A

AQA

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Centre Number _____

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Candidate Signature _____

I declare this is my own work.

GCSE
COMPUTER SCIENCE

Paper 1 Computational Thinking and Problem-Solving

8520/1

Monday 11 May 2020 Morning

Time allowed: 1 hour 30 minutes

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]

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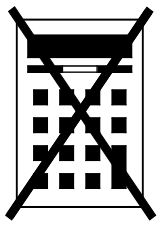
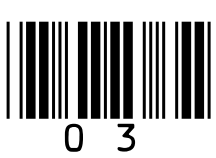
There are no additional materials required for this paper.



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.**
- **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.**

[Turn over]



- **Unless the question states otherwise, 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.**

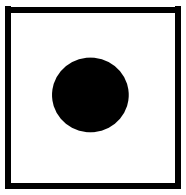
INFORMATION

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

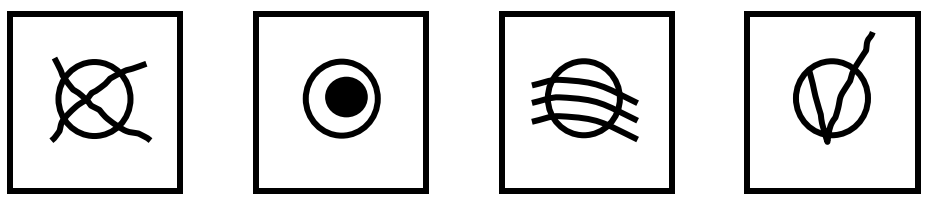
ADVICE

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

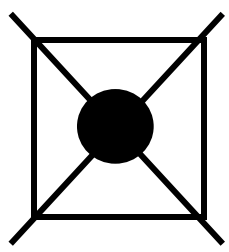
CORRECT METHOD



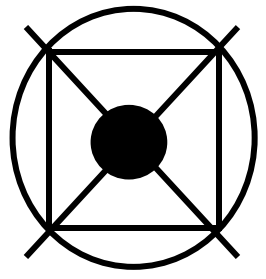
WRONG METHODS



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.



DO NOT TURN OVER UNTIL TOLD TO DO SO

Answer ALL questions.

0 1 . 1

A bitmap image is represented as a grid of pixels.

State what is meant by the term pixel.
[1 mark]

0 1 . 2

State the maximum number of different colours that can be used if a bitmap image has a colour depth of six bits.
[1 mark]

0 1 . 3

What is the minimum file size for an 800 pixel by 1000 pixel bitmap image that uses 20 different colours? You should give your answer in KILOBYTES.

You should show your working.
[3 marks]

Answer _____ **kB**

[Turn over]

0 1 . 4

The algorithm shown in FIGURE 1, on the opposite page, converts binary data entered as a string by the user into a representation of a black and white image.

The algorithm uses the `+` **operator to concatenate two strings.**

Characters in the string are indexed starting at zero. For example `bdata[2]` **would access the third character of the string stored in the variable** `bdata`

The `MOD` **operator calculates the remainder after integer division, for example** `17 MOD 5 = 2`

FIGURE 1

```
bdata ← USERINPUT
image ← ''
FOR i ← 0 TO LEN(bdata) - 1
    IF bdata[i] = '0' THEN
        image ← image + '*'
    ELSE
        image ← image + '/'
    ENDIF
    IF i MOD 3 = 2 THEN
        OUTPUT image
        image ← ''
    ENDIF
ENDFOR
```

[Turn over]

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Complete the trace table for the algorithm shown in FIGURE 1 when the variable `bdata` is given the following value from the user:

`110101`

You may not need to use every row in the table. The algorithm output is not required. [3 marks]

i	image

[Turn over]

0 2

Describe how the linear search algorithm works. [3 marks]

0 3 . 1

State the name of the logic gate represented by the following truth table. [1 mark]

