COMPUTER SCIENCE

UNIT 1 & UNIT 3 (PAST PAPER)

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Sample Question

Wasim has designed an algorithm to convert any measurement made in centimetres into inches and vice versa.

```
1  SEND 'Which units are you entering/ enter "I" for inches
   and "C" for centimetres.' TO DISPLAY
2  RECEIVE choice FROM (STRING) KEYBOARD
3  SEND 'Please enter the measurement as a whole number' TO
   DISPLAY
4  RECEIVE valueToConvert (INTEGER) FROM KEYBOARD
5  IF choice = 'I' THEN
6        SET conversion TO valueToConvert * 0.39
7  ELSE
8        SET conversion TO valueToConvert * 2.54
9  END IF
10 SEND conversion TO DISPLAY
```

(a) The variable 'valueToConvert' has been typecast as a STRING. Identify two other variables and state the data type of each.

1 .....

Data type.....

2 .....

Data type..... **(4)**

(b) When Wasim asks his friends to test the program it will carry out a calculation even if an entry other than 'I' or 'C' is made. Edit the algorithm by adding lines before line 2 to authenticate the user entry for the units they wish to convert.

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..... **(6)**

7 (a) 1) choice – string

2) conversion – real

(b) This is one possible solution.

```
SET acceptable TO False
WHILE acceptable = False DO
    SEND 'Which units are you entering/ enter "I"
for inches and "C" for centimetres.' TO DISPLAY
    RECEIVE choice FROM (STRING) KEYBOARD
    IF choice = 'True' OR choice = 'C' THEN
        SET acceptable TO true
    ELSE
        SEND 'Sorry that is not recognised.' TO DISPLAY
    END IF
END WHILE
```

```
SET acceptable TO False
WHILE acceptable = False DO
      SEND 'Which units are you entering/ enter "I" for inches and "C"
      for centimetres.' TO DISPLAY
      RECEIVE choice FROM (STRING) KEYBOARD
      IF choice= "I" OR choice= "C" THEN
           SET acceptable TO True
      ELSE
           SEND "Sorry" TO DISPLAY
      END IF
END WHILE
```

2017

7 Algorithms can be designed using pseudocode or flowcharts. Then, they need to be translated into code that a computing device can execute.
Figure 2 shows the pseudocode for an algorithm.

```
1  # This is the pseudocode for an algorithm
2  SET inNum TO 0
3  SET result TO 1
4  SET i TO 0
5
6  SEND "Enter a number: " TO DISPLAY
7  RECEIVE inNum FROM (INTEGER) KEYBOARD
8
9  IF (inNum < 0) THEN
10    SEND "Invalid input" TO DISPLAY
11 ELSE
12     IF (inNum = 0) THEN
13         SEND "Answer is 1" TO DISPLAY
14     ELSE
15         FOR i FROM 1 TO inNum DO
16             SET result TO result * i
17         END FOR
18         SEND "The answer is " & result TO DISPLAY
19     ENDIF
20 ENDIF
```

Figure 2
(a) Use the information in Figure 2 to answer these questions.
(i) Complete the table to show the output for the given input.
(3)

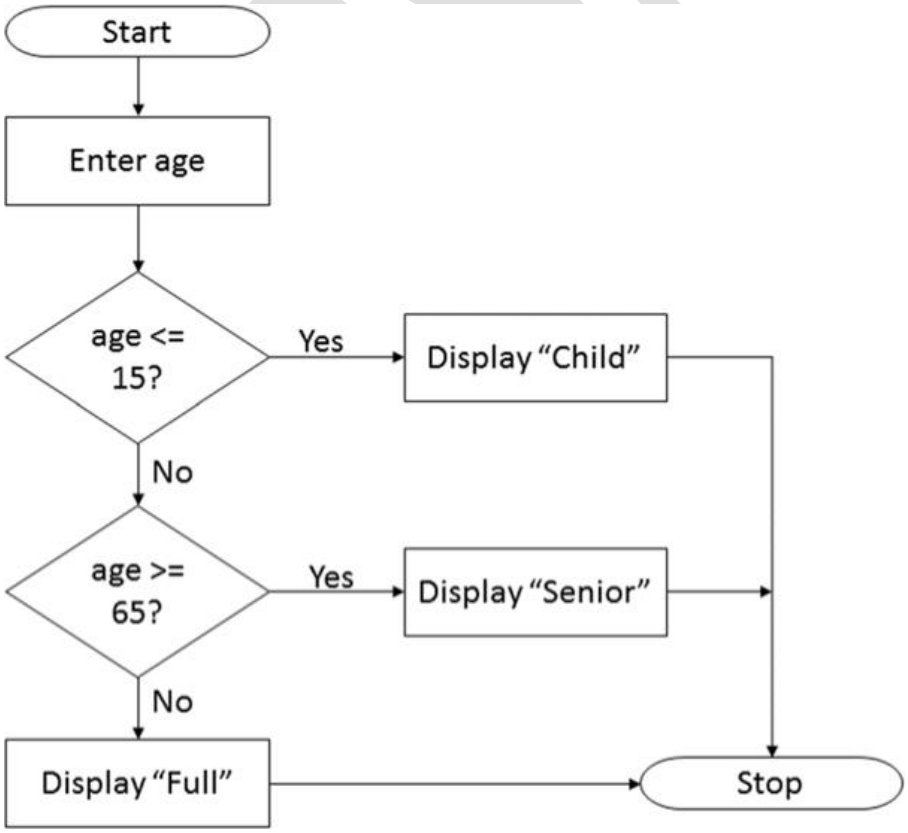
Input	Output message
0	
-12	
5	

Input	Output message	
0	Answer is 1	(1)
-12	Invalid input	(1)
5	The answer is 120	(1)

(ii) State the purpose of this algorithm.
(1)

multiplies every number between 1 and inNum.
calculates factorial of inNum.

(b) A bus company sets fares for different groups of passengers.
The fares are:
• a child fare for passengers 15 years old and younger
• a senior fare for passengers 65 years old and older
• a full fare for all other passengers.
Construct a flowchart of an algorithm that will determine the fare for one passenger when an age is input.
No validation of input is required.
(5)



(c) Users are forced to change their passwords every 28 days. This requires an algorithm that reports the days in any given month.
The algorithm must report the number of days in a month based on a number entered (e.g. 1 = January, 2 = February etc.).
This pseudocode algorithm does not produce accurate results. These are the test results.

Input	Expected behaviour	Actual behaviour
2	The month is February and it has 28 days.	The month is March and it has 31 days.
13	The month number 13 is not valid.	Potential runtime error: index out of range.
-4	The month number -4 is not valid.	Potential runtime error: index out of range.

