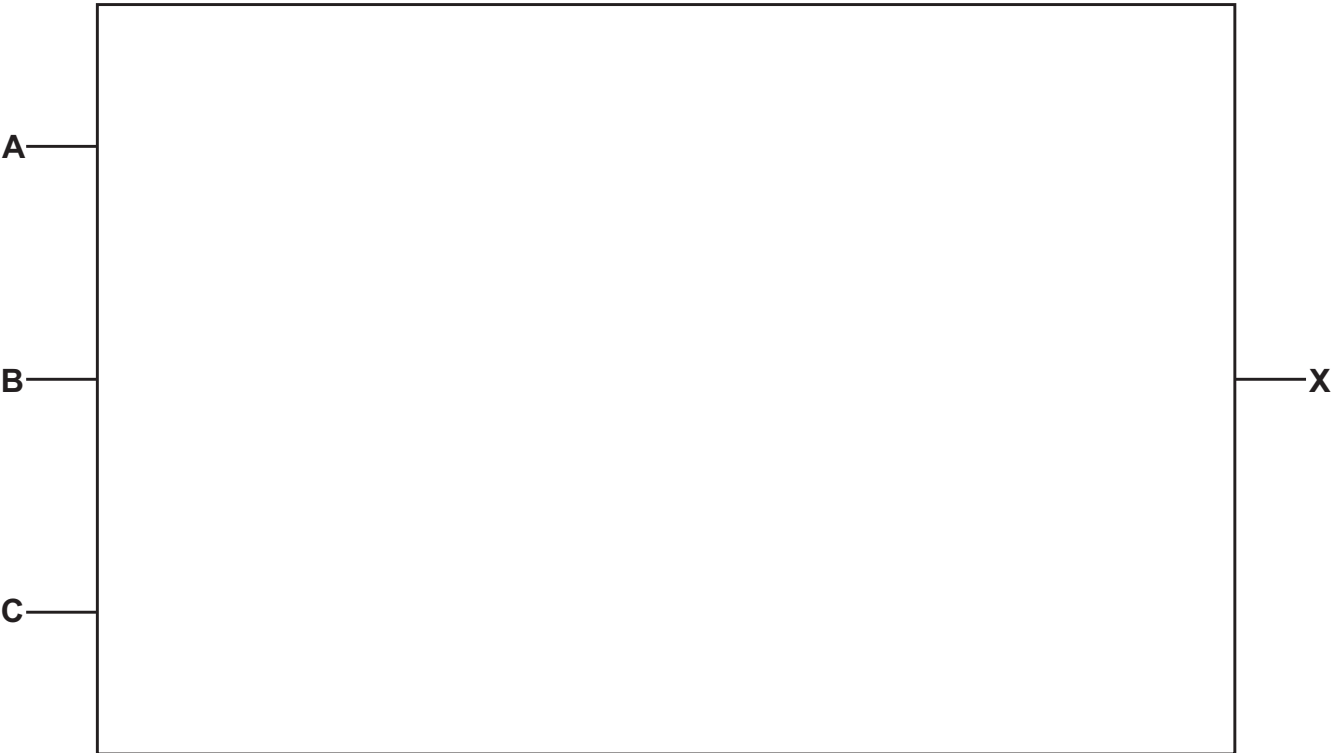


3 (a) Draw a logic circuit for the logic expression:

$$X = \text{NOT } ((A \text{ NAND } B) \text{ XOR } (\text{NOT } A \text{ OR } \text{NOT } C))$$



[2]

(b) Write the logic expression for the following truth table.

