

BOARD OF STUDIES
NEW SOUTH WALES

2002

**HIGHER SCHOOL CERTIFICATE
EXAMINATION**

Software Design and Development

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil

Total marks – 100

Section I Pages 2–9

20 marks

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

Section II Pages 10–17

60 marks

- Attempt Questions 21–23
- Allow about 1 hour and 50 minutes for this section

Section III Pages 18–21

20 marks

- Attempt either Question 24 or Question 25
- 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.

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9
A B C D

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A B C D

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word *correct* and drawing an arrow as follows.

A B C D
correct ↙

- 1 A team has been engaged to design and develop software to control the manufacturing processes of a factory making spare parts for off-road vehicles. The team needs to understand and document the processes undertaken in the manufacture of the spare parts.

Which documentation technique would be most appropriate?

- (A) A storyboard
- (B) A data dictionary
- (C) A system flowchart
- (D) A data flow diagram

- 2 A development team is writing software to be used by a school to handle its timetabling requirements. The system will allow the user to select a day and to print the timetable for that day.

Which of the following screen elements would be the most appropriate to use to select the day?

- (A) A text box
- (B) Check boxes
- (C) Radio buttons
- (D) A pulldown menu

- 3 While developing a software package for a business, the developer should maintain effective channels of communication with the end users of the system.

On which of the following would the end-user input be likely to have the most impact?

- (A) Financial feasibility
- (B) Operational feasibility
- (C) Schedule feasibility
- (D) Technical feasibility

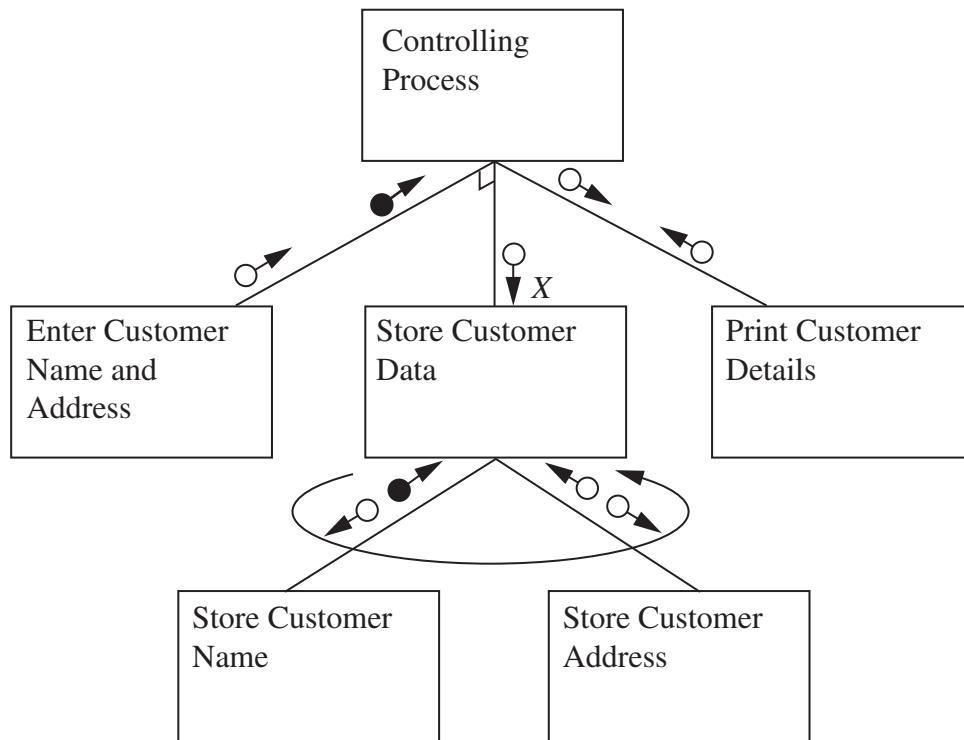
- 4 Which of the following best describes the process of compilation?

- (A) The entire source code is translated into object code that may be executed at any time.
- (B) The entire source code is translated into object code, after which the code is immediately executed.
- (C) Each line or statement of a piece of source code is translated into object code and immediately executed before moving on to the next line.
- (D) Parts of the source code are translated into object code as a whole and parts are translated into object code one line at a time, and then executed immediately.

