AQA

SPECIMEN MATERIAL

GCSE
COMPUTER SCIENCE
8520/1

Paper 1

Specimen 2015 am/pm Time allowed: 1hr 30mins

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.
- Some questions will require you to shade a lozenge. If you make a mistake cross through the incorrect answer.
- Do all rough work in this book. Cross through any work that 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 marks for questions are shown in brackets.
- The maximum mark for this paper is 80.
- You are reminded of the need for good English and clear presentation in your answers.

Please write clearly, in block capitals, to allow character computer recognition.

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

Surname

Forename(s)

Candidate signature ____________________

Answer **all** questions in the space provided.

0 1 Two computer programs that add together two numbers are shown in **Figure 1**. One is written in a high-level language and the other is written in a low-level language.

Figure 1

High-level program	**Low-level program**

`x = 12`
`y = 3`
`z = x + y`
	`0001 1100`
	`0010 0001`
	`0001 0011`
	`0010 0010`
	`0011 0001`
	`0010 0011`

0 1 . 1 Shade **two** lozenges to give the reasons why computer programs are most commonly written in high-level languages instead of low-level languages.

[2 marks]

A It saves the programmer time. ⬭

B The programs will always run faster. ⬭

C Program code written in high-level language is often easier for humans to understand. ⬭

D Computers understand only high-level languages. ⬭

E The programs are often easier for a computer to decode. ⬭

0 1 . 2 The low-level program shown in **Figure 1** is written in machine code.

Suggest **two** reasons why it would have been better for the programmer to use assembly language instead of machine code.

[2 marks]

Reason 1 ____

____

Reason 2 ____

____

4

0 2 **Figure 2** contains a subroutine that returns a value.

Figure 2

```
SUBROUTINE TotalOut(a, b)
  c ← a + b
  WHILE a < c
    a ← a + 1
    b ← b - a
  ENDWHILE
  RETURN b
ENDSUBROUTINE
```

0 2 . 1 Complete the trace table below when the subroutine call `TotalOut(3, 4)` is made (you may not need to use all of the rows in the table):

[3 marks]

a	b	c

0 2 . 2 A programmer mistakenly tries to shorten the subroutine in **Figure 2** by replacing the lines:

```
c ← a + b
WHILE a < c
```

With the line:

```
WHILE a < (a + b)
```

Explain why this change is a mistake.

[2 marks]

___

___

___

___

0 2 . 3 What value is returned by the subroutine call `TotalOut(x, 0)` where x is any positive integer?

[1 mark]

6

There are no questions printed on this page

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

0 3 Black and white bitmap images can be encoded using 1 to represent black and 0 to represent white and arranging the pixels in a two-dimensional array.

The algorithm in **Figure 3** calculates the number of black pixels in a bitmap image stored in a two-dimensional array called `image`, which has 4 rows and 3 columns.

Four parts of the code labelled **L1**, **L2**, **L3** and **L4** are missing.

Figure 3

- For this algorithm, array indexing starts at 1.

```
num_of_black ← L1
num_of_rows ← 4
num_of_cols ← 3
x ← 1
WHILE x L2 num_of_rows
  y ← 1
  WHILE y ≤ num_of_cols
    IF image[x][y] = L3 THEN
      num_of_black ← num_of_black + 1
    ENDIF
    y ← L4
  ENDWHILE
  x ← x + 1
ENDWHILE
```

0 3 . 1 Shade **one** lozenge to show which value should be written at point **L1** of the algorithm in **Figure 3**.

[1 mark]

A -1 ⬭

B 0 ⬭

C 1 ⬭

0 3 . 2 Shade **one** lozenge to show which operator should be written at point **L2** of the algorithm in **Figure 3**.

[1 mark]

A = ⬭

B ≥ ⬭

C ≤ ⬭

0 3 . 3 Shade **one** lozenge to show which value should be written at point **L3** of the algorithm in **Figure 3**.

[1 mark]

A -1 ⬭

B 0 ⬭

C 1 ⬭

0 3 . 4 Shade **one** lozenge to show what code should be written at point **L4** of the algorithm in **Figure 3**.

[1 mark]

A `x` ⬭

B `x + 1` ⬭

C `y` ⬭

D `y + 1` ⬭

4

0 4 The algorithm in **Figure 4** is the binary search algorithm designed to search for a value within an array.