R	S	T	Q
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	0

Q = [2]

3 (a) Complete the truth table for the following logic expression:

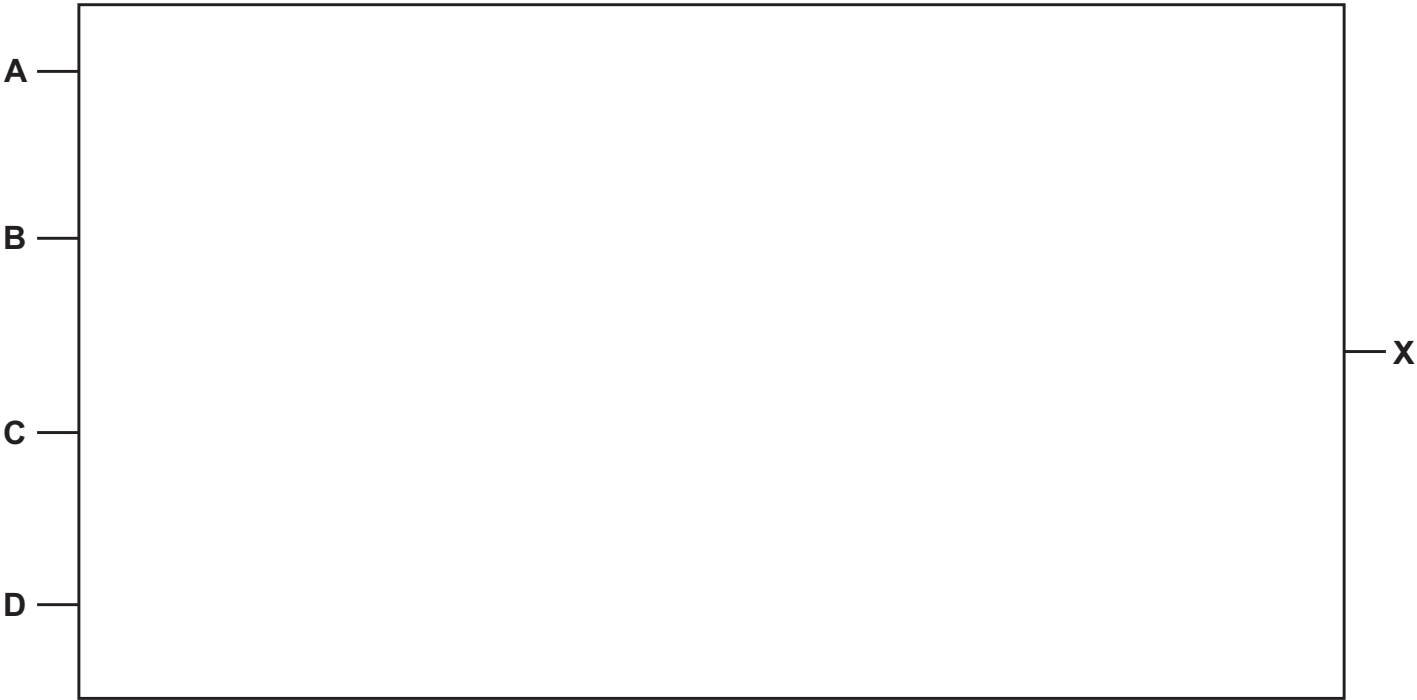
$$X = (A \text{ NOR } B) \text{ NAND } (C \text{ XOR } B)$$

A	B	C	Working space	X
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

[2]

