



NSW Education Standards Authority

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Centre Number

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Student Number

2023 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 pages 33 and 37 or pages 39 and 43

Total marks: 100

Section I – 20 marks (pages 2–9)

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

Section II – 60 marks (pages 13–32)

- Attempt Questions 21–32
- Allow about 1 hour and 50 minutes for this section

Section III – 20 marks (pages 33–45)

- Attempt either Question 33 or Question 34
- 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 a valid reason to include comments in the source code?
 - A. To enable the code to work correctly
 - B. To show users how to effectively use the software
 - C. To assist other programmers in maintaining the code
 - D. To ensure that the source code is protected by copyright

- 2** Which of the following tools can be used to perform tasks such as version control and test data generation?
 - A. CASE tools
 - B. Documentation tools
 - C. System debugging tools
 - D. Project management tools

- 3** Which of the following is NOT a typical use of a logbook during software development?
 - A. Listing issues encountered
 - B. Providing installation instructions
 - C. Identifying tasks to be addressed next
 - D. Keeping a record of tasks successfully completed

4 While developing software, a programmer uses a compiler prior to execution.

Which row of the table correctly matches a type of error with the stage at which it may be detected?

	<i>Type of error</i>	<i>Stage detected</i>
A.	Logic	Execution
B.	Syntax	Execution
C.	Runtime	Compilation
D.	Overflow	Compilation

5 What is the purpose of a post implementation review?

- A. To develop a maintenance plan
- B. To review user training schedules
- C. To discuss plans for future projects
- D. To evaluate the software with the client before sign-off

6 The following EBNF statements describe the structure of a valid identifier.

```
identifier = <letter> {<digit> | <letter>} <digit> [$ | %]  
letter = A | B | C | ... | Y | Z  
digit = 0 | 1 | 2 | ... | 8 | 9
```

Which of the following is a valid identifier?

- A. 2B2B2\$
- B. B1A9\$%
- C. F12B2
- D. Y9Z9Z%

7 Consider the following code.

```
BEGIN Main
  Num is local
  Num = 4
  Sub2
  print Num
END Main
```

```
BEGIN Sub2
  Num is local
  Num = 4
  Num = Num - 2
  print Num
END Sub2
```

What is the output produced when the above code is executed?

- A. 2 2
 - B. 2 4
 - C. 4 2
 - D. 4 4
- 8 At which stage in the software development cycle is a developer most likely to consult a railroad diagram?
- A. Defining and understanding the problem
 - B. Planning and designing software solutions
 - C. Implementing software solutions
 - D. Testing and evaluating software solutions
- 9 A developer examines the functionality and interfaces of an existing software application with a view to developing their own enhanced version of the software.

Which term best describes the developer's actions?

- A. Outsourcing
- B. Customising
- C. Decompilation
- D. Reverse engineering

Use the following information to answer Questions 10–11.

Game scores for 1000 players are stored in memory. Details of the first three players are shown.

<i>Name</i>	<i>Score</i>
Jones B	23
Poulllos W	45
Cheng C	32

The following code finds and displays a score for a given player.

```
BEGIN
  Get name
  count = 1
  WHILE count <= 1000
    IF GameScore(count).Name = name THEN
      Display GameScore(count).Score
    ENDIF
    count = count + 1
  ENDWHILE
END
```

10 Which of the following best describes the data structure used in the code?

- A. An array of strings
- B. An array of records
- C. A 1-dimensional array
- D. A 2-dimensional array

