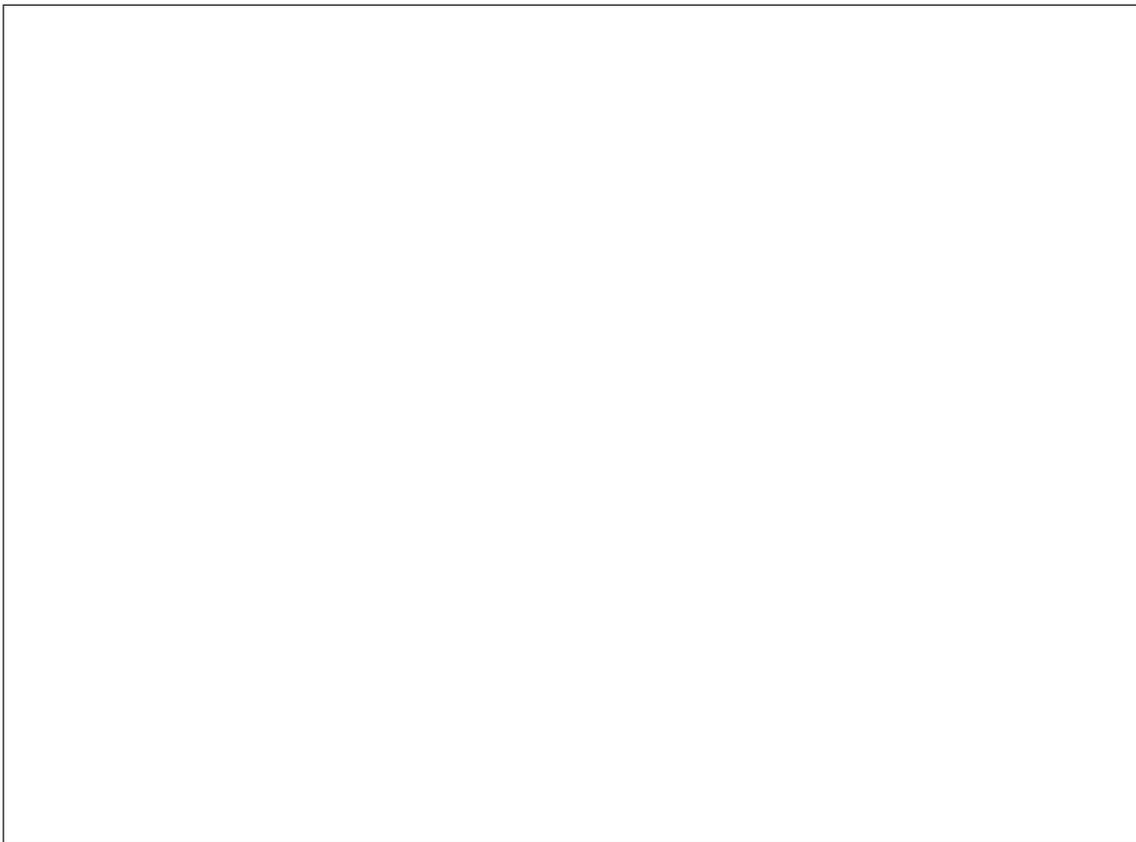
Question 24 (continued)

(b)   Construct a data flow diagram (DFD) to document the complete app as   **4**
        described.

Question 24 (continued)

(c)   Describe how the developer might have addressed ONE inclusivity concern and ONE privacy concern associated with the use of this app.   **3**

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End of Question 24

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Question 25 (4 marks)

A software company is developing a system that will require a large development team. They have decided to use their own developers, and hire additional contract programmers when necessary.

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Explain how various types of documentation can be used by the contract programmers to enable them to quickly contribute to the project.

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Question 26 (6 marks)

Many software applications use a software generated test to deter automated spam attacks by confirming that data is being entered by a human.

An example of such a test, named CheckIfHuman, is shown.