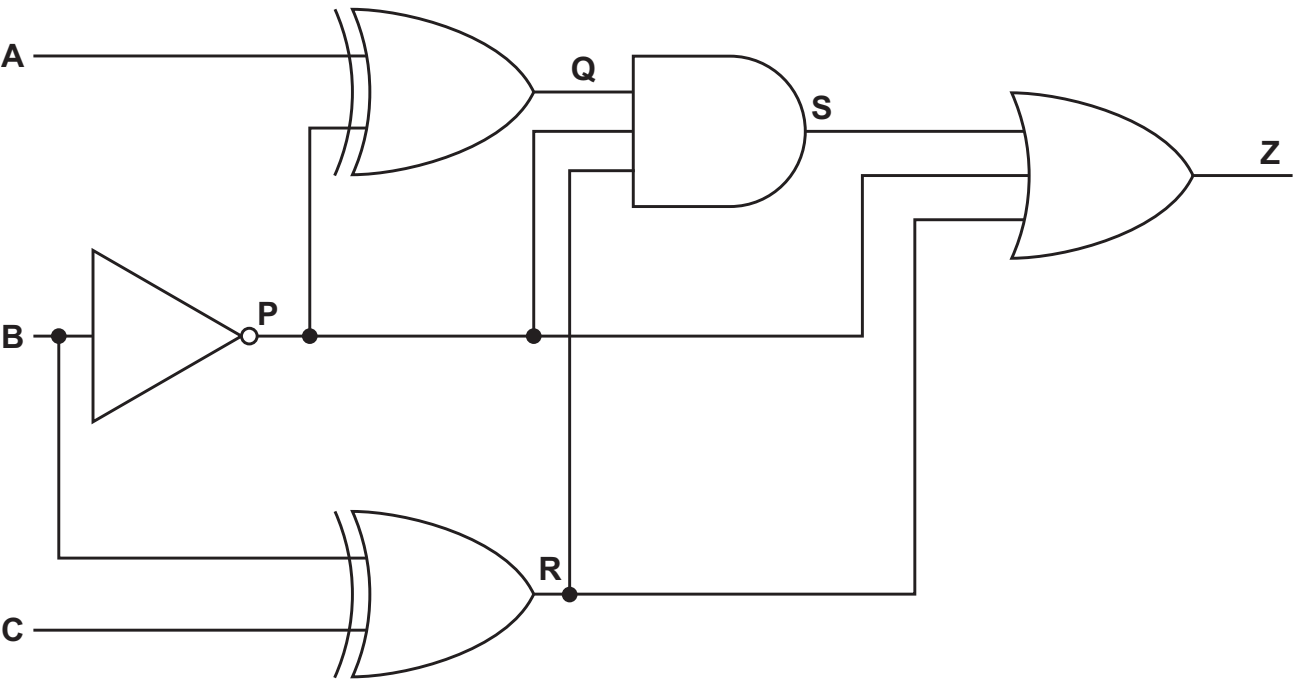
(b) Draw a logic circuit for the logic expression:

$$X = \text{NOT } (((A \text{ AND } B) \text{ OR } C) \text{ AND } (C \text{ NOR } D))$$



[2]

6 (a) The diagram shows a logic circuit.



Complete the truth table for the given logic circuit.
Show your working.

			Working space				
A	B	C	P	Q	R	S	Z
0	0	0					
0	0	1					
0	1	0					
0	1	1					
1	0	0					
1	0	1					
1	1	0					
1	1	1					

[3]

(b) (i) Complete the Karnaugh map (K-map) for the Boolean expression:

