

Please write clearly in block capitals.

Centre number

Candidate number

Surname \_\_\_\_\_

Forename(s) \_\_\_\_\_

Candidate signature \_\_\_\_\_

I declare this is my own work.

# GCSE COMPUTER SCIENCE

## Paper 1 Computational thinking and programming skills – C#

Friday 19 May 2023

Afternoon

Time allowed: 2 hours

### Materials

- There are no additional materials required for this paper.
- You must **not** use a calculator.



### 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.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Questions that require a coded solution must be answered in C#.
- You should assume that all indexing in code starts at 0 unless stated otherwise.

For Examiner's Use	
Question	Mark
1	
2–3	
4–5	
6–7	
8–9	
10–11	
12	
13–14	
15	
16	
<b>TOTAL</b>	

### Information

The total number of marks available for this paper is 90.

### Advice

For the multiple-choice questions, completely fill in the lozenge alongside the appropriate answer.

CORRECT METHOD  WRONG METHODS

If you want to change your answer you must cross out your original answer as shown.



If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown.



Answer **all** questions.

0 1

**Figure 1** shows an algorithm, represented using pseudo-code, which assigns a different value to four variables.

**Figure 1**

```
country ← 'United States of America'
state ← 'California'
city ← 'San Francisco'
landmark ← 'Alcatraz Island'
```

0 1 . 1

Define the term **algorithm**.

[2 marks]

---



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0 1 . 2

The variable  $x$  is assigned a value using the statement:

```
 $x \leftarrow \text{LEN}(\text{state})$ 
```

Using **Figure 1**, what is the value of  $x$ ?

Shade **one** lozenge.

[1 mark]

- |          |    |                          |
|----------|----|--------------------------|
| <b>A</b> | 1  | <input type="checkbox"/> |
| <b>B</b> | 5  | <input type="checkbox"/> |
| <b>C</b> | 10 | <input type="checkbox"/> |
| <b>D</b> | 12 | <input type="checkbox"/> |



**0 1 . 3** What is the result of concatenating the contents of the variables `city` and `landmark` in **Figure 1**?

Shade **one** lozenge.

[1 mark]

- A** San Francisco Alcatraz Island
- B** San Francisco,Alcatraz Island
- C** San Francisco, Alcatraz Island
- D** San FranciscoAlcatraz Island

**0 1 . 4** The subroutine `SUBSTRING` extracts characters from a given string.

For example, `SUBSTRING(3, 5, 'Computing')` would return `put`

The variable `y` is assigned a value using the statement:

$$y \leftarrow \text{SUBSTRING}(4, 7, \text{landmark})$$

Using **Figure 1**, what is the value of `y`?

Shade **one** lozenge.

[1 mark]

- A** Alca
- B** Atra
- C** land
- D** traz

**Question 1 continues on the next page**

Turn over ►



**Figure 1** has been included again below.

**Figure 1**

```
country ← 'United States of America'  
state ← 'California'  
city ← 'San Francisco'  
landmark ← 'Alcatraz Island'
```

**0 1 . 5** The subroutine POSITION finds the first position of a character in a string.

For example, POSITION('Computing', 'p') would return 3

The variable z is assigned a value using the statement:

```
z ← POSITION(landmark, 't')
```

Using **Figure 1**, what value is assigned to z?

Shade **one** lozenge.

**[1 mark]**

- A** -1
- B** 3
- C** 4
- D** 5

**6**



**Turn over for the next question**

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ANSWER IN THE SPACES PROVIDED**

**Turn over ►**



0 2

**Figure 2** shows an algorithm that uses integer division which has been represented using pseudo-code.

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

**Figure 2**

```

1  again ← True
2  WHILE again = True
3      a ← USERINPUT
4      IF a > 0 THEN
5          counter ← 0
6          WHILE a > 0
7              a ← a DIV 3
8              counter ← counter + 1
9          ENDWHILE
10     ELSE
11         again ← False
12     ENDIF
13     OUTPUT a
14 ENDWHILE

```

Integer division is the number of times one integer divides into another, with the remainder ignored.

