NSW Education Standards Authority

2018 **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 either pages 29 and 33 or pages 37 and 41

Total marks: 100

Section I – 20 marks (pages 2–8)

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

Section II – 60 marks (pages 9–28)

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

Section III – 20 marks (pages 29–44)

- 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 Consider the following code fragment.

```
BEGIN
    X = 5
    Y = 8
    X = Y
    Y = X
    print X, Y
END
```

What output is produced?

	X	Y
A.	5	5
B.	5	8
C.	8	5
D.	8	8

2 An algorithm has been developed to check temperature. 'Too cold' is displayed if the temperature is below 40 degrees and 'Too hot' is displayed if it is 60 degrees or more. Otherwise, the display is 'Just right'. The algorithm has been tested with the values 30, 50, 60 and 70.

Which other value should definitely be tested?

A. 0

B. 20

C. 40

D. 80

3 Consider the following code fragment.

```
get r
get t
y = r / t
```

Which combination of inputs for r and t will cause a runtime error when the code is executed?

	r	t
A.	0	4
B.	4	0
C.	2	4
D.	4	2

4 Which of the following is part of software maintenance?

A. Defragmenting data files on a regular basis

B. Modifying code in response to changed requirements

C. Ensuring that software is compatible with a range of hardware

D. Making sure all personnel are trained in the use of any upgraded software

5 How is a code of conduct relevant to software developers?

A. It defines the rate of pay.

B. It defines their expected professional behaviour.

C. It describes the various duties included in their role.

D. It describes the minimum conditions for them to be allowed to work.

6 Which type of software is NOT protected by copyright laws?

A. Shareware

B. Open source

C. Public domain

D. Creative commons

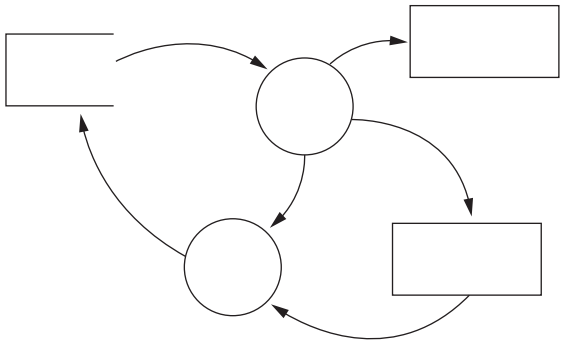
7 Read the following code fragment.

```
IF Locked = TRUE THEN
        Increment Choice
ENDIF
```

Which row of the table shows the most appropriate data types for Locked and Choice?

	Locked	*Choice*
A.	Boolean	Integer
B.	Boolean	String
C.	String	Integer
D.	String	String

8 Consider the following diagram of a system.



What information does the diagram provide about the system?

A. The links between different types of modules

B. The movement of data between entities and processes

C. The connection and navigation between different user interfaces

D. The relationship between the software and hardware components

9 Which row of the table best matches a screen element with the data being entered?

	Screen element	*Data*
A.	Text boxes	A scanned signature
B.	Check boxes	Your date of birth
C.	Drop-down list	The name of your first pet
D.	Radio buttons	Your favourite day of the week

10 A programmer can make use of stubs to

A. reuse previously written and tested modules.

B. help clarify the operation of the software to the user.

C. improve the performance of the code by removing unnecessary detail.

D. test the logic of the mainline, without having to fully code all modules.

11 During which stages of the software development cycle is benchmarking relevant?

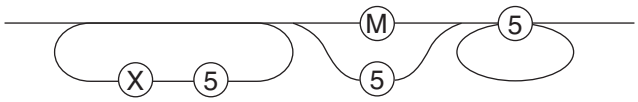
A. Implementing, testing and evaluating

B. Planning and designing, testing and evaluating

C. Defining and understanding the problem, implementing

D. Defining and understanding the problem, planning and designing

12 A railroad diagram is shown.



Which EBNF definition is equivalent to the railroad diagram?

