

B O A R D O F S T U D I E S
NEW SOUTH WALES

2006

**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 Which name is given to the documentation that introduces new users to the commonly used features of a software package?
- (A) Tutorials
 - (B) Installation guides
 - (C) Data dictionary
 - (D) Systems documentation
- 2 Which tool best communicates deadlines to project staff?
- (A) Macros
 - (B) Gantt charts
 - (C) System flowcharts
 - (D) System specifications
- 3 Which hardware item needs to be considered when choosing a programming language?
- (A) Data
 - (B) Network card
 - (C) Dynamic link library (DLL)
 - (D) Random access memory (RAM)
- 4 Which method of implementation is represented by the diagram?



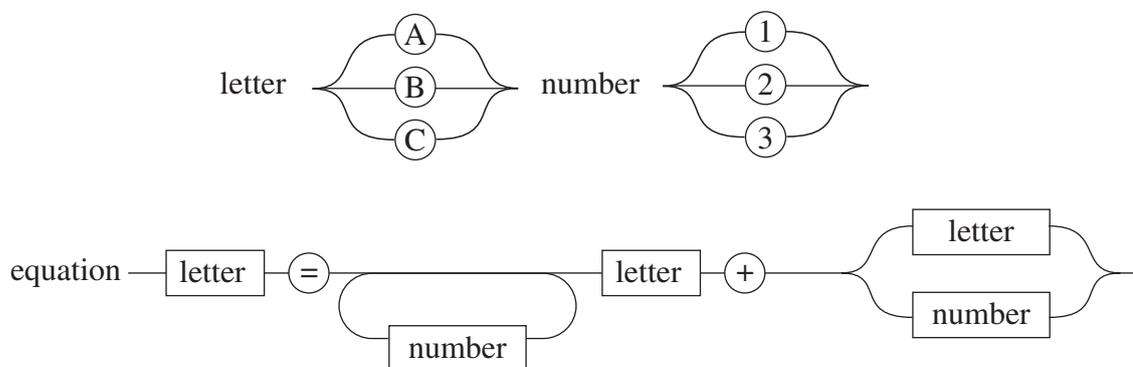
- (A) Pilot
- (B) Phased
- (C) Parallel
- (D) Direct cut-over

- 5 A programmer is developing a database application that will calculate the number of fish caught by a local fishing company. The company needs to print out a report regularly on a special high-speed photocopier printer.

Which of the following would need to be considered when looking at the hardware environment of this system?

- (A) CASE tools
- (B) Data dictionary
- (C) Appropriate drivers
- (D) User documentation

- 6 Consider the railroad diagrams drawn below:



Which of the following is a valid equation?

- (A) $C = B + A$
 - (B) $B = 2\ 1 + C$
 - (C) $B = 2\ B\ B + C$
 - (D) $A = 1\ B + C + 2\ A$
- 7 Email, Internet Relay Chat, Internet telephony and high-bandwidth peer-to-peer networks allow programmers to communicate instantly around the world, allowing collaboration and the sharing of source code.

Which software technology most relies on these emerging communication methods?

- (A) USB drives
- (B) Graphics cards
- (C) Open source software
- (D) Off-the-shelf software

- 8** A software package is being developed for a large company using a structured approach. Upon completion of the installation of the software package it is discovered that the package does not meet the needs of the company.

What is the most likely reason for this?

- (A) No internal documentation
- (B) Poor software maintenance
- (C) Inadequate program specifications
- (D) Incorrect programming language

- 9** Consider the information below:

Int "function to produce an integer. Int rounds down"

Rnd "function to produce a random number between 0 and 0.9999"

T1 = Rnd * 6

T2 = T1 + 1

T3 = Int (T2)

Which scenario would be best simulated by these three lines of code?

- (A) Tossing a coin
 - (B) Rolling a six-sided die
 - (C) Selecting a letter from the alphabet
 - (D) Choosing a number between 1 and 7
- 10** A programming language requires programmers to declare the data type of variables prior to writing code.

What is the most likely reason for this?