For example:

- 14 DIV 5 evaluates to 2
- 25 DIV 3 evaluates to 8

0 2 . 1

Where is iteration **first** used in the algorithm in **Figure 2**?

Shade **one** lozenge.

[1 mark]

- A** Line number 2
- B** Line number 4
- C** Line number 6
- D** Line number 11



**0 2 . 2** In the algorithm in **Figure 2**, what will be output when the user input is 10?

Shade **one** lozenge.

[1 mark]

- A** 0
- B** 1
- C** 2
- D** 4

**0 2 . 3** In the algorithm in **Figure 2**, what is the largest possible value of the variable counter when the user input is 36?

Shade **one** lozenge.

[1 mark]

- A** 0
- B** 2
- C** 4
- D** 5

**0 3** Explain **one** advantage of the structured approach to programming.

[2 marks]

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5

Turn over ►



0 4

**Figure 3** shows a program written in C# that calculates the area of a rectangle or the volume of a box from the user inputs.

**Figure 3**

```
public static int calculate(int width, int length,
int height) {
    if (height == -1)
    {
        return width * length;
    } else
    {
        return width * length * height;
    }
}

public static void Main() {
    int numOne, numTwo, numThree, answer;
    Console.Write("Enter width: ");
    numOne = Convert.ToInt32(Console.ReadLine());
    Console.Write("Enter length: ");
    numTwo = Convert.ToInt32(Console.ReadLine());
    Console.Write("Enter height, -1 to ignore: ");
    numThree = Convert.ToInt32(Console.ReadLine());

    answer = calculate(numOne, numTwo, numThree);

    if (numThree == -1)
    {
        Console.WriteLine($"Area {answer}");
    } else
    {
        Console.WriteLine($"Volume {answer}");
    }
}
```

0 4 . 1

Complete the trace table using the program in **Figure 3**.

**[3 marks]**

numOne	numTwo	numThree	Final output
5	6	-1	
10	4	0	
3	5	10	





0	4	.	2
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Describe **one** way that the program in **Figure 3** could be made more robust.

**[1 mark]**

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**Turn over for the next question**

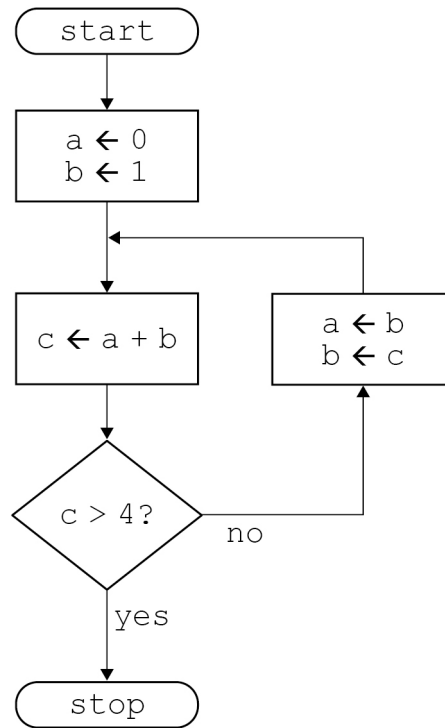
**Turn over ►**



0 5

Figure 4 shows an algorithm presented as a flowchart.

Figure 4



Complete the trace table for the algorithm in **Figure 4**.

You may not need to use all the rows in the table.

[3 marks]

a	b	c

7



**Turn over for the next question**

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**Turn over ►**



0 6

**Figure 5** shows an algorithm represented using pseudo-code.

The algorithm is for a simple authentication routine.

The pseudo-code uses a subroutine `getPassword` to check a username:

- If the username exists, the subroutine returns the password stored for that user.
- If the username does not exist, the subroutine returns an empty string.

Parts of the algorithm are missing and have been replaced with the labels **L1** to **L4**.