A. { 5 X } (M | 5) 5 { 5 }

B. { X 5 } (M | 5) { 5 }

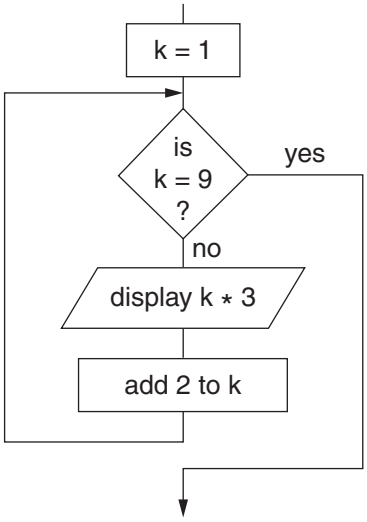
C. { 5 X } (M | 5) { 5 }

D. { X 5 } M | 5 { 5 }

13 Which row of the table correctly identifies ALL the search methods that can be used for unsorted and sorted arrays?

	Unsorted array	*Sorted array*
A.	Linear	Binary
B.	Binary, linear	Linear
C.	Linear	Binary, linear
D.	Binary, linear	Binary, linear

14 Consider the following flow chart fragment.



Which pseudocode fragment will generate the same output as the flow chart?

A.
```
k = 1
WHILE k ≤ 9
    display k * 3
    k = k + 2
ENDWHILE
```

B.
```
FOR k = 1 TO 9 STEP 2
    display k * 3
NEXT k
```

C.
```
FOR k = 1 TO 7 STEP 2
    display k * 3
NEXT k
```

D.
```
k = 0
WHILE k ≤ 8
    display (k + 1) * 3
    k = k + 2
ENDWHILE
```

15 At what level of the testing process does acceptance testing occur?

A. Live

B. Module

C. Program

D. System

16 What is a program counter?

A. A register that holds the next machine code instruction to be executed

B. A variable that holds the next machine code instruction to be executed

C. A register that holds the address of the next machine code instruction to be executed

D. A variable that holds the address of the next machine code instruction to be executed

17 The following code fragment was developed to display the awards at a competition, based on scores up to 100.

```
BEGIN Awards
        Input Score
        CASEWHERE Score IS
            <91:          Display "Distinction"
            <71:          Display "Credit"
            <51:          Display "Participation"
            OTHERWISE:    Display "High Distinction"
        ENDCASE
END Awards
```

What is displayed if a score of 51 is entered?

A. Credit

B. Distinction

C. Participation

D. High Distinction

18 The table shows the initial contents of an array and the contents after one pass of a valid sorting procedure.

Initial	3	1	5	7	6	2	4	8
After one pass	3	1	5	7	6	2	4	8

What are the contents of the array after the second pass?

A.

3	1	5	7	6	2	4	8

B.

1	3	5	6	2	4	7	8

C.

1	2	3	4	5	6	7	8

D.

7	5	3	1	6	2	4	8

19 An item in an array containing N elements needs to be removed, and the elements following it shuffled back.

As an example, the diagram shows the array list before and after the number 4 is removed.

Before	3	5	4	8	7	2
After	3	5	8	7	2	

Note that list (1) = 3

Which code is best able to achieve this?

A.
```
get location of element to be removed
FOR index = location to (N – 1)
    list (index) = list (index + 1)
NEXT index
clear list(N)
```

B.
```
get location of element to be removed
FOR index = location to (N – 1)
    list (index) = list (index – 1)
NEXT index
clear list(N)
```

C.
```
get location of element to be removed
FOR index = N to location step –1
    list (index) = list (index + 1)
NEXT index
clear list(N)
```

D.
```
get location of element to be removed
FOR index = N to location step –1
    list (index) = list (index – 1)
NEXT index
clear list(N)
```

20 A driver has been developed to test the logic of a module.

Which of the following best describes the use of the driver?