Type the characters shown above:
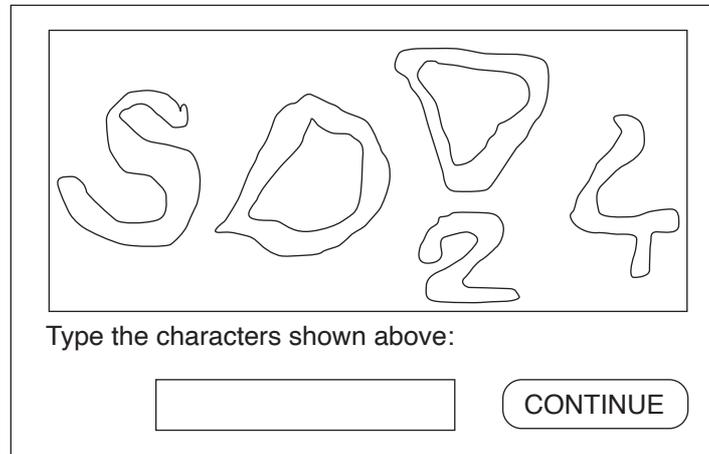
CONTINUE

The user is required to type the displayed characters into the dialogue box. The system checks if there is a match, and generates a flag.

(a)   Create a context diagram to model the CheckIfHuman test.   **2**

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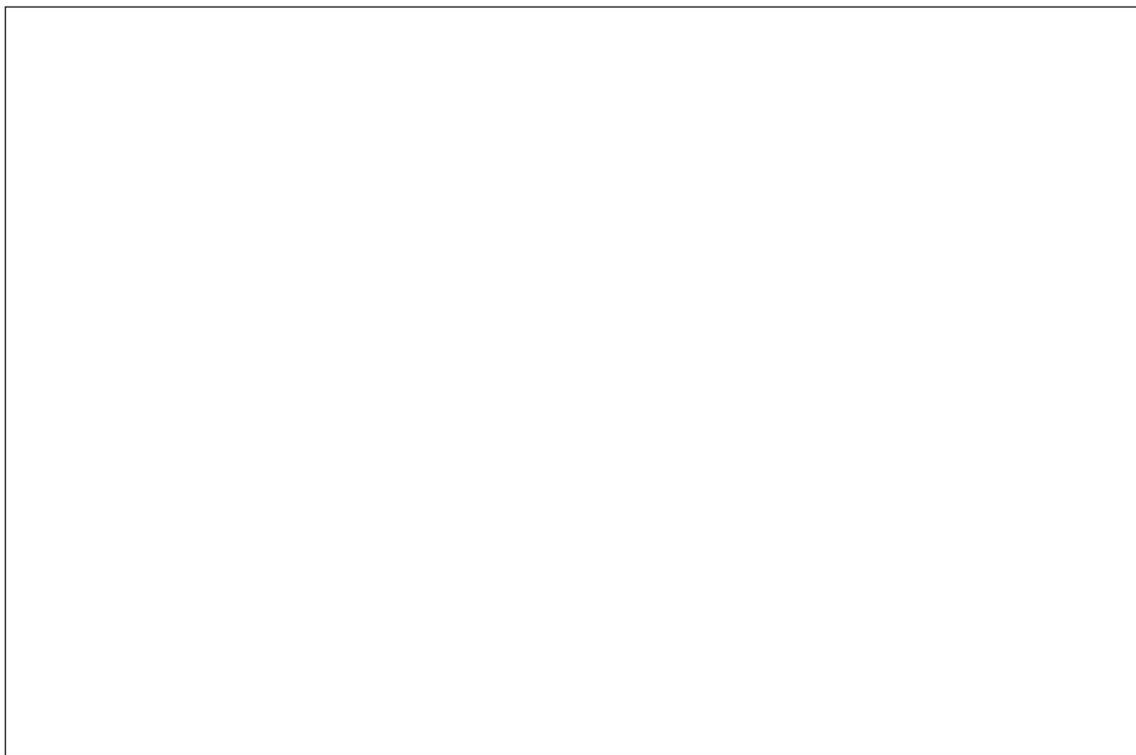
(b)   In the following code, CheckIfHuman is called to confirm that the correct text   **4**
       characters have been entered before proceeding.

```
BEGIN Main
       OK = TRUE
       REPEAT
              HumanDetected = CheckIfHuman
              IF HumanDetected THEN
                     DisplayMessage (HumanDetected)
                     DoMainProcessing
                     OK = TRUE
              ELSE
                     DisplayMessage (HumanDetected)
                     OK = FALSE
              ENDIF
       UNTIL OK = TRUE
END Main
```

Explain why it is important that CheckIfHuman and DisplayMessage are
implemented as subroutines for this application.