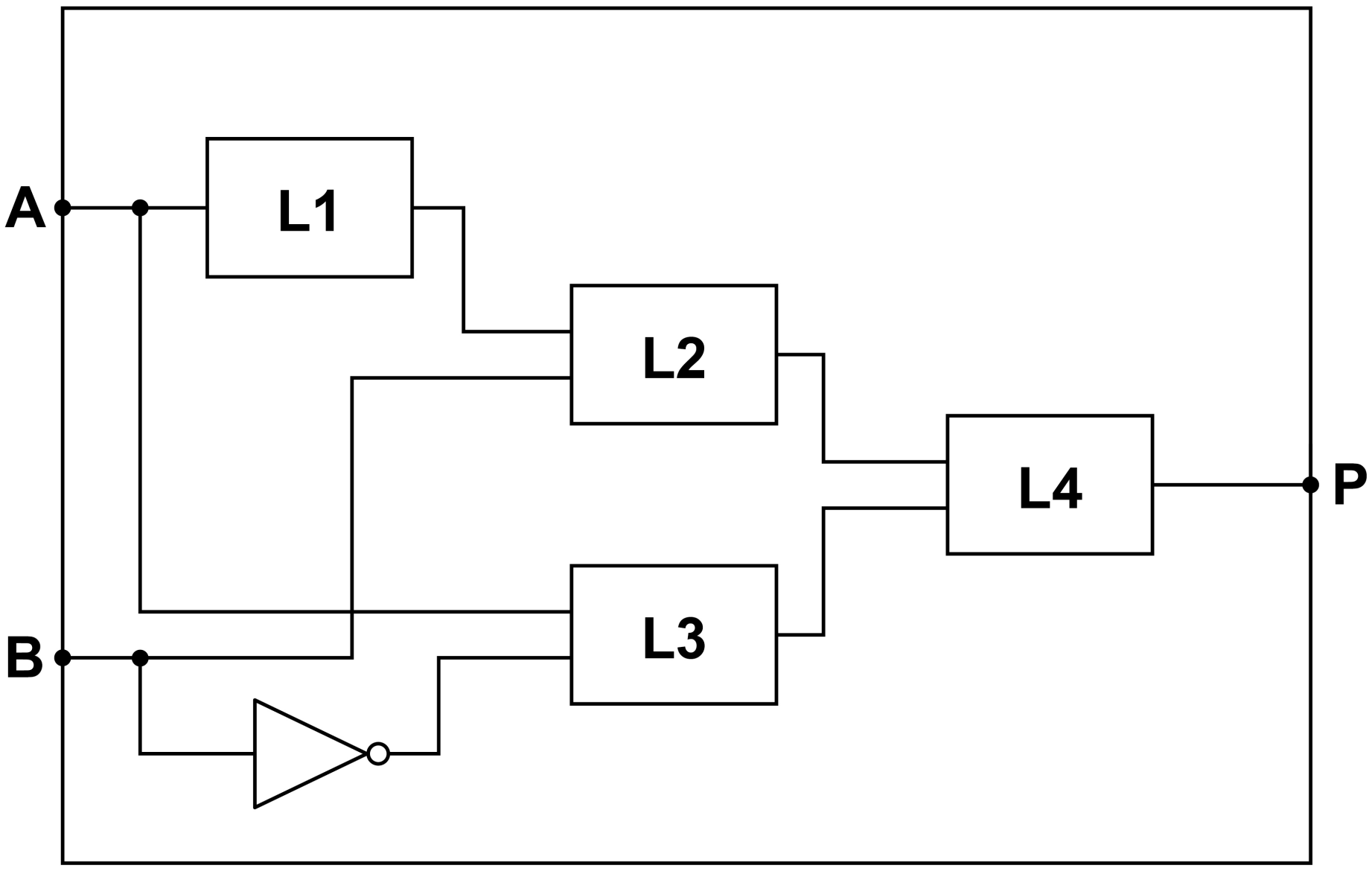
Input A	Input B	Output
0	0	0
0	1	0
1	0	0
1	1	1

Logic gate _____

A partially complete logic circuit is shown in FIGURE 2, on the opposite page, that detects if a computer system has been set up correctly. There are two keyboard input devices, keyboard A and keyboard B, and either one can be connected to the computer system. However, if they are both connected then the computer system will not work.

Output P has the value 1 if either keyboard A or keyboard B, but not both, is connected to the computer system and 0 otherwise.

FIGURE 2



[Turn over]

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0 3 . 2

State the name of the logic gates that should be placed in the positions indicated by the labels L1, L2, L3 and L4 in FIGURE 2, on page 17. [3 marks]

LABEL	LOGIC GATE
L1	
L2	
L3	
L4	

0 4

The algorithm shown in FIGURE 3 is used to check if the start of an instruction for a particular assembly language is valid.