A. It mimics the logic of the module and compares the outputs produced.

B. It calls the module repeatedly until the required output has been achieved.

C. It calls the module with a range of values and displays the values returned.

D. It mimics the logic of the module, allowing the response time to be assessed.

2018 HIGHER SCHOOL CERTIFICATE EXAMINATION

Centre Number

Student Number

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 (9 marks)

A new smartphone app is to be developed for registered users to hire cars. Registered users can use the app to find the location of available cars, unlock them for use and lock them after use. The bank account of the user is debited automatically based on the time for which the car was used. The app will also be continually upgraded to enhance user experience.

(a) Outline the social and ethical issues that the developer needs to take into account when developing this app. **3**

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Question 21 continues on page 11

Question 21 (continued)

(b) Justify an appropriate software development approach for the smartphone app. **3**

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(c) Justify a suitable installation method for the smartphone app. **3**

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End of Question 21

Question 22 (9 marks)

The function SubString(name, start, finish) returns the portion of name from position start to position finish (inclusive).

If the value of finish is greater than the length of name, then SubString continues from the beginning of name.

For example:

SubString ("Barry", 3, 5) = "rry"
SubString ("Barry", 3, 7) = "rryBa"

A proposed algorithm for SubString has been developed:

```
10      BEGIN SubString(name, start, finish)
20          set len to the number of characters in name
30          set result to ""
40          WHILE start ≤ finish
50              append start^th character of name to result
60              add 1 to start
70              IF start > len THEN
80                  set start to 1
90              ENDIF
100         ENDWHILE
110         return result
120     END SubString
```

This algorithm contains a logic error and does not always produce the expected result.

(a) Perform a desk check of the algorithm using Name = "Dog", start = 2 and finish = 4. **3**

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Question 22 continues on page 13

Question 22 (continued)

(b) Explain how breakpoints and single line stepping can be used to locate and confirm the source of the error. **3**

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(c) Modify the algorithm so that it always produces the correct result. You may refer to line numbers in your response. **3**

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End of Question 22

Question 23 (9 marks)

In a particular software development company, programmers are required to work on several major projects at the same time. Each project is managed by a project leader, and each project includes production of both the software and associated documentation.

(a) Describe ways in which the project leaders can effectively manage their projects and teams. **3**

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(b) The associated documentation produced includes user and reference manuals. **3**

Distinguish between user manuals and reference manuals with respect to their purpose and content.

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Question 23 continues on page 15

Question 23 (continued)

(c) The sales of the company have been declining over the last few years due to poor user satisfaction with the software produced. **3**

Describe ways in which the company could ensure that the software and documentation better meet user expectations.

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End of Question 23

Question 24 (5 marks)

Table is a two-dimensional array with 4 rows and 4 columns. In the example below, Table (2, 1) = 2.

5	8	1	
2	6	4	

The following algorithm describes a process that can be applied to the elements in the array.

```
10      BEGIN Process
20          Number_of_rows = 4
30          Number_of_columns = 4
40          FOR row = 1 TO Number_of_rows
50              FOR col = row + 1 TO Number_of_columns
60                  temp = Table (row, col)
70                  Table (row, col) = Table (col, row)
80                  Table (col, row) = temp
90              NEXT col
100         NEXT row
110     END Process
```

(a) Show the contents of Table after the algorithm above has been applied. **2**

Question 24 continues on page 17

(b) Add statements to the algorithm to determine, and store in row 4, the largest value of each column. You may refer to line numbers in your response. **3**

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End of Question 24

Question 25 (3 marks)

Explain the benefits of regular contact between developers and clients during the software development process. **3**

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Question 26 (3 marks)

During a one-day sale, an online shopping site became unresponsive when too many people attempted to visit the site at the same time. **3**

Describe the testing techniques that could have been used to prevent this issue from occurring.