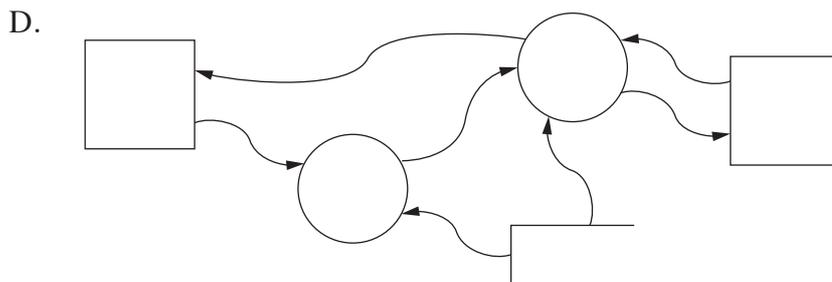
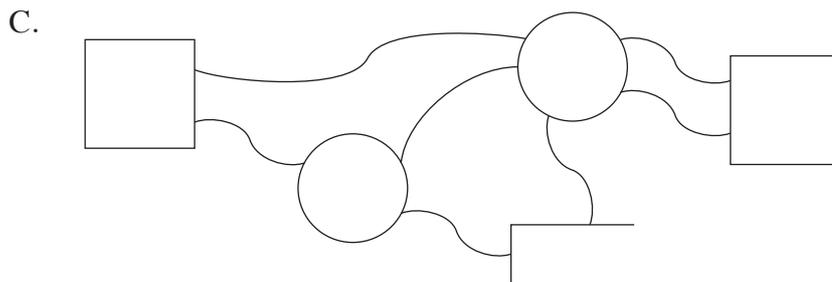
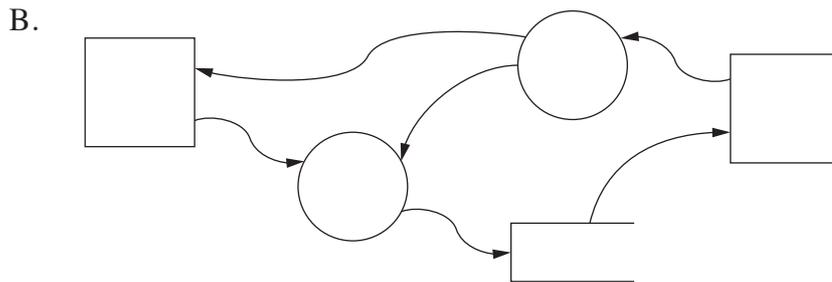
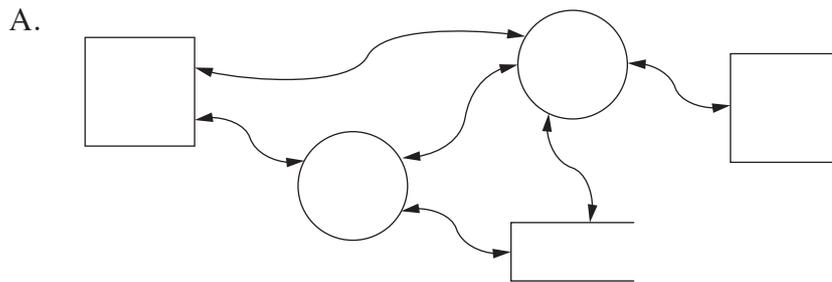
11 No two players have the same name.

Which of the following is the best way to modify the code to execute more efficiently?

- A. Use a FOR/NEXT loop
- B. Use a binary search on score
- C. Use a flag to terminate the loop
- D. Use a sequential file to store the data

- 12 Which of the following statements is true about error detection?
- A. A variable can be used to check if certain conditions have been met.
 - B. A breakpoint identifies where a program stops due to a runtime error.
 - C. A stub requires programmer input before a program trace can continue.
 - D. A debugging output statement produces a message when a syntax error occurs.

- 13 Which of the following conforms to the rules for constructing data flow diagrams?



14 Which of the following is a step of the fetch-execute cycle which involves the arithmetic logic unit (ALU)?

- A. Decode
- B. Execute
- C. Fetch
- D. Translate

15 A software developer decides to include a call to a library routine.

Which of the following must the developer consider?