- (A) To ensure that code cannot be compiled
- (B) To ensure that the computer efficiently manages memory
- (C) To ensure that multiple data types are stored as Boolean variables
- (D) To ensure that the Central Processing Unit is working at maximum speed

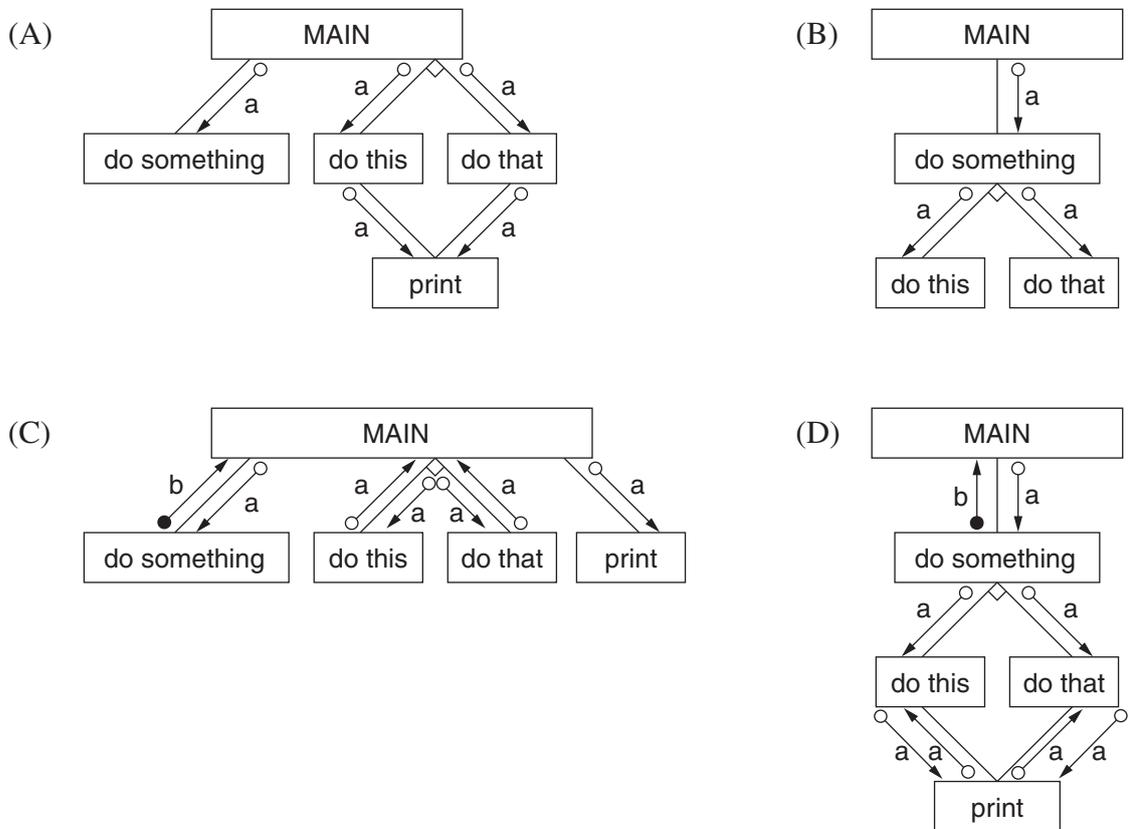
11 Consider the algorithm below:

```

BEGIN MAIN
  a = 1
  do something (a,b)
  IF b = TRUE
    THEN do this (a)
    ELSE do that (a)
  END IF
  print (a)
END MAIN

```

Which structure chart is a correct representation of this algorithm?



12 Consider the algorithm below:

```
BEGIN
  a = 2
  b = 6
  WHILE b ≥ a
    print b
    b = b - 2
  ENDWHILE
  print b
END
```

Which represents the output of the algorithm?

- (A) 6, 4, 2
- (B) 6, 4, 4
- (C) 6, 4, 2, 0
- (D) 6, 4, 2, 2

13 Stephanie, a Year 12 student studying Software Design and Development, wants to program her personal computer to play simple 'arcade-style' games.

Which combination of software development approaches would produce the game quickly?

- (A) Structured/End User
- (B) Prototyping/Structured
- (C) End User/Rapid Application Development
- (D) Rapid Application Development/Structured Walkthrough

14 An automated robotics system has been installed recently by a manufacturing company. The software program that controls the operation of the robotics system is found to have a periodic fault. It has been determined that the fault can be repaired by the installation of a software update.

