

- 7 A system is monitored using sensors. The sensors output binary values corresponding to physical conditions, as shown in the table:

Parameter	Description of parameter	Binary value	Description of condition
P	oil pressure	1	pressure \geq 3 bar
		0	pressure $<$ 3 bar
T	temperature	1	temperature \geq 200°C
		0	temperature $<$ 200°C
R	rotation	1	rotation \leq 1000 revs per minute (rpm)
		0	rotation $>$ 1000 revs per minute (rpm)

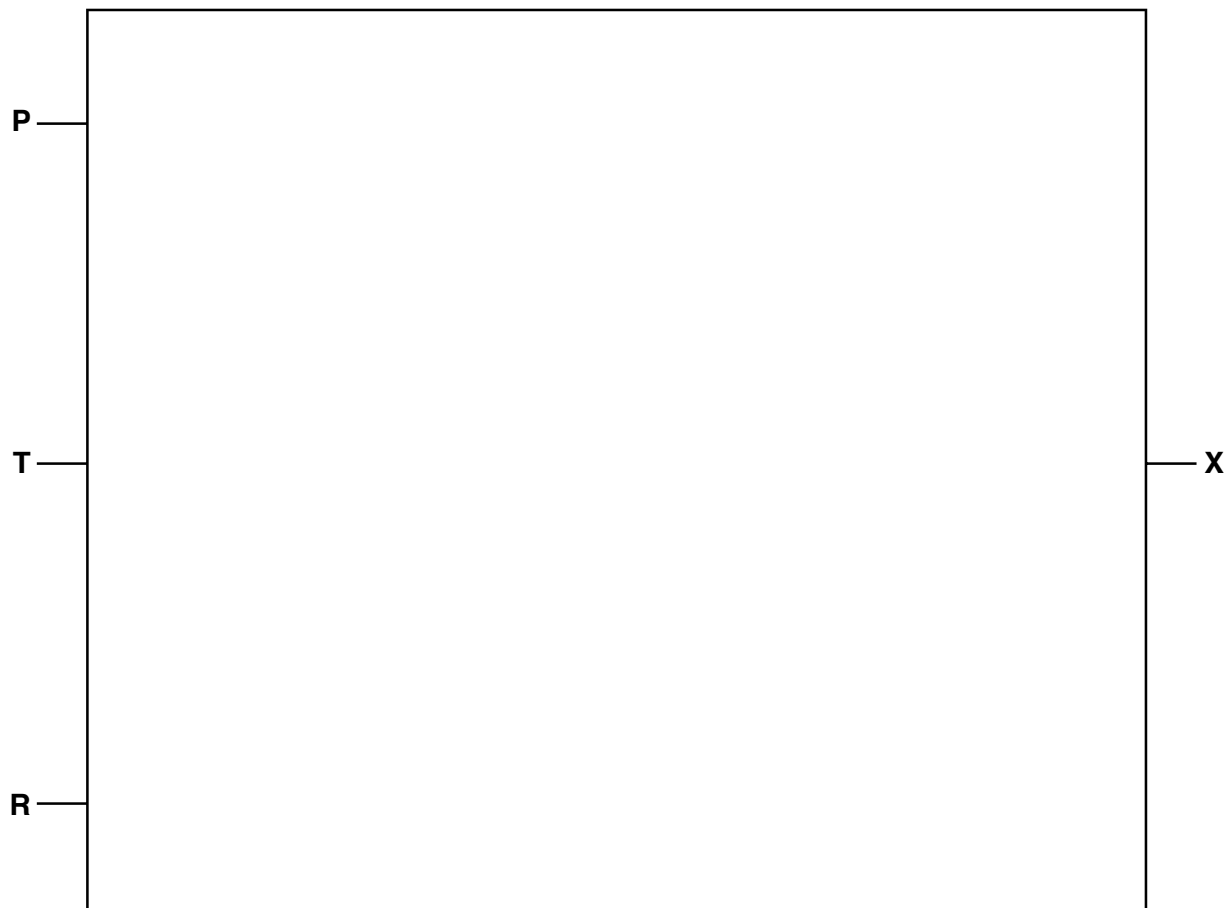
The outputs of the sensors form the inputs to a logic circuit. The output from the circuit, X, is 1 if any of the following three conditions occur:

either oil pressure \geq 3 bar **and** temperature \geq 200°C

or oil pressure $<$ 3 bar **and** rotation $>$ 1000 rpm

or temperature \geq 200°C **and** rotation $>$ 1000 rpm

- (a) Draw a logic circuit to represent the above system.



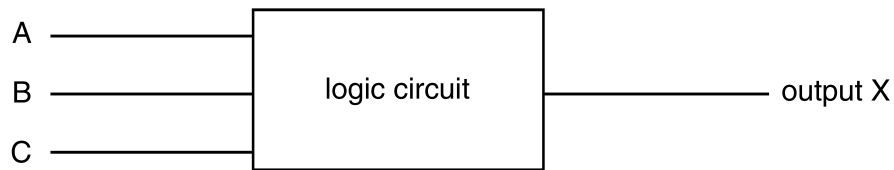
(b) Complete the truth table for this system.

P	T	R	Workspace	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		

[4]

- 6 (a) Three digital sensors A, B and C are used to monitor a process. The outputs from the sensors are used as the inputs to a logic circuit.

A signal, X, is output from the logic circuit:



Output, X, has a value of 1 if either of the following two conditions occur:

- sensor A outputs the value 1 OR sensor B outputs the value 0
- sensor B outputs the value 1 AND sensor C outputs the value 0

Draw a logic circuit to represent these conditions.