- A. The logic of the library routine
- B. The space required to store the library routine
- C. The language used to produce the library routine
- D. The order of parameters to be passed to the library routine

16 Consider the algorithm fragment.

```
REPEAT
  DoThis
UNTIL x<=5 OR y=8
```

Which of the following is logically equivalent?

- A. DoThis
WHILE x>5 AND Y<>8
 DoThis
ENDWHILE
- B. DoThis
WHILE x<=5 AND y=8
 DoThis
ENDWHILE
- C. DoThis
WHILE x<=5 OR y=8
 DoThis
ENDWHILE
- D. DoThis
WHILE x>5 OR Y<>8
 DoThis
ENDWHILE

17 Consider this code fragment.

```
BEGIN ReadFile
  Line = 101
  s = 0
  OPEN ThisFile for INPUT
  Read NextLine from ThisFile
  WHILE NextLine <> Line AND s < 100
    Array[s] = NextLine
    s = s + 1
    Read NextLine from ThisFile
  ENDWHILE
  CLOSE ThisFile
END ReadFile
```

What is the sentinel value in this subroutine?

- A. 0
- B. 1
- C. 99
- D. 101

18 A sort is applied to the array

C	D	A	S	F
---	---	---	---	---

.

The result of the first pass of the sort is

D	C	A	S	F
---	---	---	---	---

.

Which of the following will be the result of the next pass?

- A.

D	A	C	S	F
---	---	---	---	---
- B.

D	C	A	S	F
---	---	---	---	---
- C.

F	D	C	A	S
---	---	---	---	---
- D.

S	D	C	A	F
---	---	---	---	---

19 A programmer defined a variable called IF. This caused an error during compilation.

In which stage of the translation process would the error be detected?

- A. Lexical analysis
- B. Code generation
- C. Token generation
- D. Syntactical analysis

20 The function Random(N) returns a random integer from 1 to N inclusive.

Which of the following algorithms displays four different random integers from 1 to 100?

A. BEGIN
 FOR Index = 1 to 100
 Used(Index) = 0
 NEXT Index
 Count = 0
 REPEAT
 Num = Random(100)
 IF Used(Num) = 0 THEN
 Display Num
 Used(Num) = 1
 ENDIF
 Count = Count + 1
 UNTIL Count = 4
END

B. BEGIN
 FOR Index = 1 to 100
 Used(Index) = 0
 NEXT Index
 Count = 1
 REPEAT
 REPEAT
 Num = Random(100)
 UNTIL Used(Num) = 1
 Display Num
 Used(Num) = 1
 Count = Count + 1
 UNTIL Count = 4
END

C. BEGIN
 FOR Index = 1 to 100
 Used(Index) = 0
 NEXT Index
 Count = 0
 REPEAT
 REPEAT
 Num = Random(100)
 UNTIL Used(Num) = 0
 Display Num
 Used(Num) = 1
 Count = Count + 1
 UNTIL Count = 4
END

D. BEGIN
 FOR Index = 1 to 100
 Used(Index) = 0
 NEXT Index
 Count = 1
 REPEAT
 Num = Random(100)
 IF Used(Num) = 1 THEN
 Display Num
 Used(Num) = 0
 ENDIF
 Count = Count + 1
 UNTIL Count = 4
END

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Software Design and Development

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Section II Answer Booklet

60 marks

Attempt Questions 21–32

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

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Question 21 (2 marks)

Outline how a prototype can be used in the development of a software application. **2**

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Question 22 (3 marks)

Explain why it is important for developers to communicate with their clients. Refer to specific stages of the software development cycle in your answer. **3**

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Question 23 (5 marks)

An online medical database stores the medical history of patients. It is updated each time a person seeks medical treatment.