Figure 4

- Line numbers are included but are not part of the algorithm.
- For this algorithm, array indexing starts at 1.

```
1    val ← 43
2    arr ← [3, 5, 13, 43, 655, 872]
3    left ← 1
4    right ← LENGTH(arr)
5    WHILE left ≠ right
6      mid ← (left + right) DIV 2
7      IF val ≤ arr[mid] THEN
8        right ← mid
9      ELSE
10       left ← mid + 1
11     ENDIF
12   ENDWHILE
```

0 4 . 1 Complete the trace table for the algorithm in **Figure 4** (you may not need to use all of the rows in the table). The final value of `left` is already given.

[5 marks]

val	**left**	**right**	**mid**	**arr[mid]**
	4			

0 4 . 2 Why would the binary search algorithm shown in **Figure 4** not work when the array `arr` contains `[5, 3, 13, 872, 655, 43]`?

[1 mark]

0 4 . 3 There are alternative statements that could have been used on line 5 of the algorithm shown in **Figure 4** that would not change the functionality of the algorithm.

Shade **one** lozenge to show which of the following lines could **not** replace line 5 in **Figure 4** as it would change the functionality of the algorithm.

[1 mark]

New Line 5

A `WHILE left < right`

B `WHILE NOT (left = right)`

C `WHILE left < right AND left > right`

D `WHILE left < right OR left > right`

Question 4 continues on the next page

0 4 . 4 The final value of `left` in the algorithm shown in **Figure** 4 is 4. A programmer realises that they can use this value to check whether `val` has been found or not in the algorithm shown in **Figure 4**.

The programmer wants to extend the algorithm and introduce a new variable called `found` that is `true` when the value has been found in the array or `false` otherwise.

Write the pseudo-code or draw the flowchart that is needed to **extend** the algorithm so that when the algorithm finishes, the new variable `found` is:

- `true` when `val` is found in `arr`
- `false` when `val` is not found in `arr`

This code should follow on from the end of the algorithm in **Figure 4**.

[4 marks]

11

0 5 . 1 Calculate the file size in bits for a two minute sound recording that has used a sample rate of 1000 Hertz (Hz) and a sample resolution of 5 bits.

You should show your working.

[3 marks]

0 5 . 2 Another sound file has a size of 24,000 bits. What is 24,000 bits in kilobytes?

You should show your working.

[2 marks]

Question 5 continues on the next page

0 5 . 3 Sound files are stored as bit patterns. Bit patterns are often compressed.

Compress the following bit pattern using run length encoding.

```
0000 0011 1111 1000 0000 0000 0111 1111
```

[4 marks]

0 5 . 4 Shade **one** lozenge which shows the **true** statement about run length encoding:

[1 mark]

A It will always make a file smaller. ⬭

B It is most effective on data that appears random. ⬭

C It will not lose any of the original data. ⬭

10

0 6 **Figure 5** shows the start of an algorithm.

Figure 5

```
OUTPUT 'enter the 24 hour number (0-23)'
hour ← USERINPUT
```

The algorithm in **Figure 5** asks the user to enter a number between 0 and 23 that represents an hour using the 24 hour clock. The input is stored in a variable called `hour`.

Extend the algorithm in **Figure 5**, using either pseudo-code or a flowchart, so that it outputs the equivalent time using the 12 hour clock, ie a number between 1 and 12, followed by either `am` or `pm`.

For example:

- If the user enters `0`, the program outputs `12` followed by `am`.
- If the user enters `4`, the program outputs `4` followed by `am`.
- If the user enters `12`, the program outputs `12` followed by `pm`.
- If the user enters `15`, the program outputs `3` followed by `pm`.

You can assume that the variable `hour` is an integer and that the value that the user inputs will be between 0 and 23.

