AQA

GCSE
COMPUTER SCIENCE

Paper 1 Computational thinking and problem-solving

Monday 14 May 2018   Morning   Time allowed: 1 hour 30 minutes

Materials
- There are no additional materials required for this paper.

Instructions
- Use black ink or black ball-point pen. Use pencil only for drawing.
- Answer **all** questions.
- You must answer the questions in the spaces provided**.**
- Do all rough work in this book. Cross through any work you do not want to be marked.
- You are free to answer questions that require a coded solution in whatever format you prefer as long as your meaning is clear and unambiguous.
- You must **not** use a calculator.

Information
- The total number of marks available for this paper is 80.

Advice

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

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ANSWER IN THE SPACES PROVIDED

Answer **all** questions.

| 0 | 1 | . | 1 | Define the term algorithm.

[2 marks]

_____

_____

_____

_____

| 0 | 1 | . | 2 | The following are computer science terms (labelled **A** – **E**).

A abstraction
B data type
C decomposition
D efficiency
E input

For each of the definitions in the table, write the label of the most suitable computer science term. Use a label only once.

[3 marks]

	Label
Breaking a problem down into a number of sub-problems.	
The process of removing unnecessary detail from a problem.	
Defines the range of values a variable may take.	

5

Turn over for the next question

Turn over ▶

0 2   The algorithm in **Figure 1** has been developed to automate the quantity of dog biscuits to put in a dog bowl at certain times of the day. The algorithm contains an error.

- Line numbers are included but are not part of the algorithm.

Figure 1

```
1      time ← USERINPUT
2      IF time = 'breakfast' THEN
3         q ← 1
4      ELSE IF time = 'lunch' THEN
5         q ← 4
6      ELSE IF time = 'dinner' THEN
7         a ← 2
8      ELSE
9         OUTPUT 'time not recognised'
10     ENDIF
11     FOR n ← 1 TO q
12        IF n < 3 THEN
13           DISPENSE_BISCUIT('chewies')
14        ELSE
15           DISPENSE_BISCUIT('crunchy')
16        ENDIF
17     ENDFOR
```

0 2 . 1   Shade **one** lozenge which shows the line number where selection is **first** used in the algorithm shown in **Figure 1**.

[1 mark]

A Line number 2   ⬯

B Line number 4   ⬯

C Line number 9   ⬯

D Line number 12   ⬯

0 2 . 2 Shade **one** lozenge which shows the line number where iteration is **first** used in the algorithm shown in **Figure 1**.

[1 mark]

A Line number 1 ⬭

B Line number 8 ⬭

C Line number 11 ⬭

D Line number 13 ⬭

0 2 . 3 Shade **one** lozenge which shows how many times the subroutine DISPENSE_BISCUIT would be called if the user input is 'breakfast'.

[1 mark]

A 1 subroutine call ⬭

B 2 subroutine calls ⬭

C 3 subroutine calls ⬭

D 4 subroutine calls ⬭

0 2 . 4 Shade **one** lozenge which shows the data type of the variable time in the algorithm shown in **Figure 1**.

[1 mark]

A Date/Time ⬭

B String ⬭

C Integer ⬭

D Real ⬭

Question 2 continues on the next page

Turn over ▶

0 2 . 5 State how many times the subroutine DISPENSE_BISCUIT will be called with the parameter 'chewies' if the user input is 'lunch'.

[1 mark]

0 2 . 6 State how many possible values the result of the comparison time = 'dinner' could have in the algorithm shown in **Figure 1**.

[1 mark]

0 2 . 7 The programmer realises they have made a mistake. State the line number of the algorithm shown in **Figure 1** where the error has been made.

[1 mark]

0 2 . 8 Write **one** line of code that would correct the error found in the algorithm in **Figure 1**.

[1 mark]

8

State how many times the subroutine DISPENSE_BISCUIT will be called with the parameter 'chewies' if the user input is 'lunch'.

0 3 The following bit pattern represents a binary number.

00000110

0 3 . 1 What is the result of applying a left binary shift of 2 to this bit pattern? Express your answer as a bit pattern.

[1 mark]

0 3 . 2 The arithmetic effect of applying a left binary shift of 1 to a binary number is to multiply that number by 2.