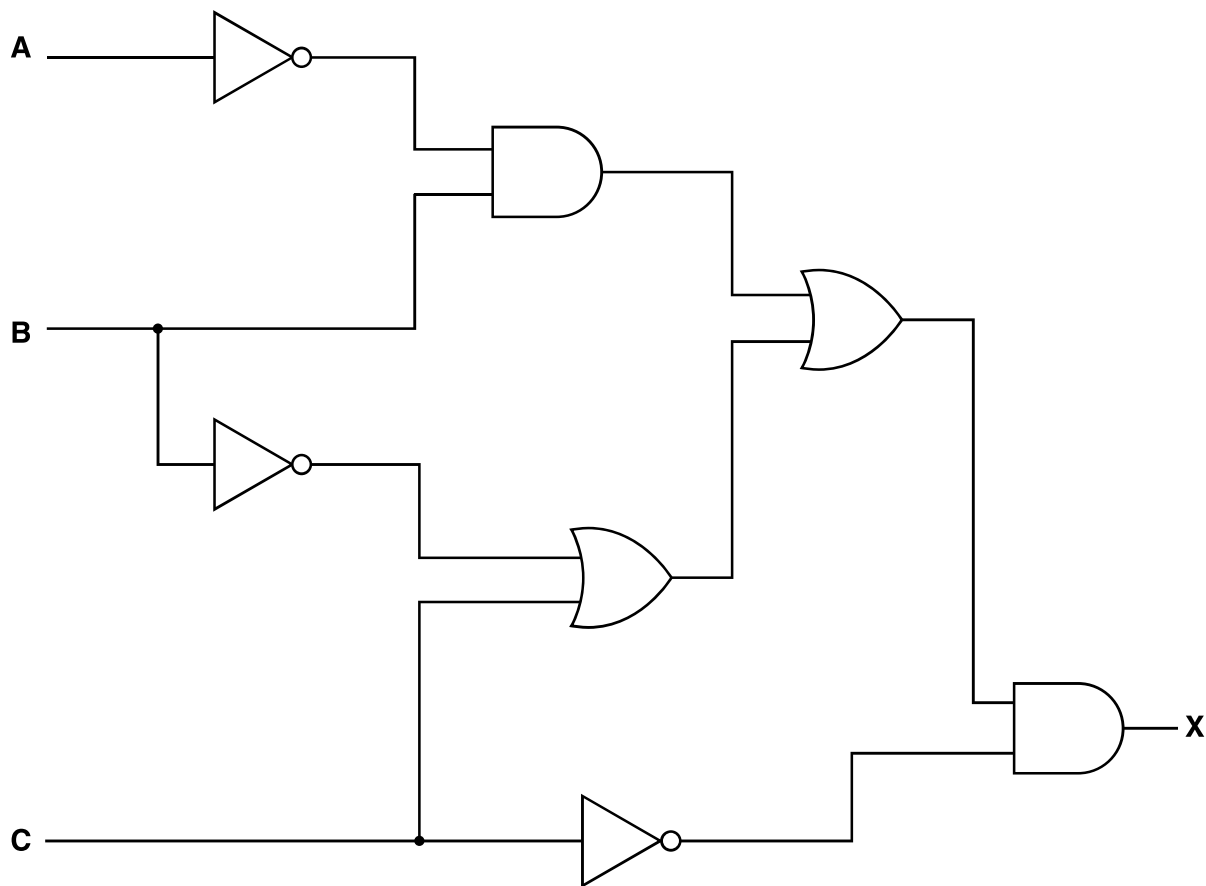
[5]

(b) Complete the truth table for the logic circuit described in **part (a)**.

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		

[4]

(c) Write a logic statement that describes the following logic circuit.



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..... [3]

- 4 (a) An alarm system (X) is enabled and disabled using either a switch (A) or a remote control (B). There are **two** infra-red sensors (C, D) and **one** door pressure sensor (E).

Parameter	Description of parameter	Binary value	Condition
A	Switch	1	Switch enabled
		0	Switch disabled
B	Remote control	1	Remote enabled
		0	Remote disabled
C	Infra-red sensor	1	Activated
		0	Not activated
D	Infra-red sensor	1	Activated
		0	Not activated
E	Door pressure sensor	1	Activated
		0	Not activated

The alarm sounds ($X = 1$) if the alarm is enabled **and** any one or more of the sensors is activated.

Draw a logic circuit to represent the alarm system.



[3]

(b) Complete the truth table for the logic expression: $X = A \text{ OR } (B \text{ XOR } C)$

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		

[4]

- 2 (a) A greenhouse control system has four input parameters (H, D, T, W) and two outputs (X, Y).

Parameter	Description of parameter	Binary value	Condition
H	Humidity	0	Too low
		1	Acceptable
D	Day	0	Night
		1	Day
T	Temperature	0	Too high
		1	Acceptable
W	Windows	0	Closed
		1	Open