$$\bar{A}.\bar{B}.C + \bar{A}.B.C + A.\bar{B}.C + A.B.\bar{C}$$

		BC			
A	0	00	01	11	10
	1				

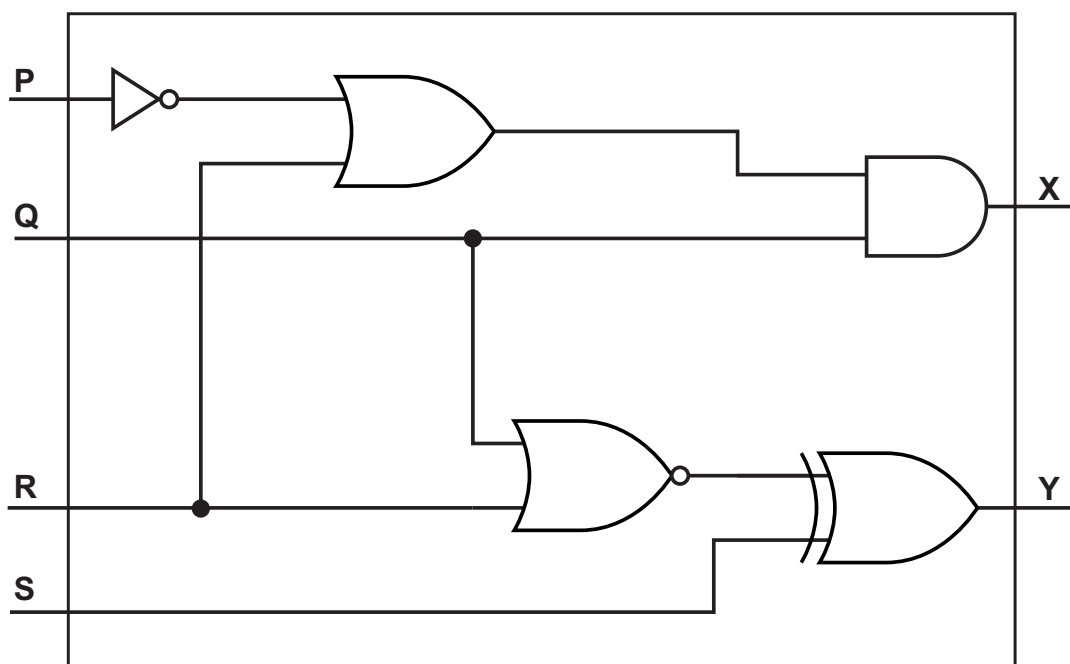
[2]

(ii) Draw loop(s) around appropriate group(s) in the K-map to produce an optimal sum-of-products. [2]

(iii) Write the Boolean expression from your answer to part **b(ii)** as a simplified sum-of-products. Do **not** carry out any further simplification.

.....
 [2]

1 (a) Write the logic expressions for the following logic circuit.

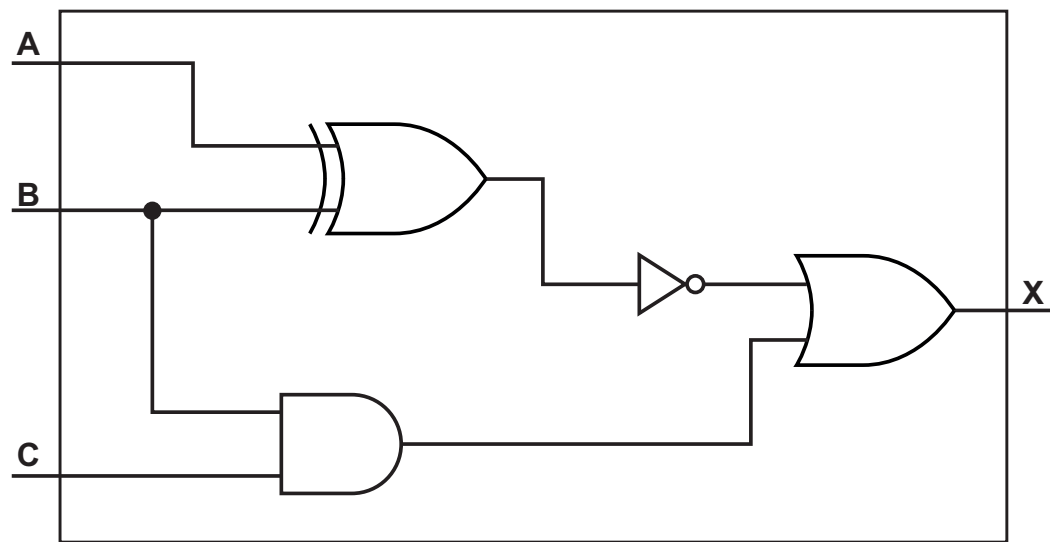


X =

Y =

[2]