Figure 3 shows the errors are on lines 12, 13, and 14.

```
1
2  SET monthNames TO ["January", "February", "March", "April",
3                     "May", "June", "July", "August", "September",
4                     "October", "November", "December"]
5
6  SET monthDays TO [31, 28, 31, 30, 31, 30, 31, 31, 30, 31, 30, 31]
7
8  SEND "Enter the month number.  0 to exit." TO DISPLAY
9  RECEIVE number FROM (INTEGER) KEYBOARD
10
11 WHILE NOT (number = 0) DO
12     IF (number > 1) OR (number < 12) THEN
13         SET month TO monthNames[number]
14         SET days TO monthDays[number]
15
16         SEND "The month is " & month & " and it has " & days & "days."
17     ELSE
18         SEND "The month number: " & number & " is invalid."
19     ENDIF
20
21     SEND "Enter the month number.  0 to exit." TO DISPLAY
22     RECEIVE number FROM (INTEGER) KEYBOARD
23
24 END WHILE
```

Figure 3 Write the corrected replacement codes for lines 12, 13, and 14. **(4)**

Line 12 .....

Line 13 .....

Line 14 .....

(number >= 1) (1)
Boolean operator AND (1)
(number <= 12) (1)
Both instances of [number -1] (1)

```
12      IF (number >= 1) AND (number <= 12) THEN
13          SET month TO monthNames[number - 1]
14          SET days TO monthDays[number - 1]
15
```

2018

5 Ships carry cargo around the world in containers.
(a) Containers come in two sizes.
Figure 2 shows an algorithm written using flowchart symbols.

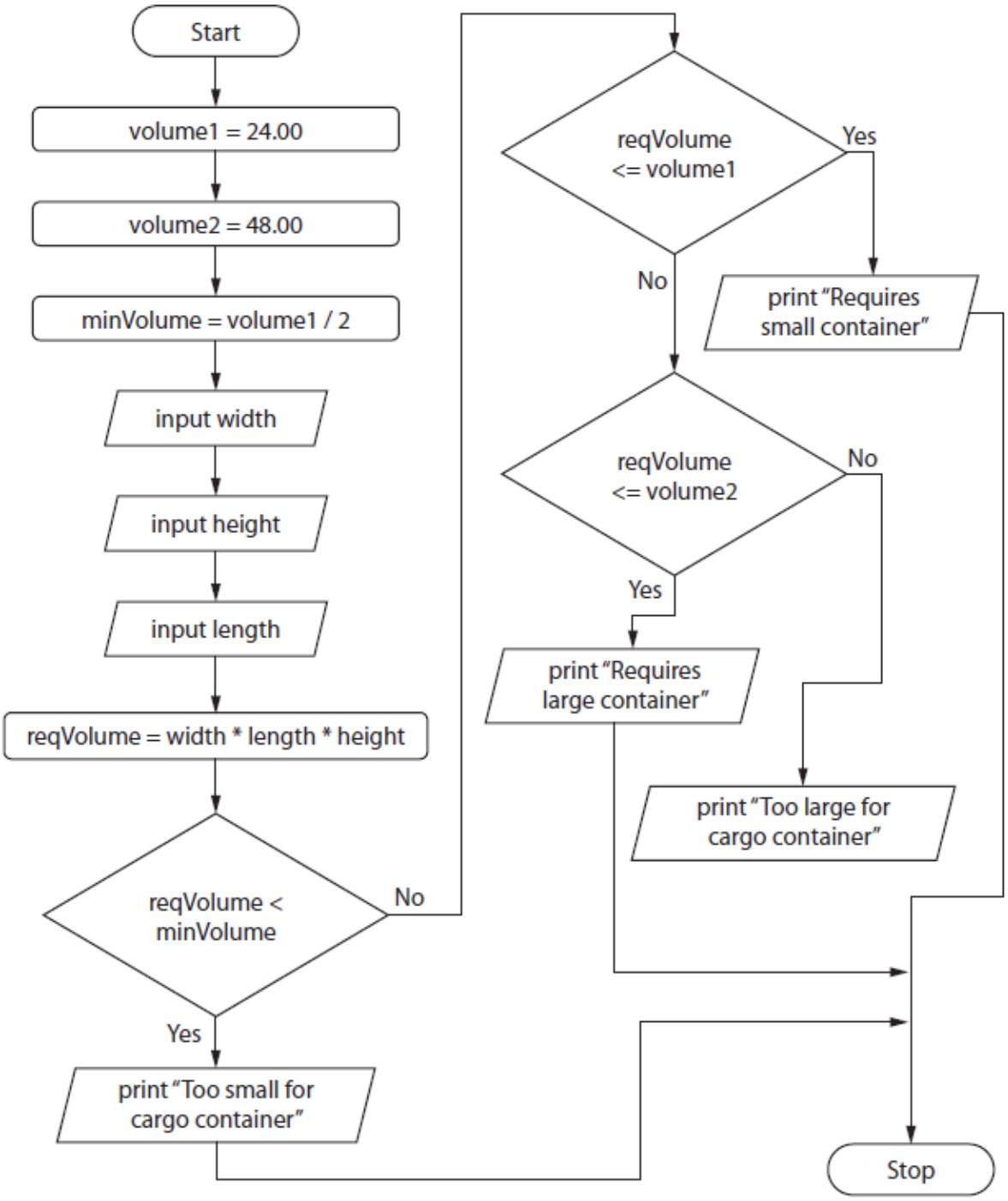


Figure 2

(i) Complete the table to show the output for each cargo item.

(3)

Cargo item			Output
width	length	height	
4	4	2	
2	2	2	
3	8	5	

(ii) State the purpose of the algorithm in **Figure 2**.

(1)

.....

Width	Length	Height	Output
4	4	2	Requires large container (1)
2	2	2	Too small for cargo container (1)
3	8	5	Too large for cargo container (1)

(b) Each ship is registered to a state.
Figure 3 shows a partially completed algorithm written in pseudocode.
The completed algorithm must:
• print each state to the display on a new line
• count the number of states
• create a message as a single string (e.g. there are *number* states)
• print the message to the display.
Complete the algorithm in the space provided in **Figure 3**.