**Figure 5**

```

login ← False
REPEAT
  username ← ''
  WHILE username = ''
    OUTPUT 'Enter username: '
    username ← L1
  ENDWHILE
  password ← ''
  WHILE password = ''
    OUTPUT 'Enter password: '
    password ← USERINPUT
  ENDWHILE
  storedPassword ← getPassword(L2)
  IF storedPassword = L3 THEN
    OUTPUT 'L4'
  ELSE
    IF password = storedPassword THEN
      login ← True
    ELSE
      OUTPUT 'Try again.'
    ENDIF
  ENDIF
UNTIL login = True
OUTPUT 'You are now logged in.'

```



**Figure 6**

-1	OUTPUT	0
username	True	SUBROUTINE
1	User not found	' '
USERINPUT	password	Wrong password

State the items from **Figure 6** that should be written in place of the labels in the algorithm in **Figure 5**.

You will not need to use all the items in **Figure 6**.

**[4 marks]**

L1

---

L2

---

L3

---

L4

---

**Turn over for the next question**

**Turn over ►**



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0 7

A theme park charges £15 per person for a daily ticket. If there are six or more people in a group, the group is given a £5 discount.

Write a C# program to calculate the total charge for a group of people visiting the theme park.

The program must:

- get the user to enter the number of people in a group
- calculate the total charge by:
  - charging £15 per person
  - reducing the total charge by £5 if there are six or more people
- output the total charge.

You **should** use meaningful variable name(s) and C# syntax in your answer.

The answer grid below contains vertical lines to help you indent your code.

[6 marks]

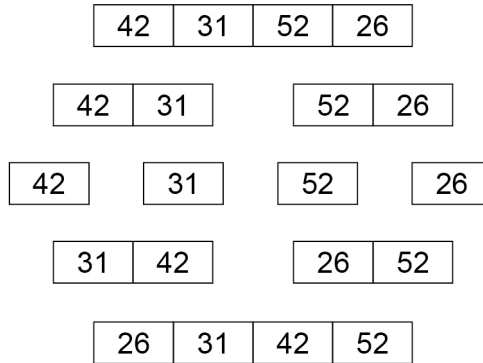

10



0 8

Figure 7 shows a merge sort being carried out on a list.

Figure 7



Explain how the merge sort algorithm works.

[4 marks]

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Turn over ▶



0 9

**Figure 8** shows an algorithm, written using pseudo-code, that uses a RECORD data structure for storing information about a film.

Each record stores four pieces of information about a film:

- film title
- certificate (eg 12A, PG)
- year the film was made
- if the film is currently being shown at a cinema.

There are records for three films and these films are stored alphabetically in an array called `filmCollection`.

The pseudo-code outputs the title of the newest of the three films.

- Part of the algorithm has been replaced by the label **L1**.

### Figure 8

```

RECORD Film
  title : String
  certificate : String
  year : Integer
  beingShown : Boolean
ENDRECORD

hulk ← Film('Hulk', '12A', 2005, False)
ironMan ← Film('Iron Man', '12A', 2008, False)
antMan ← Film('Ant-Man', '12A', 2015, False)
filmCollection ← [antMan, hulk, ironMan]
year ← 0
position ← 0

FOR i ← 0 TO L1
  IF filmCollection[i].year > year THEN
    year ← filmCollection[i].year
    position ← i
  ENDIF
ENDFOR

OUTPUT filmCollection[position].title, ' is the
newest film'

```





**0 9**. **1** How many different values can the field `beingShown` have?

Shade **one** lozenge.

[1 mark]

- A 2
- B 3
- C 128
- D 256

**0 9**. **2** Which assignment statement changes the year the film *Hulk* was made to 2003?

Shade **one** lozenge.

[1 mark]

- A `hulk.year ← 2003`
- B `filmCollection[0].year ← 2003`
- C `Film(year) ← 2003`
- D `hulk(year) ← 2003`

**0 9**. **3** What should the label **I1** in **Figure 8** be replaced by?

Shade **one** lozenge.

[1 mark]

- A 3
- B `LEN(filmCollection)`
- C `LEN(filmCollection) - 1`
- D `Position`

**0 9**. **4** Write a pseudo-code statement that updates the `antMan` record to show that the film is currently being shown at the cinema.