At which stage is the update most likely to be implemented?

- (A) Maintenance of software solutions
- (B) Defining and understanding the problem
- (C) Planning and design of software solutions
- (D) Testing and evaluation of software solutions

15 Who is most likely to use breakpoints?

- (A) User
- (B) Programmer
- (C) Systems analyst
- (D) Interface designer

Use the algorithm to answer Questions 16 and 17.

Note: The symbol '&' is an operator used to join strings, eg 'cat' & 'dog' = 'catdog'.
Sentence is an array of characters, indexed from 0.

```
10 BEGIN MAIN
20     extract "    Comment: extract is an EMPTY STRING
30     start = 4
40     finish = 9
50     position = start
60     WHILE position ≤ finish
70         extract = extract & sentence(position)
80         increment position
90     ENDWHILE
100    print extract
110 END MAIN
```

16 Which control structure is used in the algorithm?

- (A) Pre-test loop
- (B) Post-test loop
- (C) Binary selection
- (D) Multiway selection

17 If sentence = 'modular approach' what will be printed?

- (A) lar ap
- (B) modu
- (C) ular a
- (D) ularap

- 18** A software solution is being written for use by kindergarten children at school. The purpose of the software is to help children learn the sounds of the letters of the alphabet.

Which kindergarten group(s) would be best to survey when designing the software?

- (A) Children
- (B) Parents
- (C) Teachers and parents
- (D) Teachers and children

- 19** The legibility of text is important in user interface design.

Which set of factors affects the legibility of text?

- (A) Justification, font type
- (B) Justification, relevant ethical issues
- (C) Unambiguous messages, font type
- (D) Unambiguous messages, relevant ethical issues

- 20** A computer system receives data from a network. The CPU initially stores the data in RAM, then moves the data to secondary storage via a register, ensuring the permanent record of the data.

What would be the sequence of the locations of the data?

- (A) RAM, Secondary Storage
- (B) RAM, Register, Secondary Storage
- (C) RAM, Register, RAM, Secondary Storage
- (D) RAM, Secondary Storage, Register, Secondary Storage

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) A hospital in rural NSW needs to improve its services to people who live in isolated regions. The hospital wants to develop a web-based system that will provide online answers to health questions.

The system will be composed of:

- an interface that allows the user to log on, and displays a series of questions leading to a diagnosis or recommendation;
- a database that will be used to make a diagnosis from the user's response to the questions.

Information from the system will be used by the hospital to plan resource usage.

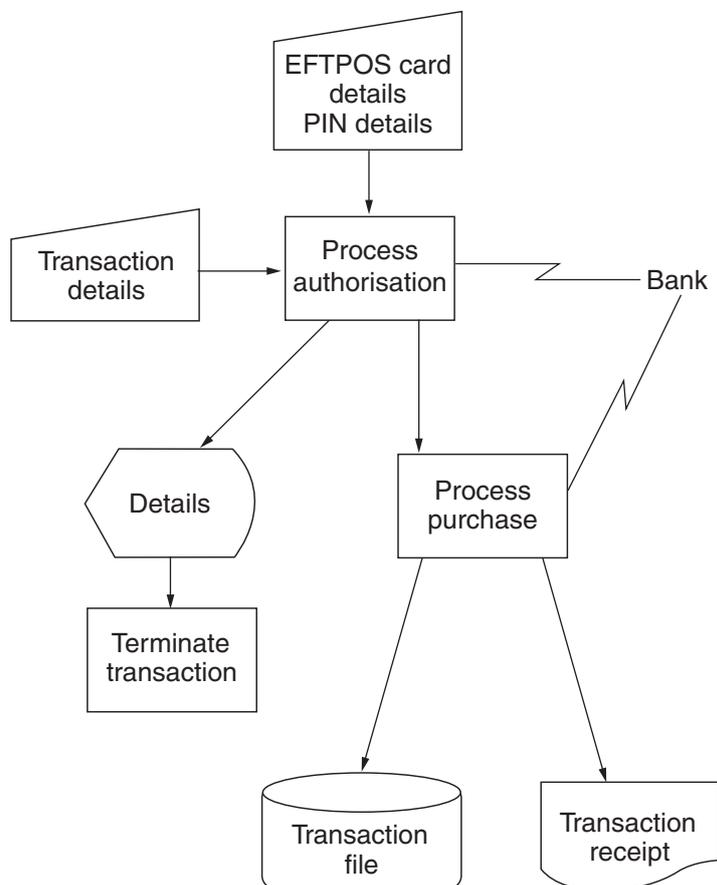
The software developer plans to amend a previously created database and to build a new interface based on substantial user feedback.

