AQA

AS
COMPUTER SCIENCE

Paper 1

Time allowed: 1 hour 45 minutes

Materials
For this paper you must have:
- a computer
- a printer
- appropriate software
- the Electronic Answer Document
- an electronic version and a hard copy of the Skeleton Program
- an electronic version and a hard copy of the Preliminary Material
- an electronic version of the Data Files **puzzle1.txt**, **puzzle1P.txt** and **puzzle1S.txt**

You must **not** use a calculator.

Instructions
- Type the information required on the front of your Electronic Answer Document.
- Before the start of the examination make sure your **Centre Number**, **Candidate Name** and **Candidate Number** are shown clearly **in the footer** of every page (not the front cover) of your Electronic Answer Document.
- Enter your answers into the Electronic Answer Document.
- Answer **all** questions.
- Save your work at regular intervals.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.
- No extra time is allowed for printing and collating.
- The question paper is divided into **three** sections.

Advice
You are advised to allocate time to each section as follows:
Section A – 20 minutes; **Section B** – 25 minutes; **Section C** – 60 minutes.

At the end of the examination
Tie together all your printed Electronic Answer Document pages and hand them to the Invigilator.

Warning
It may not be possible to issue a result for this paper if your details are not on every page of your Electronic Answer Document.

Section A

You are advised to spend no more than **20 minutes** on this section.

Enter your answers to **Section A** in your Electronic Answer Document. You **must save** this document at regular intervals.

Question **03** in this section asks you to write program code **starting from a new program/project/file**.

You are advised to save your program at regular intervals.

0 1 The algorithm, represented using pseudo-code in **Figure 1**, describes a method to access numbers in the data structure, `List`, shown in **Table 1**.

Figure 1

```
SUBROUTINE A(S, X, Y)
  P ← -1
  WHILE P = -1 AND X <= Y
    Z ← (X + Y) DIV 2
    IF List[Z] = S THEN
      P ← Z
    ELSE
      IF List[Z] < S THEN
        X ← Z + 1
      ELSE
        Y ← Z - 1
      ENDIF
    ENDIF
  ENDWHILE
  RETURN P
ENDSUBROUTINE
```

The `DIV` operator calculates the whole number part resulting from an integer division, for example, `10 DIV 3 = 3`

Complete **Table 2** by hand-tracing the algorithm in **Figure 1** when the following statement is executed.

```
Result ← A(38, 0, 18)
```

You may not need to use all the rows in **Table 2**.

The first row of **Table 2** has already been completed for you.

Table 1

List

[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]
2	8	12	18	25	29	36	42	49	51	57	61	68	71	79	83	84	91	97

Table 2

S	X	Y	P	Z	List[Z]
38	0	18	-1		
Result:					

Copy the contents of all the unshaded cells in **Table 2** into your Electronic Answer Document.

[5 marks]

Turn over for the next question

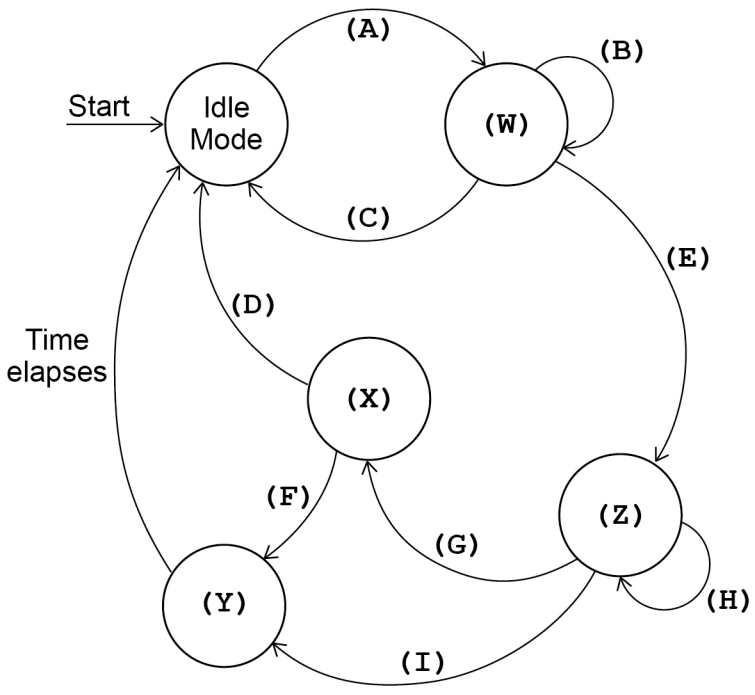
0 2 A parking meter has an Add hours button (+), an Accept button, a coin slot, a payment card reader, a Cancel button and a number keypad.

