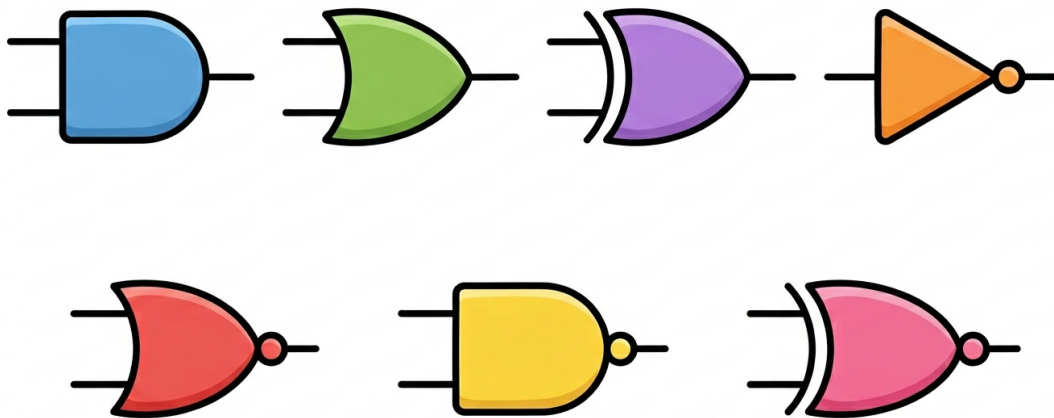


Topic 101 Logic Systems Question Pack

for

Eduqas GCE A-Level Electronics



Student Name:

Class / Group:



Question 1

3

Answer all questions.

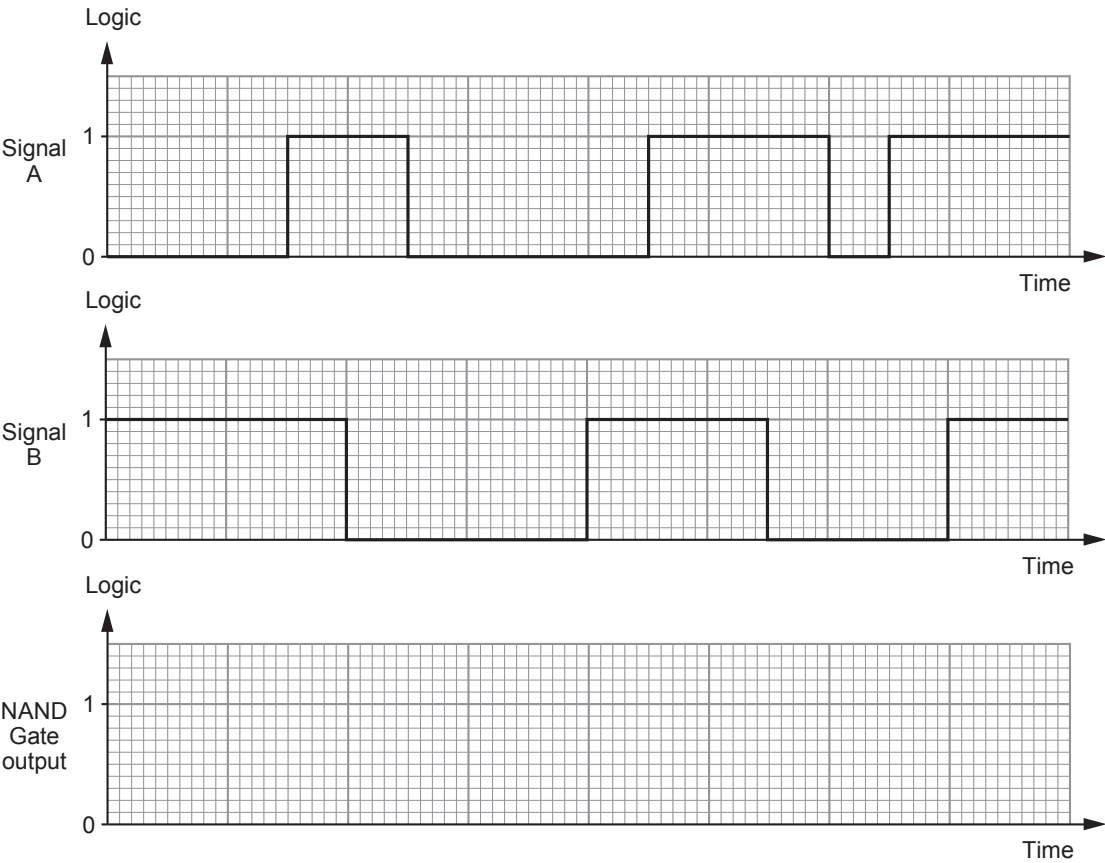
Examiner
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1. (a) Which 2-input logic gate outputs a logic 1 only when both inputs are different? [1]
.....