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Question 27 (4 marks)

The syntax rules of the programming language XYZ are described below. **4**

```
Program = START <Identifier> { <Statement> # } END <Identifier>
Statement = <Repetition> | <Selection> | <Sequence>
Repetition = LOOP <Integer> { <Statement> # } ENDLOOP
Selection = IF <Condition> { <Statement> # } OTHERWISE { <Statement> # } ENDIF
Sequence = <Inc> | <Print> | <Assign>
Inc = ++ <Identifier>
Print = Display <Identifier>
Assign = Put < Integer> into <Identifier>
Identifier = <Letter> { <Letter> } <Digit>
Letter = A | B | C | D | E
Digit = 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
Integer = <Digit> { <Digit> }
```

The following program is written in XYZ.

```
10      START A
20          Put 20 into F1 #
30          LOOP 5
40              ++ F1 #
50              Print F1 #
60          ENDLOOP
70      END A
```

This program contains some syntax errors.

With reference to the syntax rules provided, explain each of the errors.

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Do NOT write in this area.

Question 28 (10 marks)

A piece of software is to be developed. It will load a list of words together with their length, and then check if an entered string is found within any of the words in the list.

An example of the list is shown.

hippopotamus	12
computer	8

For example, if the string *pop* is entered it will count as a match with *hippopotamus*, whereas *top* will not.

If an entered string is not found in any of the words in the list, it is added to the list as a new word, together with its length.

The pseudocode for part of the software has already been developed, as follows:

```
BEGIN CheckForStrings
    Words() = LoadList
    REPEAT
        Match = FALSE
        CheckForMatch (Words(), Match, String)
        IF Match = FALSE THEN
            AddToList (Words(), String)
        ENDIF
        Input "Any more checks?" reply
    UNTIL reply = "NO"
END CheckForStrings

BEGIN CheckForMatch (Words(), n, Vstring)
    Vstring = EnterValidString
    n = FindString (Words(), Vstring)          'REM This routine checks whether the
END CheckForMatch                              string has been found in any of the words.
```

(a) Describe a suitable data structure for storing each word in the original list together with its length. **2**

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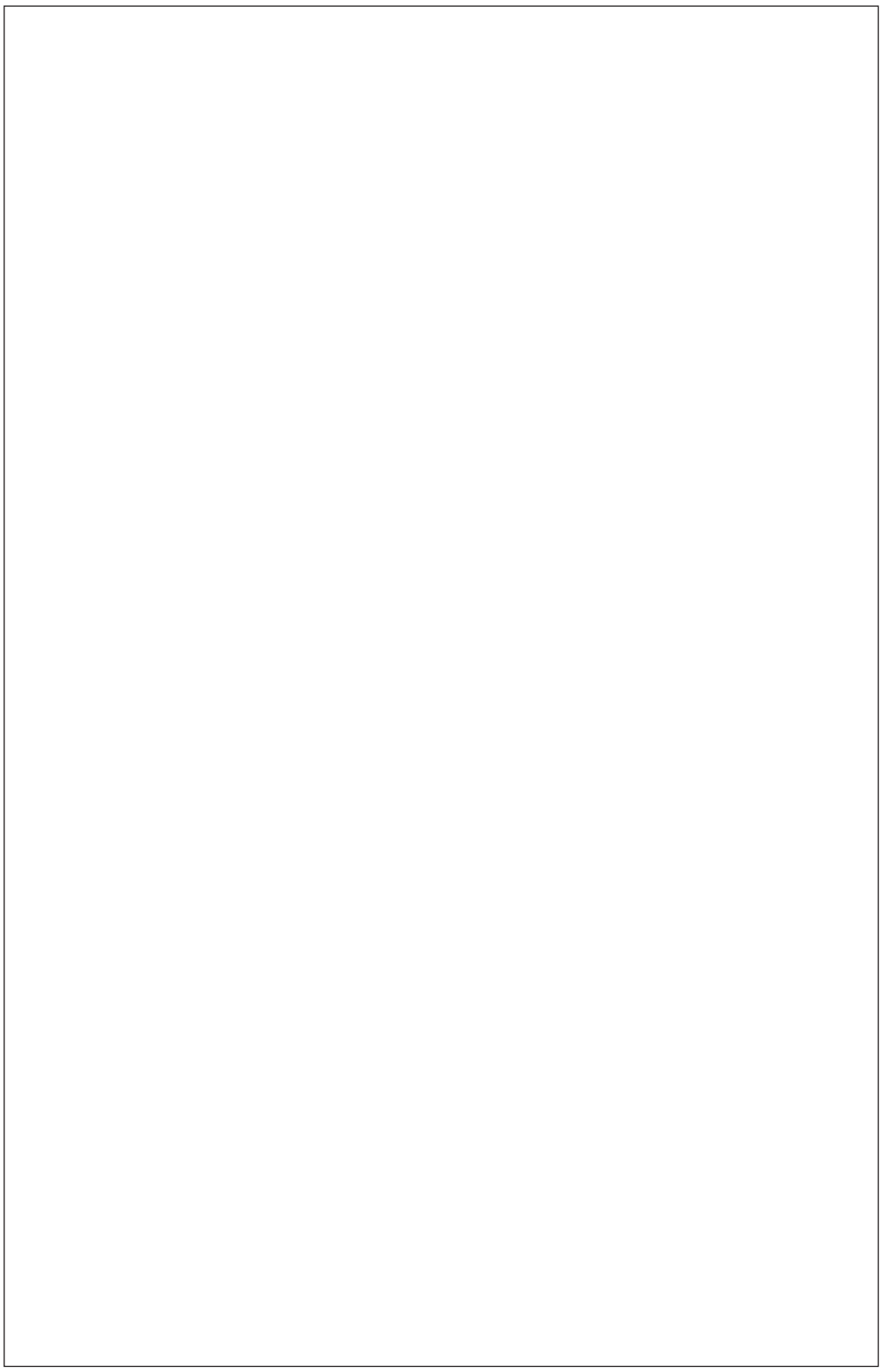
Question 28 continues on page 21