The string representation of the assembly language instruction is stored in the variable `instr`

Characters in the string are indexed starting at zero. For example `instr[2]` **would access the third character of the string stored in the variable** `instr`

FIGURE 3

```
code ← ''
i ← 0
WHILE instr[i] ≠ ':' AND i < 4
    code ← code + instr[i]
    i ← i + 1
ENDWHILE
valid ← False
IF code = 'ADD' OR code = 'SUB' OR code = 'HALT' THEN
    valid ← True
ENDIF
```

[Turn over]

BLANK PAGE

0 4 . 1

Shade ONE lozenge to show the most appropriate data type of the variable `i` in the algorithm in FIGURE 3.
[1 mark]

○ **A Character**

○ **B Integer**

○ **C Real**

○ **D String**

[Turn over]

REPEAT OF FIGURE 3

```
code ← ''
i ← 0
WHILE instr[i] ≠ ':' AND i < 4
    code ← code + instr[i]
    i ← i + 1
ENDWHILE
valid ← False
IF code = 'ADD' OR code = 'SUB' OR code = 'HALT' THEN
    valid ← True
ENDIF
```

0 4 . 2

State the data type of the variable `valid` in the algorithm in FIGURE 3. [1 mark]

[Turn over]

REPEAT OF FIGURE 3

```
code ← ''
i ← 0
WHILE instr[i] ≠ ':' AND i < 4
    code ← code + instr[i]
    i ← i + 1
ENDWHILE
valid ← False
IF code = 'ADD' OR code = 'SUB' OR code = 'HALT' THEN
    valid ← True
ENDIF
```

0 4 . 3

State the final value of the variable `valid` in the algorithm in FIGURE 3 for the following different starting values of `instr` [3 marks]

Value of `instr`	**Final value of** `valid`
`ADD R0, R1`	
`ADD: R0, R1`	
`HALT`	

[Turn over]

0 4 . 4

State what an assembly language program must be translated into before it can be executed by a computer. [1 mark]

0 4 . 5

State TWO reasons why a programmer, who can program in both high-level and low-level languages, would usually choose to develop in a high-level language rather than a low-level language. [2 marks]

Reason 1

Reason 2

[Turn over]

0 4 . 6

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

- **initialises a variable called** `regValid` **to** `False`
- **sets a variable called** `regValid` **to** `True` **if the string contained in the variable** `reg` **is an uppercase** `R` **followed by the character representation of a single numeric digit.**

Examples:

- **if the value of** `reg` **is** `R0` **or** `R9` **then** `regValid` **should be** `True`
- **if the value of** `reg` **is** `r6` **or** `Rh` **then** `regValid` **should be** `False`

You may wish to use the subroutine `isDigit(ch)` **in your answer. The**

subroutine `isDigit` **returns** `True` **if the character parameter** `ch` **is a string representation of a digit and** `False` **otherwise. [3 marks]**

0	5

The algorithms shown in FIGURE 4 and FIGURE 5 both have the same purpose.

The operator `LEFTSHIFT` **performs a binary shift to the left by the number indicated.**

For example, `6 LEFTSHIFT 1` **will left shift the number** `6` **by one place, which has the effect of multiplying the number** `6` **by two giving a result of 12**

FIGURE 4

```
result ← number LEFTSHIFT 2
result ← result - number
```

FIGURE 5

```
result ← 0
FOR x ← 1 TO 3
    result ← result + number
ENDFOR
```

0 5 . 1

Complete the trace table for the algorithm shown in FIGURE 4 when the initial value of `number` is 4

You may not need to use all rows of the trace table. [2 marks]

result

[Turn over]

0 5 . 2

Complete the trace table for the algorithm shown in FIGURE 5, on page 33, when the initial value of `number` **is 4**

You may not need to use all rows of the trace table. [2 marks]

x	result

0 5 . 3

The algorithms in FIGURE 4 and FIGURE 5 have the same purpose.

State this purpose. [1 mark]

0 5 . 4

Explain why the algorithm shown in FIGURE 4 can be considered to be a more efficient algorithm than the algorithm shown in FIGURE 5. [1 mark]

0	6

Show the steps involved, on the opposite page, for either the bubble sort algorithm OR the merge sort algorithm, to sort the array shown in FIGURE 6 so the result is

`[1, 4, 5, 8]`

FIGURE 6

`[8, 4, 1, 5]`

CIRCLE the algorithm you have chosen:

Bubble sort

Merge sort

[4 marks]

Steps:

[Turn over]

0 7 . 1

Four subroutines are shown in FIGURE 7.