The system operates in a specific sequence:

- the system is initially in Idle Mode
- when the user presses the + button the system goes into Select Hours Mode with the parking time set to 1 hour and the payment owed set to £1.00
  - each time the user presses the + button again, the number of hours' parking time increases by 1 and the payment owed increases by £0.50
  - when the user presses the Accept button the system goes into Payment Due Mode and the user is able to make payments using cash or a payment card
  - the user can cancel the operation by pressing the Cancel button
- using cash:
  - each time the user inserts a coin (except the final coin), the value of it is deducted from the payment owed
  - when the final coin that completes the payment is inserted, the system goes into Paid Mode
- using a payment card:
  - when the user inserts a payment card into the card reader, the meter goes into a mode that allows the user to enter their PIN
  - the user then enters their PIN on the keypad
  - if the PIN is correct, the system goes into Paid Mode; otherwise the system goes into Idle Mode
- the system remains in Paid Mode until the time paid for has elapsed.

Figure 2 shows a partially completed state transition diagram that represents the operation of the parking meter. Four of the states are labelled **(W)** to **(Z)** and events are labelled **(A)** to **(I)**.

Figure 2



Complete **Table 3** by filling in the unshaded cells with the correct labels from **Figure 2**. You should write:

- which labels **(A)** to **(I)** represent which event(s)
- which labels **(W)** to **(Z)** represent which state.

Some of the cells in the table may need to be assigned more than one label.

Each label **must** only be used once.

Table 3

Event / State	**Label(s): (A) to (I), (W) to (Z)**
Card Payment Mode	
Enter correct PIN	
Enter incorrect PIN	
Insert a coin (except final coin)	
Insert final coin	
Insert payment card	
Paid Mode	
Payment Due Mode	
Press Accept	
Press Cancel	
Press + button	
Select Hours Mode	

Copy the contents of all the unshaded cells in **Table 3** into your Electronic Answer Document.

[6 marks]

Turn over for the next question

0 3 **Figure 3** shows an algorithm represented using pseudo-code.

Figure 3

```
C ← 0
D ← 0
S ← 0
T ← 0
WHILE C < 3 AND D < 3
  T ← T + 1
  N1 ← generate random integer between 1 and 6 inclusive
  N2 ← generate random integer between 1 and 6 inclusive
  OUTPUT N1, N2
  S ← S + N1 + N2
  IF N1 = 6 OR N2 = 6 THEN
    C ← C + 1
  ENDIF
  IF N1 = N2 THEN
    D ← D + 1
  ENDIF
ENDWHILE
A ← S DIV (T * 2)
OUTPUT C, D, A
```

The `DIV` operator calculates the whole number part resulting from an integer division, for example, `10 DIV 3 = 3`

Table 4 lists the `DIV` operators for each of the available programming languages. You should refer to the row for your programming language.

Table 4

Programming language	**DIV**
C#	/
Java	/
Pascal	div
Python	//
VB.NET	\

What you need to do:

Task 1
Write a program to implement the algorithm in **Figure 3**.

Task 2
Test that your program works:
- run your program.

Evidence that you need to provide
Include the following evidence in your Electronic Answer Document.

0 3 . 1 Your PROGRAM SOURCE CODE for **Task 1**.

[8 marks]

0 3 . 2 SCREEN CAPTURE(S) showing the test described in **Task 2**.