Question 28 (continued)

(b) Represent the pseudocode provided as a structure chart. **4**



Question 28 continues on page 22

Question 28 (continued)

(c) Design an algorithm for the module EnterValidString which continues to ask for a string until a valid string is entered. **4**

To be valid, the string must:

- consist of letters only
- have a length of at least two characters.

Ensure that your algorithm displays an appropriate error message.

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End of Question 28

Question 29 (3 marks)

The three main steps in the translation process are: **3**

- lexical analysis
- syntactical analysis
- code generation.

With reference to these three steps, describe how the statement

```
total = number1 + number2
```

is translated into machine code.

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Do NOT write in this area.

Question 30 (5 marks)

A company hires 10 employees on the same day, and generates a password for each of them according to the following rules. **5**

Each password generated on a day must:

- be 4 characters in length
- start with a different digit (0–9)
- contain 3 randomly generated uppercase letters (A–Z).

The algorithm to generate the passwords may use the following functions:

RAND (min, max) returns a randomly generated integer between min and max, inclusive.

CHAR (integer) returns the character corresponding to the ASCII value provided.

For example:

CHAR (65) = 'A' CHAR (90) = 'Z'

STR (digit) returns the text character equivalent to a numerical digit.

For example:

STR (3) = '3'

ASC (character) returns the ASCII value of the character.

For example:

ASC ('A') = 65

GetLetter (start, end) returns a random letter between two given letters, inclusive.

For example:

GetLetter ('A', 'E') returns a single letter between 'A' and 'E' inclusive.

Question 30 continues on page 25

Question 30 (continued)

Design the algorithm to randomly generate the 10 passwords. In your answer, include the logic for the function GetLetter according to the rules provided.

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End of Question 30

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Section III

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

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

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

Question 31 — Programming Paradigms (20 marks)

(a) Describe the benefits of using encapsulation in object oriented programming. **3**

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Question 31 continues on page 30

Question 31 (continued)

(b) Consider the following facts and rules written using the logic paradigm.

Facts	Meaning
1. coach(soccer, fred)	fred is the coach of the soccer team
2. coach(netball, fred)	
3. coach(debating, lee)	
4. coach(chess, boris)	
5. team(soccer, jane)	jane is a member of the soccer team
6. team(netball, ivy)	
7. team(netball, jim)	
8. team(chess, jim)	

Rules

1. is_coached_by(X, Y):- coach(A, X), team(A, Y)	determines whether Y is coached by X
2. same_team(A, X, Y):- team(A, X), team(A, Y), X ≠ Y	determines whether X and Y are on the same team and are not the same person

The numbers have been added for your reference.