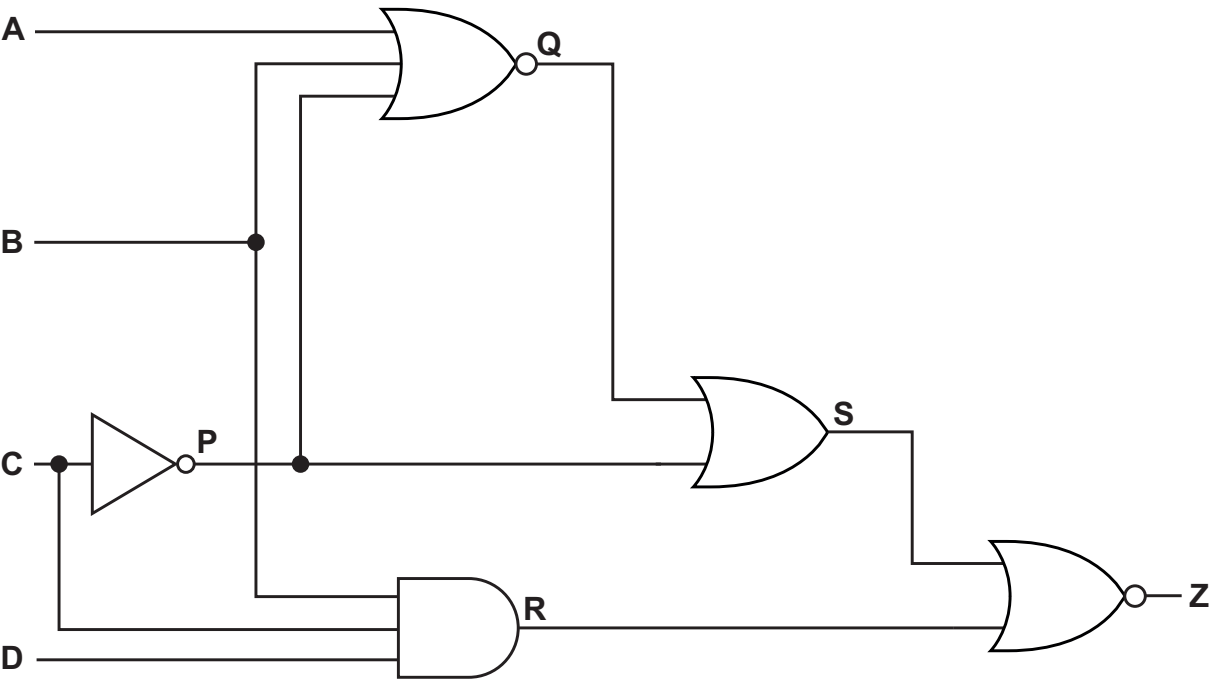
(b) Complete the truth table for the following logic circuit.



A	B	C	Working space	X
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

[2]

7 The diagram shows a logic circuit.



(a) Complete the truth table for the given logic circuit.
Show your working.

				Working space				
A	B	C	D	P	Q	R	S	Z
0	0	0	0					
0	0	0	1					
0	0	1	0					
0	0	1	1					
0	1	0	0					
0	1	0	1					
0	1	1	0					
0	1	1	1					
1	0	0	0					
1	0	0	1					
1	0	1	0					
1	0	1	1					
1	1	0	0					
1	1	0	1					
1	1	1	0					
1	1	1	1	6				

(b) Write the Boolean logic expression that corresponds to the given logic circuit as the sum-of-products.

Z =
..... [1]

(c) Use Boolean algebra including De Morgan’s laws to simplify the following expression.
Show all working.

$$\overline{(A + B)} \cdot (\overline{A \cdot B} + \overline{B \cdot C})$$

Working
.....
.....
.....
.....
.....

Simplified expression
..... [4]

3 This truth table represents a logic circuit.

INPUT				OUTPUT
A	B	C	D	Z
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

(a) Write the Boolean logic expression that corresponds to the given truth table as the sum-of-products.