[1 mark]

Turn over for the next section

Section B

You are advised to spend no more than **25 minutes** on this section.

Enter your answers to **Section B** in your Electronic Answer Document. You **must save** this document at regular intervals.

These questions refer to the **Preliminary Material** and the **Skeleton Program**, but do **not** require any additional programming.

Refer **either** to the **Preliminary Material** issued with this question paper **or** your electronic copy.

0 4 . 1 State the most appropriate data type to use for whole numbers.

[1 mark]

0 4 . 2 State the identifier of a variable in the **Skeleton Program** that can only represent whole numbers.

[1 mark]

0 5 State the identifier **and** data type of a variable in the **Skeleton Program** that can only represent two different values.

[2 marks]

0 6 The **Skeleton Program** uses the data structure `Answer`.

0 6 . 1 State what the second element of this data structure, `Answer[1]`, is used for.

[1 mark]

0 6 . 2 Explain the purpose of the third element of this data structure, `Answer[2]`, **and** how it is used.

[3 marks]

0 7 The grid size of the puzzle is currently 9 and sub-grids are 3 x 3.

If the grid size were to be increased to 16, the sub-grids would be 4 x 4 and the hexadecimal digits 0 1 2 3 4 5 6 7 8 9 A B C D E F could be used to solve the puzzle.

Describe **two** changes that would need to be made to the subroutine `DisplayGrid` to enable this.

You should not make any changes to the **Skeleton Program** to answer this question.

[2 marks]

0 8 Explain what is meant by decomposition.

[2 marks]

0 9 . 1 Explain the differences between definite and indefinite iteration.

[2 marks]

0 9 . 2 State the identifier of a subroutine in the **Skeleton Program** that contains **definite** iteration.

[1 mark]

0 9 . 3 State the identifier of a subroutine in the **Skeleton Program** that contains **indefinite** iteration.

[1 mark]

1 0 . 1 Explain what exception handling is used for.

[2 marks]

1 0 . 2 State the identifier of a subroutine in the **Skeleton Program** that performs exception handling **and** give an example of a circumstance that might cause an exception within that subroutine.

[2 marks]

1 1 . 1 What is a subroutine?

[1 mark]

1 1 . 2 The use of subroutines promotes code re-use.

Describe, with references to subroutine(s) in the **Skeleton Program**, an example of how a subroutine has been re-used.

[1 mark]

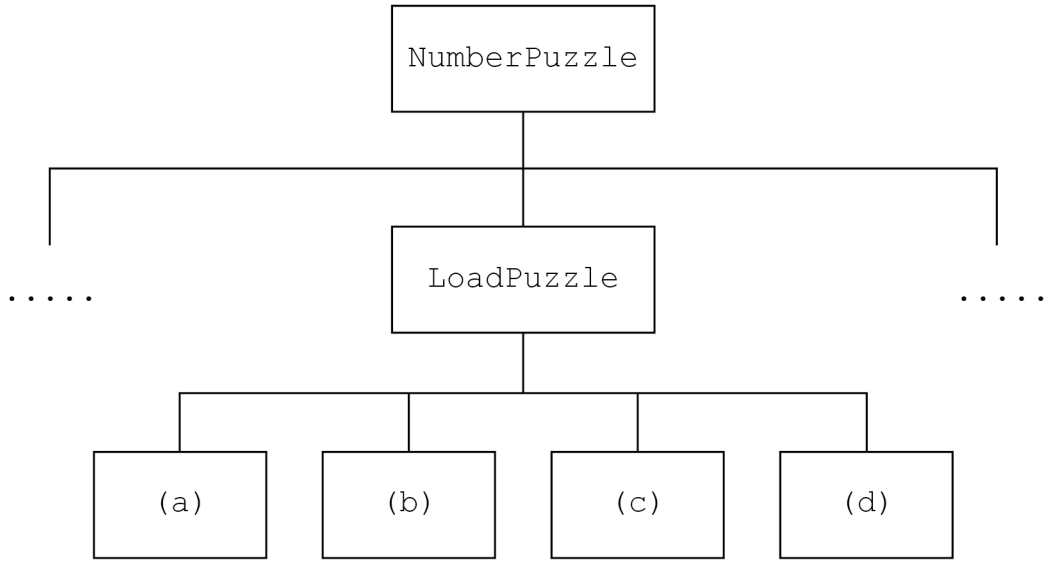
1 1 . 3 Describe an advantage of re-using subroutines.