- 5** Which of the following is an example of plagiarism?
- (A) Using source code from your organisation's program library
 - (B) Referring to a user manual produced by another organisation
 - (C) Photocopying data flow diagrams for review by a project team
 - (D) Using source code obtained from the World Wide Web without acknowledging the author
- 6** Which of the following personnel has the major responsibility for the quality of a software solution?
- (A) Systems analyst
 - (B) Project team leader
 - (C) Documentation editor
 - (D) Application programmer
- 7** Which of the following would be the major reason for a company's dissatisfaction with a newly implemented system?
- (A) Online documentation is not available.
 - (B) The graphical user interface is of poor quality.
 - (C) The users do not have access to the project manager.
 - (D) The system does not meet the predetermined requirements.
- 8** What is one disadvantage of CASE tools?
- (A) They do not generate test data.
 - (B) They are an unproven technology.
 - (C) They can inhibit the creativity of the designer.
 - (D) They are poorly understood by most programmers.
- 9** Which of the following best describes why the laws of copyright exist for computer software?
- (A) To physically stop the copying of software
 - (B) To protect the intellectual property of the software creator
 - (C) To prevent software being installed on more than one computer
 - (D) To increase the ability of the authorities to detect software piracy

- 10** A software developer produces database applications for small businesses operating in a changing environment. What is an appropriate software development approach they would use?
- (A) Structured approach
 - (B) End-user development
 - (C) Event-driven approach
 - (D) Rapid applications development
- 11** What is the difference between a one-dimensional array and a record?
- (A) The fields of a record can be of different types but the elements of an array must be of the same type.
 - (B) The fields of a record can be of the same type but the elements of an array must be of different types.
 - (C) The fields of a record can be accessed directly but the elements of an array can only be accessed sequentially.
 - (D) The elements of an array can be accessed directly but the fields of a record can only be accessed sequentially.
- 12** A business uses a payroll program to prepare employee wages. This process involves entering the name and the number of hours worked for each employee. The payroll program progressively calculates the amount owing to each employee. When a negative number is entered for the hours worked, the amount owing to each employee is printed.
- To achieve this task, what control structure would be used?
- (A) Sequence only
 - (B) Pre-test repetition
 - (C) Multiple selection
 - (D) Post-test repetition

Use the diagram to answer Questions 13 and 14.



- 13** In the diagram, what does the symbol at *X* represent?
- (A) A flag recording that the data has been passed to Store Customer Data
 - (B) The data customer name only has been passed to Store Customer Data
 - (C) The data customer name and address has been passed from Controlling Process
 - (D) A flag recording that the customer name only has been passed from Controlling Process
- 14** The diagram describes the entry of data into a Retail Store Customer Management System.
- Which of the following is true of this system?
- (A) Data parameters are passed to all modules.
 - (B) Control parameters are passed to all modules.
 - (C) Store Customer Name may repeatedly call Store Customer Data.
 - (D) Controlling Process may call Enter Customer Name and Address or Store Customer Data.

- 15** A fishing cooperative has hired a systems analyst to design a new system that will record the catch of each fishing vessel and the sale of the catch. Many of the members of the cooperative have their own computers and wish to contribute to the design.

What should the systems analyst do?

- (A) Invite all members to be part of a committee to define the goals and requirements of the new system.
- (B) Involve the members in the development of the user and technical documentation for the new system.
- (C) Provide the interested members with minor issues to keep them involved.
- (D) Limit the input of the interested members, as they have insufficient knowledge to contribute to the technical development of the system.

- 16** The following steps represent a segment of a computer program.

Step 1 Load the number in memory location 100 into the accumulator.

Step 2 Add the contents of memory location 101 to the accumulator.

Step 3 Add the contents of memory location 102 to the accumulator.

Step 4 Store the contents of the accumulator in location 105.

Which of the following best describes what takes place in this program segment?

- (A) The numbers 100, 101 and 102 are added together.
- (B) The numbers 100, 101, 102 and 105 are added together.
- (C) The numbers stored in three different RAM locations are added together and stored in RAM.
- (D) The numbers stored in four different RAM locations are added together and stored in RAM.

- 17** A professional photographer wishes to buy a new digital image-manipulation product.

In choosing the product, which of the following statements made by the sales assistant would be the most important?