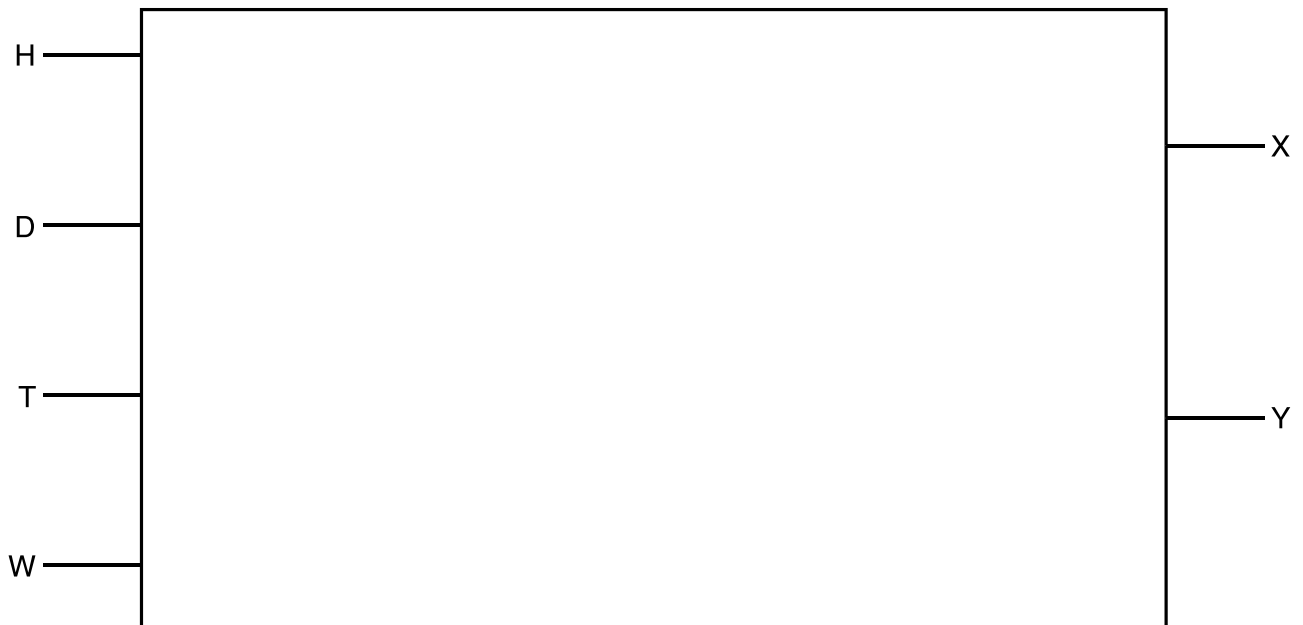
The watering system turns on ($X = 1$) if:

either it is daytime **and** the temperature is too high

or the humidity is too low.

The fan turns on ($Y = 1$) if the temperature is too high **and** the windows are closed.

Draw a logic circuit to represent the greenhouse control system.



[6]

(b) Complete the truth table for the logic expression: $X = \text{NOT } A \text{ AND } (B \text{ NAND } C)$

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		

[4]

- 5 (a) A student needs to design a logic circuit to model the requirements for membership of a snooker club. Membership (X) depends on four criteria, as shown in the table:

Parameter	Description of parameter	Binary value	Condition
A	Over 18	1	True
		0	False
B	Recommended	1	True
		0	False
C	Full-time	1	True
		0	False
D	Retired	1	True
		0	False

Membership is approved ($X = 1$) if the person:

- is over the age of 18 **and** has been recommended by a pre-existing member **and**
- **either** is working full-time **or** is retired, but not both.

Draw a logic circuit to represent the membership requirements.



[3]

(b) Complete the truth table for the logic expression: $X = (A \text{ XOR } B) \text{ AND NOT } C$

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		

[4]

- 6 (a) Draw a logic circuit to represent the logic expression:

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



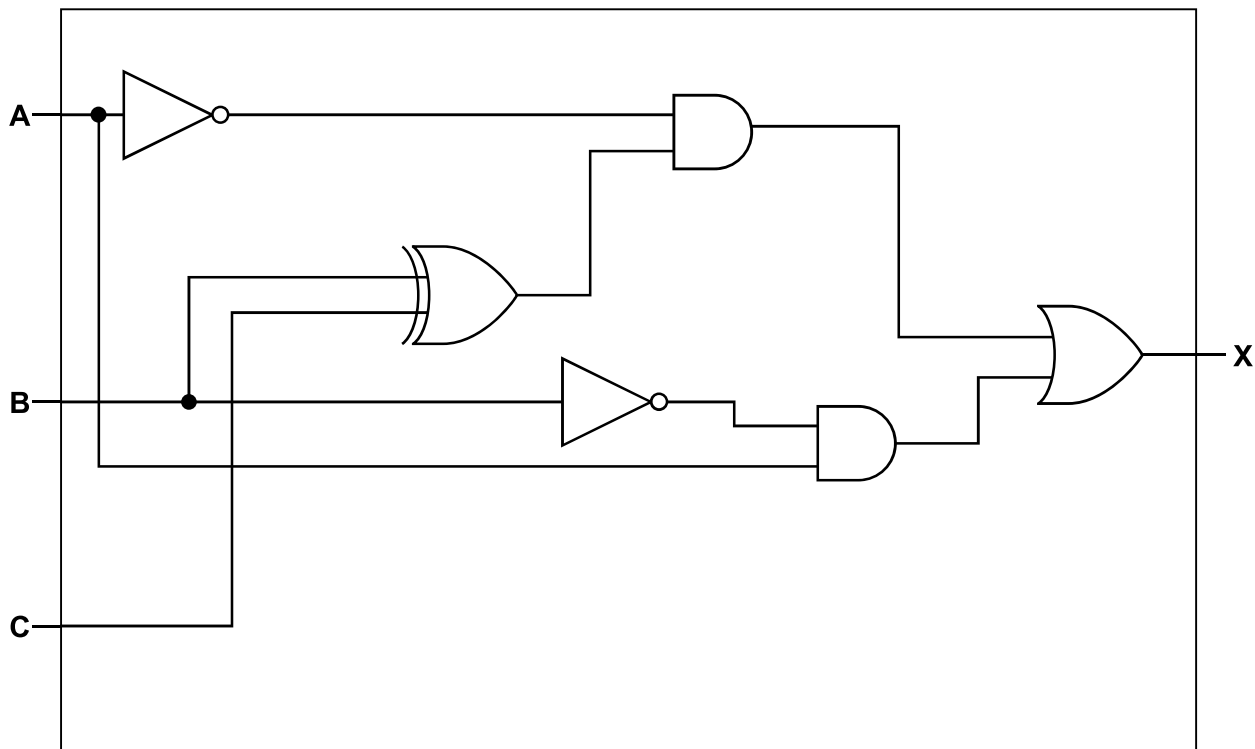
[5]

- (b) Complete the truth table for the logic expression in part (a).