[1 mark]

Question 11 continues on the next page

1 1 . 4 **Figure 4** shows an incomplete hierarchy chart for part of the **Skeleton Program**.

Figure 4



Complete **Table 5** by writing the labels that should appear in each of the boxes `(a)` to `(d)` in **Figure 4**.

Table 5

Box	Label
(a)	
(b)	
(c)	
(d)	

Copy the contents of all the unshaded cells in **Table 5** into your Electronic Answer Document.

[2 marks]

Turn over for the next section

Section C

You are advised to spend no more than **60 minutes** on this section.

Enter your answers to **Section C** in your Electronic Answer Document. You **must save** this document at regular intervals.

These questions require you to load the **Skeleton Program** and to make programming changes to it.

1 2 This question adds further validation to the **Skeleton Program**.

When a puzzle is loaded, some cells already contain numbers. These cells are referred to as protected cells.

Figure 5 shows the numbers in the puzzle grid cells when **`puzzle1`** is first loaded. These are the protected cells for this puzzle.

Figure 5

```
   1   2   3   4   5   6   7   8   9
 |===.===.===|===.===.===|===.===.===|
1| 8 .   . 5 |   .   .   |   .   . 7 |
 |...........|...........|...........|
2| 9 .   .   | 5 .   . 4 |   .   .   |
 |...........|...........|...........|
3| 4 . 1 .   |   . 6 .   |   .   .   |
 |===.===.===|===.===.===|===.===.===|
4|   .   .   | 7 .   .   | 1 . 6 .   |
 |...........|...........|...........|
5| 1 .   .   | 4 .   . 6 |   .   . 3 |
 |...........|...........|...........|
6|   . 5 . 8 |   .   . 1 |   .   .   |
 |===.===.===|===.===.===|===.===.===|
7|   .   .   |   . 1 .   |   . 4 . 9 |
 |...........|...........|...........|
8|   .   .   | 2 .   . 7 |   .   . 1 |
 |...........|...........|...........|
9| 2 .   .   |   .   .   | 5 .   . 6 |
 |===.===.===|===.===.===|===.===.===|
```

The **Skeleton Program** is to be changed so that the user cannot change the contents of any protected cells.

The subroutine `SolvePuzzle` needs to be modified so that the user cannot change a digit in a protected cell but can still enter a digit into an empty cell or change a digit that they have previously entered.

What you need to do:

Task 1
Amend the subroutine `SolvePuzzle` so that it checks every cell reference entered by the user against the protected cell references in `Puzzle` and only allows the contents of the cell to be changed if the cell referenced by `CellInfo` is not a protected cell.

If a protected cell is referenced, an appropriate error message should be displayed.

Task 2
Test that the changes you have made work by conducting the following test:
- run your amended **Skeleton Program**
- enter `P`
- load **`puzzle1`**
- enter `S`
- enter `117`
- enter `323`
- enter `993`
- enter `853`
- enter `854`

Evidence that you need to provide
Include the following evidence in your Electronic Answer Document.

1 2 . 1 Your PROGRAM SOURCE CODE for the entire subroutine `SolvePuzzle`.

[7 marks]

1 2 . 2 SCREEN CAPTURE(S) showing the requested test described in **Task 2**.

The SCREEN CAPTURE(S) need(s) to show the puzzle grid before and after the described test.

[1 mark]

Turn over for the next question

1 3 This question adds further validation to the **Skeleton Program**. The subroutine `SolvePuzzle` asks the user to enter coordinates and a digit. The **Skeleton Program** is to be changed so that if the digit entered by the user already exists in the referenced row, column or sub-grid, the digit cannot be used.

Figure 6 shows the numbers in the puzzle grid cells of **`puzzle1`** when first loaded.