- (A) 'This product will process any digital image.'
- (B) 'This product is the most expensive in the store.'
- (C) 'A reputable supplier distributes and services this product.'
- (D) 'We have this digital image product in stock and available.'

- 18 In the algorithm, what would be the appropriate test values to generate a return value of $D = 4$?

```

1   BEGIN
2   INPUT A,B,C
3   IF A = 1 THEN
4   D = 2
5   ELSE
6   IF B = 2 THEN
7   D = 3
8   ELSE
9   D = 4
10  ENDIF
11  ENDIF
12  PRINT D
13  END

```

- (A) $A = 1, B = 1, C = 1$
 (B) $A = 2, B = 1, C = 2$
 (C) $A = 2, B = 2, C = 3$
 (D) $A = 2, B = 2, C = 4$
- 19 An algorithm uses nested loops to fill a two-dimensional array with random numbers as shown. The array is filled by columns, starting at the top of each column and filling down.

		Column			
		A	B	C	D
Row	1	A_1	B_1	C_1	D_1
	2	A_2	B_2	C_2	D_2
	3	A_3	B_3	C_3	D_3
	4	A_4	B_4	C_4	D_4

Which of the following is necessary to change the algorithm so that the array is filled by rows?

- (A) Reverse the counters in the loop statement using 'down to'.
 (B) Change the inner loop counter to count by rows and the outer loop counter to count by columns.
 (C) Change the inner loop counter to count by columns and the outer loop counter to count by rows.
 (D) Swap the indexes in the assignment statement to (row, row) instead of (column, column).

20 Consider the following syntax statements for a language called OONOZE

<while statement> ::= WHILE <condition> DO <statement list> ENDWHILE
<statement list> ::= <statement>;{<statement>;}
<statement> ::= any acceptable instruction
<condition> ::= <expression> <operator> <expression>
<expression> ::= (any mathematical statement that produces a value) | <identifier>
<operator> ::= equals | is greater than | is less than | does not equal

Which of the following is an acceptable WHILE statement?

- (A) WHILE <identifier> does not equal fred DO ENDWHILE
- (B) WHILE <identifier> is less than 60 <statement> ; ENDWHILE
- (C) WHILE <identifier> is greater than 5 DO <statement> ; <statement> ; ENDWHILE
- (D) WHILE <identifier> equals 12 DO <statement> <statement> <statement> ; ENDWHILE

Section II

60 marks

Attempt Questions 21–23

Allow about 1 hour and 50 minutes for this section

Answer each question in a SEPARATE writing booklet. Extra writing booklets are available.

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

	Marks
Question 21 (20 marks) Use a SEPARATE writing booklet.	
(a) Identify TWO important project management techniques. For each technique you have identified, discuss its importance in ensuring the successful completion of a software development project.	4
(b) A particular software development project has serious implications for the working conditions of an organisation's employees. There will be job losses and significant changes in people's roles. In this situation the employees may have negative feelings towards the project and could be quite obstructive as the project team tries to do its work. Both management and the project team must consider this problem. Discuss TWO strategies that might be adopted.	4

Question 21 continues on page 11

Question 21 (continued)

- (c) The ABC Motel is a small country motel that has recently been taken over by a large administration company, the XYZ Company. You are a systems analyst who has been employed by XYZ to review current operations at the ABC Motel with a view to upgrading and expanding its current computer system.

At present the ABC Motel has a small computer-based system (ABC Motel System) that handles the following:

- reservation of rooms;
- issuing of bills to guests;
- recording of payment; and
- issuing of receipts for payment.

The motel does not accept credit card payments, nor provide EFTPOS facilities. Payment is by cash or cheque only. All money taken is banked daily.

Each week a room occupancy report and a financial report are forwarded to the XYZ Company.

- | | |
|--|----------|
| (i) Draw the context diagram for the existing ABC Motel System as described above. | 3 |
| (ii) Draw a data flow diagram (DFD) showing the main processes of the existing ABC Motel System. This diagram should show any relevant data storage. | 5 |
| (iii) Explain how the motel employees might assist you in your review of the motel operations and the production of such data flow diagrams. | 4 |

End of Question 21

Question 22 (20 marks) Use a SEPARATE writing booklet.