(b) Complete the truth table for a 2-input NAND gate. [1]

B	A	Q
0	0	
0	1	
1	0	
1	1	

(c) Signals A and B are applied to the inputs of a 2-input NAND gate. Sketch the output. [2]



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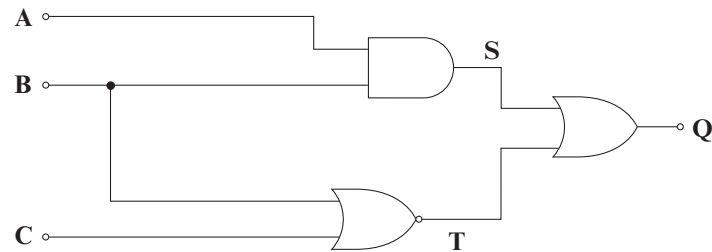
Turn over.

Question 2

4

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2. The diagram shows a logic system.



- (a) Write down the Boolean expression for each of the outputs **S**, **T** and **Q** in terms of inputs **A**, **B** and **C**. [3]

S = ...

T = ...

Q = ...

- (b) Complete the truth table for this system. [3]

C	B	A	S	T	Q
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

5

- (c) (i) In the space below, draw the same logic system, but with the logic gates replaced by their NAND equivalents. [3]

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- (ii) Cross out all redundant gates.

[2]

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Question 3

6

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3. (a) Simplify the following expression.

$$\bar{X} + \bar{X}.Y = \dots\dots\dots$$

[1]

- (b) Using a Karnaugh map or Boolean algebra, simplify the following expression as much as possible.

[4]

$$Q = C.B.A + \bar{D}.\bar{C}.B.\bar{A} + \bar{D}.C.\bar{B}.\bar{A} + C.\bar{B}.A + D.\bar{C}.B.\bar{A}$$

.....

.....

.....

.....

.....

BA		00	01	11	10
DC	00				
	01				
	11				
	10				

- (c) Apply DeMorgan's theorem to the following expression
- and**
- simplify the result.

[3]

$$Q = \overline{A + B.\bar{A}}$$

.....

.....

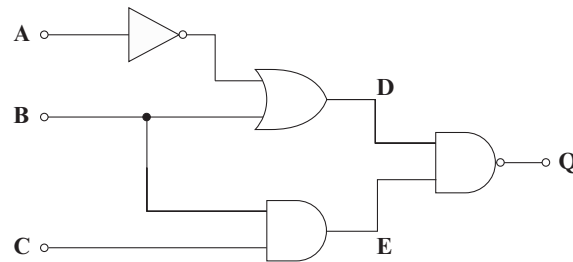
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Question 4

3

*Answer all questions.*Examiner
only

1. The following diagram shows a logic system.



- (a) Write down the Boolean expressions for D, E and Q in terms of inputs A, B and C. [3]

D = ...

E = ...

Q = ...

- (b) A student produces the following Boolean expression for the output of another logic system.

$$Q = \overline{\overline{A.C}} + \overline{B + A}$$

The teacher suggests that one of the inputs is not needed.

Apply DeMorgans theorem to this expression and simplify it to identify the input that is not needed. [4]

.....

.....

.....

.....

Which input is not needed?

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Question 5

4

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only

2. A system of logic gates gives the following truth table.

C	B	A	P	Q
0	0	0	0	1
0	0	1	0	1
0	1	0	1	0
0	1	1	0	0
1	0	0	1	1
1	0	1	0	1
1	1	0	1	1
1	1	1	0	1

- (a) (i) Use the table to write down the **unsimplified** (3 terms) Boolean expression for output P in terms of C, B and A. [1]

P = ...

- (ii) Complete the Karnaugh map and determine the **simplest** expression for the output P. [3]

.....

BA		00	01	11	10
C	0				
	1				

P = ...