Question 31 continues on page 31

Question 31 (continued)

(i) Expand the code to include: **3**

- a new fact that jim is a member of the volleyball team
- a new rule for same_coach(X, Y, Z) where Y and Z are both coached by X.

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(ii) With reference to the relevant facts and rules, show how the query is_coached_by(fred, X) would be evaluated, using forward chaining. **3**

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Question 31 continues on page 32

Question 31 (continued)

(c) Explain why different programming paradigms needed to be developed after the introduction of the imperative programming paradigm. In your answer, include reference to relevant concepts of the programming paradigms developed. **3**

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Question 31 continues on page 33

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Student Number

Section III (continued)

Question 31 (continued)

(d) Outline why heuristics are used in artificial intelligence applications. **2**

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Question 31 continues on page 34

Question 31 (continued)

(e) The following fragment of code from a sporting equipment supplier application uses the object oriented programming paradigm.

```
class GolfBall {
    private –
        containsAir: Boolean
        cost: float
        dimpleDepth: float
        setCost()
    public –
        colour: string
        setBrand()
        setPieces()
}

class CricketBall {
    private –
        containsAir: Boolean
        cost: float
        seamHeight: float
        setCost()
    public –
        colour: string
        setBrand()
        setPieces()
}

class BasketBall {
    private –
        containsAir: Boolean
        cost: float
        size: integer
        setCost()
    public –
        colour: string
        setBrand()
        setPieces()
        setSize()
}
```

Question 31 continues on page 35

Question 31 (continued)

(i) Demonstrate how the concept of inheritance can be used to improve this code. Support your answer with relevant code fragments. **3**

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(ii) Describe the use of polymorphism with reference to the code fragment provided. **3**

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End of Question 31

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Software Design and Development

Student Number

Section III (continued)

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

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

(a) Explain TWO limitations of ASCII in representing data. **3**

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Question 32 continues on page 38

Question 32 (continued)

(b) A system uses 8-bit 2's complement to represent signed integers. **3**

Perform the following calculations in binary, and explain why they produce the same result.

- 64 + 64
- −32 − 96

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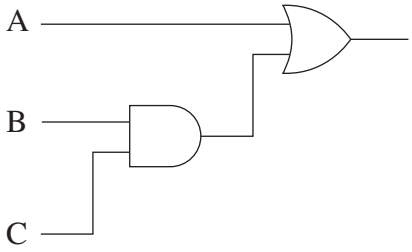
Question 32 continues on page 39

Question 32 (continued)

(c) Students were asked to design a circuit to solve a particular problem. Two solutions were submitted. **3**

One solution was:



The second solution was $\overline{A}BC + A\overline{B}\overline{C} + A\overline{B}C + AB\overline{C} + ABC$.

Show that the two solutions are logically the same.

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Question 32 continues on page 41

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Student Number

Section III (continued)

Question 32 (continued)

(d) A logic circuit requires three inputs and one output. **3**

The output of the circuit is 1 if at least two of the inputs are 1, otherwise the output is 0.

Draw a circuit that satisfies these requirements. To assist you in designing the circuit, you may use a truth table.

Question 32 continues on page 42

Question 32 (continued)

(e) A chemical factory has four large vessels in which reactions are taking place. The temperature and pressure in each vessel need to be controlled. Pressure and temperature sensors are constantly monitoring conditions in each vessel. Each vessel has its own heater and pressure release valve.