[1 mark]

---



1 0

**Figure 9** shows an algorithm, represented in pseudo-code, used to display students' test scores. The algorithm does not work as expected and the teacher wants to find the error.

The algorithm should display three test scores for each student:

- Natalie has results of 78, 81 and 72
  - Alex has results of 27, 51 and 54
  - Roshana has results of 52, 55 and 59.
- Line numbers are included but are not part of the algorithm.

**Figure 9**

```

1  names ← ['Natalie', 'Alex', 'Roshana']
2  scores ← [78, 81, 72, 27, 51, 54, 52, 55, 59]
3  count ← 0
4  FOR i ← 0 TO 2
5      person ← names[i]
6      OUTPUT 'Student: ', person
7      FOR j ← 0 TO 1
8          OUTPUT j + 1
9          result ← scores[i * 3 + j]
10         OUTPUT result
11         count ← count + 1
12     ENDFOR
13 ENDFOR

```

1 0 . 1

Complete the trace table for the algorithm shown in **Figure 9**.

You may not need to use all the rows in the table.

[5 marks]

count	i	person	j	result



1 0 . 2 How could the error in the algorithm in **Figure 9** be corrected?

Shade **one** lozenge.

[1 mark]

- A** Change line number 3 to: `count ← -1`
- B** Change line number 4 to: `FOR i ← 1 TO 4`
- C** Change line number 7 to: `FOR j ← 0 TO 2`
- D** Change line number 9 to: `result ← scores[j * 3 + i]`

**Turn over for the next question**

**Turn over ►**



1	1
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**Figure 10** shows part of an algorithm that has been written in pseudo-code.

There is an error in the algorithm.

The algorithm should:

- get the start year and end year from the user
  - check that the start year is before the end year
  - check that the start year is before 2000
  - calculate the difference between the two years after a valid start year has been entered.
- 
- Line numbers are included but are not part of the algorithm.

**Figure 10**

```
1  validChoice ← False
2  REPEAT
3    difference ← -1
4    OUTPUT 'Enter a start year '
5    startYear ← USERINPUT
6    OUTPUT 'Enter an end year '
7    endYear ← USERINPUT
8    IF startYear ≥ endYear THEN
9      OUTPUT 'Start year must be before end year'
10   ELSE
11     IF startYear < 2000 THEN
12       OUTPUT 'Start year must be before 2000'
13     ELSE
14       validChoice ← True
15     ENDIF
16   ENDIF
17 UNTIL validChoice = True
18 difference ← endYear - startYear
19 OUTPUT difference
```



1 1 . 1

**Table 1** shows three tests used to check the algorithm in **Figure 10**.

Complete the table to show what the values of the `validChoice` and `difference` variables would be for the given test data.

[4 marks]

**Table 1**

Test type	Test data		<code>validChoice</code>	<code>difference</code>
<b>Normal</b>	<code>startYear</code>	1995		
	<code>endYear</code>	2010		
<b>Erroneous</b>	<code>startYear</code>	2015		
	<code>endYear</code>	2000		
<b>Boundary</b>	<code>startYear</code>	2000		
	<code>endYear</code>	2023		

1 1 . 2

The algorithm in **Figure 10** contains a logic error on **line 11**.

Describe how the error on **line 11** can be corrected.

[1 mark]

---



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11

**Turn over for the next question**

Turn over ►



1 2 . 1

**Figure 11** shows a binary search algorithm that has been programmed in C#.

The `CompareTo` method is used to compare two strings. It returns:

- -1 if the first string is less than the second
- 0 if the first string is equal to the second
- 1 if the first string is greater than the second.