Z =
..... [2]

(b) (i) Complete the Karnaugh map (K-map) for the given truth table.

		AB			
		00	01	11	10
CD	00				
	01				
	11				
	10				

[2]

(ii) Draw loop(s) around appropriate group(s) in the K-map to produce an optimal sum-of-products. [2]

(iii) Write the Boolean logic expression from your answer to part (b)(ii) as the simplified sum-of-products.

Z =
..... [2]

5 A security system has both a floodlight (very bright light) and an audio alarm.

The data from multiple sensors is analysed and used to:

- turn on the floodlight
- sound the audio alarm.

Sensors can be used to detect:

- if doors are open
- the external daylight level
- if people are detected within a set distance.

(a) Complete the table to identify the most appropriate type of sensor for each scenario.

Scenario	Type of sensor
A door is open.	
The external daylight level is below a set amount.	
A person is detected within 2 metres.	

[1]

(b) The floodlight (X) and audio alarm (Y) operate according to the following criteria:

Parameter	Description of parameter	Binary value	Condition
A	external daylight level	1	Low
		0	High
B	front door	1	Open
		0	Closed
C	person is within 2 m	1	Detected
		0	Not detected
D	back door	1	Open
		0	Closed
E	security system	1	Switched on
		0	Switched off

The floodlight turns on (X = 1) if:

- the security system is switched on
and
- the external daylight level is low
and
- a person is detected within 2 m.

The audio alarm turns on (Y = 1) if:

- the security system is switched on
and
- one or more doors are open, or a person is detected within 2 m.

Write logic expressions for the security system.

X =

.....

Y =

.....

[2]

(c) Explain whether the security system is an example of a monitoring system or a control system.

.....

.....

.....

.....

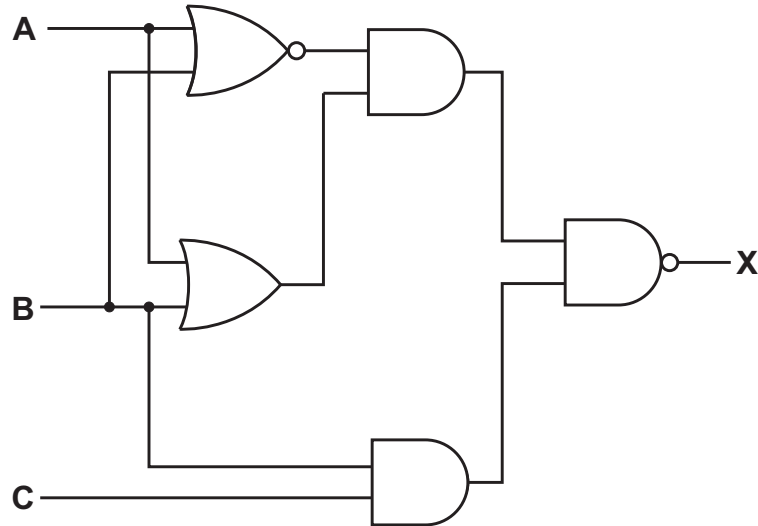
.....

11

1 (a) Describe the operation of a 2-input XOR gate.

.....
 [1]

(b) Write the logic expression for the following logic circuit.



X =
 [2]

(c) Draw the logic circuit for the logic expression:

$$X = ((\text{NOT } A \text{ AND } (B \text{ AND } C)) \text{ OR } (B \text{ NAND } C)) \text{ AND NOT } A$$



[2]

1 (a) Describe the operation of each of the following logic gates:

NAND

.....

NOR

.....

XOR

.....