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		

[4]

5 (a) A logic circuit is given:



Complete the following truth table for the 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		

[4]

(b) Identify **one** logic gate not used in the logic circuit in **part (a)**.

Draw the symbol for this logic gate **and** complete its truth table.

Logic gate:

Symbol:

Truth table:

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

[3]

- 3 (a) The following is a logic expression.

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

Draw the logic circuit for the given expression, using a maximum of **four** logic gates.



[4]

(b) Complete the truth table for the logic expression:

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

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		

[4]

(c) The following is a logic expression.

$$A \text{ AND } B \text{ XOR } C \text{ OR NOT } A$$

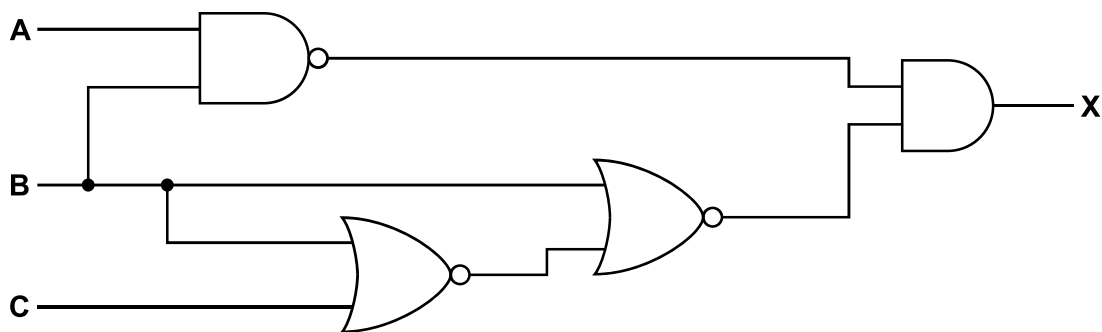
Identify **one** logic gate that would **not** be used in the logic circuit for this expression.
 Draw the symbol for the logic gate.

Logic gate

Logic gate symbol:

[2]

4 Consider the following logic circuit:



(a) Complete the truth table for the 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		

[4]

(b) Identify **three** logic gates **not** used in the logic circuit.

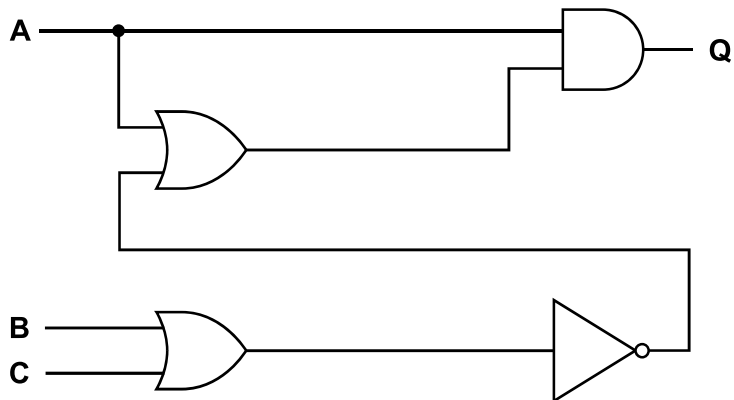
Gate 1

Gate 2

Gate 3

[1]

1 Consider the following logic circuit:



(a) Complete the truth table for the logic circuit.

A	B	C	Working space	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		

[4]

(b) Identify the **three** logic gates used in the given logic circuit.

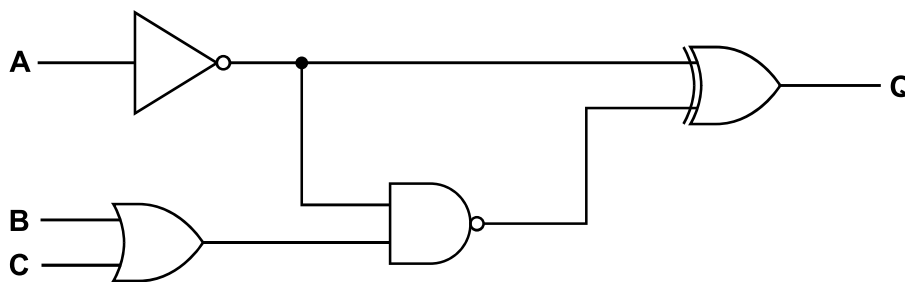
Gate 1

Gate 2

Gate 3

[1]

2 Consider the following logic circuit:



(a) Complete the truth table for the logic circuit.

A	B	C	Working space	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		

[4]

(b) Identify **four** logic gates used in the logic circuit above.