- (i) Construct a context diagram which describes the web-based system. 2
- (ii) It has been decided that a combination of two software development approaches (prototyping and structured) will be used to develop this software solution. Discuss the benefits that would result from using this combination of approaches in the development of the hospital web-based system. 4
- (iii) Define the term *benchmarking*, and describe the role that benchmarking would play in the development of this software solution. 3

Question 21 continues on page 11

Question 21 (continued)

- (b) Using the reference table, describe in detail the system shown in the following system flowchart. 4



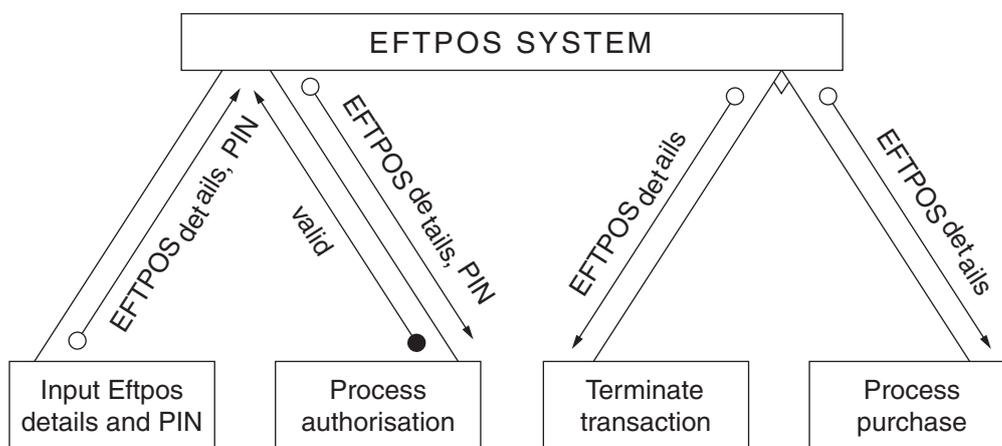
Reference table

	Input/output		Manual operation
	Paper document		Magnetic tape
	Online display		Direct access storage device
	Online input		Telecommunications link
	Punched card		
	Process		

Question 21 continues on page 12

Question 21 (continued)

(c) Consider the structure chart below.



- (i) Identify a flag in the above system. 1

- (ii) Compare and contrast the purpose of a structure chart and a system flowchart. 3

- (iii) From the above structure chart, construct an algorithm for the sub-procedure 'Process authorisation'. 3

End of Question 21

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

(a) After detailed investigations, a university has determined that many students enrolled in its software development courses are engaged in plagiarism. The students are either:

- using existing code, without appropriately acknowledging the source;
- copying other students' code; or
- paying an online service to produce code.

(i) Define *intellectual property*. 2

(ii) Describe the relationship between *plagiarism* and *intellectual property*. 2

In an attempt to solve its plagiarism issue, the university has decided to implement a software solution.

The software scans files submitted by students, looking for identical patterns in all submitted work. It compares:

- intrinsic documentation;
- comments; and
- the order of control structures used in the solutions.