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End of Question 26

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Question 27 (3 marks)

A palindrome is a word that reads the same forward and backward, such as the words 'refer' and 'noon'.

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The following code fragment checks whether a word is a palindrome.

```
1     BEGIN PalindromeCheck(word, palindrome)
2           palindrome = TRUE
3           F = 1
4           N = number of letters in word
5           L = N
6           REPEAT
7                 IF Fᵗʰ letter of word is not equal to Lᵗʰ letter of word THEN
8                       palindrome = FALSE
9                 END IF
10                L = L–1
11                F = F+1
12          UNTIL F > N
13          RETURN palindrome
14    END PalindromeCheck
```

There are no errors in the code fragment.

Explain the effect of changing line 12 to the following code.

```
12          UNTIL F > N/2 OR palindrome = FALSE
```

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Question 28 (3 marks)

Distinguish between the use of debugging output statements and breakpoints when developing a software solution.

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Please turn over

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Question 29 (4 marks)

Compare the use of compilation and interpretation. **4**

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Question 30 (7 marks)

For a particular concert, there are 10 000 tickets available, and 2000 customers wanting to buy tickets. Customers are allocated tickets randomly.

Customers are required to indicate the number of tickets they would like to purchase, up to a limit of 8.

Seats are not allocated until all ticket requests have been entered.

Details of the 2000 customers are already stored, in no particular order, in an array of records called Customer_Array.

Each customer record has the following structure:

Cust_ID	: String
Name	: String
Num_Tickets	: Integer
Allocated	: Boolean (becomes TRUE when tickets have been allocated)

For example:

Cust_ID	Name	Num_Tickets	Allocated
Wong4567	Wong, F	1	FALSE
Jones34	Jones, Q	3	FALSE

Question 30 continues on page 34

(a)   An algorithm called AllocateTickets is required to allocate ticket numbers to   **5**
        customers.

        Customers are selected at random to receive their requested tickets until all
        available tickets are allocated. The tickets allocated will always be sequentially
        numbered.

        The Cust_ID of the chosen customers are stored next to the relevant ticket
        number in a 10 000-element array of records called Ticket_Array.

        For example:

TicketNumber	AllocatedCustomer
1	Jones34
2	Jones34
3	Jones34
4	Abu507
5	Abu507
...	...
9998	Wong4567
9999	Rakash234
10000	Rakash234

        As the last tickets are allocated, a customer may not get all the tickets they have
        requested (as there may be no more tickets left). Some customers may not be
        allocated any tickets at all.

        In the example shown above, even if Rakash234 requested five tickets, there will
        only be two allocated because that is all that is left.

        Design an appropriate algorithm for AllocateTickets.

        You may use this function:
        • Rand (Min, Max) generates a random integer between Min and Max, inclusive

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Question 30 (continued)

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Question 30 (continued)

(b)   The algorithm AllocateTickets, as described in part (a), is implemented as code.   **2**

Explain why the function Rand(), as described in part (a), cannot be a stub during the testing of this code.

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End of Question 30

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Software Design and Development

Section III Answer Booklet

3 1

Question Number

20 marks
Attempt either Question 31 or 32
Allow about 35 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 for this question.

Please turn over

Question 31 — Programming Paradigms (20 marks)

(a) Consider the following code, written using the imperative paradigm.

```
BEGIN CheckPlanet (A1, A2, SmallerPlanet)
    IF A1.size < A2.size THEN
        IF A1.weight < A2.weight THEN
            SmallerPlanet = TRUE
        ELSE
            SmallerPlanet = FALSE
        ENDIF
    ELSE
        SmallerPlanet = FALSE
    ENDIF
END
```

The code is rewritten using the logic paradigm, and includes data about many planets.

(i) It is found that the new code using the logic paradigm sometimes produces incorrect output.