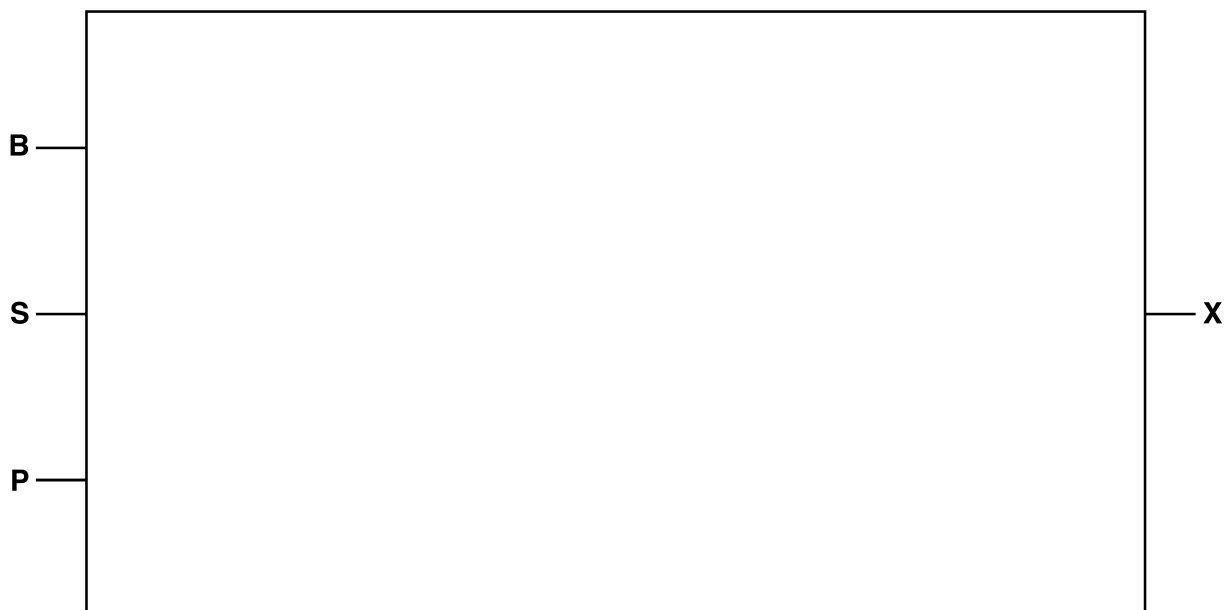
- 1
- 2
- 3
- 4

[1]

- 6 (a) A student wrote the following logic statement:

X is 1 if (B is NOT 1 AND S is NOT 1) OR (P is NOT 1 AND S is 1)

Draw a logic circuit to represent the above logic statement.



[6]

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

B	S	P	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		

[4]

- 5 A motor is controlled by a logic circuit. The circuit has inputs (0 or 1) from three sensors R, T and W. The motor is switched off when the output from the logic circuit is 1.

The following table shows the three sensors and the conditions being monitored.

Sensor	Description	Binary value	Condition
R	rotation	0	rotation < 4000 rpm
		1	rotation \geq 4000 rpm
T	temperature	0	temperature \geq 90 °C
		1	temperature < 90 °C
W	water flow rate	0	water flow rate \geq 50 litre/min
		1	water flow rate < 50 litre/min

The output, X, is 1 if:

temperature \geq 90 °C and rotation \geq 4000 rpm

or

temperature < 90 °C and water flow rate \geq 50 litre/min

- (i) Draw a corresponding logic circuit.



[5]

(ii) Give a logic statement corresponding to the logic circuit in part (i).

.....
[2]

(iii) Complete the truth table for this system.

INPUT			Workspace	OUTPUT
R	T	W		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		

[4]

6 A user watches a video available on a website. The website uses on-demand bit streaming. Describe how it is possible to watch the video without it continually pausing.

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[4]

- 1 (a) A student writes the following logic expression:

$X \text{ is } 1 \text{ IF } (B \text{ is NOT } 1 \text{ AND } S \text{ is NOT } 1) \text{ OR } (P \text{ is NOT } 1 \text{ AND } S \text{ is } 1)$

Draw a logic circuit to represent this logic expression.

Do not attempt to simplify the logic expression.



[6]

- (b) Complete the truth table for the logic expression given in **part (a)**.

B	S	P	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		

[4]

- 8 (a) Draw a logic circuit to represent the logic expression:

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



[4]

- (b) Complete the truth table for the logic expression in **part (a)**.

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		

[4]