(4)

```
SET numStates TO 0
SET states TO ["France", "Singapore", "Malta", "Panama", "Greece", "Italy"]



FOR EACH state FROM states DO




END FOREACH
```

Figure 3

```
SET numStates TO 0
SET states TO ["France", "Singapore",
               "Malta", "Panama",
               "Greece", "Italy"]
FOR EACH state FROM states DO
    SEND state TO DISPLAY
    SET numStates TO numStates + 1
END FOREACH
SEND "There are " & numStates & "states" TO DISPLAY
```

SEND states [numStates] TO DISPLAY (1)
or
SEND state TO DISPLAY (1)

SET numStates TO numStates + 1 (1)
or
LENGTH(states) (1)

Concatenation of message and variable uses "
and &

& numStates & TO DISPLAY (1)

(c) Cargo ships have maximum weight loads.
Figure 4 shows an algorithm written using pseudocode.
The algorithm should identify the size of cargo ship required for any load.
There is an error on line 9.

```
2   SET loadWeight TO [20000, 28000, 40000, 50000]
3   SET index TO 0
4   SET found TO FALSE
5
6   SEND "Enter cargo weight" TO DISPLAY
7   RECEIVE target FROM (INTEGER) KEYBOARD
8
9   WHILE (NOT found) DO
10      IF (loadWeight [index] >= target) THEN
11          SEND loadWeight [index] TO DISPLAY
12          SET found TO TRUE
13      ELSE
14          SET index TO  index + 1
15      END IF
16  END WHILE
17
18  IF (NOT found) THEN
19      SEND "No ship available" TO DISPLAY
20  END IF
```

Figure 4

(i) Trace tables are used to identify errors in algorithms.
Complete the trace table for an input of 50500 to show what happens due to the error on line 9 in the pseudocode in **Figure 4**.
You may not need to fill in all the rows in the table.

(2)

target	found	index	loadWeight[index]
50500	FALSE	0	

(ii) Construct a single line of pseudocode to correct line 9.
(2)

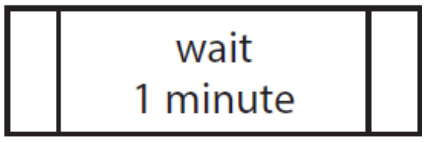
.....

target	found	index	loadWeight[index]
50500	FALSE	0	20000
		1	28000
		2	40000
		3	50000
		4	

WHILE ((NOT found) AND (index < LENGTH (loadWeight))) DO

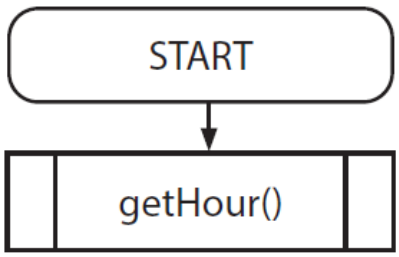
2020

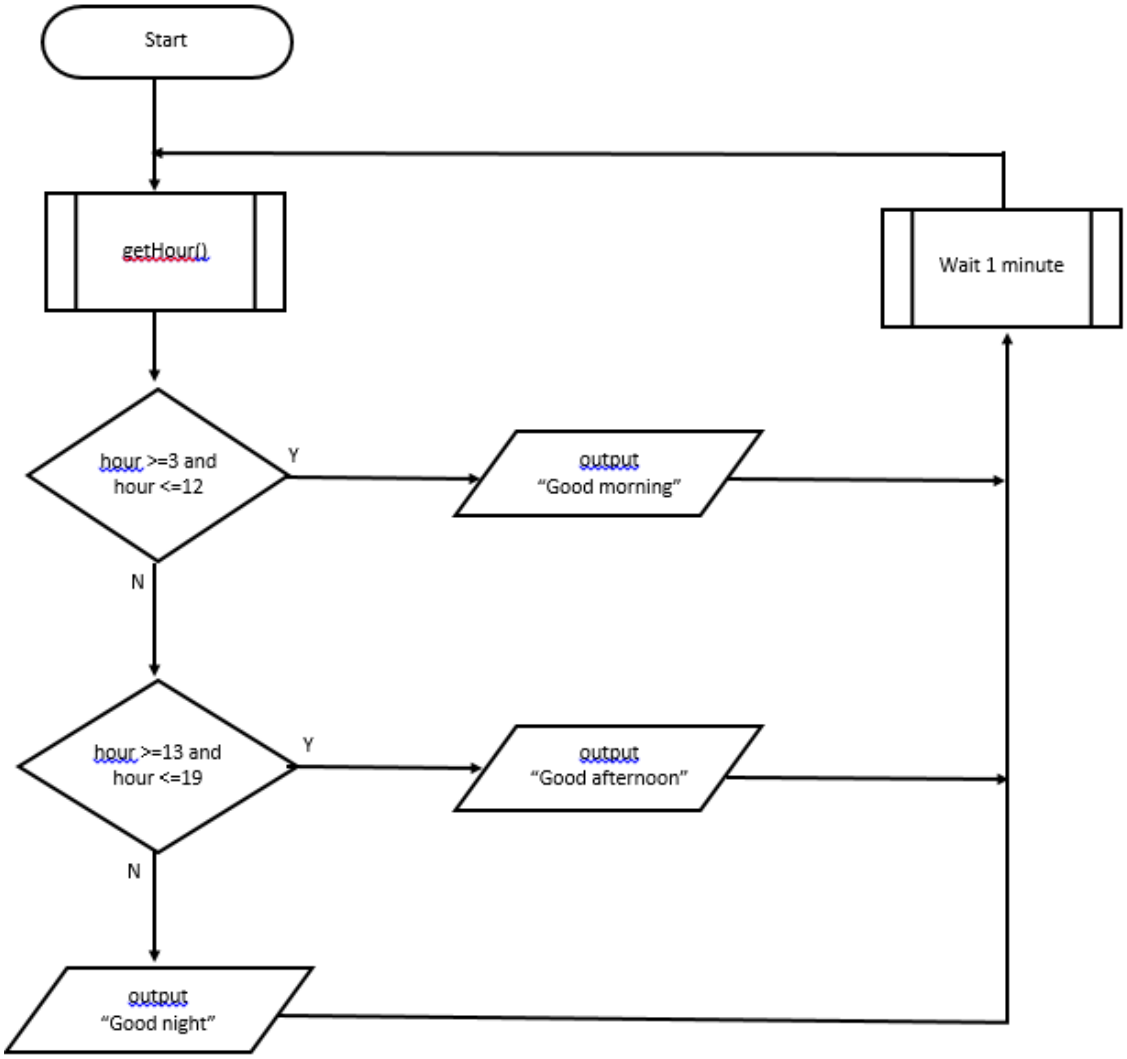
6 A software engineer is working with some algorithms.
(a) An algorithm needs to be developed.
The algorithm must:
• check for a change of hour every minute
• use the library subprogram getHour() to get the hour part of the current time in the 24-hour clock (0 to 23)
• output “Good morning” when the hour is between 3 and 12, inclusive
• output “Good afternoon” when the hour is between 13 and 19, inclusive
• output “Good night” at all other times.
Complete the flowchart to represent this algorithm, in the space provided on the next page.
The call to the library subprogram getHour() has already been included.
Use this subprogram symbol to show waiting for 1 minute.



(6)

Draw your flowchart here.