(a) Give TWO reasons why security is important for this database. **2**

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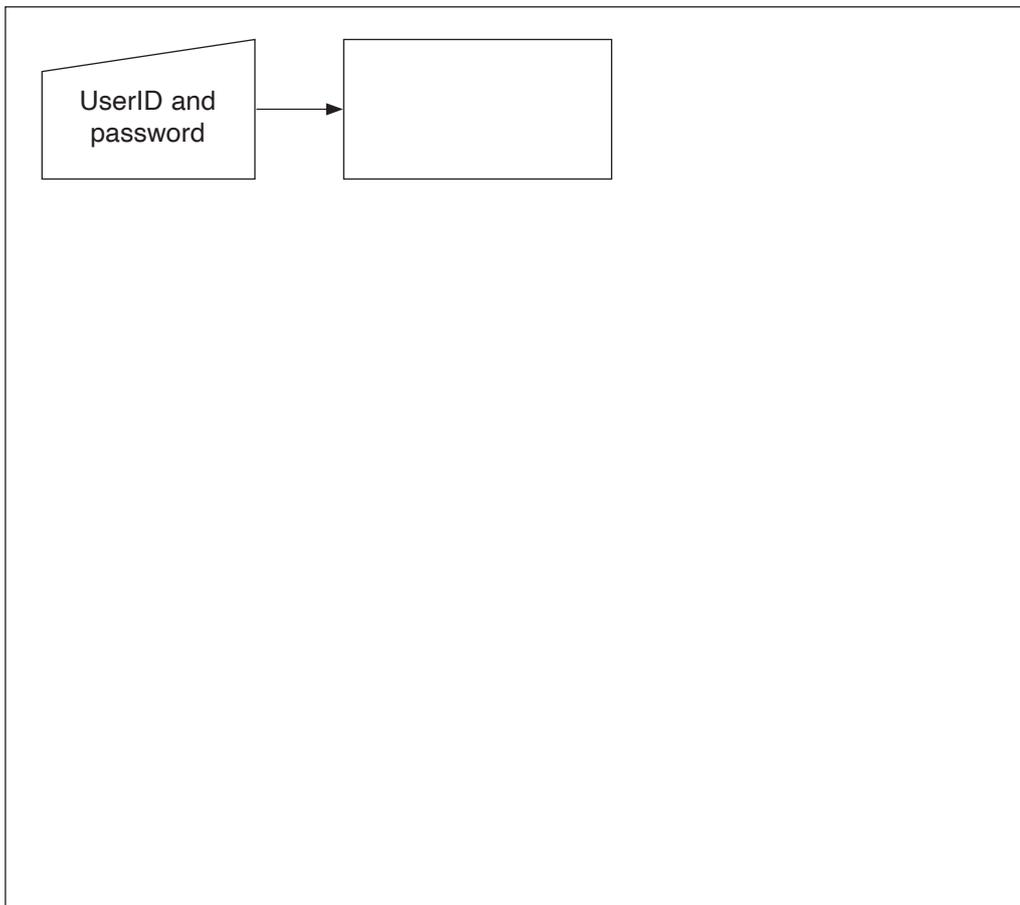
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(b) To provide increased security for the database, two-step authentication is implemented which requires a user to: **3**

- provide a valid username and password
- enter an automatically generated six-digit verification code which is sent to their mobile phone.

Complete the system flowchart for this two-step authentication process.



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Question 24 (3 marks)

A software company is developing a suite of related applications.

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Outline TWO problems that may arise if the company decides to outsource the development of one of these applications.

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Question 25 (4 marks)

Dominant developers have a large share of the software market.

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Explain how features of their software help them maintain their market share.

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Question 26 (9 marks)

Consider the following module.

```
1 BEGIN CustomerOrders
2     REPEAT
3         Tries = Tries + 1
4         Get UserId, Password
5         CheckPasswordCorrect (UserId, Password, OK)
6     UNTIL Tries > 3 OR OK = "Y"
7     IF OK = "Y" THEN
8         Open TodaysOrders for Input
9         Read the next record from TodaysOrders into Order_Rec
10        WHILE NOT EOF
11            IF Order_Rec.CustId = UserId THEN
12                PrintDetailsofOrder (Order_Rec)
13            ENDIF
14            Read the next record from TodaysOrders into Order_Rec
15        ENDWHILE
16        Close TodaysOrders
17    ELSE
18        InvalidUser (UserId)
19    ENDIF
20 END CustomerOrders
```

(a) Why is the Read statement needed in both line 9 and line 14?