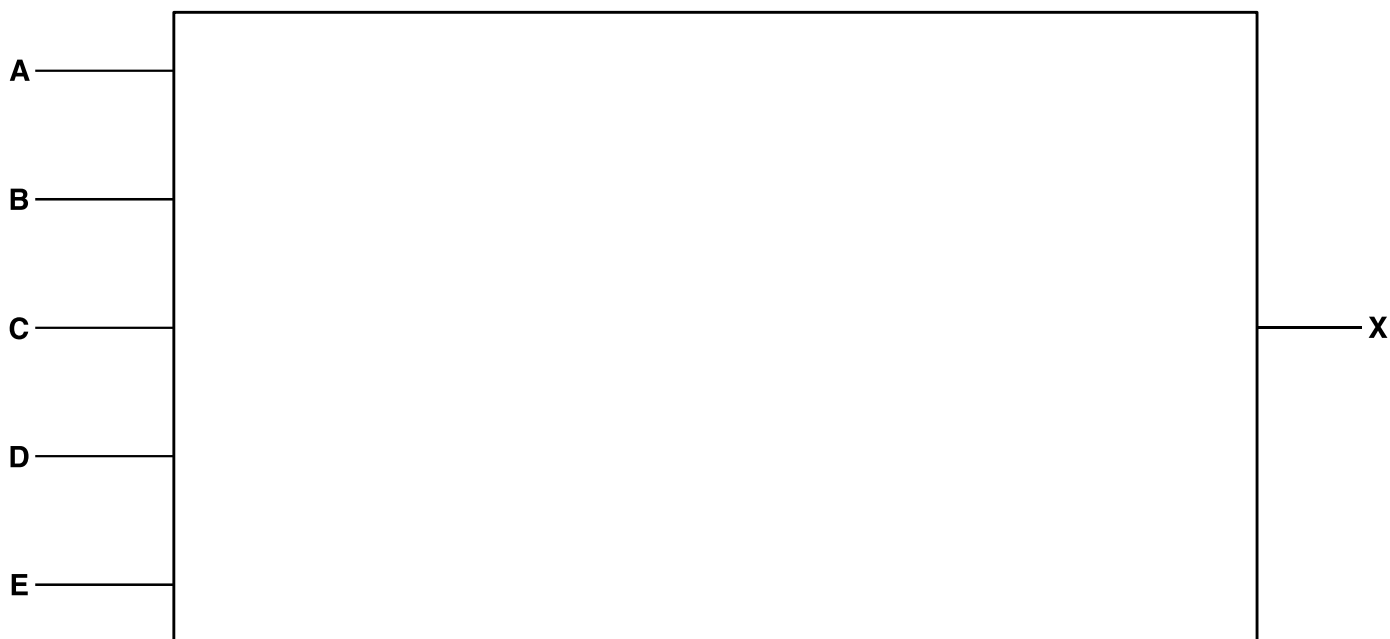
3 (a) A bank approves a customer for an account based on the criteria in the following table.

Parameter	Description of parameter	Binary value	Condition
A	Employed	1	True
		0	False
B	Self-employed	1	True
		0	False
C	Over 21	1	True
		0	False
D	Earn more than 30 000	1	True
		0	False
E	Another account	1	True
		0	False

A customer is approved ($X = 1$) if the person:

- is over 21 **and** employed
or
- is over 21 **and** self-employed **and**
 - **either** earns more than 30 000
or
 - has another account.

Draw a logic circuit to represent the model.



[5]

(b) Complete the truth table for the logic expression:

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

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		

[4]

- 2 (a) Draw a logic circuit to represent the following logic expression:

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



[4]

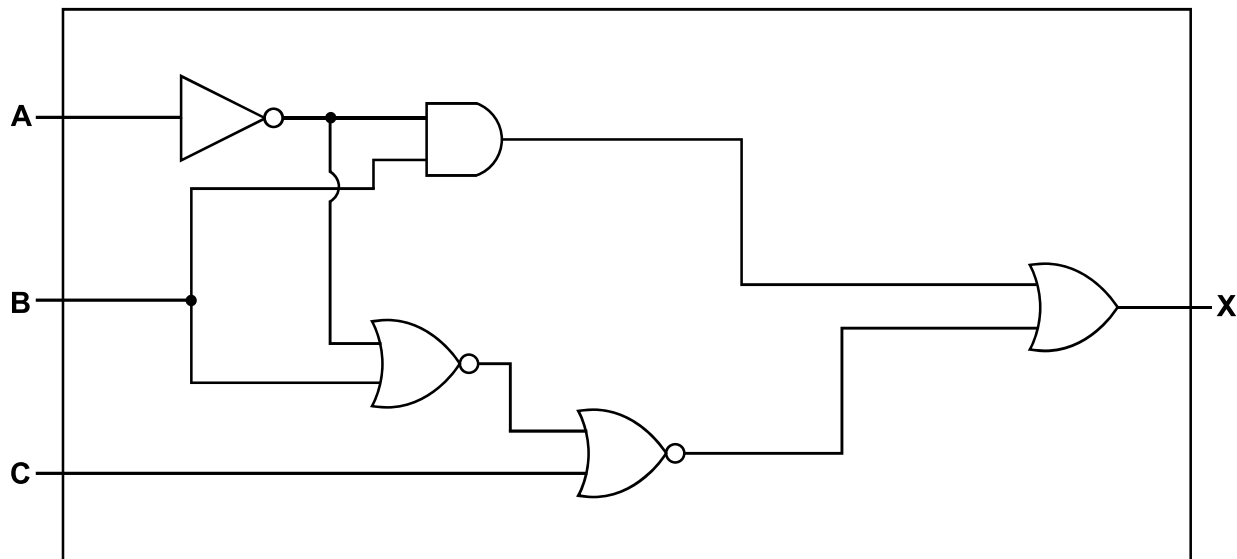
- (b) Complete the truth table for the logic expression:

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

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		

[4]

8 Consider the following logic circuit.



(a) Complete the truth table for the 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		

[4]

(b) Identify **one** logic gate **not** used in the logic circuit shown. Complete the truth table for this logic gate with the inputs **A** and **B**.