(b) Another algorithm determines when to change the flavoured syrups for a drinks dispensing machine.
Figure 4 shows this algorithm written in pseudocode.

```
 1 SET flavours TO ["anise", "mango", "cola", "apple", "papaya", "strawberry",
   "lychee", "banana"]
 2
 3 SET volume TO [0.7, 0.2, 0.6, 0.1, 0.05, 0.8, 0.4, 0.6]
 4
 5 SET i TO 0
 6
 7 WHILE i < 8 DO
 8
 9     IF (volume[i] < 0.1) THEN
10         SEND (flavours[i] & " needs changing") TO DISPLAY
11
12     ELSE
13         IF (volume[i] >= 0.3) AND (volume[i] <= 0.5) THEN
14             SEND (flavours[i] & " needs ordering")  TO DISPLAY
15         END IF
16     END IF
17
18     SET i TO i + 1
19
20 END WHILE
```

(i) Give the output produced by the algorithm.

(2)

The algorithm works with a fixed number of flavours.

(ii) Give the number of the line in the algorithm that would need to be amended to allow for any number of flavours.

(1)

(iii) State how the pseudocode needs to be changed to make this amendment.

(1)

papaya needs changing (1)
lychee needs ordering (1)

7

WHILE i < LENGTH(flavours) DO (1)

2021

5 Isaac is a program developer.

(a) **Figure 3** shows an algorithm Isaac has written.

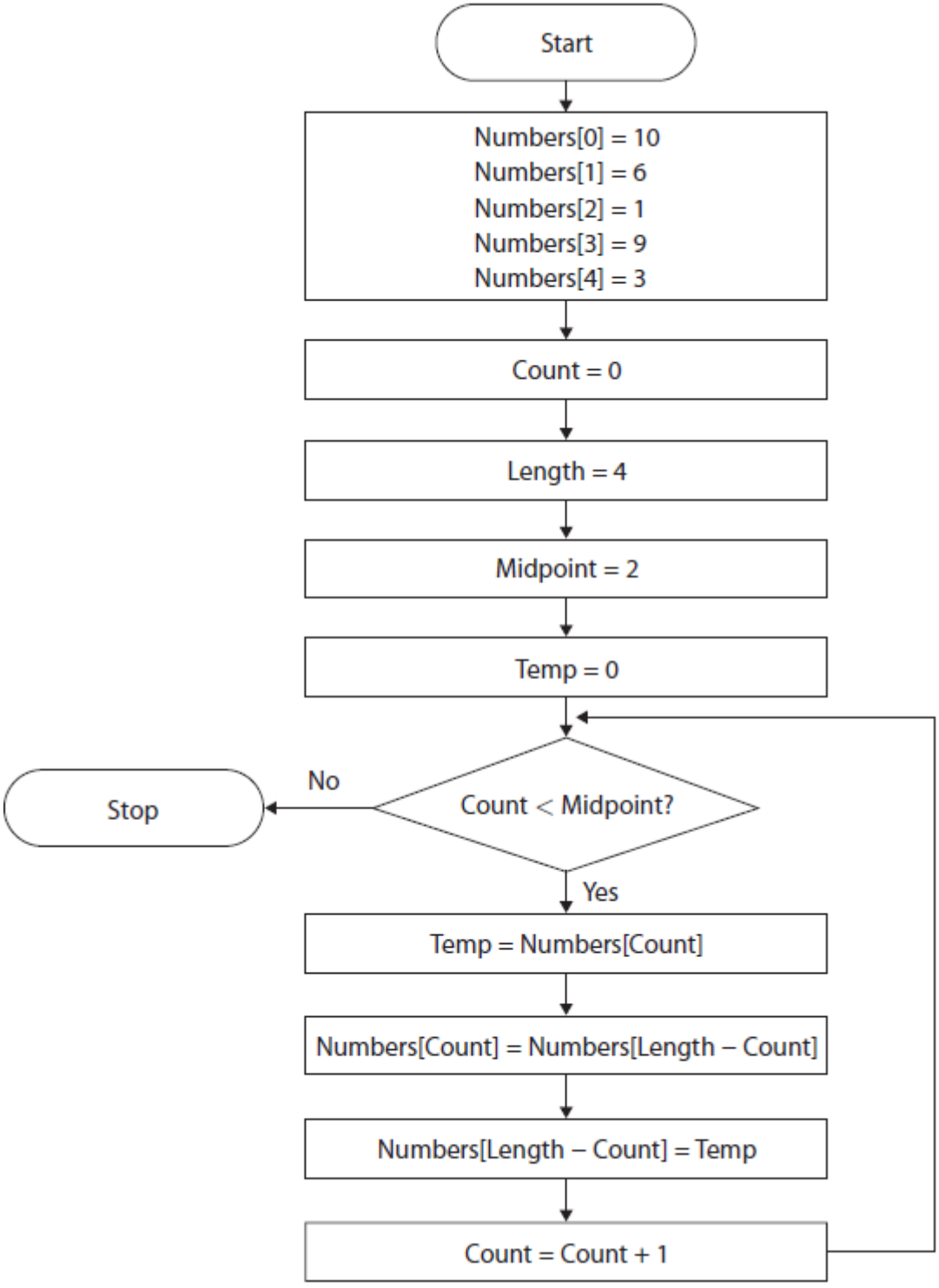


Figure 3

(i) Complete the trace table. You may not need to use all of the rows.

(5)

				Numbers array				
Count	**Length**	**Midpoint**	**Temp**	[0]	[1]	[2]	[3]	[4]
0	4	2	0	10	6	1	9	3

				Numbers array				
Count	Length	Midpoint	Temp	0	1	2	3	4
0	4	2	0	10	6	1	9	3
1			10	3				10
2			6		9		6	

(ii) Give the purpose of the algorithm.
(1)

To reverse the contents of the array

.....

(iii) Explain why the variable Temp is needed.
(2)

You need to swap the contents of array values (1) and without Temp one of the values would be lost (2)

.....

(b) **Figure 4** shows an algorithm Isaac has written using pseudocode.
The algorithm should display the average of the numbers that have been input.

```
1    SET total TO 0
2    SET number TO 0
3    SET count TO 0
4    WHILE number <> –1 DO
5       SEND 'Input a number or –1 to end the program' TO DISPLAY
6       RECEIVE number FROM (INTEGER) KEYBOARD
7       SET total TO total + number
8       SET count TO count + 1
9    END WHILE
10   SET average TO total / count
11   SEND 'The average is ' & average TO DISPLAY
```

Figure 4

Isaac uses the input 2, 3, 5, 2, –1 to test the algorithm. He discovers an error.