The national railway network has been privatised. In its reorganisation, the new owners decide to automate the operation of the ticket sales and timetable information. They will install a computer system to dispense tickets and timetable information at all stations. Existing staff will be reassigned to assist in the day-to-day running of this system. Touch screens will be installed so that customers will not need to use keyboards to purchase tickets or gain information. Tickets can be paid for by swiping a credit or debit card through a standard magnetic card reader, or by cash. The system will perform the following tasks:

- process the purchase of tickets;
- display train timetable information on the screen;
- display information regarding the early or late arrival of trains currently running; and
- plan journeys.

(a) Discuss the software development approach that would be most suitable for this system. **3**

(b) Currently a feasibility study is being undertaken. **4**

Identify TWO key factors to be considered in determining the technical feasibility of the system. Discuss the importance of each factor you have identified.

(c) The development of the system involves the consideration of a number of interactive components.

(i) Construct a storyboard to describe the purchase of tickets. **4**

(ii) Design a screen that could be used as the main menu for the system. **2**

(d) The system has been implemented and it is found that the information on the touch screens is not accessible to all train travellers. **2**

Identify ONE group of travellers who may have a major problem in using touch screens and explain how this problem could be resolved.

Question 22 continues on page 13

Question 22 (continued)

- (e) Write an algorithm to calculate the cost of the tickets that the train traveller wants to buy. 5

Part of the algorithm is to conduct a search of an array of records containing the single full fare and return full fare for each destination. The search needs to extract fare information for the destination station selected by the train traveller.

The structure of the array of records is:

destination (index).station	destination (index).fullsingle	destination (index).fullreturn
-----------------------------	--------------------------------	--------------------------------

A portion of the array of records is shown below.

⋈	⋈	⋈	⋈
Scone	\$23.80	\$42.50	
Singleton	\$15.40	\$28.40	
Springwood	\$ 5.20	\$ 9.60	
⋈	⋈	⋈	⋈

Use the variable names:

- UserDest to stand for the destination station selected by the train traveller;
- NumSingle to stand for the number of one-way tickets the traveller wishes to purchase;
- NumReturn to stand for the number of return tickets the traveller wishes to purchase; and
- TotalFare to stand for the total cost of all tickets purchased.

For this algorithm you may assume that:

- there are 100 records in the array of records;
- no concession, child or student fares are available;
- the variables NumSingle and NumReturn could be zero. (If both variables were zero then TotalFare would be zero.)

End of Question 22

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Question 23 (20 marks) Use a SEPARATE writing booklet.

Use the information below and the algorithm on page 16 to answer Question 23.

An event ticket agency sells tickets for theatre, cinema and pop concerts. You have been employed to rectify errors in their ticketing system.

The goal of the ticketing system is to accept messages from remote terminals that include transaction details relating to events and ticket sales. The system collects the transactions and stores the relevant data in TICKET and EVENT files.

Following a ticket sale, tickets are printed at the remote terminal with a unique ticket number and the date and time of printing.

At the end of the day a supervisor concludes the processing by entering SystemStatus equals 'OFF'.

Question 23 continues on page 16

Question 23 (continued)

The algorithm for the ticketing system is:

```
1   BEGIN TicketSystem
2     SystemStatus = 'ON'
3     READ LastEventNumber
4     READ SystemDate, SystemTime
5     WHILE SystemStatus = 'ON'
6       READ MessageHeader
7       IF MessageHeader = 'EVENT' THEN
8         ProcessEvent
9       ENDIF
10      IF MessageHeader = 'TICKET' THEN
11        ProcessTicket
12      ELSE
13        SystemStatus = 'OFF'
14      ENDIF
15      READ SystemDate, SystemTime
16    END WHILE
17  END TicketSystem

18  BEGIN ProcessEvent
19    EventNumber = LastEventNumber + 1
20    LastEventNumber = EventNumber
21    STORE LastEventNumber
22    OPEN EVENT
23    STORE (EventName, EventDate, EventTime, EventLocation,
24          EventTicketsAvailable, EventNumber)
25    CLOSE EVENT
26  END ProcessEvent

27  BEGIN ProcessTicket
28    OPEN EVENT
29    IF EventTicketsAvailable < > 0 THEN
30      EventTicketsAvailable = EventTicketsAvailable – NumberTicketsSold
31    ENDIF
32    CLOSE EVENT
33    OPEN TICKET
34    STORE (TicketEventNumber, TicketEventName, NumberTicketsSold,
35          TicketEventDate, TicketEventTime)
36    FOR PrintTicket = 1 to NumberTicketsSold
37      PRINT (TicketCurrentTicketNumber, TicketEventName,
38            TicketEventDate, TicketEventTime, SystemDate, SystemTime)
39    ENDFOR
40    CLOSE TICKET
41  END ProcessTicket
```

Question 23 continues on page 17

Question 23 (Continued)

- (a) There are a number of errors in this algorithm. One error is as follows:

If the program reads an unrecognisable message, then the program does not perform as expected. This error occurs between lines 7 and 16 of the algorithm.