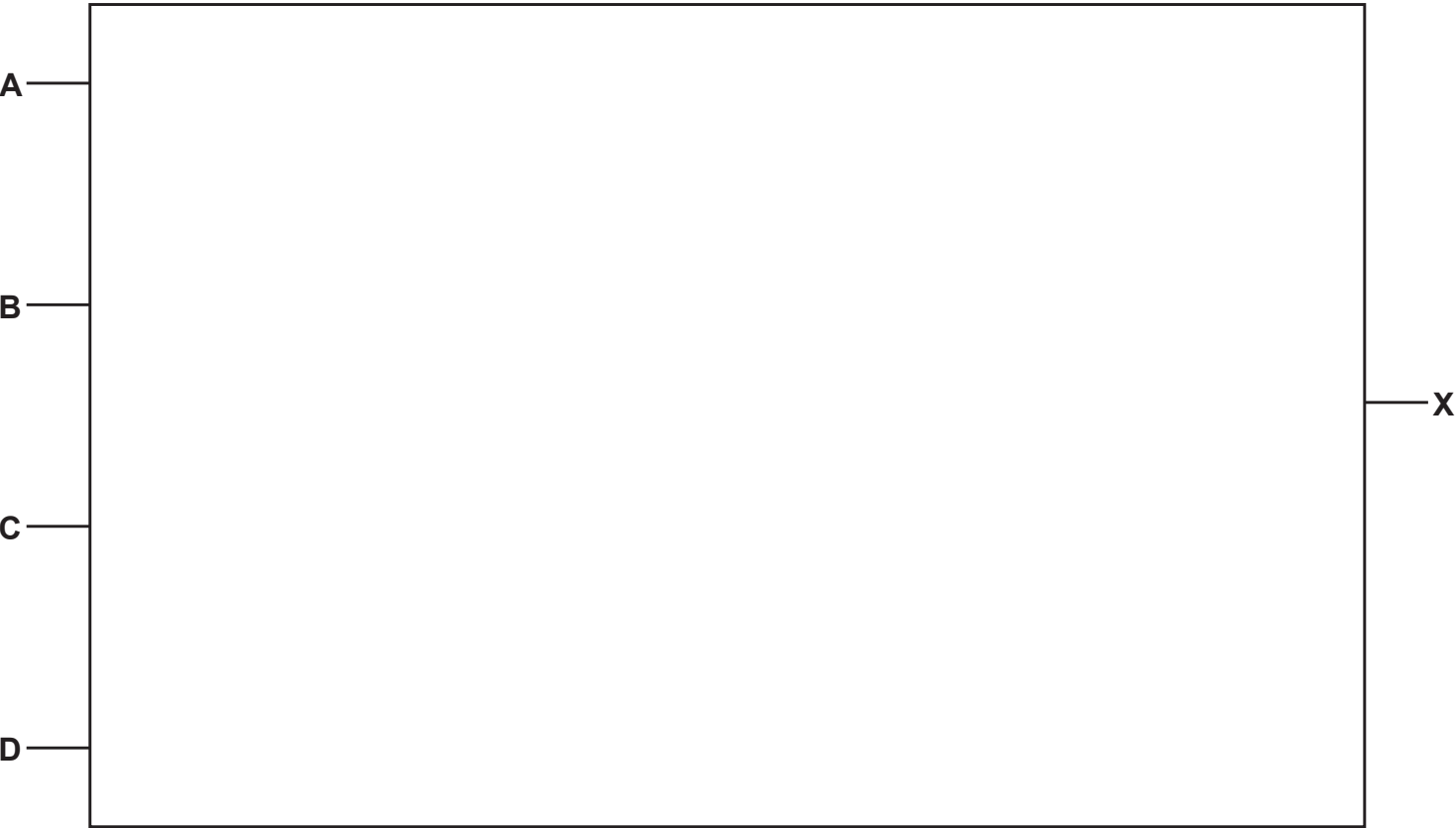
OR

.....

[4]

(b) Draw a logic circuit for this logic expression:

$$X = \text{NOT } ((A \text{ AND } B) \text{ OR } (C \text{ AND } D))$$



[2]