**Figure 11**

```
string[] animals = {"cat", "dog", "hippo", "llama",
"ox", "rat", "tiger", "wolf"};
Console.Write("What animal would you like to find? ");
string animalToFind = Console.ReadLine();
bool validAnimal = false;
int start = 0;
int finish = animals.Length - 1;
while (validAnimal == false && start <= finish) {
    int mid = (start + finish) / 2;
    if (animals[mid] == animalToFind) {
        validAnimal = true; }
    else if (animalToFind.CompareTo(animals[mid]) == 1)
    {
        start = mid + 1;
    } else {
        finish = mid - 1;
    }
}
Console.WriteLine(validAnimal);
```

Complete the trace table for the program in **Figure 11** if the user input is `wolf`

Part of the table has already been filled in.

You may not need to use all the rows in the table.

**[4 marks]**

<code>animalToFind</code>	<code>validAnimal</code>	<code>start</code>	<code>finish</code>	<code>mid</code>
wolf	False	0	7	3



1 2 . 2 Figure 12 shows a line of C# code that creates an array of fruit names.

Figure 12

```
string[] fruits = {"banana", "apple", "orange",
                  "pear", "grape", "pineapple"};
```

Extend the program in Figure 12. Your answer must be written in C#.

The program should get the user to enter a word and perform a linear search on the array `fruits` to find if the word is in the array or not.

The program should:

- ask the user what word they would like to find
- output the message `True` if the word is found
- output the message `False` if the word is not found.

You must write your own linear search routine and **not** use any built-in search function available in C#.

You **should** use meaningful variable name(s) and C# syntax in your answer.

The answer grid below contains vertical lines to help you indent your code.

[7 marks]

```
string[] fruits = {"banana", "apple", "orange",
                  "pear", "grape", "pineapple"};
```


Question 12 continues on the next page

Turn over ►




**1** **2** **3** State why a binary search cannot be used on the array `fruits`

**[1 mark]**

---

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1 2 . 4

**Figure 13** shows an algorithm, represented using pseudo-code, that should display currency names in reverse alphabetical order, starting with yen.

There are errors in the logic of the algorithm.

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

**Figure 13**

```

1  SUBROUTINE diffCurrencies(currencies)
      currencies ← ['baht', 'dollar', 'euro',
2      'koruna', 'lira', 'rand',
      'rupee', 'yen']
3      RETURN currencies[x]
4  ENDSUBROUTINE
5
6  FOR i ← 8 TO 0 STEP 1
7      OUTPUT(diffCurrencies(i))
8  ENDFOR

```

Rewrite **line 1** and **line 6** from **Figure 13** to make the algorithm work as intended.

**[3 marks]**

Line 1 \_\_\_\_\_

\_\_\_\_\_

Line 6 \_\_\_\_\_

\_\_\_\_\_

15

**Turn over for the next question**

**Turn over ►**



1 3

A programmer is writing a game. The game uses a 3 x 3 grid containing nine squares.

Figure 14

	A	B	C
1			
2			
3			X

In the game, a square on the grid is referred to by a letter and a number. For example, square **C3** in **Figure 14** contains an X.

**Figure 15** shows part of a C# program that checks the grid reference entered by a player.

The grid reference is valid if:

- there are exactly two characters
- the first character entered is A, B or C
- the second character entered is 1, 2 or 3.

Figure 15

```
bool check = false;
while (check == false) {
    string square = "";
    while (square.Length != 2) {
        Console.Write("Enter grid reference (eg C2): ");
        square = Console.ReadLine();
        square = square.ToUpper();
    }
}
```

The C# function `ToUpper()` converts letters into uppercase, eg `b1` would be converted to `B1`

Extend the program from **Figure 15** so it completes the other checks needed to make sure a valid grid reference is entered.

Your extended program must:

- use the variable `check`
- repeat the following steps until a valid grid reference is entered:
  - get the user to enter a grid reference
  - output an appropriate message if the grid reference entered is not valid.

You **should** use meaningful variable name(s) and C# syntax in your answer.

The answer grid contains vertical lines to help you indent your code.

[6 marks]



```
bool check = false;
while (check == false) {
    string square = "";
    while (square.Length != 2) {
        Console.Write("Enter grid reference (eg C2): ");
        square = Console.ReadLine();
        square = square.ToUpper();
    }
}
```

Turn over ►



1 4

50 students have voted for the music genre they like best.