Logic gate

A	B	Output
0	0	
0	1	
1	0	
1	1	

[2]

- 5 Complete the truth table for the following logic expression:

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

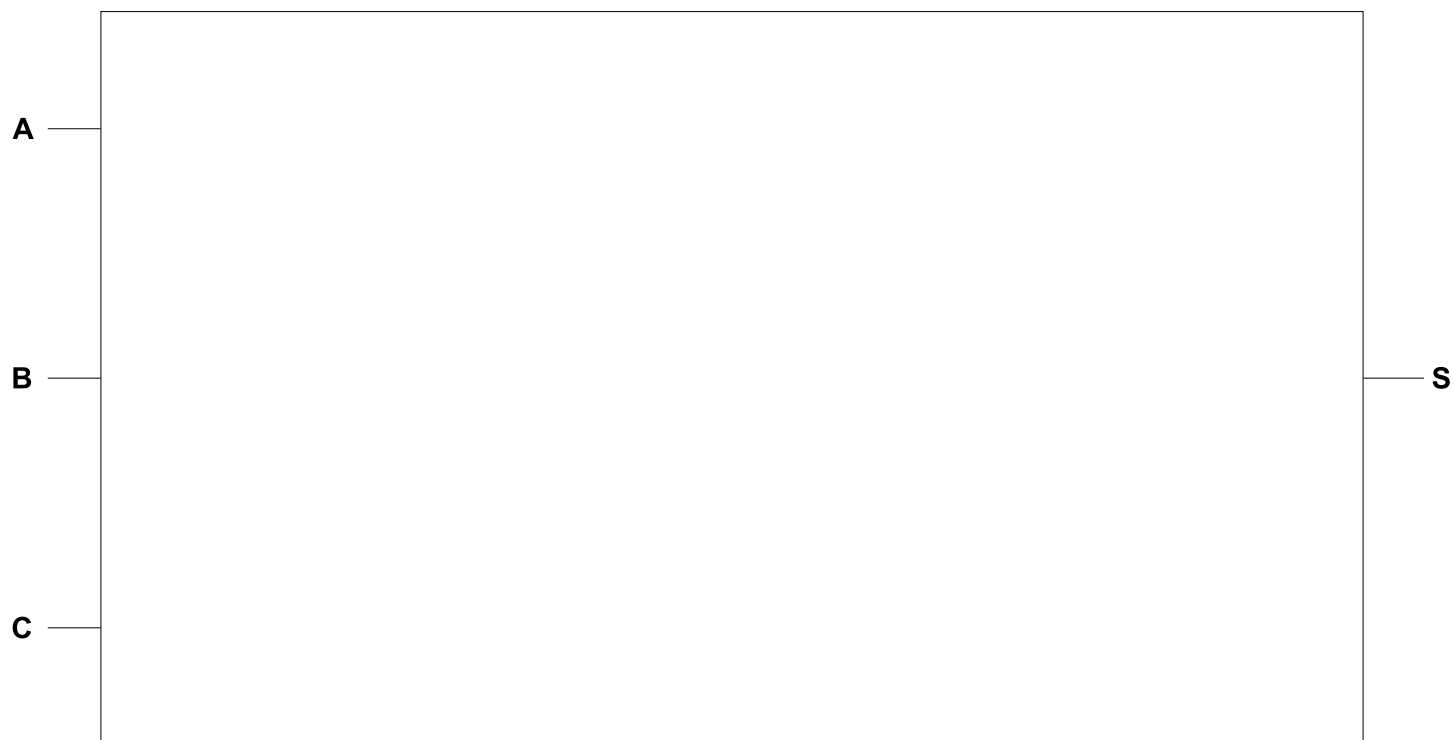
A	B	C	Working space	X
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

[4]

3 A logic expression is given:

$$S = (A \text{ AND } B \text{ AND } C) \text{ OR } (B \text{ XOR } C)$$

(a) Draw the logic circuit for the given expression.



[4]

(b) Complete the truth table for the logic expression:

$$S = (A \text{ AND } B \text{ AND } C) \text{ OR } (B \text{ XOR } C)$$

A	B	C	Working space	S
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]

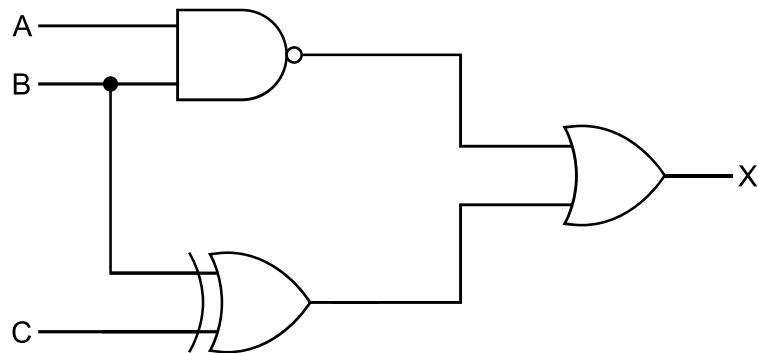
(c) Computers consist of logic gates.

(i) Complete the table by writing **one** set of values (input 1 and input 2) for each gate that will give the output 1.

Gate	Input 1	Input 2	Output
AND			1
NAND			1
XOR			1
NOR			1

[4]

(ii) Write the logic expression for the given logic circuit.



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 [3]

7 Complete the truth table for the following logic expression:

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

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]