- (iii) Draw the logic diagram for P using a combination of NOT, AND and OR gates. [3]

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(b) The Boolean expression for Q is

$$Q = \bar{B} + C$$

Show how the output Q can be obtained using NAND gates. Cross out any redundant gates. [2]

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Question 6

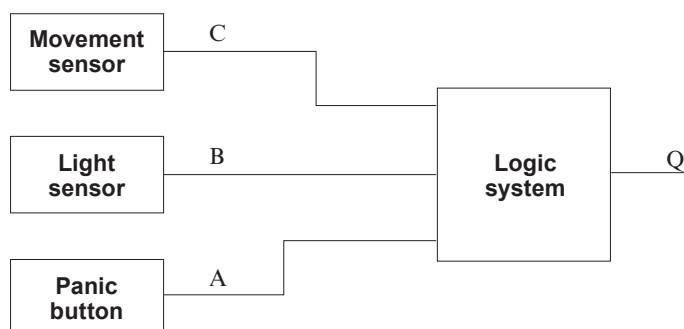
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3. (a) A student designs a security system to switch on a floodlight when movement is detected or a panic button is pressed. The system should operate **only** when it is dark. The specifications for the sub-systems are given below:

C	Movement sensor	Movement = logic 1
B	Light sensor	Dark = logic 0
A	Panic button	Pressed = logic 1

The block diagram for the input and logic system is:



- (i) Complete the truth table for the logic system such that **Q = logic 1** when the floodlight is **on**. [1]

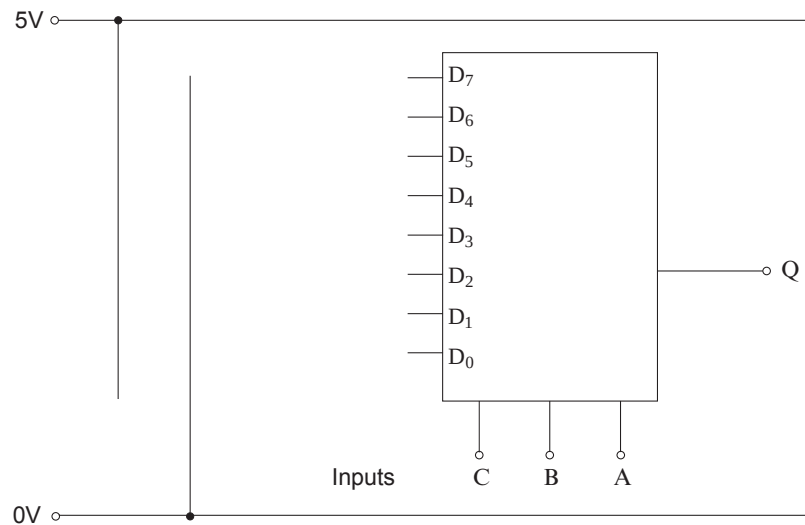
C	B	A	Q
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

- (ii) Write down the Boolean expression for Q. [1]

Q = ...

7

- (b) Complete the diagram to show how the output Q could be generated using a multiplexer. [1]



- (c) The student tests the multiplexer sub-system using a LED. Add the necessary components to the diagram so that the LED is ON when Q is high (logic 1). [2]

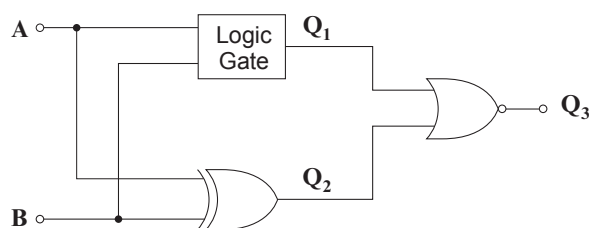
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Question 7

4

*Answer all questions.*Examiner
only

1. The following diagram shows a logic system.



- (a) The partially completed truth table for the logic system is shown below.

INPUTS		OUTPUTS		
B	A	Q_1	Q_2	Q_3
0	0	1		
0	1	1		
1	0	1		
1	1	0		

- (i) Identify the logic gate that gives output Q_1 . [1]

Gate

- (ii) **Complete the truth table** for the outputs Q_2 and Q_3 . [2]

- (b) Give the Boolean expression for each of the outputs Q_1 , Q_2 and Q_3 in terms of A and B. [3]

Q_1 = ...

Q_2 = ...

Q_3 = ...