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Question 26 continues on page 19

Do NOT write in this area.

Question 26 (continued)

- (b) Give TWO reasons why the code in the CustomerOrders module is easy to maintain. Support your answer with examples from the module. 3

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- (c) The logic in the CustomerOrders module has been successfully tested with small files of test data, and using stubs in lines 5, 12 and 18. 4

The module is to be included in a larger system, with the stubs replaced with existing subroutines that are known to work.

Explain why both module and system testing are now required.

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End of Question 26

Question 27 (10 marks)

A parking station requires a software application which allows customers to make an online booking for a parking space.

(a) When making a booking online, customers will input:

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- date
- time of entry
- time of exit
- car number plate eg SDD223
- large or small vehicle.

Design a user interface for capturing these booking details, using appropriate screen design elements.



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Question 27 continues on page 21

– 20 –

Question 27 (continued)

Customers will be charged at an hourly rate, based on their actual entry and exit times. When a customer arrives at the parking station, the car number plate will be scanned. The system uses this to retrieve their booking record, and update it with the current time. The boom gate then opens to allow entry.

On leaving the car park, the car number plate is scanned. The system retrieves the booking record and calculates the cost using the hourly rate. The customer swipes their credit card, their account is debited and the boom gates open.

- (b) Construct a structure chart to represent this system. 4

- (c) Describe how this system can be evaluated with reference to TWO quality assurance criteria. 3

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End of Question 27

Do NOT write in this area.

Question 28 (6 marks)

In a retail business, all product codes must start with an uppercase letter and then be followed by one or more lowercase letters.

The algorithm below is designed to validate a product code. It contains errors.

Note that Extract(string, start, N) returns N characters from a string, starting from position start. Eg Extract("Names", 3, 2) returns "me".

Line numbers have been provided for reference.

```
10     BEGIN validate
20         OK = "F"
30         Get ProductCode
40         Len = Number of characters in ProductCode
50         WHILE OK = "F" AND ProductCode <> "Q"
60             OK = "T"
70             IF Extract(ProductCode, 1, 1) is not an uppercase letter THEN
80                 OK = "F"
90                 Display "Not uppercase"
100            ENDIF
110            FOR Count = 1 to Len
120                IF Extract(ProductCode, Count, 1) is not a lowercase letter THEN
130                    OK = "F"
140                    Display "Not all lowercase"
150                ENDIF
160            NEXT Count
170            IF OK = "F" THEN
180                Display "Invalid code"
190                Get ProductCode
200            ENDIF
210        ENDWHILE
220    END validate
```

Question 28 continues on page 23

Question 28 (continued)

- (a) Perform a desk check of the algorithm using the test data “p3”, “Pad”, “Q”, “X”. 3

OK	ProductCode	Len	Extracted character	Count	Display

- (b) The algorithm contains errors. 3

Identify TWO errors and suggest how they can be corrected. Refer to line numbers in your answer.

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End of Question 28

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Question 29 (4 marks)

In a programming language, an Expression can include numerical values, variables and operators.

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Each of the following is a valid Expression in this language:

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A + 14.375

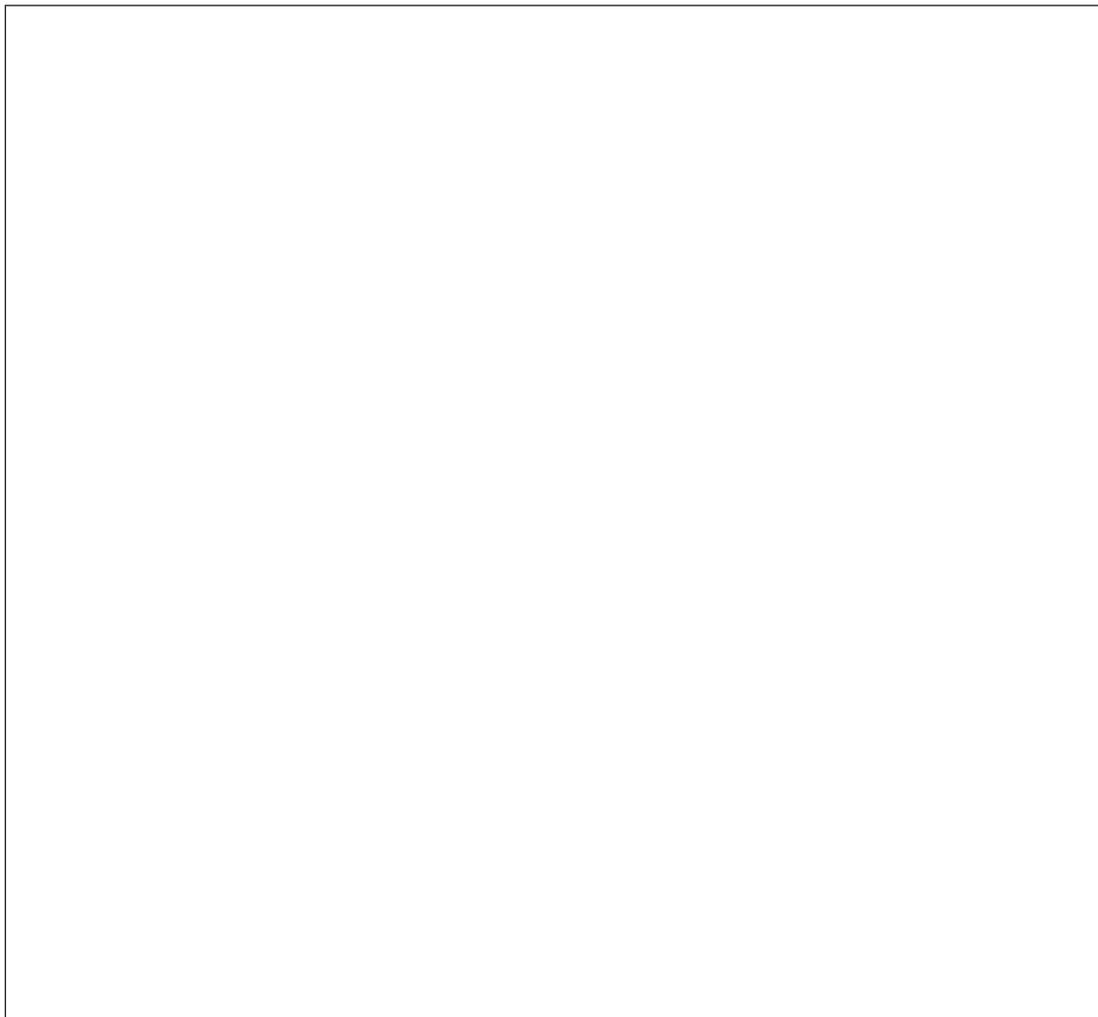
23.8 * Rate

NumAadvarks - B / C + 2

Note that brackets are NOT used in an Expression in this language.

Construct railroad diagram(s) to define the syntax of valid expressions in this language.

You can assume that Digit (from 0 to 9), Variable and Operator (+, -, *, /) are already defined.