[7 marks]

7

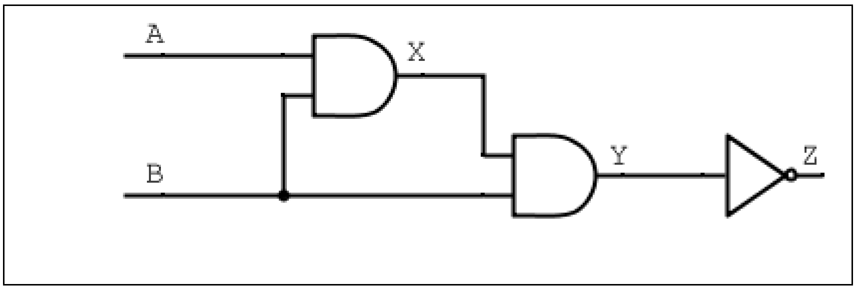
0 7 . 1 Complete the truth table for the OR logic gate:

[1 mark]

A	B	A OR B
0	0	
0	1	
1	0	
1	1	

0 7 . 2 Complete the truth table for the logic circuit shown in **Figure 6**.

Figure 6



[3 marks]

A	B	X	Y	Z
0	0			
0	1			
1	0			
1	1			

0 7 . 3 A logic circuit is being developed for an automatic door system:

- The automatic door has two sensors, one on either side of the door, sensor **F** and sensor **B.** The door opens when either of these sensors is activated.
- The door system can also be turned on/off using a manual switch, **S.** The door will not open unless **S** is on.
- The output from this logic circuit, for whether the door is open or not, is **D**.

Complete the logic circuit diagram for this system:

[3 marks]

7

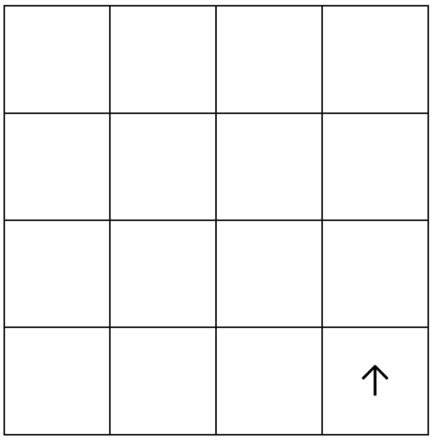
0 8 Four separate subroutines have been written to control a robot.

- `Forward(n)` moves the robot `n` squares forward.
- `TurnLeft()` turns the robot 90 degrees left
- `TurnRight()` turns the robot 90 degrees right
- `ObjectAhead()` returns `true` if the robot is facing an object in the next square or returns `false` if this square is empty.

0 8 . 1 Draw the path of the robot through the grid below if the following program is executed (the robot starts in the square marked by the ↑ facing in the direction of the arrow).

```
Forward(2)
TurnLeft()
Forward(1)
TurnRight()
Forward(1)
```

[3 marks]

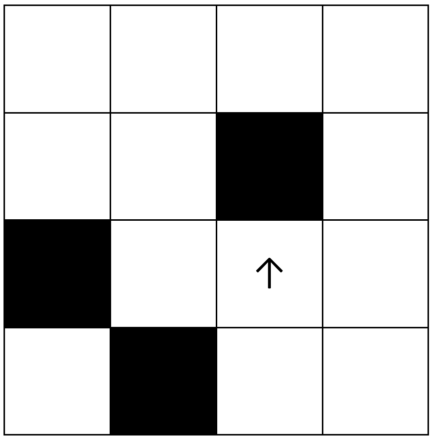


Question 8 continues on the next page

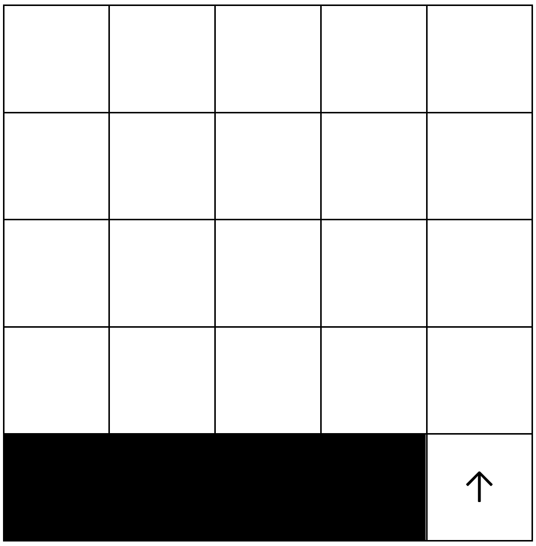
0 8 . 2 Draw the path of the robot through the grid below if the following program is executed (the robot starts in the square marked by the ↑ facing in the direction of the arrow). If a square is black then it contains an object.

```
WHILE ObjectAhead() = true
  TurnLeft()
    IF ObjectAhead() = true THEN
      TurnRight()
      TurnRight()
    ENDIF
  Forward(1)
ENDWHILE
Forward(1)
```

[3 marks]



0 8 . 3 A robot needs to visit every square in the following grid that does not contain an object:



The objects are shown as black squares.