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Identify TWO possible causes for this.

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(ii) Write the rule for SmallerPlanet in the logic paradigm.

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Question 31 continues on page 43

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Question 31 (continued)

    (iii)   Backward chaining is used to evaluate the query   **3**

           ?SmallerPlanet(Mercury, Saturn).

           Describe how the inference engine determines the truth of this query.

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(b)   A game is to be developed where it is important that all of the characters are   **4**
identical and cannot be changed, but can wear different hats.

    Justify an appropriate paradigm for developing this game.

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Question 31 (continued)

(c) Consider this OOP code fragment.

```
Class tree {
        int height;    // height of tree in cm
        String type;  // tree type can be wattle, maple or oak
        float xcoord; // x coordinate of the tree position
        float ycoord; // y coordinate of the tree position
}

tree Background[16]      //creates an array of 16 tree objects

FOR (i = 0 to 15)
        Background[i].height = 500
        Background[i].type = "oak"
        Background[i].xcoord = Random()   //Random () generates a random integer
        Background[i].ycoord = Random()   //between 0 and 1024
NEXT i
```

The Background[ ] array is then used to create a display on the screen.

(i) Describe the output generated by executing this code, noting potential   **3**
issues that could occur.

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(ii) Describe the benefits of defining the different types of trees as subclasses.   **3**

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Question 31 (continued)

(iii) Based on the OOP code fragment on the previous page, provide the **3**
code that will display 10 maple trees of height 600 cm in the shape of a
triangle, as shown in the diagram.

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End of Question 31

Question 31 extra writing space only

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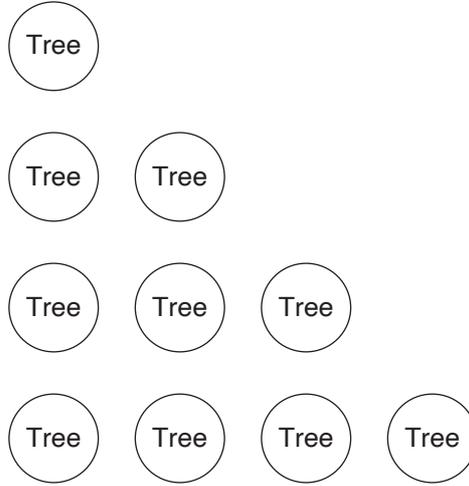
Do NOT write in this area.

Question 31 extra writing space only

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

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Centre Number

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Software Design and Development

Section III Answer Booklet (continued)

3 2

Question Number

20 marks
Do NOT attempt Question 32 if you have already attempted Question 31
Allow about 35 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 for this question.

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

(a)   Perform the following subtraction using binary arithmetic. Show working.   **3**

01011100 – 00010001

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(b)   The ASCII code for a lowercase letter is 32 greater than the ASCII code for the   **2**
corresponding uppercase letter.

By considering the binary ASCII values, explain why a difference of 32 was
chosen when the ASCII table was first designed.

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Question 32 continues on page 51

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Question 32 (continued)

(c)   Produce an algorithm that will find the sum of two 8-bit binary numbers using   **3**
      binary addition.

   You may treat the two 8-bit numbers and the sum as arrays with 8 elements.

   NOTE: You may assume that the sum will be an 8-bit number.

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Question 32 continues on page 52

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Question 32 (continued)

(d) In some computer systems the date and time is stored as a signed 32-bit integer, **3** representing the number of seconds since January 1st, 1970.

Explain why the use of this representation will cause issues in the future.

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(e) A system is used to detect the speed of cars. As shown in the diagram below, Sensor 1 is used to detect the speed of a car. This speed is shown on a roadside display. Sensor 2, a short distance along the road, senses the speed of the car again.

If the car's speed detected at Sensor 2 is over the speed limit, a camera located just past Sensor 2 takes a photo of the car. This generated data is used by the system to fine the driver.