Expected result	Actual result
The average is 2.75	The average is 2.2

(i) Explain why the **Actual** result is not the same as the **Expected** result.
(2)

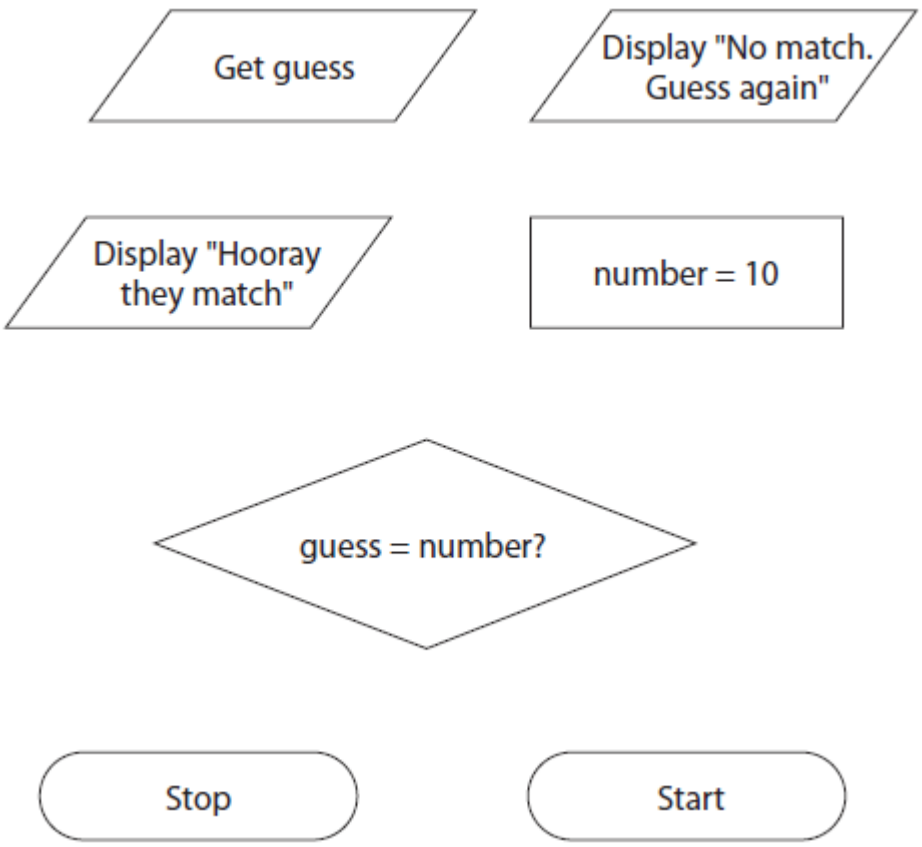
(ii) Give the number of the line that contains the error.
(1)

(iii) Amend a single line of pseudocode to correct the error.
(1)

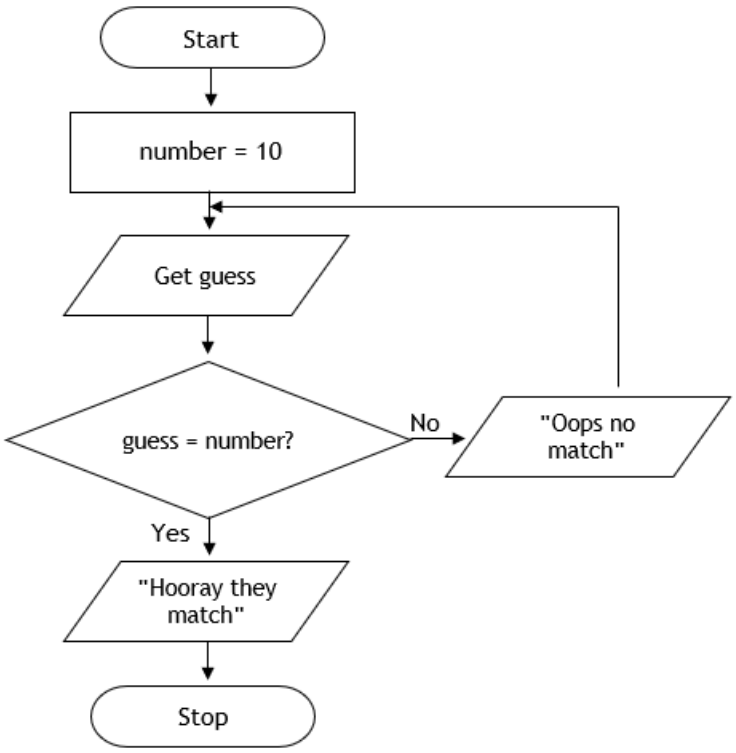
5(b)(i)	Award **two** marks for a linked explanation such as: • Isaac has included the -1 as a number in the addition (1) but the number has not been added to the count (1) • Isaac has misunderstood the WHILE loop (1) as it should not execute after the -1 has been input (1) • Isaac is expecting the wrong result (1) it should be 3 (1) • The count is 1 too many as the -1 is counted as a number (1) and the total is incorrect as 1 is subtracted from the total (1)
5(b)(ii)	Line 3 (1) Line 10 (1)
5(b)(iii)	SET count TO -1 (1) SET average TO (total + 1) / (count – 1)

2022

4 Reba likes writing programs.
(a) She is writing a guessing game.
She needs a flowchart to show the logic of the game.
(i) These are the components needed to draw the flowchart.



Draw the flowchart for the algorithm in the box on the next page.
Use each component once.
Do not add any additional components.
Use as many arrows and yes/no labels as you need.
(5)



(c) **Figure 2** shows the pseudocode for an early version of an algorithm that Reba has written for another game.
The algorithm:
• asks the user to input a colour or input –1 to end the game
• awards 1 point for red
• awards 8 points for orange
• generates the score for the game
• displays the results of the game.

```
 1 SET Colour TO ""
 2 SET Score TO 0
 3 SET RedPoints TO 0
 4 SET OrangePoints TO 0
 5 SET NumOranges TO 0
 6
 7 WHILE Colour <> "-1" DO
 8    RECEIVE Colour FROM (STRING) KEYBOARD
 9    IF Colour = "red" THEN
10       SET RedPoints TO RedPoints + 1
11    ELSE
12       IF Colour = "orange" THEN
13          SET OrangePoints TO OrangePoints + 8
14          SET NumOranges TO NumOranges + 1
15       END IF
16    END IF
17 END WHILE
18
19 SET Score TO RedPoints + OrangePoints
20
21 SEND ("Score: "& Score) TO DISPLAY
22 SEND ("Number of reds: "& RedPoints) TO DISPLAY
23 SEND ("Number of oranges: "& OrangePoints) TO DISPLAY
```

Figure 2

Reba inputs: red, orange, red, red, orange, –1
The outputs are not as she expects.
(i) Complete the trace table to show the outputs.
(4)

Colour	Score	RedPoints	OrangePoints	NumOranges	Outputs
	0	0	0	0	
red					
orange					
red					
red					
orange					
–1					

(ii) Give the line number of the pseudocode that contains the error.
(1)

23

(iii) Write a replacement line of pseudocode to correct the error.
(1)

SEND ("Number of oranges: "& NumOranges) TO DISPLAY

Colour	Score	Red Points	Orange Points	Num Oranges	Outputs
	0	0	0	0	
red		1			
orange			8	1	
red		2			
red		3			
orange			16	2	
-1					
	19				
					Score: 19
					Number of reds: 3
					Number of oranges: 16

2023

6 Programmers share algorithms with different people and write algorithms for different reasons.

(a) A programmer is showing a new algorithm to a group of non-technical managers.
State an appropriate method for writing the algorithm.
Justify your answer.