8 Describe **one** application of Artificial Intelligence (AI).

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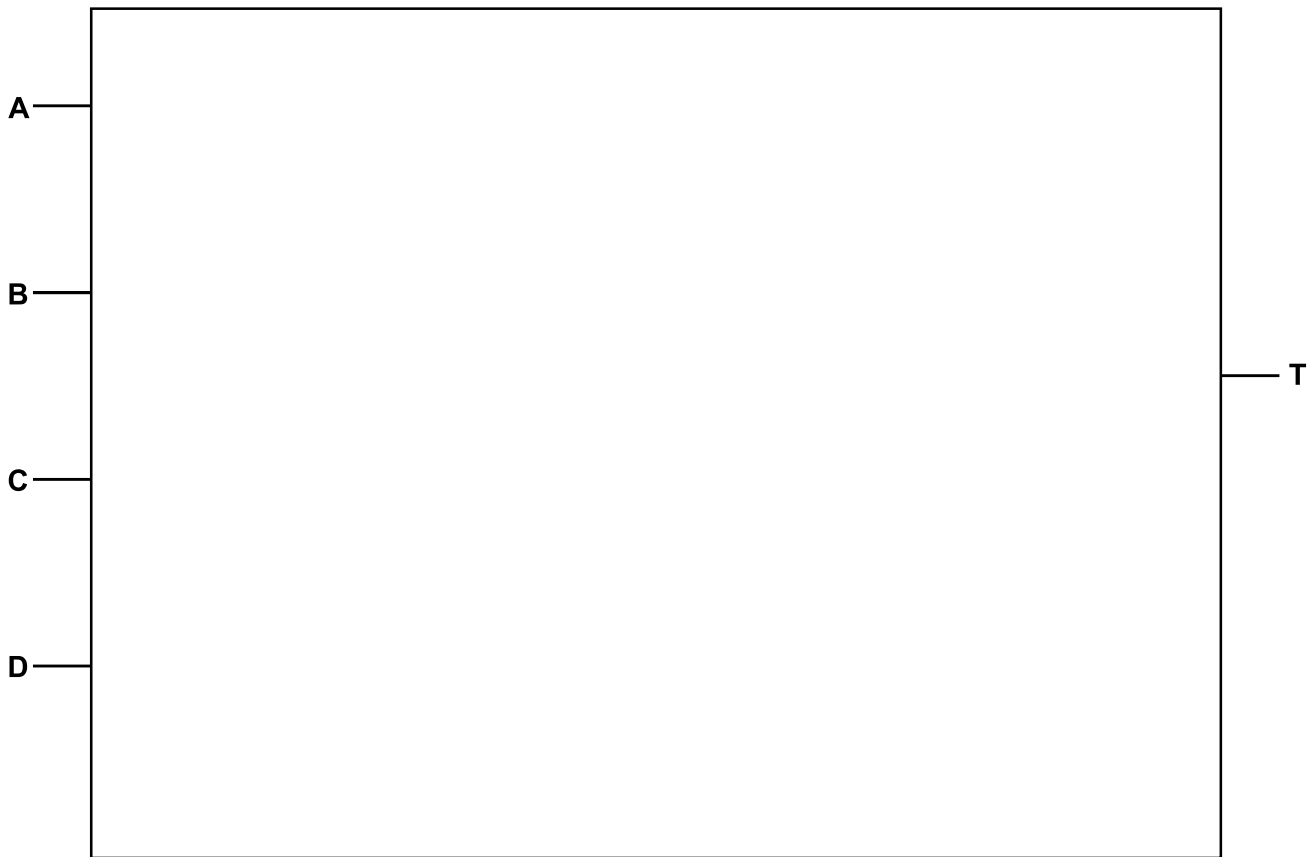
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..... [3]

5 (a) Draw the logic circuit for this logic expression:

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



[2]

(b) Describe the function of the NAND and NOR logic gates.

NAND

.....

NOR

.....

[2]

- 6 (a) Draw the logic circuit for this logic expression:

$$Z = (R \text{ XOR } S) \text{ AND } (\text{NOT } T \text{ NOR } P)$$



[2]

- (b) Complete the truth table for this logic expression:

$$Z = (\text{NOT } P \text{ OR } Q) \text{ XOR } (R \text{ NOR } Q)$$

P	Q	R	Working space	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		

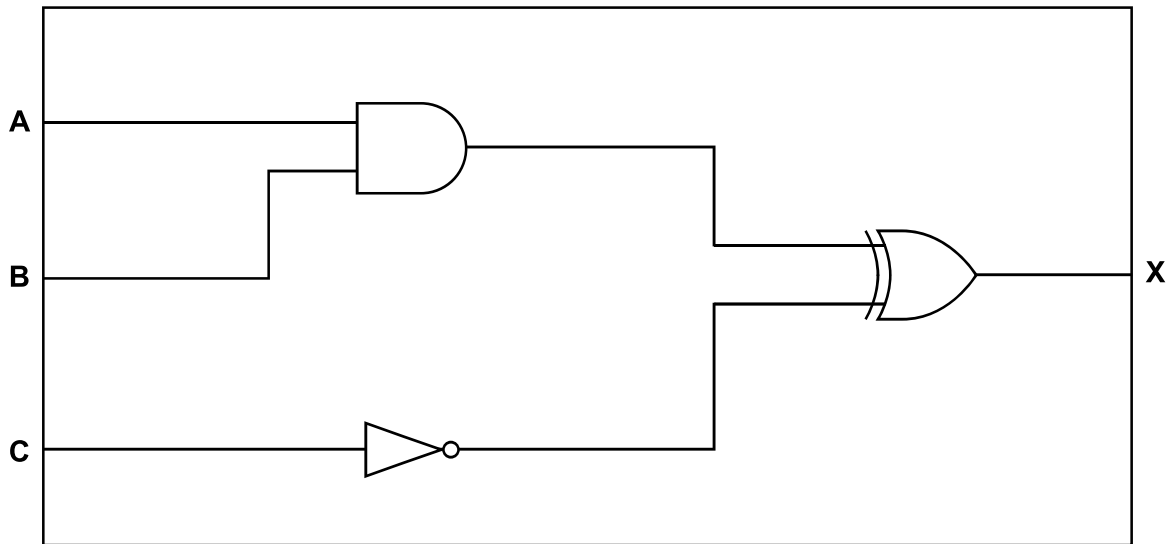
[2]

1 (a) Write the logic expression for this truth table:

A	B	C	X
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

..... [1]

(b) Complete the truth table for this 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]