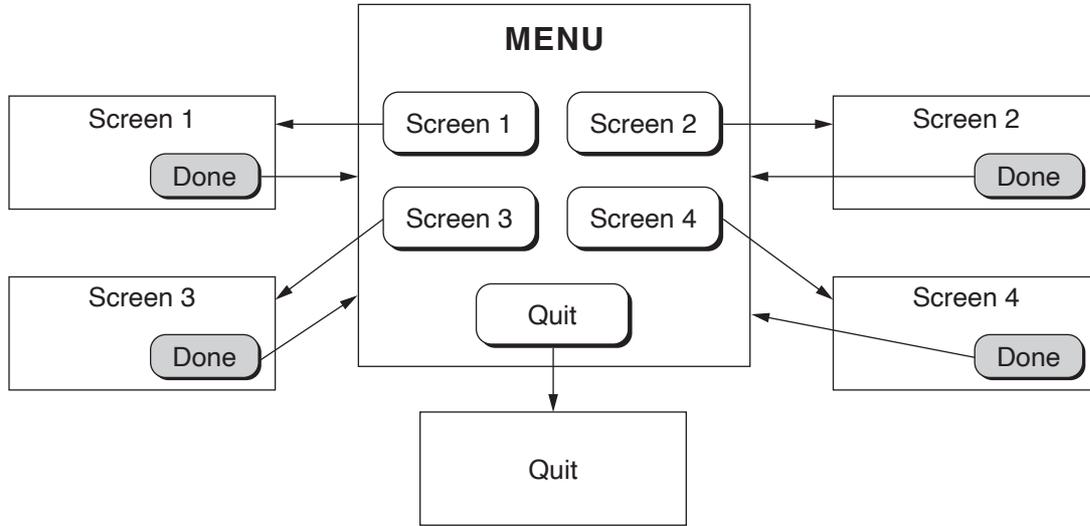


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Question 30 (3 marks)

The following storyboard shows the navigation for a simple menu structure.

3



A click on a button on the menu screen generates an appropriate number (from 1 to 4, or 9 if Quit is clicked) which is stored in the variable ButtonClick.

A click anywhere else on the screen generates a 0.

Write an algorithm for the menu screen that allows a user to access the other screens, exiting when the Quit button is clicked.

Do NOT include the logic for any of the other screens.

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Question 31 (3 marks)

Between the stages of compilation and execution, the process of linking occurs.

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Explain why linking is necessary.

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Question 32 (8 marks)

An algorithm is required to convert a date in DD/MM/YYYY format into its equivalent long date such as 29 October 2023.

The entered date will always be 10 characters and in the format DD/MM/YYYY.

The date is validated as follows:

- the month must be a valid month (from 1 to 12)
- the day value must be valid for that month
(for example, no more than 28 for February – ignore leap years).

- (a) Complete the table with **THREE** items of test data that test different aspects of the logic of the algorithm. **3**

<i>Test data</i>	<i>Reason for inclusion</i>

Question 32 continues on page 28

Do NOT write in this area.

Question 32 (continued)

- (b) Design an algorithm to validate a date in the form DD/MM/YYYY and output the equivalent long date, eg 29 October 2023.

5

Include all meaningful error messages to assist the user to understand why their entered date is not valid.

You may use the following two library routines in your pseudocode:

- Extract(string, start, N)
eg Extract("Names", 3, 2) returns "me"
- Value(string) converts a string to its numerical value
eg Value("42") returns 42.

You may use the following two arrays (indexed from 1) in your pseudocode.

MonthName	DaysinMonth
January	31
February	28
March	31
April	30
May	31
June	30
July	31
August	31
September	30
October	31
November	30
December	31

Question 32 continues on page 29

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Section II extra writing space

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Section III

20 marks**Attempt either Question 33 or Question 34****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 33 — Programming Paradigms (20 marks)

Please turn over



Question 33 (continued)

- (b) Explain a benefit of *instantiation* in the object oriented programming (OOP) paradigm. Include an example in your answer. **3**

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- (c) A programmer has been asked to develop a module for a large project. **4**

Describe **THREE** factors that could influence the programmer's choice of paradigm for the module.

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Question 33 continues on page 37





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Question 33 (continued)

- (e) Robots are used to serve food in a restaurant. The food is placed on a shelf of a robot and a table number is entered, which tells the robot where to take the food.