**Figure 16** shows an **incomplete** algorithm, represented using pseudo-code, designed to output the highest or lowest results of the vote.

The programmer has used a two-dimensional array called `results` to store the genre and the number of votes for each genre.

Parts of the algorithm are missing and have been replaced with the labels **L1** to **L3**.

**Figure 16**

```

SUBROUTINE showResults(method, numberOfGenres)
  results ← [['Pop', 'Post-Punk', 'Techno', 'Metal',
             'Dance'], ['7', '19', '14', '1', '9']]
  pos ← 0
  high ← -1
  IF method = 'HIGHEST' THEN
    FOR i ← 0 TO numberOfGenres - 1
      Votes ← STRING_TO_INT(results[L1][i])
      IF votes > high THEN
        high ← votes
        pos ← L2
      ENDIF
    ENDFOR
  ELSE
    OUTPUT 'not yet working'
  ENDIF
  IF high ≠ -1 THEN
    OUTPUT results[0][pos], ' with ', results[1][pos]
  ENDIF
ENDSUBROUTINE

OUTPUT 'Show the genre with the HIGHEST or LOWEST number
of votes? '
method ← USERINPUT
showResults(L3, 5)

```



State what should be written in place of the labels L1 to L3 in the algorithm in Figure 16.

[3 marks]

L1 \_\_\_\_\_

L2 \_\_\_\_\_

L3 \_\_\_\_\_

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9

Turn over for the next question

Turn over ►



**1 5**

A group of people have a meal in a restaurant. Instead of one person paying for the whole meal, each person will pay for what they eat.

Write a C# program that asks each person in the group how much they are paying towards the meal and works out when the bill is fully paid. Each person can pay a different amount.

The program should:

- get the user to enter the total amount of the bill
- get a person to enter how much they are paying towards the bill
- subtract the amount entered from the bill:
  - if the amount left to pay is more than 0, output how much is left to pay and repeat until the amount left to pay is 0 or less
  - if the amount left to pay is 0, then output the message `Bill paid`
  - if the amount left to pay is less than 0, then output the message `Tip is` and the difference between the amount left to pay and 0

You **should** use meaningful variable name(s) and C# syntax in your answer.

The answer grid below contains vertical lines to help you indent your code.

**[8 marks]**




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1 6

Question **16** is about a dice game played against a computer.

The aim of the game is to get as close to a score of 21 as you can, without going over 21. If your score goes over 21 then you lose.

The player's score starts at 0.

For each turn:

- two dice (each numbered from 1 to 6) are rolled
- the total of the two dice rolls is added to the player's score
- the value of each dice and the player's new total score is output
- if the current score is less than 21, the player is asked if they would like to roll the dice again: if the player says yes, they get another turn; otherwise, the game ends.

At the end of the game, the program should work as follows:

- if the final score is 21, output a message to say the player has won
- if the final score is greater than 21, output a message to say the player has lost
- if the final score is less than 21, the program generates a random number between 15 and 21 inclusive:
  - if this random number is greater than the player's final score, output a message to say the player has lost
  - otherwise, output a message to say the player has won.

**Figure 17** shows the output of a program that plays this dice game.

**Figure 17**

```

Roll 1: 1
Roll 2: 4
Current score: 5
Would you like to roll again? yes

Roll 1: 1
Roll 2: 6
Current score: 12
Would you like to roll again? yes

Roll 1: 1
Roll 2: 2
Current score: 15
Would you like to roll again? yes

Roll 1: 6
Roll 2: 1
Current score: 22
You lost!

```

Write a C# program to simulate this game.

The first line has been written for you in the answer grid.





The dice rolls are carried out by the program generating random numbers between 1 and 6. You will need to use the C# function `r.Next(a, b)` which generates a random integer in the range `a` to `b` starting at `a` but finishing one before `b`.

You **should** use meaningful variable name(s) and C# syntax in your answer.

The answer grid below contains vertical lines to help you indent your code.

**[11 marks]**

```
Random r = new Random();
```


Turn over ►



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**END OF QUESTIONS**



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