State the arithmetic effect of applying a left binary shift of 3 to a binary number.

[1 mark]

0 3 . 3 What will be the arithmetic effect of left binary shifting a binary number by 4 and then right binary shifting the result by 5?

[1 mark]

3

Turn over for the next question

Turn over ▶

0 4 A sound engineer is recording a singer.

0 4 . 1 Describe why the sound must be converted to a digital format before it can be stored on a computer system.

[2 marks]

_____

_____

_____

_____

0 4 . 2 The sound engineer is using a sampling rate of 2000 Hz and a sample resolution of 4 bits. What is the minimum file size of a 5 second recording? Your answer should be given in **bytes**.

You should show your working.

[4 marks]

_____

_____

_____

_____

_____

_____

Answer: _____

0 4 . 3 The sound engineer currently uses a sample resolution of 4 bits which enables a sample to be stored as one of 16 different bit patterns. She wants to increase the number of bit patterns available from 16 to 32. Shade **one** lozenge which shows the **minimum** sample resolution (in bits) she can choose that will allow her to do this.

[1 mark]

A 3 bits ○

B 5 bits ○

C 8 bits ○

D 16 bits ○

0 4 . 4 Shade **one** lozenge to show which of the following correctly states the effects of increasing the sampling rate.

[1 mark]

A Decreases both the quality of the recording and the file size ○

B Has no effect on the quality of the recording or the file size ○

C Improves the quality of the recording and has no effect on file size ○

D Improves the quality of the recording and increases the file size ○

8

Turn over for the next question

0 5

The subroutine CHAR_TO_CODE(character) returns the integer ASCII value of a character. For example,

CHAR_TO_CODE('a') returns the value 97
CHAR_TO_CODE('z') returns the value 122
CHAR_TO_CODE('`') returns the value 96
CHAR_TO_CODE('{') returns the value 123

Develop an algorithm, using either pseudo-code or a flowchart, that:

- asks the user to enter a character
- outputs 'LOWER' if the user has entered a lowercase character
- outputs 'NOT LOWER' if the user has entered any other character.

You **must** use the built-in CHAR_TO_CODE subroutine in your answer.

[7 marks]

Turn over for the next question

7

Turn over ▶

0 6 The algorithm in **Figure 2** is a sorting algorithm.

- Array indexing starts at 0.
- Line numbers are included but are not part of the algorithm.

Figure 2

```
1   arr ← [4, 1, 6]
2   sorted ← false
3   WHILE sorted = false
4       sorted ← true
5       i ← 0
6       WHILE i < 2
7           IF arr[i+1] < arr[i] THEN
8               t ← arr[i]
9               arr[i] ← arr[i+1]
10              arr[i+1] ← t
11              sorted ← false
12          ENDIF
13          i ← i + 1
14      ENDWHILE
15  ENDWHILE
```

0 6 . 1 State the data type of the variable `sorted` in the algorithm shown in **Figure 2**.

[1 mark]

0 6 . 2 The identifier `sorted` is used in the algorithm shown in **Figure 2**.

Explain why this is a better choice than using the identifier `s`.

[2 marks]

0 6 . 3   Shade **one** lozenge to show which of the following contains the **false** statement about the algorithm in **Figure 2**.

[1 mark]

A The algorithm uses a named constant ⬭

B The algorithm uses indefinite iteration ⬭

C The algorithm uses nested iteration ⬭

0 6 . 4   Complete the trace table for the algorithm shown in **Figure 2**. Some values have already been entered.

[6 marks]

arr			sorted	i	t
[0]	[1]	[2]			
4	1	6	false		

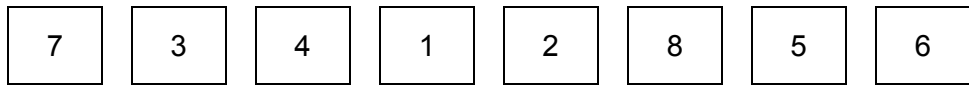**Question 6 continues on the next page**

Turn over ▶

0 6 . 5 Fill in the values in the boxes to show how the merge part of the merge sort algorithm operates. The first and last rows have been completed for you.