The two sensors, the display unit and the camera are all connected to a control unit. Communication between each of these hardware devices occurs via data streams.
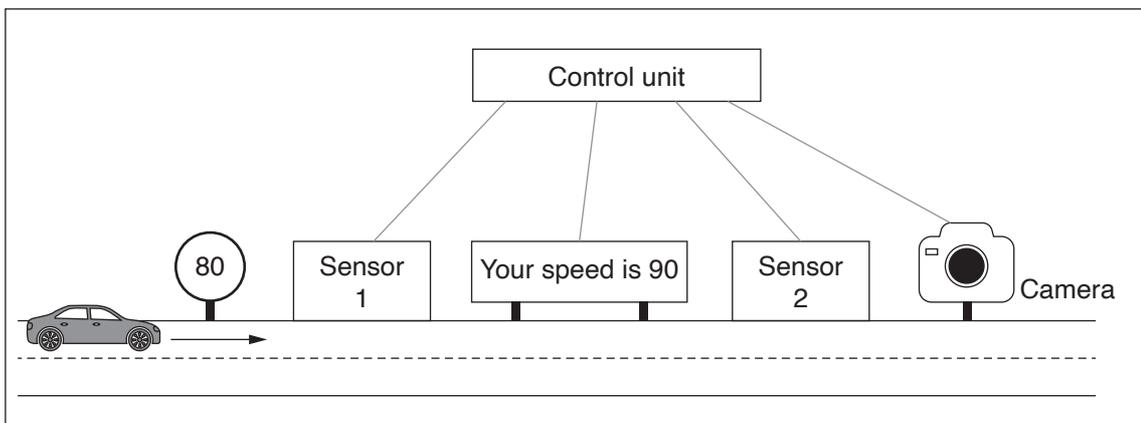
Question 32 continues on page 53

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Question 32 (continued)

(i) If the first sensor detects a speed that is over the limit, the display **2** will show this speed as a flashing red number. Otherwise, the speed is displayed in green without flashing.

The data block to be sent from the control unit to the display requires 12 bits:

- 8 bits for the speed to be displayed in kilometres per hour (kph)
- 2 bits for colour
- 2 bits for flashing.

Colour	Flashing
00 – green	00 – not flashing
01 – red	01 – flashing

At the first sensor, a car is detected moving at 90 kph in an 80 kph zone.

Construct the data block sent to the display from the control unit.

(ii) Data streams from the sensors are generated when a car is detected, and **3** include date and time information stored in four bytes.

Design an appropriate data stream, including the header, data block and trailer, to be sent from the sensors to the control unit as a car passes.

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Question 32 continues on page 54

– 53 –

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(f)   Consider the following logic circuit.   **4**
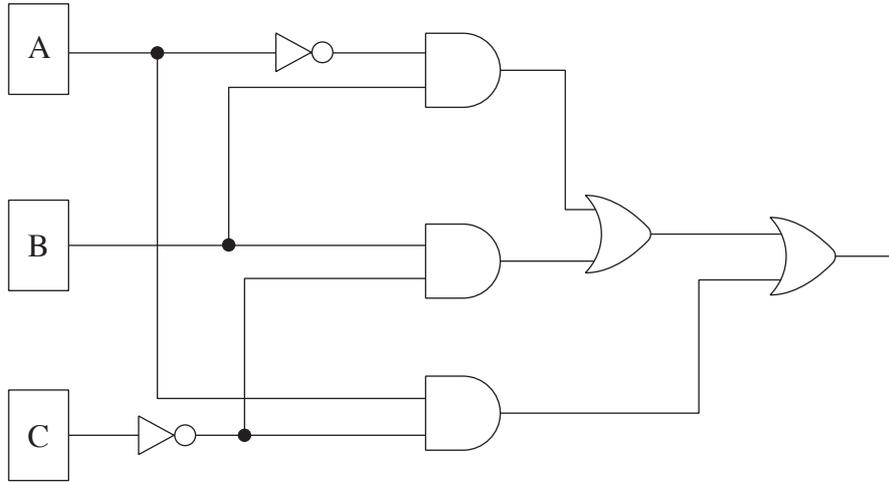
Design a circuit that produces the same output as the circuit provided, using less than six logic gates.

You may use Boolean algebra and/or a truth table to assist you.

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Question 32 continues on page 55

Question 32 (continued)

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Question 32 extra writing space only

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