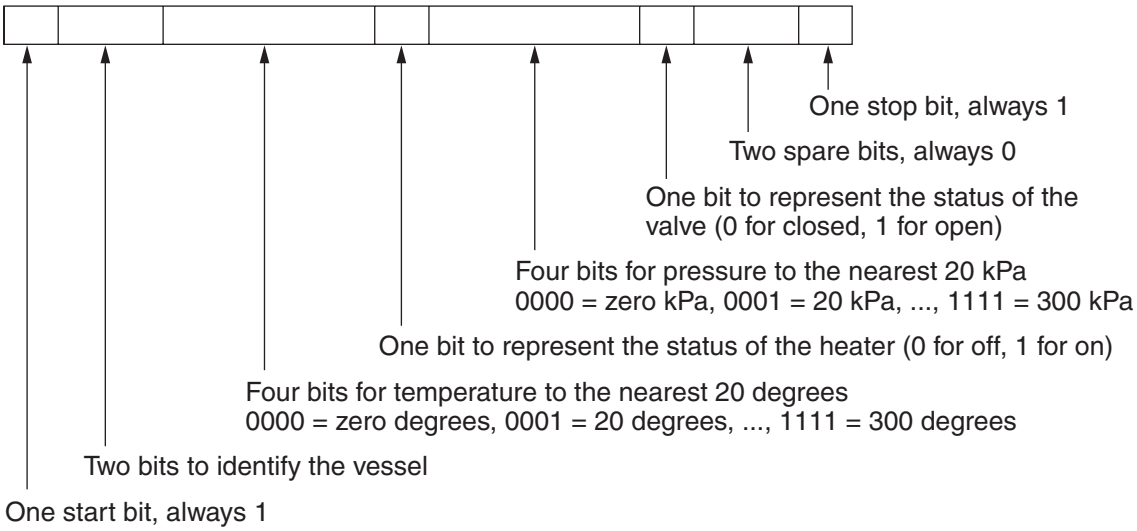
If the temperature falls below 100 degrees, the heater must be switched on.

If the temperature rises above 200 degrees, the heater must be switched off.

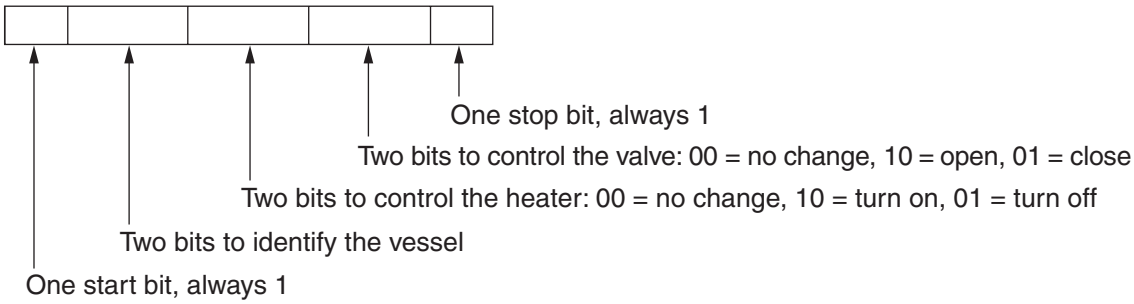
If the pressure rises above 200 kPa, the pressure release valve must be opened.

If the pressure falls below 100 kPa, the pressure release valve must be closed.

Data streams from the vessels are regularly sent to a central processor. The structure of these data streams is shown below.



The central processor sends data streams back to the vessels. The structure of these data streams is shown below.



Question 32 continues on page 43

Question 32 (continued)

(i) The following data streams are sent to the central processor. **3**

```
1 01 1111 1 0110 0 00 1

1 10 0100 0 1100 1 00 1
```

What are the contents of the data streams sent back to the vessels from the central processor? Justify your answer.

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(ii) Changes need to be made to allow for eight vessels and the reporting of temperature to the nearest 10 degrees. **2**

How could the structure of the data streams be modified to accommodate the changes?

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Question 32 continues on page 44

Question 32 (continued)

(iii) Design an algorithm that accepts a data stream from a vessel as input and outputs a decimal number representing the pressure. **3**

You may treat the data stream as a string of characters.

For example:

If the input is 1 10 0100 0 1100 1 00 1, the output is 'Pressure = 12'.

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End of paper