CAMBRIDGE IGCSE (0478)

Module Q: Boolean logic

Workbooklet · 7 parts · 147 marks

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	Total	**147**

MODULE Q BOOLEAN LOGIC · Q1

Logic gates: AND, OR and NOT

Original practice questions · 20 marks · ~25 minutes · Cambridge 0478 syllabus 10.1, 10.2, 10.3

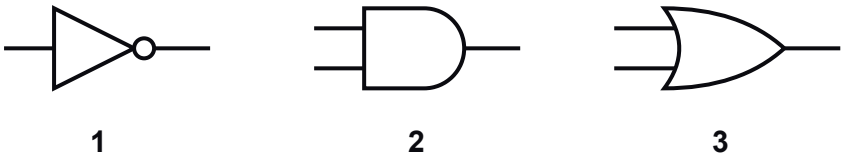
Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**. Use the standard logic gate symbols when you draw a logic circuit. All scenarios are made up.

1

Total: 3 marks

(a) Identify the logic gate shown by each symbol. **[3]**



Symbol 1 _____

Symbol 2 _____

Symbol 3 _____

2

Total: 3 marks

(a) Complete the table by writing the name of the logic gate (AND, OR or NOT) that each description matches. **[3]**

Description	Logic gate
The output is 1 only when both inputs are 1.	
The output is the opposite of its single input.	
The output is 0 only when both inputs are 0.	

3

Total: 4 marks

(a) Complete the truth table to show the output of an AND gate and of an OR gate for every combination of inputs A and B. **[4]**

A	B	A AND B	A OR B
0	0		
0	1		
1	0		
1	1		

4 **Total: 3 marks**

A sign at the entrance of a car park lights up (X = 1) when the car park is **not** full. A sensor gives input **F**: F = 1 when the car park is full and F = 0 when it is not full.

(a) Write the logic expression for X. **[1]**

X =

(b) Draw the logic circuit for the sign. Connect input F to output X. **[2]**



5 **Total: 7 marks**

A cold store in a food warehouse has a warning buzzer. The buzzer sounds (X = 1) if the door is open **or** the temperature is above the safe limit.

Input	Input of 1 means	Input of 0 means
D	the door is open	the door is closed
T	the temperature is above the safe limit	the temperature is at or below the safe limit

(a) Write the logic expression for this problem statement. **[1]**

X =

(b) Draw the logic circuit for the buzzer. Connect inputs D and T to output X. **[2]**



(c) State the output X when D = 0 and T = 1. **[1]**

(d) Explain why an AND gate would **not** be suitable for this buzzer. Use one combination of input values in your answer. **[3]**

Total for this worksheet: 20 marks

MODULE Q BOOLEAN LOGIC · Q2

NAND, NOR and XOR gates

Original practice questions · 21 marks · ~25 minutes · Cambridge 0478 syllabus 10.1, 10.2, 10.3

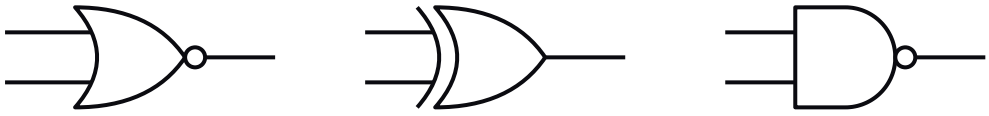
Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **21 marks**. In every logic circuit, NOT has one input and every other logic gate has exactly two inputs. All scenarios on this sheet are made up.

1

Total: 3 marks

Here are the symbols for three logic gates.



Gate 1 Gate 2 Gate 3

(a) Identify each logic gate. **[3]**

Symbol	Name of logic gate
Gate 1	
Gate 2	
Gate 3	

2

Total: 3 marks

(a) Complete the truth table to show the output of each logic gate for every combination of the inputs A and B. **[3]**

A	B	A NAND B	A NOR B	A XOR B
0	0			
0	1			
1	0			
1	1			

3 **Total: 4 marks**

(a) Describe the function of a NAND gate. **[2]**

(b) Explain how the output of an XOR gate is different from the output of an OR gate. **[2]**

4 **Total: 5 marks**

A loading bay has two roller doors. A control system uses these inputs:

Input	Binary value	Condition
A	1	Door A is open
	0	Door A is closed
B	1	Door B is open
	0	Door B is closed

It has three outputs:

- the heater **H** is on (1) when neither door is open
- the indicator lamp **L** is on (1) when either door A or door B is open, but not both
- the ready signal **R** is 1 except when both doors are open.

(a) Write a logic expression for each output. **[3]**

H =

L =

R =

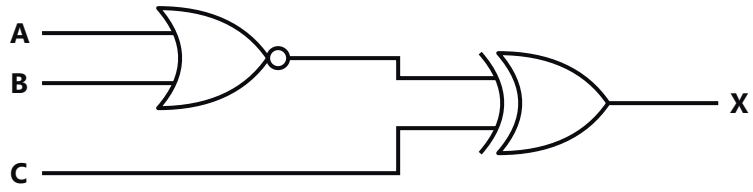
(b) Draw the logic gate for the heater H and the logic gate for the indicator lamp L. Use **one** logic gate for each output. **[2]**





5 **Total: 6 marks**

Consider this logic circuit.