[3 marks]

| 7 | 3 | 4 | 1 | 2 | 8 | 5 | 6 |

| | | | | | | | |

| | | | | | | | |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
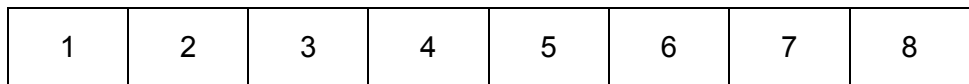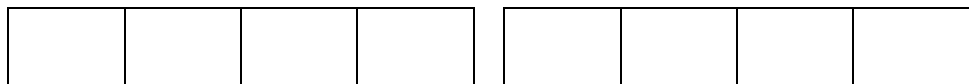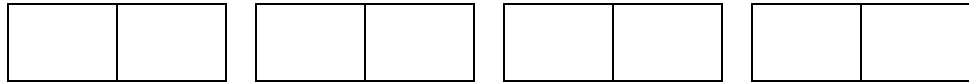
0 6 . 6 State **one** advantage of the merge sort algorithm compared to the sorting algorithm in **Figure 2**.

[1 mark]

_____

_____

0 6 . 7 A programmer implementing the algorithm in **Figure 2** decided to create it as a subroutine. Line 1 was removed and the array `arr` was made a parameter of the subroutine.

State **two** reasons why the programmer decided to implement the algorithm as a subroutine.

[2 marks]

Reason 1: _____

_____

Reason 2: _____

_____

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0 7 Develop an algorithm using either pseudo-code or a flowchart that allows a taxi company to calculate how much a taxi fare should be.

The algorithm should:
- prompt the user to enter the journey distance in kilometres
  - the distance entered must be greater than zero
  - the user should be made to re-enter the distance until the distance entered is valid
- prompt the user to enter the number of passengers (no validation is required)
- calculate the taxi fare by
  - charging £2 for every passenger regardless of the distance
  - charging a further £1.50 for every kilometre regardless of how many passengers there are
- output the final taxi fare.

[8 marks]

Turn over for the next question

8

0 8 . 1 Complete the truth table for the AND logic gate.

[1 mark]

| A	B	A AND B
0	0	
0	1	
1	0	
1	1	

0 8 . 2 A logic circuit is being developed for an audio advert in a shop that plays automatically if a customer is detected nearby.

- The system has two sensors, A_1 and A_2, that detect if a customer is near. The audio plays if either of these sensors is activated.
- The system should only play if another audio system, S, is not playing.
- The output from the circuit, for whether the advert should play or not, is Q.

Complete the logic circuit for this system.

[3 marks]