FIGURE 7

```
SUBROUTINE main(k)
    OUTPUT k
    WHILE k > 1
        IF isEven(k) = True THEN
            k ← decrease(k)
        ELSE
            k ← increase(k)
        ENDIF
        OUTPUT k
    ENDWHILE
ENDSUBROUTINE
```

```
SUBROUTINE decrease(n)
    result ← n DIV 2
    RETURN result
ENDSUBROUTINE
```

```
SUBROUTINE increase(n)
    result ← (3 * n) + 1
    RETURN result
ENDSUBROUTINE

SUBROUTINE isEven(n)
    IF (n MOD 2) = 0 THEN
        RETURN True
    ELSE
        RETURN False
    ENDIF
ENDSUBROUTINE
```

[Turn over]

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Complete the table showing ALL of the outputs from the subroutine call `main(3)`

The first output has already been written in the trace table. You may not need to use all rows of the table. [4 marks]

Output
3

REPEAT OF FIGURE 7

```
SUBROUTINE main(k)
    OUTPUT k
    WHILE k > 1
        IF isEven(k) = True THEN
            k ← decrease(k)
        ELSE
            k ← increase(k)
        ENDIF
        OUTPUT k
    ENDWHILE
ENDSUBROUTINE

SUBROUTINE decrease(n)
    result ← n DIV 2
    RETURN result
ENDSUBROUTINE

SUBROUTINE increase(n)
    result ← (3 * n) + 1
    RETURN result
ENDSUBROUTINE
```

```
SUBROUTINE isEven(n)
    IF (n MOD 2) = 0 THEN
        RETURN True
    ELSE
        RETURN False
    ENDIF
ENDSUBROUTINE
```

0 7 . 2

Describe how the developer has used the structured approach to programming in FIGURE 7. [2 marks]

0	8

The subroutine `CODE_TO_CHAR` **can be used to convert a character code into the corresponding Unicode character. For example:**

`CODE_TO_CHAR(97)` **will return the character** `'a'`
`CODE_TO_CHAR(65)` **will return the character** `'A'`

The subroutine `CHAR_TO_CODE` **can be used to convert a Unicode character into the corresponding character code. For example:**

`CHAR_TO_CODE('a')` **will return the integer** `97`
`CHAR_TO_CODE('A')` **will return the integer** `65`

0 8 . 1

Shade ONE lozenge to show what value would be returned from the subroutine call `CODE_TO_CHAR(100)` **[1 mark]**

○ **A** `'c'`

○ **B** `'d'`

○ **C** `'e'`

○ **D** `'f'`

0 8 . 2

State the value that will be returned from the subroutine call:

`CODE_TO_CHAR(CHAR_TO_CODE('E') + 2)`

[1 mark]

Value returned _____

0 8 . 3

Write a subroutine `TO_LOWER`**, using either pseudo-code OR a flowchart, that takes an upper case character as a parameter and returns the corresponding lower case character.**

For example, if the subroutine `TO_LOWER` **is passed the character** `'A'` **as a parameter, the subroutine should return the character** `'a'`**.**

You should make use of the subroutines `CODE_TO_CHAR` **and** `CHAR_TO_CODE` **in your answer.**

You can assume that the parameter passed to the subroutine will be in upper case. [5 marks]

[Turn over]

0	9

A developer needs to store data about thousands of songs in a program. She needs to be able to hold information on every song's title, singer and year of release.

Explain how the developer could use a combination of an array and records to store this information.

In your answer you should refer to the data types that would be used by the developer. [4 marks]

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[Turn over]

1 0

An application allows only two users to log in. Their usernames are stated in TABLE 1 along with their passwords.

TABLE 1

username	password
`gower`	`9Fdg3`
`tuff`	`888rG`

Develop an algorithm, using either pseudo-code OR a flowchart, that authenticates the user. The algorithm should:

- **get the user to enter their username and password**
- **check that the combination of username and password is correct and, if so, output the string** `'access granted'`

- **get the user to keep re-entering their username and password until the combination is correct.**

[6 marks]

[Turn over]

6

56

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[Turn over]

1	1

Develop an algorithm, using either pseudo-code OR a flowchart, that helps an ice cream seller in a hot country calculate how many ice creams they are likely to sell on a particular day. Your algorithm should:

- **get the user to enter whether it is the weekend or a weekday**
- **get the user to enter the temperature forecast in degrees Celsius (they should enter a number between 20 and 45 inclusive; if the number falls outside of this range then they should be made to re-enter another number until they enter a valid temperature)**
- **calculate the number of ice creams that are likely to be sold using the following information:**

- 100 ice creams are likely to be sold if the temperature is between 20 and 30 degrees inclusive,
- 150 ice creams are likely to be sold if the temperature is between 31 and 38 degrees inclusive,
  - and 120 ice creams are likely to be sold if the temperature is higher than 38 degrees

- double the estimate if it is a weekend
- output the estimated number of ice creams that are likely to be sold.