- (i) Identify this error in the algorithm. **2**
- (ii) Modify the appropriate line(s) of the algorithm to solve this error. **3**
- (iii) There are three classes of messages involved with the operation of this ticketing system. These messages are passed from the remote terminals to the main module. **2**
- What is the data type of each message class?
- (iv) Using a desk check, identify TWO further errors in the algorithm. **3**
- (b) The users of the remote terminals produce end-of-day reports listing the number of tickets sold for each event. The TICKET and EVENT files will be numerically sorted by ticket number and event number prior to processing. **6**

Write an algorithm to produce a report. The algorithm must:

- create an array of records (TicketArray) and insert the number of tickets sold, and the name and number of each event;
- sort the array by event number; and
- calculate and print the number of tickets sold and the event name for each event for the day.

- (c) The ticket agency is currently reviewing the manner in which it provides documentation for the users of the remote terminals. **4**

After a study of the users it has been determined that they need support to:

- learn the application;
- learn specific functions in the application; and
- understand the application and its function and purpose.

The ticket agency wants to ensure that its user documentation meets these needs and is considering three alternative formats: paper, online documentation and video documentation.

Briefly describe TWO of these user documentation formats and evaluate the suitability of ONE of the formats described for the ticket agency.

End of Question 23

Section III

20 marks

Attempt either Question 24 or Question 25

Allow about 35 minutes for this section

Answer the question in a SEPARATE writing booklet. Extra writing booklets are available.

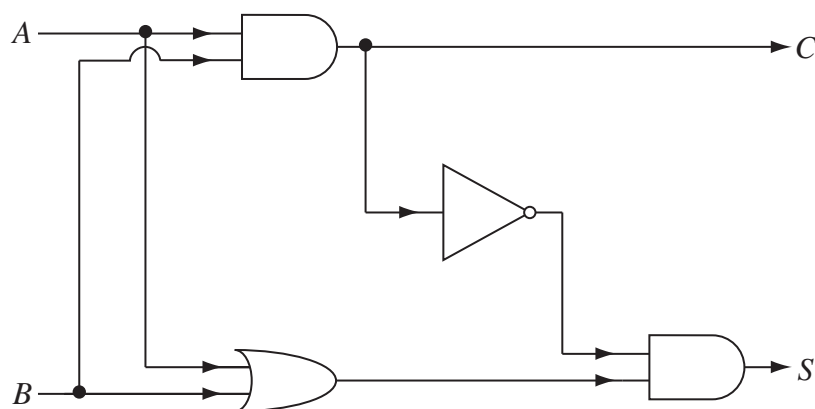
If you include diagrams in your answer, ensure that they are clearly labelled.

	Marks
Question 24 — Evolution of Programming Languages (20 marks)	
(a) A need for greater productivity has influenced the development of different paradigms.	
(i) Discuss the main influences on a programmer's productivity.	4
(ii) Discuss other factors that have influenced the development of paradigms.	4
(b) Inheritance, encapsulation and polymorphism are all aspects of object-oriented programming languages. Define each of these aspects and explain how they improve the reusability and maintainability of code.	6
(c) A programmer has been asked to develop a system for a doctor to help in the selection of antibiotic medicines for hospital patients who have certain bacterial infections. The system uses data about the bacteria, patient history, symptoms and laboratory test results to suggest the type and dosage of antibiotic.	6
Recommend the most appropriate paradigm for the solution of this problem. Explain why the other paradigms would be less appropriate.	

OR

Question 25 — The Software Developer’s View of the Hardware (20 marks)

(a) The diagram shows a half-adder circuit.