(2)

Method

.....

Justification

.....

Method

- Flowchart (1)

Justification

- It is a visual representation / does not use many words / does not rely on use of English language (1)
- It does not rely on understanding specific syntax (1)
- Overview without unnecessary detail (1)

(b) **Figure 1** shows an algorithm that displays a string based on the number input by the user.

```
1  SEND ("Enter a number: ") TO DISPLAY
2  RECEIVE inNum FROM (INTEGER) KEYBOARD
3  IF ((inNum = 1) OR (inNum = 2)) THEN
4      IF (inNum = 1) THEN
5          SEND ("First") TO DISPLAY
6      ELSE
7          IF (inNum = 2) THEN
8              SEND ("Second") TO DISPLAY
9          END IF
10     END IF
11 ELSE
12     SEND ("Invalid input") TO DISPLAY
13 END IF
```

Figure 1

Give **one** reason why the selection statement on line 7 is not required.

(1)

(c) **Figure 2** shows an algorithm that manipulates arrays.
The algorithm works with any number of scores.

```
1 SET oldScores TO [10, 20, 30, 40, 50]
2 SET newScores TO [0, 0, 0, 0, 0]
3 SET newIndex TO 0
4
5 FOR oldIndex FROM (LENGTH (oldScores) - 1) TO 0 STEP -1 DO
6 SET newScores[newIndex] TO oldScores[oldIndex]
7 SET newIndex TO newIndex + 1
8 END FOR
```

Figure 2

(i) Describe what happens to the variable **oldIndex** when line 5 is executed.
(2)

(ii) State the purpose of the algorithm in **Figure 2**.
(1)

.....

Question Number	Answer	Additional Guidance	Mark
6(b)	Award **one** mark for any of the following: • The test on line 3 has already limited the values to 1 and 2 (1) • The only value left for inNum to be (on line 7) is 2 (1)		1

Question Number	Answer	Additional Guidance	Mark
6(c)(i)	Award up to **two** marks for a linked description, such as: • The oldIndex value will go from highest to lowest (1) the step value is negative/decremented by 1 (each iteration) (1)	Allow 4 to 0 instead of highest and lowest	2

Question Number	Answer	Additional Guidance	Mark
6(c)(ii)	Award **one** mark for any of the following: • Reverse the (array of) scores (1) • Copy the oldScores into newScores, in reverse order (1)		1

2019 May Jun

3 (e)

(e) Information sent across networks is represented in bit patterns.

(i) The bit pattern 1101 0001 uses sign and magnitude representation.

Convert this bit pattern to a denary number.

(2)

3(e)(i)

-81

One mark for negative sign
One mark for 81.

(ii) Convert the denary number 75 to 8-bit binary.

(2)

3(e)(ii)

One mark for each nibble in correct order

0100 1011

(iii) The addition of these two 8-bit binary patterns generates an error condition.

0	1	1	0	1	1	0	1	
1	1	0	0	0	0	0	0	+
0	0	1	0	1	1	0	1	

Explain this error condition.

(2)

Any **two** from:

1. This is an overflow (1) error
2. It is caused by adding two 1s in the most significant bit (1)
3. The resulting number is too large to fit in the number of bits available / requires 9 bits / the number is larger than 2^8 / there

4 One function of an operating system is file management.

(a) Both kibibyte and kilobyte can be used as measures of file size.

Compare kibibyte and kilobyte.

(2)

Kilobyte is equivalent to 1000 bytes, whereas a kibibyte is equivalent to 1024 bytes (1)

Kilobyte is equivalent to 10^3 bytes, whereas a kibibyte is equivalent to 2^{10} bytes (1)

Kilobyte is a base 10 measurement, whereas a kibibyte is a base 2 measurement (1)

(b) An image is 2322 pixels high and 4128 pixels wide.

The image is stored with a 16-bit colour depth.

The metadata for the image is 975 bytes.

Construct an expression to show how the file size, in megabytes, is calculated.

You do **not** need to do the calculation.

(4)

- Calculates correct bits/bytes(1)
- Adds metadata (1)
- Calculates correct megabytes (1)
- Completely correct response (1)

Examples:

$$\frac{\frac{2322 \times 4128 \times 16}{8} + 975}{1000 \times 1000}$$

$$\frac{(2322 \times 4128 \times 2) + 975}{1000 \times 1000}$$

((2322 x 4128 x 16 bits per colour) ÷ 8 bits per byte) + 975 bytes
---
1000 bytes per KB x 1000 kilobytes per MB

((2322 x 4128 x 2 bytes per colour) + 975 bytes

1000 bytes per KB x 1000 kilobytes per MB

(d) A text file is stored on a hard disc.

The file holds information from one side of a sheet of paper.

The sheet of paper is represented as a grid, 80 columns wide and 66 rows long.

Each cell in the grid contains a single 2-byte Unicode character.

The file also contains 40 characters of metadata.

The hard disc allocates space in blocks of 1024 bytes.

Construct an expression to show the number of blocks required to store the file.

You do **not** need to do the calculation.

(4)

Award 4 marks for 11
Award 3 marks for a value between 10 and 11

One mark for each:

- 80 x 66 x 2 or 80 x 66 x 16 ÷ 8 (1)
- + 40 or + 80 (1)
- ÷ 1024 (1)
- Ceiling or RoundUp (1)

2020 May Jun

2 Computers use binary digits to represent data.

(a) Sign and magnitude and two's complement are two ways of representing signed integer numbers.

(i) Convert the denary number -94 to a binary pattern using sign and magnitude representation.

(2)

1101 1110

(ii) 1000 1001 is a signed integer that uses two's complement representation.

Convert this signed integer to denary.

(2)

- (1)
119 (1)

(b) Denary numbers use base 10

Identify the base for hexadecimal numbers.

(1)

☒ **A** 32

☒ **B** 16

☒ **C** 8

☒ **D** 2

B 16

(c) Computers encode characters using ASCII and Unicode.