A_1 ●

A_2 ●   ● Q

S ●
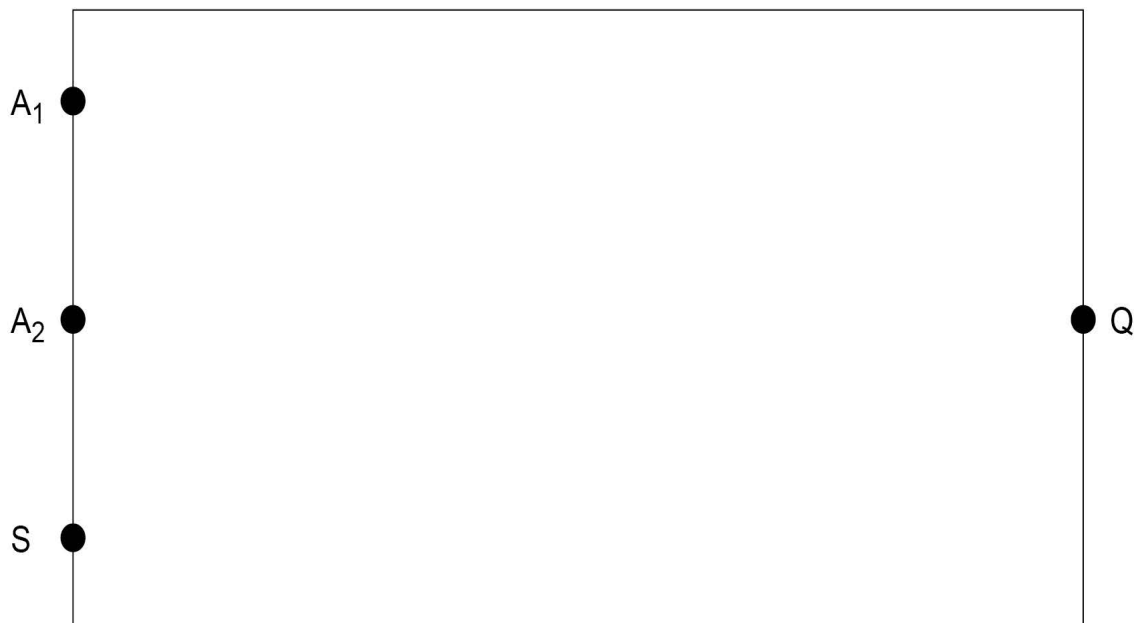
4

| 0 | 9 | The following subroutines control the way that labelled blocks are placed in different columns. |

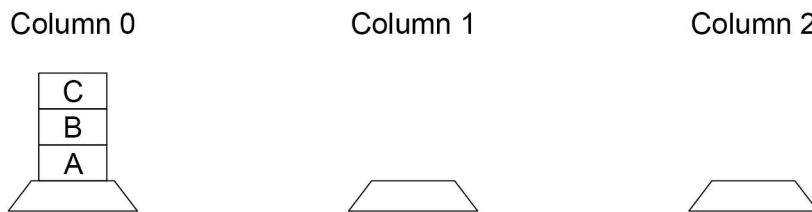BLOCK_ON_TOP(column) returns the label of the block on top of the column given as a parameter.

MOVE(source, destination) moves the block on top of the source column to the top of the destination column.

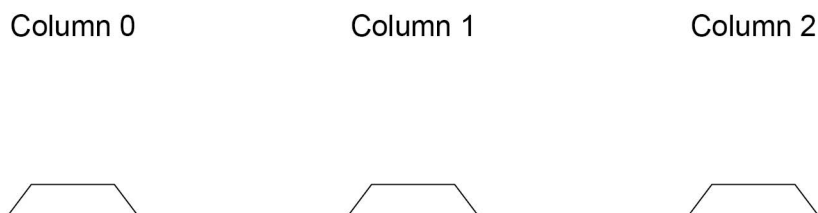HEIGHT(column) returns the number of blocks in the specified column.

| 0 | 9 | . | 1 | This is how the blocks A, B and C are arranged at the start. |

Column 0   Column 1   Column 2

Draw the final arrangement of the blocks after the following algorithm has run.

```
MOVE(0, 1)
MOVE(0, 2)
MOVE(0, 2)
```

Column 0   Column 1   Column 2

[3 marks]

Question 9 continues on the next page

Turn over ▶

0	9	.	2

This is how the blocks A, B and C are arranged at the start.

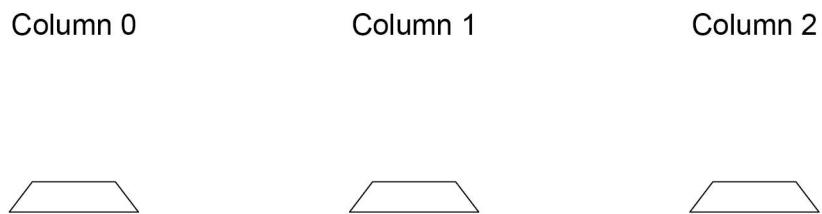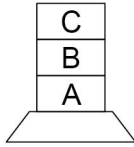Column 0   Column 1   Column 2

```
C
B
A
```
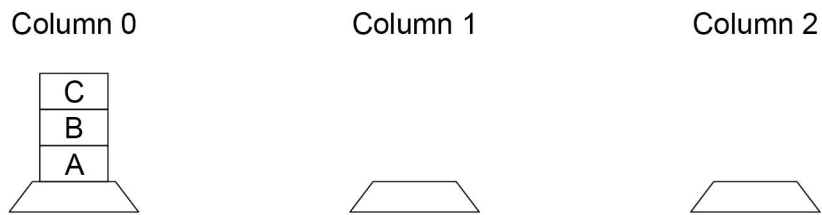
Draw the final arrangement of the blocks after the following algorithm has run.

```
WHILE HEIGHT(0) > 1
    MOVE(0, 1)
ENDWHILE
MOVE(1, 2)
```

Column 0   Column 1   Column 2

[3 marks]

| 0 | 9 | . | 3 |

This is how the blocks A, B and C are arranged at the start.