3



Between the kitchen and the table, there are several obstacles, such as other robots, customers, chairs and other tables that need to be navigated.

Explain how heuristics and goals could be used in the software system for these robots.

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End of Question 33

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Section III (continued)

Do NOT attempt Question 34 if you have already attempted Question 33.

Question 34 — The Interrelationship between Software and Hardware
(20 marks)

- (a) Complete the following table. **2**

<i>Hexadecimal representation</i>	<i>Binary representation</i>
B	1011
9	
	00011110

- (b) Binary multiplication is also known as ‘shift and add’. **3**

Perform the following binary multiplication, showing all working and clearly indicating where the shifting occurs.

$$110110 \times 101$$

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Question 34 continues on page 40



Question 34 (continued)

- (c) Numbers can be represented in binary as integers or as floating point numbers.

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Compare the use of these representations for storing very large and very small numbers.

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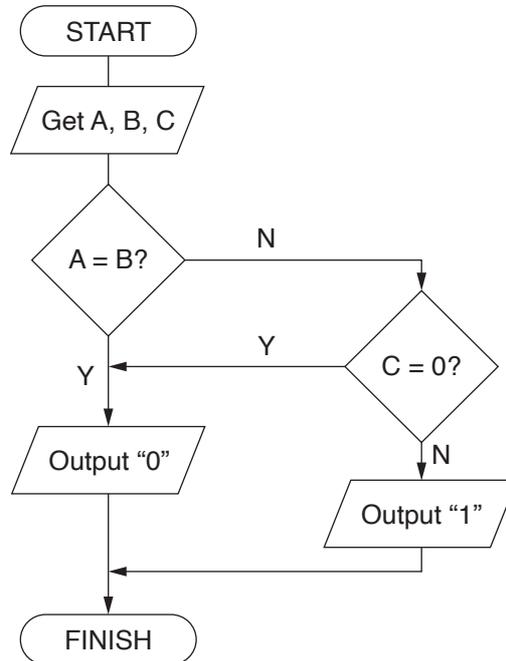
Question 34 continues on page 41



Question 34 (continued)

(d) Consider the following algorithm.

3



Draw a circuit with logic gates that will produce the same output as the algorithm. You may use a truth table to assist you.

Question 34 continues on page 43



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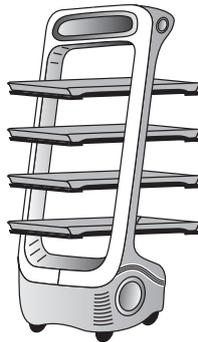
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Student Number

Section III (continued)

Question 34 (continued)

- (e) Six robots are used to serve food in a restaurant. The food is placed on a shelf of a robot and a table number is entered.



A controller sends data streams to the robots to specify their destination.

- (i) If the robot senses an obstacle in its path, it stops and sends a data stream to the controller. The controller then sends a stream to the robot causing a warning beep to sound. The warning beep sounds until a staff member presses a switch on the beeping robot. **3**

A circuit inside the robot is needed to turn the beep on and keep it on until turned off by the staff member.

Explain how a flip-flop can be used in this circuit. You may include a labelled circuit with logic gates in your response.

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Question 34 continues on page 44



Question 34 (continued)

The restaurant is in a square room, represented by a 10×10 two-dimensional array called Room.

The table numbers are stored in that array, indicating their location in the room.

A typical set-up could be as shown.

								5	
						3			
	1								
			2						
							4	6	
			7						
						8			

For this set-up, Room(3, 2) contains 1, indicating that Table 1 is in row 3, column 2 in the restaurant.

When an order is ready, one of the six robots is selected to take the food to a designated table.

The structure of the data stream sent from the controller to each robot has the following format:

RobotID	Row of table location	Column of table location

- (ii) Write the binary data stream that sends Robot 5 to Table 4 using the set-up shown. 2

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Question 34 continues on page 45





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