(i) State the number of characters that can be represented using standard ASCII.

(1)

128

(ii) The ASCII system uses 7 bits to represent a character. The ASCII code for the character 'A' using denary is 65; other alphabetical characters follow on from this in sequence.

Identify the ASCII code for 'H'.

(1)

- ☒ **A** 1000111
- ☒ **B** 1001010
- ☒ **C** 1001000
- ☒ **D** 1000101

(iii) Explain why Unicode was developed.

(2)

C

Standard ASCII only provides 128 different patterns (1) can't represent all major languages/symbols/characters (1)

Unicode uses a minimum of 16 bits (1) so can represent at least 2^{16} characters (1)

2021 May Jun

1 Binary digits (bits) are grouped together to represent different types of data.

(a) Hexadecimal notation is sometimes used to represent patterns of binary digits.

Identify **one** reason why programmers use hexadecimal notation.

(1)

- ☒ **A** Easier for a computer to understand.
- ☒ **B** Easier for humans to read.
- ☒ **C** Takes up less computer memory.
- ☒ **D** Quicker than binary to execute.

B

(b) Convert the bit pattern 0101 1010 to hexadecimal.

(2)

5A

(c) Identify the number of binary patterns that can be represented by 8 bits.

(1)

- ☒ **A** 128
- ☒ **B** 256
- ☒ **C** 512
- ☒ **D** 1024

B

(d) Complete the table by adding these two 8-bit binary integers.

(2)

0	0	1	1	0	0	1	0
0	0	1	1	0	0	1	1

0110 0101

(e) Give the result of performing a logical left shift of 1 place on the binary integer 0100.

(1)

01000 (OR) 1000

(f) Give the number of bits per character used by standard ASCII.

(1)

7

(g) **Figure 1** shows a black and white bitmap image.

The pixels in row 5 are represented by the binary pattern 1001 1001

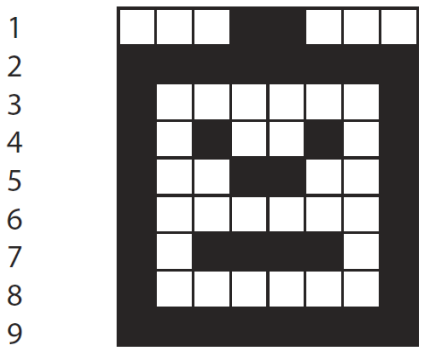


Figure 1

(i) State what is meant by the term **pixel**.

(1)

A picture element

(ii) Construct an expression to show the number of pixels in the image.

(1)

8 x 9 (OR) 9 x 8 (OR) 72

(iii) The image is changed so that any pixel can be one of 16 different colours.

State the minimum number of bits that would be needed to represent **one** pixel.

(1)

4

(ii) Identify which **one** of these file formats uses lossy compression.

(1)

- ☒ **A** BMP
- ☒ **B** DOC
- ☒ **C** JPEG
- ☒ **D** PNG

C

(iii) Here is a string of data.

CCCWWWCCWWWWWWCCC

Give the result of compressing the string using a run-length encoding algorithm.

(1)

3c3w2c6w3c (1)

c3w3c2w6c3 (1)

(g) A video file is to be transmitted over the internet.

- The network transmission speed is 54 Mbps.
- The file size is 6 gigabytes (GB).

Construct an expression to show how the transmission time, in seconds, is calculated.

You do **not** have to do the calculation.

(4)

$$\frac{6 \times 1000 \times 1000 \times 1000 \times 8}{54 \times 1000 \times 1000}$$

2021 Nov

1 Computers use binary to represent and store data.

(a) Binary and hexadecimal notation can be used to represent numbers.

(i) Convert the denary number 77 to 8-bit binary.

(2)

0100 1101

(ii) Convert the denary number –126 to 8-bit binary using two's complement.

(2)

1000 0010

(iii) Convert the binary pattern 11000110 to hexadecimal.

(2)

C (1)
6 (1)

(b) Images are stored as binary data.

(i) A bitmap image is 400 pixels wide by 200 pixels high.

It has a colour depth of 12 bits.

Construct an expression to show how the image size, in bytes, is calculated.

Do **not** calculate the answer.

(2)

400 pixels x 200 pixels x 12 bits / 8 bits per byte
Allow expression in word form

$$\frac{400 \times 200 \times 12}{8}$$

400 x 200 **OR** 80000(1)

12/8 **OR** 1.5 (1)

(ii) **Figure 1** is an image of an icon, set out in an 8 × 8 pixel grid.

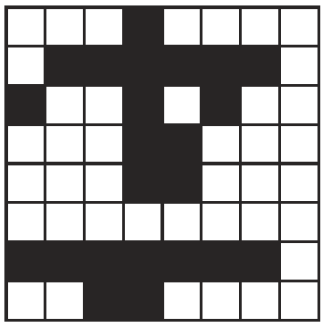


Figure 1

A run-length encoding compression algorithm uses:

- W for white pixels
- B for black pixels.

Give the result of compressing the first 4 lines of the icon using the algorithm.

(3)

Spaces are to help legibility.
Award **three** marks for:

Line 1 3W 1B 4W
Line 2 1W 6B 1W
Line 3 1B 2W 1B 1W 1B 2W
Line 4 3W 2B 3W

Award **two** marks for any three lines correctly encoded

Award **one** mark for any two lines correctly encoded

2022 May Jun

2 Computers use binary to represent and store data.

(a) The denary number 78 is the ASCII code for the character **N**.

(i) Convert the denary number 78 to 8-bit binary.

(2)

0100 1110

(ii) Identify the number of characters that can be represented using standard ASCII.

(1)

☒ **A** 64

☒ **B** 128

☒ **C** 256

☒ **D** 512

B

(iii) Explain **one** reason for using Unicode rather than ASCII to encode languages other than English.

(2)

Unicode can represent all/more characters/any language (1) whereas ASCII can only represent English/Latin/128 characters/doesn't have enough characters (1)

(b) Convert the denary number –43 to 8-bit binary using sign and magnitude representation.

(2)

1010 1011

(c) Complete the table by adding these two 8-bit binary integers.

(2)

0	0	1	1	0	1	0	0
0	0	0	1	0	1	1	0

0100 1010

(i) An image has five colours.

Complete the table by adding a unique binary pattern for each colour.

Each pattern must use the **same minimum colour depth**.

(2)

Colour	Binary pattern
Green	
Black	
White	
Red	
Blue	

Award up to **two** marks for:

- 3 bits used for all patterns (1)/
- No pattern repeated (1)

Example:

Colour	Binary pattern
Green	000
Black	001
White	010
Red	011
Blue	100

(ii) Another image is 3579 pixels high and 6128 pixels wide.