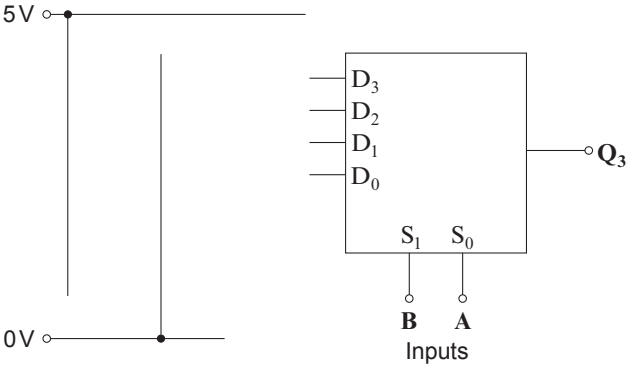
- (c) Name the single logic gate that would produce the same output as Q_3 . [1]

.....



(d) Show how the output Q_3 could be generated using a multiplexer.

[1] Examiner only



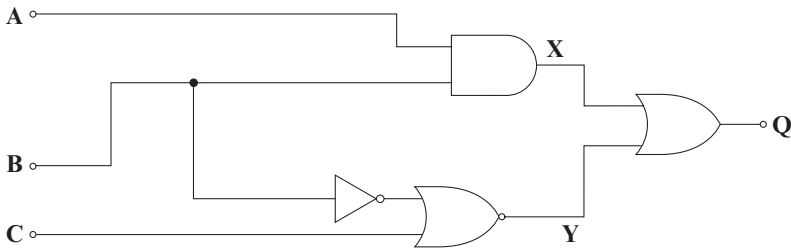
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Question 8

6

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2. A system of logic gates is shown below.



(a) Complete the truth table for this system.

[3]

C	B	A	X	Y	Q
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

(b) (i) Redraw this logic system using NAND gates only.

[3]

(ii) Draw lines through all redundant gates. Identify each redundant pair.

[3]

Question 9

7

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only

3. (a) Simplify the following expression.

[1]

$$\bar{C}.C = \dots\dots\dots$$

- (b) Using a Karnaugh map or Boolean algebra simplify the following expression as much as possible.

[4]

$$Q = D.C.B + \bar{D}.\bar{C}.B.\bar{A} + D.\bar{C}.A + D.B.\bar{A} + D.\bar{C}.\bar{B}.A$$

.....

.....

.....

.....

.....

DC \ BA	BA			
	00	01	11	10
00				
01				
11				
10				

- (c) Apply DeMorgan's theorem to the following expression
- and**
- simplify the result.

[2]

$$Q = \overline{C.A.C}$$

.....

.....

.....

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Question 10

3

Answer all questions.

Examiner
only

1. (a) Which type of 2-input logic gate outputs a logic 1:
- (i) when either input is at logic 1? [1]
- (ii) when either input is at logic 0? [1]

(b) The truth table for a logic gate is shown below.

B	A	Q
0	0	1
0	1	0
1	0	0
1	1	1

- (i) What logic gate produces this truth table? [1]
-
- (ii) Draw the circuit symbol for this logic gate. [1]

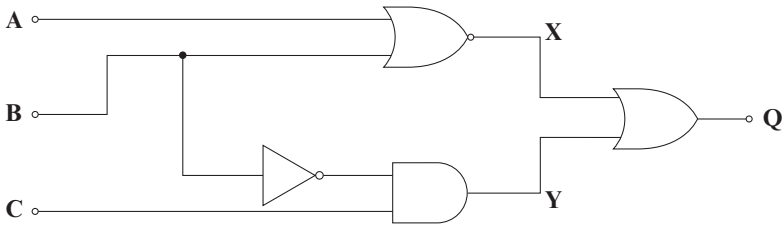
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Question 11

4

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2. A system of logic gates is shown below.



(a) Give the Boolean expression for each of the outputs **X**, **Y** and **Q** in terms of the inputs **A**, **B** and **C**. [3]

X = ...

Y = ...

Q = ...

(b) Complete the truth table for this system. [3]

C	B	A	X	Y	Q
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			



(c) (i) Redraw this logic system using NAND gates only.

[3]

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(ii) Deduce the **minimum** number of NAND gates needed to construct the equivalent circuit **and** explain how this number was achieved.

[1]

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Question 12

6

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3. The truth table for a logic system is given below.