Column 0   Column 1   Column 2

Draw the final arrangement of the blocks after the following algorithm has run.

```
FOR c ← 0 TO 2
    IF BLOCK_ON_TOP(0) = 'B' THEN
        MOVE(0, (c+1) MOD 3)
    ELSE
        MOVE(0, (c+2) MOD 3)
    ENDIF
ENDFOR
```

This algorithm uses the MOD operator which calculates the remainder resulting from integer division. For example, 13 MOD 5 = 3.

Column 0   Column 1   Column 2

[3 marks]

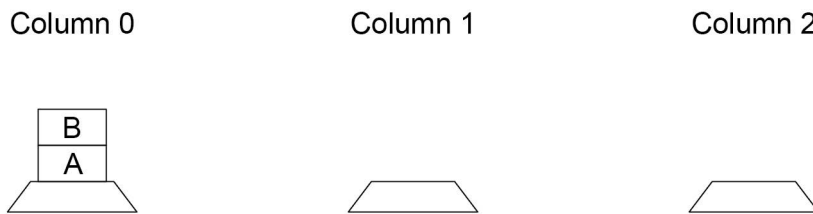**Question 9 continues on the next page**

Turn over ▶

0 9 . 4 Develop an algorithm using either pseudo-code or a flowchart that will move every block from column 0 to column 1.

Your algorithm should work however many blocks start in column 0. You may assume there will always be at least one block in column 0 at the start and that the other columns are empty.
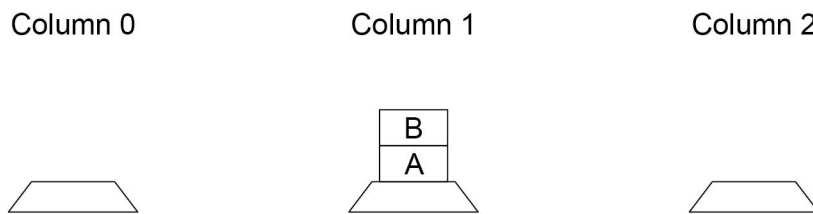
The order of the blocks must be preserved.

The MOVE subroutine must be used to move a block from one column to another. You should also use the HEIGHT subroutine in your answer.

For example, if the starting arrangement of the blocks is:

Column 0   Column 1   Column 2

Then the final arrangement should have block B above block A:

Column 0   Column 1   Column 2

[5 marks]

Turn over for the next question

14

Turn over ▶

1 0 The subroutine in **Figure 3** is used to authenticate a username and password combination.

- Array indexing starts at 0.
- Line numbers are included but are not part of the algorithm.

Figure 3

```
1    SUBROUTINE Authenticate(user, pass)
2        us ← ['dave', 'alice', 'bob']
3        ps ← ['abf32', 'woof2006', '!@34E$']
4        z ← 0
5        correct ← false
6        WHILE z < 3
7            IF user = us[z] THEN
8                IF pass = ps[z] THEN
9                    correct ← true
10               ENDIF
11           ENDIF
12           z ← z + 1
13       ENDWHILE
14       RETURN correct
15   ENDSUBROUTINE
```

1 0 . 1 Complete the trace table for the following subroutine call:

```
Authenticate('alice', 'woof2006')
```

[3 marks]

z	correct

1 0 . 2 State the value that is returned by the following subroutine call:

```
Authenticate('bob', 'abf32')
```

[1 mark]

1 0 . 3 Lines 7 and 8 in **Figure 3** could be replaced with a single line. Shade **one** lozenge to show which of the following corresponds to the correct new line.

[1 mark]

A `IF user = us[z] OR pass = ps[z] THEN` ⬭

B `IF user = us[z] AND pass = ps[z] THEN` ⬭

C `IF NOT (user = us[z] AND pass = ps[z]) THEN` ⬭

1 0 . 4 A programmer implements the subroutine shown in **Figure 3**. He replaces line 9 with

```
RETURN true
```

He also replaces line 14 with

```
RETURN false
```

Explain how the programmer has made the subroutine more efficient.

[2 marks]

END OF QUESTIONS

7

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