The image is stored with a 32-bit colour depth.

The metadata for the image is 732 bytes.

Construct an expression to show how the file size, in **megabytes**, is calculated.

You do **not** need to do the calculation.

(4)

Award **one** mark for each of:

- 3579 x 6128 x 32 (1)
- ÷ 8 (1)
- + 732 (1)
- ÷ (1000 x 1000) (1)

Examples

$$\frac{\frac{3579 \times 6128 \times 32}{8} + 732}{1000 \times 1000}$$

2023 May Jun

2 Computers manipulate binary patterns. People interpret those patterns.

(a) Complete the table by adding the hexadecimal notation for each of the denary values.

(2)

Denary	Hexadecimal
8	
12	

Denary	Hexadecimal
8	8 (1)
12	C (1)

(b) Identify the expression to give the number of unique binary patterns that can be stored in six bits.

(1)

☒ **A** 6^2

☒ **B** 6×2

☒ **C** $6^2 - 1$

☒ **D** 2^6

D

(c) Binary patterns are manipulated by shifts.

(i) Give the result of applying a logical shift right by two to the binary pattern 0101 1100

(1)

0001 0111

(ii) Give the result of applying an arithmetic shift right by three to the binary pattern 1100 0101

(1)

1111 1000

(d) Binary patterns can be interpreted as signed or unsigned integers.

(i) Convert the denary unsigned integer 60 to 8-bit binary.

(2)

0011 1100

(ii) Here is a binary bit pattern for a signed integer in sign and magnitude format.

1001 0110

Convert the binary bit pattern to denary.

Be sure to include a sign symbol in your answer.

(2)

-22

(iii) Negating a signed integer means changing its sign without changing its value.

The negation of +16 is –16. The negation of –24 is +24.

Here is the binary bit pattern for a signed integer in two's complement format.

1110 0101

Convert the binary pattern to its negation in two's complement.

(2)

0001 1011

(e) Construct an expression to convert 13 kilobytes to kibibytes.

You **do not** need to do the calculation.

(2)

Award **one** mark for each of:

1. 13 x 1000 // 13000 in the numerator (1)
2. 1024 in the denominator (1)

Examples:

$$\frac{13 \times 1000}{1024}$$

$$\frac{13000}{1024}$$

$$\frac{13 \times 500}{512}$$

$$\frac{13 \times 250}{256}$$

$$\frac{13 \times 125}{128}$$

$$\frac{13 \times 10^3}{2^{10}}$$

(d) Here is an image of secondary storage.

Two files (W and Z) are stored on it.

Each file is made up of several blocks (e.g. Z1, Z2, Z3).

	W4	Z1					W2			W3	Z3		W1		Z2

Complete the image to show the state after running a defragmentation utility.

(2)

W1	W2	W3	W4	Z1	Z2	Z3									

										Z1	Z2	Z3	W1	W2	W3	W4

Z1	Z2	Z3	W1	W2	W3	W4									

										W1	W2	W3	W4	Z1	Z2	Z3

(e) Here is part of a file that contains electric meter readings.

04631 04984 05103 05163 05271 05383 05487 05722

Explain the effect on the file of applying a run-length encoding algorithm to this data file.

(2)

The file size will not be decreased/will increase (1) because there are very few/no repeating patterns / because a run length of one would be added to each digit (1)

2020 May Jun

5 Programmers work as part of a team to develop software.

(a) They use truth tables to determine if an expression evaluates to true or false.

Complete this truth table for the Boolean expression

P AND (Q OR R)

You may not need to use all rows.

(3)

P	Q	R	Q OR R	P AND (Q OR R)

P	Q	R	Q OR R	P AND (Q OR R)
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	1	0
1	0	0	0	0
1	0	1	1	1
1	1	0	1	1
1	1	1	1	1

(b) The team is working on software for a ride-on lawn mower.

The lawn mower must not start unless it is safe for the driver.

- The brake (B) must be engaged.
- The driver's seat sensor (S) must be engaged.
- The blade safety lock (L) must be removed.

Construct a Boolean expression, using AND, OR, and NOT with the letters B, S and L to show the safe starting condition.

(2)

B AND S AND NOT L

Award **one** mark for each of:

NOT L or B AND S (1)

Fully correct (1)

2021 May Jun

4(c) A scientist uses Boolean logic in programs.
Complete the table to show the results of each operation.

(3)

R	S	W	NOT S	R AND W	(NOT S) OR (R AND W)
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

NOT S	R AND W	(NOT S) OR (R AND W)
1	0	1
1	0	1
0	0	0
0	0	0
1	0	1
1	1	1
0	0	0
0	1	1

2021 Nov

(c) Akiko is also working on a burglar alarm system.

The alarm must only be triggered if:

- the alarm (A) is set
- it is dark outside (O)
- a window (W) or a door (D) has been opened.

Construct a Boolean expression, using AND, OR and NOT with the letters A, O, W, and D to show the conditions that will trigger the alarm.

(4)

A AND O AND (W OR D)

Award **one** mark each to a maximum of **four** marks for:

- A AND O (1)
- W OR D (1)
- Brackets around W OR D (1)
- AND between A AND O (W OR D) (1)

2023 May Jun

(d) Programs use logic statements to control physical hardware.

(i) A window shuts when the temperature is too cool or it is a rainy night.

The values are defined as:

- A shows it is night time
- B shows it is too cool
- C shows it is raining.

Complete the truth table to show the results of each operation.

Two rows have been done for you.

(3)

A	B	C	A AND C	(A AND C) OR B
0	0	0	0	0
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1	1	1

A	B	C	A AND C	(A AND C) OR B
0	0	0	0	0
0	0	1	0	0
0	1	0	0	1
0	1	1	0	1
1	0	0	0	0
1	0	1	1	1
1	1	0	0	1
1	1	1	1	1

(ii) A warehouse has an automated alarm system.

When the alarm system is activated it will sound if:

- a movement sensor (M) is activated
- a pressure pad (P) is activated
- a key code (C) to deactivate the alarm system has not been entered.

Construct a logic statement, using AND, OR and NOT with the letters M, P and C, to show the conditions that will sound the alarm.

(3)

Award **one** mark for each of:

- M OR P (1)
- NOT C (1)
- <expr1> AND <expr2> (1)

Example statements:

(M OR P) AND (NOT C)
(M OR P) AND NOT C
(M AND NOT C) OR (P AND NOT C)
M AND NOT C OR P AND NOT C

For information only:

M	P	C	M OR P	NOT C	(M OR P) AND (NOT C)
0	0	0	0	1	0
0	0	1	0	0	0
0	1	0	1	1	1
0	1	1	1	0	0
1	0	0	1	1	1
1	0	1	1	0	0
1	1	0	1	1	1
1	1	1	1	0	0