(iii) Explain how these factors could be used to identify possible cases of plagiarism. 2

(iv) Discuss limitations of this software solution, and propose improvements. 4

Question 22 continues on page 14

Question 22 (continued)

- (b) In the following algorithm the sub-procedure EnterStudent is designed to add a student's name, and the identity (ID) of the race the student has entered to a sequential file called StudentRaces in preparation for an upcoming sports carnival. The sub-procedure Check determines whether the student has already been entered for that race.

```

BEGIN EnterStudent
    INPUT Name, RaceID
    Entered = FALSE
    Check (Name, RaceID, Entered)
    IF Entered = FALSE
        OPEN (StudentRaces)
        APPEND Name, RaceID to the end of the file StudentRaces
        CLOSE (StudentRaces)
    ENDIF
END EnterStudent

BEGIN Check (Name, RaceID, Entered)
    OPEN (StudentRaces)
    WHILE NOT EndOfFile(StudentRaces) AND Entered = FALSE
        READ NextName, NextRaceID from StudentRaces
        IF NextName = Name AND NextRaceID = RaceID
            THEN Entered = TRUE
        ENDIF
    ENDWHILE
    CLOSE (StudentRaces)
END Check

```

- (i) Draw the following data dictionary in your answer booklet, and complete it for all variables in the sub-procedure EnterStudent. 2

<i>Variable name</i>	<i>Type</i>	<i>Size</i>	<i>Description</i>
StudentRaces	File	undefined	contains Name and RaceID for all race events

- (ii) Compare and contrast the use of the variables Entered, RaceID and NextRaceID in the sub-procedure Check. 3

Question 22 continues on page 15

Question 22 (continued)

- (iii) Another file, `RaceDetails`, contains the fields `RaceID` and `RaceName`. Both files, `RaceDetails` and `StudentRaces` are sorted on the `RaceID`. Write an algorithm, in pseudocode, for a new sub-procedure `PrintRaceList`, using these files to print a report such as the one shown below. It should show the name of the race, the students in the race and the total number entered in each race. **5**

100 m Hurdles

Sally Smith

Anna Brown

Betty Lee

3 Students

200 m Hurdles

Bob Tao

Bill Browne

2 Students

End of Question 22

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

(a) Outline the differences between interpretation and compilation of source code. 2

(b) Consider the following fragment of code.

<i>Instruction number</i>	<i>Instruction</i>	<i>Register</i>	<i>Comments</i>
10	INP	R1	Read a number into register R1
20	LDA	R1	Copy the number in register R1 to the accumulator
30	INP	R2	Read a number into register R2
40	ADD	R2	Add the number in register R2 to the number in the accumulator
50	STO	R1	Copy the number in the accumulator to register R1
60	JPN30	R2	Return to Instruction Number 30 if the content of the accumulator is negative, otherwise proceed to the next instruction
70	OUT	R1	Print out the number in register R1

(i) Desk check this fragment of code using the test data $-3, -1, 0, 2, 4, 6$. 3

(ii) Explain what will happen if the Instruction JPN30 (line 60) is changed to “Return to Instruction Number 30 if the content of the accumulator is zero, otherwise proceed to the next instruction”. 2

Question 23 continues on page 17

Question 23 (continued)

- (c) An existing school software system is to be upgraded to allow staff to look up student attendance. The system will allow the user to enter a student's first name and surname, student identification number (`student_id`), the student's Year (7–12) and the start and finish dates of the search. The system will return the student's last five absences.
- (i) Justify the importance of defining the data before constructing the user interface. **2**
- (ii) Discuss the advantages of developing the software using a language that allows the drag and drop of screen elements. **3**
- (iii) Sketch an effective user interface for the above system. **3**
- (iv) An extension to the software system is being proposed. The new module will find the student(s) with the most number of days absent. **5**

A two-dimensional array is used to hold the `student_id` and the number of days absent for the 100 students in the school.

Construct a search algorithm that finds the most number of days absent and prints the `student_id` of all students with this number of absences.

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) (i) Describe a reason for the development of the logic paradigm.	2
(ii) Explain the use of <i>goals</i> in the logic paradigm.	2
(iii) Discuss features of the logic paradigm that affect programmers' productivity.	3
(b) A functional language has the following built-in functions:	
ADD (2,3) = 5 //addition	
SUB (6,8) = -2 //subtraction	
SQUARE (3) = 9 //square	
SQRT (9) = 3 //square root	
(i) Determine the value of the function SQUARE (SUB (9, ADD (1,4))). Show all working.	2
(ii) Using the built-in functions provided, write the function DIAGONAL which performs the following calculation:	2

$$\sqrt{x^2 + y^2}$$

Question 24 continues on page 19

Question 24 (continued)