Complete the algorithm by writing the following instructions in the correct places (you will need to use each instruction exactly once):

```
Forward(distance)
distance ← distance - 1
distance ← 4
TurnLeft()
TurnLeft()
```

```
_______________________________

WHILE distance > 0

    ___________________________

    ___________________________

    Forward(distance)

    ___________________________

    ___________________________

ENDWHILE
```

[4 marks]

10

0 9 **Figure 7** shows a famous algorithm that calculates the largest whole number that can be divided into two given numbers without leaving a remainder. For example, given the two numbers 12 and 16, 4 is the largest whole number that divides into them both.

Figure 7

Line numbers have been included but are not part of the algorithm.

```
1   num1 ← USERINPUT
2   num2 ← USERINPUT
3   WHILE num1 ≠ num2
4     IF num1 > num2 THEN
5       num1 ← num1 – num2
6     ELSE
7       num2 ← num2 – num1
8     ENDIF
9   ENDWHILE
```

0 9 . 1 Complete the trace table for the algorithm in **Figure 7** when the user enters 15 and then 39 (you may not need to use all of the rows in the table).

The first line has been completed for you.

[4 marks]

num1	num2
15	39

0 9 . 2 State the line number from the algorithm in **Figure 7** where selection is first used.

[1 mark]

0 9 . 3 State the line number from the algorithm in **Figure 7** where iteration is first used.

[1 mark]

0 9 . 4 How many lines in the algorithm in **Figure 7** use variable assignment?

[1 mark]

0 9 . 5 A programmer wants to implement the algorithm in **Figure 7** in their code. Explain why it could be a benefit to implement this as a subroutine.

[2 marks]

9

Turn over for the next question

1 0 The variables a, b and c in **Figure 8** are assigned string values.

Figure 8

```
a ← 'bitmap'
b ← 'pixel'
c ← 'bit'
```

1 0 . 1 Shade **one** lozenge which shows the concatenation of the variables a and b shown in **Figure 8.**

[1 mark]

concatenation of the variables a and b

A bitmap pixel ⬭

B bitmappixel ⬭

C ab ⬭

Strings can also be represented as arrays of characters. For instance, the three statements below are an alternative to the statements shown in **Figure 8** where those strings are now being represented as arrays of characters.

```
a ← ['b','i','t','m','a','p']
b ← ['p','i','x','e','l']
c ← ['b','i','t']
```

- For the following questions, array indexing starts at 1.

1 0 . 2 Shade **two** lozenges which correspond to the **two true** statements about these arrays.

[2 marks]

A a[1] = b[1] OR a[1] = c[1] ⬭

B LENGTH(b) ≥ LENGTH(a) ⬭

C NOT (a[6] = b[1] AND a[3] = c[3]) ⬭

D a = a[5] ⬭

E a[LENGTH(a) – LENGTH(c)] = c[3] ⬭

1 0 . 3 Develop a subroutine called `Prefix`, using either pseudo-code or a flowchart, which takes two character arrays called `word` and `pre` as parameters and determines whether the **start** of the character array `word` is the same as **all** of the character array `pre`.

For example using the character arrays:

```
a ← ['b','i','t','m','a','p']
b ← ['p','i','x','e','l']
c ← ['b','i','t']
```

- `a` starts with the same sequence of characters as `c` so `Prefix(a, c)` would return `true`
- `b` does not start with the same sequence of characters as `c` so `Prefix(b, c)` would return `false`.

Your subroutine should also:

- work for character arrays of all lengths greater than `0`
- **not** assume that the length of `pre` is less than the length of `word`.

The start of your subroutine has been completed for you.

```
SUBROUTINE Prefix(word, pre)
```

[9 marks]

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END OF QUESTIONS

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