C	B	A	Q
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

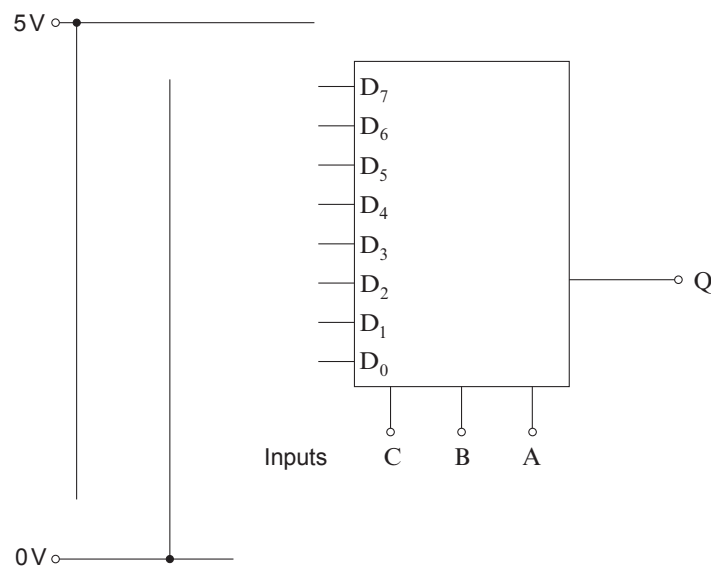
- (a) Transfer this information to a Karnaugh map and obtain the simplest Boolean expression for the output Q. [3]

.....

 Q = ...

BA	00	01	11	10
C				
0				
1				

- (b) Show how the output Q could be generated using a multiplexer. [1]



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Question 13

7

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4. (a) Simplify the following expressions.

(i) $\bar{D} + 1$ [1]

(ii) $\bar{B}.\bar{A} + B$ [1]

(iii) $\bar{D} (C + D)$ [1]

- (b) Apply DeMorgan's theorem to the following expression
- and**
- simplify the result. [3]

$$Q = \overline{(\bar{A} + B)} + A$$

.....

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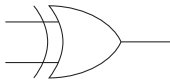


Question 14

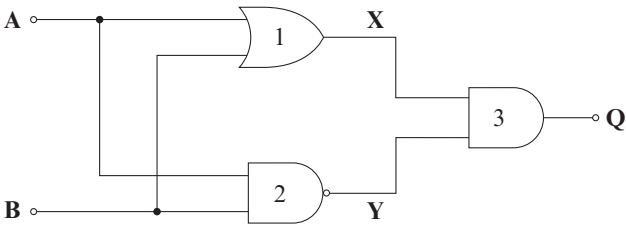
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1. The symbol for the 2-input EXOR gate is shown below.



(a) An EXOR gate can be built from other logic gates. Complete the truth table to show that the following circuit produces the same output as an EXOR gate. [3]



B	A	X	Y	Q
0	0			
0	1			
1	0			
1	1			

(b) The above circuit could be rebuilt using NAND gates only. Draw the NAND equivalent circuit for **gate 1** below. [1]

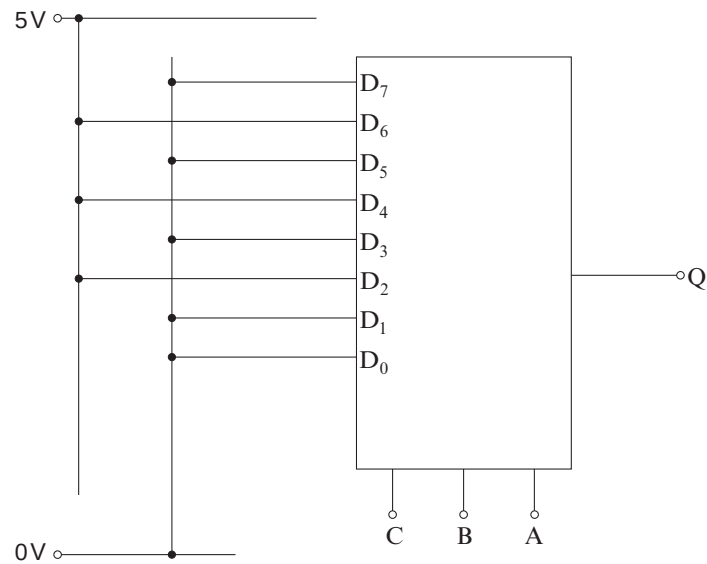
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Question 15

4

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2. (a) A multiplexer can be used to perform logic functions.



- (i) Complete the truth table for the multiplexer shown in the diagram.

[2]

Inputs			Output
C	B	A	Q
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

- (ii) Use the table to write down the **unsimplified** Boolean expression for Q in terms of C, B and A.

Q = ...

[2]

5

(b) Explain how a multiplexer can be reconfigured to perform a different logic function. [1]

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