- (c) A store uses an object-oriented program to maintain its stock.

```
class STOCK_ITEM {
    private –
        id_no : integer
        price : real
        amount_on_hand : integer
        title : string

    public –
        get_price (id_no) : real {
            return price
        }
        order_new (id_no, number) : void {
        }
} //end class STOCK_ITEM

sub-class DVD {
    is a STOCK_ITEM
    private –
        producer : string
        running_time : integer
} //end sub-class
```

- | | | |
|-------|--|----------|
| (i) | Identify an attribute from the above description. | 1 |
| (ii) | Staff receive a discount of 50% on all DVDs they purchase. Write a method of the sub-class DVD, called <code>staff_discount</code> that returns the <code>discount_price</code> for staff. | 2 |
| (iii) | Describe the use of <i>private</i> and <i>public</i> sections in the definition of a class. | 3 |
| (iv) | Using the class <code>STOCK_ITEM</code> and sub-class <code>DVD</code> , explain the concept of inheritance. | 3 |

End of Question 24

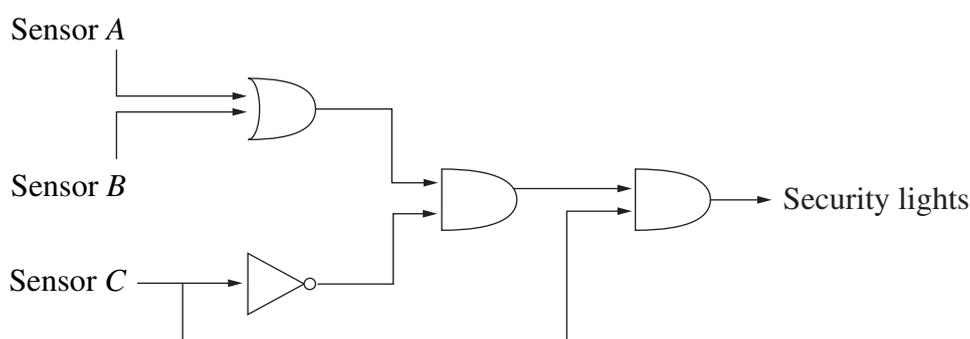
OR

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

- (a) (i) Convert the decimal integer 23 to an 8 bit binary number and state its two’s complement. 2
- (ii) Explain how two’s complement is used in binary division. 2
- (iii) Discuss different ways an 8 bit pattern, such as 1 0 0 1 0 1 1 0, could be interpreted by a computer. 3

(b) A security light system is controlled by three sensors. The sensors detect movement, causing the system to turn the security lights on.

The three sensors are connected to the lights via the circuit drawn below.



- (i) Evaluate the suitability of this circuit by constructing a truth table. 2
- (ii) Draw a circuit for the security light system which would turn the lights on when:
- Sensor A is on, AND
 - either Sensor B OR Sensor C is on.

Question 25 continues on page 21

Question 25 (continued)

- (c) A robotic manufacturing tool is used to design and create a CPU. The system allows the user to draw the basic outline of the circuit using a mouse. This information is then processed and sent to a robotic chip maker that traces the design onto a silicon chip using a single beam of laser light.

The system has the following control characters.

<i>Character</i>	<i>Description</i>
Lon	Laser light on
Loff	Laser light off
M(x,y)	Moves the laser beam source to point (x,y) on the surface of the chip
Eline (x,y)	Creates a line from the current position to point (x,y)
Mem	Creates a unit of memory (*) at the current location

Note that when the system turns on it starts at $x = 0, y = 0$.

- (i) Identify a device that is used to input data to the above system. **1**
- (ii) Using the commands below, construct the design that would appear on the chip. **2**
- Loff
M(2,2)
Lon
Eline(3,4)
Eline(4,4)
Loff
M(2,2)
Lon
Mem
Loff
- (iii) Describe TWO data structures in the data stream packet, other than system control characters, that are sent to the robotic chip maker. **3**
- (iv) The locations x and y are each stored as a byte within the control characters. **3**

When designing the system, the programmers need to consider:

- the speed of transmission of the data packets; and
- the total number of memory units that could be placed on the chip.

Explain the effect that the number of bits used to store x and y has on these two factors.

End of paper

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