Figure 6

```
   1   2   3   4   5   6   7   8   9
 |===.===.===|===.===.===|===.===.===|
1| 8 .   . 5 |   .   .   |   .   . 7 |
 |...........|...........|...........|
2| 9 .   .   | 5 .   . 4 |   .   .   |
 |...........|...........|...........|
3| 4 . 1 .   |   . 6 .   |   .   .   |
 |===.===.===|===.===.===|===.===.===|
4|   .   .   | 7 .   .   | 1 . 6 .   |
 |...........|...........|...........|
5| 1 .   .   | 4 .   . 6 |   .   . 3 |
 |...........|...........|...........|
6|   . 5 . 8 |   .   . 1 |   .   .   |
 |===.===.===|===.===.===|===.===.===|
7|   .   .   |   . 1 .   |   . 4 . 9 |
 |...........|...........|...........|
8|   .   .   | 2 .   . 7 |   .   . 1 |
 |...........|...........|...........|
9| 2 .   .   |   .   .   | 5 .   . 6 |
 |===.===.===|===.===.===|===.===.===|
```

What you need to do:

Task 1
Write a new subroutine, `DuplicateDigit`, which takes `PuzzleGrid`, `Row`, `Column` and `Digit` as parameters. The subroutine should return `True` if the digit entered by the user is already present in the row, column or sub-grid of the cell the user has entered. Otherwise, the subroutine should return `False`.

Task 2
Amend the subroutine `SolvePuzzle` so that it uses `DuplicateDigit` to check the user input and only allows the digit to be placed into the puzzle grid if the digit is not already present in the row, column or sub-grid of the cell the user has entered. If the digit is already present, an appropriate message should be given to the user.

Task 3
Test that the changes you have made work by conducting the following test:

- run your amended **Skeleton Program**
- enter `L`
- load **`puzzle1`**
- enter `S`
- enter `178`
- enter `819`
- enter `124`
- enter `989`
- enter `555`

Evidence that you need to provide
Include the following evidence in your Electronic Answer Document.

1 3 . 1 Your PROGRAM SOURCE CODE for the entire subroutine `DuplicateDigit` and the entire subroutine `SolvePuzzle`.

[8 marks]

1 3 . 2 SCREEN CAPTURE(S) showing the requested test described in **Task 3**.

The SCREEN CAPTURE(S) need(s) to show the puzzle grid before and after the described test.

[1 mark]

Turn over for the next question

1 4 This question extends the functionality of the **Skeleton Program**.

The user is to be allowed to clear the contents of the most recently changed cells. To do this, they will enter a negative integer when prompted to enter a row, column and digit. The integer will represent the number of cells to be cleared.

For example, if the user enters `-3`, the three most recently entered digits should each be replaced by a space in the puzzle grid and the `Answer` data structure should be updated.

If the number of cells to be cleared is greater than the number of entries in the `Answer` data structure, all digits entered by the user should be cleared.

What you need to do:

Task 1
Write a new subroutine, `ClearEntries`, that clears the required number of previously entered digit(s) from the puzzle grid and updates the `Answer` data structure as described above.

Task 2
Amend the subroutine `SolvePuzzle` to test user input for a negative value. If the user input is a negative integer, the subroutine should call `ClearEntries` with the necessary parameters and then re-display the puzzle grid.

Task 3
Test that the changes you have made work by conducting the following test:

- run your amended **Skeleton Program**
- enter `P`
- load **`puzzle1`**
- enter `S`
- enter `-x`
- enter `-1`
- enter `-5`

Evidence that you need to provide
Include the following evidence in your Electronic Answer Document.

1 4 . 1 Your PROGRAM SOURCE CODE for the entire subroutine `ClearEntries` and the entire subroutine `SolvePuzzle`.

[12 marks]

1 4 . 2 SCREEN CAPTURE(S) showing the requested test described in **Task 3**.

The SCREEN CAPTURE(S) need(s) to show the puzzle grid before and after the described test.

[1 mark]

END OF QUESTIONS

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