- (i) Draw a truth table for this circuit. 2
 - (ii) Describe how to construct a full adder by using two half adders. 2
A diagram may be used to illustrate your answer.
- (b) Describe the differences between integer representation and floating point representation of numbers. Give an example where each would be appropriate. 4

Question 25 continues on page 20

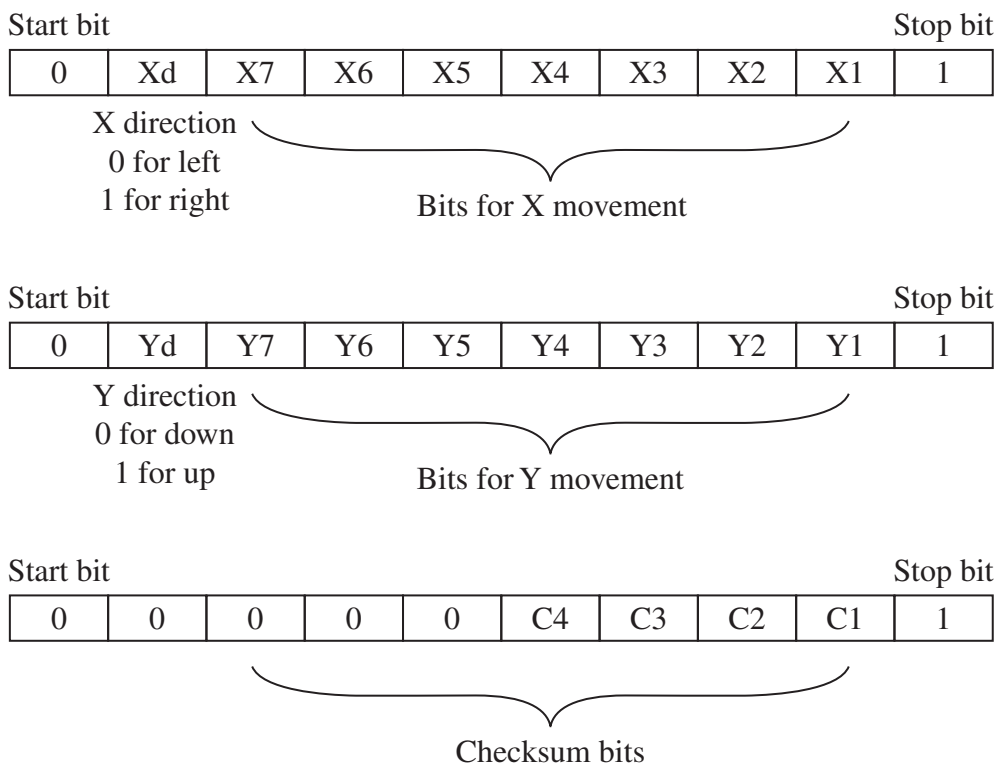
Question 25 (continued)

- (c) Uncle Bill's Toy Company is producing a computer-controlled toy car. Commands to move the car are sent via an infra-red signal from a device connected to a port on the computer. The data stream sent consists of three consecutive data packets, each of which contains a start bit, a stop bit and eight data bits.

The eight data bits for the first and second packets represent the movement of the car in the X and Y directions respectively. The first of the eight bits is an instruction for direction (0 is for left or down while 1 is for right or up). The remaining seven bits are for the movement of the car in the required direction, measured in millimetres.

The eight data bits in the third packet are used as a checksum on the first two packets. The data bits from the two packets are added, the sum is divided by 13 and then the remainder found. This is checked against the checksum packet to ensure correct transmission of the signal.

Hence the general format of the three packets in the data stream is:



Question 25 continues on page 21

Question 25 (continued)

The first two packets of one such data stream are 0101100101 0110100111.

- (i) Describe the exact movement that this sequence represents. **3**
- (ii) Calculate the remainder that will be used as the checksum for this data stream. **3**
- (iii) The software that controls the toy car's movement must first ensure that the message was received correctly. This means that the data stream needs to be of the correct length as well as having the correct checksum. **6**

The software must then extract the movement data from the input data stream and move the car accordingly.

Using pseudocode, write a structured algorithm that will correctly carry out these two tasks for an input data stream that is stored in the variable *StringIn*.

Your algorithm will need to include modules for:

- extracting the required data from the data stream;
- checking the data stream both for length and against the checksum;
- moving the toy car the correct distance in each direction.

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