[9 marks]

[Turn over]

[Turn over]

9

1	2

A developer has written a set of subroutines to control an array of lights. The lights are indexed from zero. They are controlled using the subroutines in TABLE 2.

TABLE 2

SUBROUTINE	EXPLANATION
`SWITCH(n)`	**If the light at index** `n` **is on it is set to off.** **If the light at index** `n` **is off it is set to on.**
`NEIGHBOUR(n)`	**If the light at index** `(n+1)` **is on, the light at index** `n` **is also set to on.** **If the light at index** `(n+1)` **is off, the light at index** `n` **is also set to off.**

`RANGEOFF(m, n)`	**All the lights between index `m` and index `n` (but NOT including `m` and `n`) are set to off.**

Array indices are shown above the array of lights.

For example, if the starting array of the lights is

0	1	2	3
off	on	off	on

Then after the subroutine call `SWITCH(2)` the array of lights will become

0	1	2	3
off	on	on	on

[Turn over]

And then after the subroutine call `NEIGHBOUR(0)` **the array of lights will become**

0	1	2	3
on	on	on	on

Finally, after the subroutine call `RANGEOFF(0, 3)` **the array of lights will become**

0	1	2	3
on	off	off	on

1 2 . 1

If the starting array of lights is

0	1	2	3	4	5	6
on	off	off	on	off	off	on

What will the array of lights become after the following algorithm has been followed?

```
a ← 2
SWITCH(a)
SWITCH(a + 1)
NEIGHBOUR(a - 2)
```

Write your final answer in the following array [3 marks]

0	1	2	3	4	5	6

[Turn over]

12.2

If the starting array of lights is

0	1	2	3	4	5	6
off	off	on	off	on	on	on

What will the array of lights become after the following algorithm has been followed?

```
FOR a ← 0 TO 2
    SWITCH(a)
ENDFOR
b ← 8
RANGEOFF((b / 2), 6)
NEIGHBOUR(b - 4)
```

Write your final answer in the following array [3 marks]

0	1	2	3	4	5	6

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[Turn over]

12.3

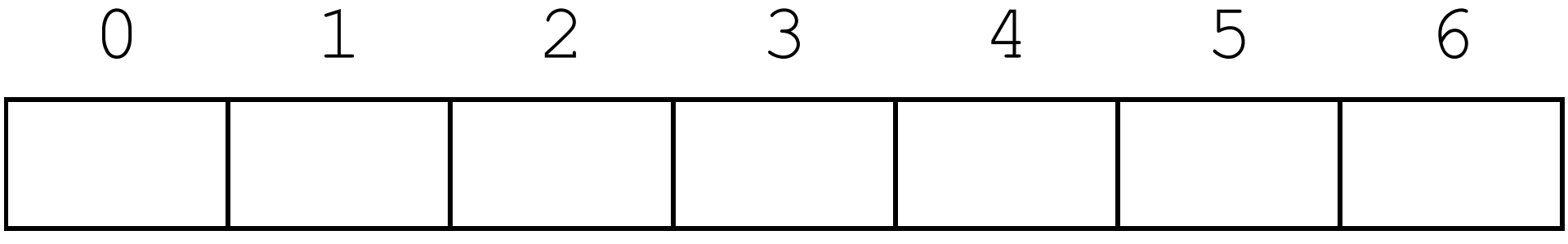
If the starting array of lights is

0	1	2	3	4	5	6
off	on	off	on	off	on	off

What will the array of lights become after the following algorithm has been followed?

```
a ← 0
WHILE a < 3
    SWITCH(a)
    b ← 5
    WHILE b ≤ 6
        SWITCH(b)
        b ← b + 1
    ENDWHILE
    a ← a + 1
ENDWHILE
```

Write your final answer in the following array [3 marks]



[Turn over]

12.4

If the starting array of lights is

0	1	2	3	4	5	6
on	on	on	on	on	on	on

Write an algorithm, using EXACTLY THREE subroutine calls, that means the final array of lights will be

0	1	2	3	4	5	6
off	off	off	off	off	off	off

You must use each of the subroutines `SWITCH`, `NEIGHBOUR` **and** `RANGEOFF` **EXACTLY ONCE in your answer. If you do not do this you may still be able to get some marks. [3 marks]**

END OF QUESTIONS

12

Additional page, if required.

Write the question numbers in the left-hand margin.

Additional page, if required.

Write the question numbers in the left-hand margin.

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For Examiner's Use	
Question	Mark
1–2	
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