(a) Write the logic expression for this logic circuit. **[2]**

X =

(b) Complete the truth table for this logic circuit. **[4]**

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		

Total for this worksheet: 21 marks

MODULE Q BOOLEAN LOGIC · Q3

Truth tables for single gates

Original practice questions · 22 marks · ~25 minutes · Cambridge 0478 syllabus 10.1, 10.2, 10.3(b), 10.3(c)

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. Write truth table values as 1 and 0. Use the gate names **NOT**, **AND**, **OR**, **NAND**, **NOR** and **XOR**. The total for this worksheet is **22 marks**.

1

Total: 3 marks

(a) State what is shown by a truth table for a logic gate. **[1]**

(b) State the number of rows needed, not counting the heading row, in the truth table for: **[2]**

(i) a NOT gate _____

(ii) an XOR gate _____

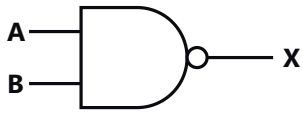
2

Total: 6 marks

Three logic gate symbols are shown. Each gate has output X.

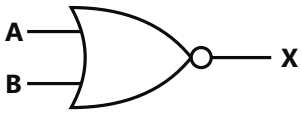
(a) Complete the truth table for **each** gate. **[6]**

Gate 1



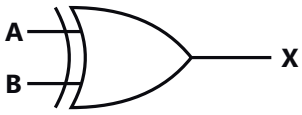
A	B	X
0	0	
0	1	
1	0	
1	1	

Gate 2



A	B	X
0	0	
0	1	
1	0	
1	1	

Gate 3



A	B	X
0	0	
0	1	
1	0	
1	1	

3 **Total: 4 marks**

The table shows the outputs of four different logic gates, E, F, G and H, for all possible values of their inputs A and B.

A	B	Gate E	Gate F	Gate G	Gate H
0	0	1	0	0	0
0	1	0	0	1	1
1	0	0	0	1	1
1	1	0	1	0	1

(a) Identify the logic gate that has been used for each of E, F, G and H. **[4]**

Gate E .....

Gate F .....

Gate G .....

Gate H .....

4 **Total: 3 marks**

(a) Complete the truth table for a NOT gate with input A and output X. **[1]**

A	X
0	
1	

(b) Explain how the output of a NAND gate is related to the output of an AND gate when both gates have the same inputs. **[2]**

.....

.....

.....

.....

5

Total: 4 marks

A water treatment works has two pumps. A warning alarm is controlled by **one** logic gate with two inputs and one output.

Input / output	1 means	0 means
P (first pump)	the pump is running	the pump is not running
Q (second pump)	the pump is running	the pump is not running
W (alarm)	the alarm sounds	the alarm is silent

The alarm sounds when neither pump is running.

(a) Identify the logic gate needed. **[1]**

(b) Complete the truth table for the alarm. **[2]**

P	Q	W
0	0	
0	1	
1	0	
1	1	

(c) Write a logic expression for the alarm, W. **[1]**

6

Total: 2 marks

There are five logic gates that have two inputs. For two of them, the output is 0 in exactly **one** row of the truth table.

(a) Identify these **two** logic gates. For each one, give the values of inputs A and B in the row where the output is 0. **[2]**

Gate ..... **Inputs** .....

Gate ..... **Inputs** .....

Total for this worksheet: 22 marks

MODULE Q BOOLEAN LOGIC · Q4

Reading logic circuits with more than one gate

Original practice questions · 21 marks · ~25 minutes · Cambridge 0478 syllabus 10.1, 10.2, 10.3(b)(iii) and 10.3(c)(ii)

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. In every circuit, 1 means on / True and 0 means off / False. Each logic gate has a maximum of two inputs, except NOT, which has one. The total for this worksheet is **21 marks**.

1

Total: 4 marks

Fig. 1 shows a logic circuit. The output of gate 1 is labelled P.

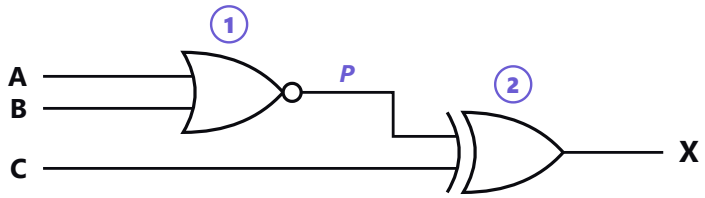


Fig. 1

(a) Identify the logic gate labelled **1** and the logic gate labelled **2** in Fig. 1. **[2]**

Gate 1	
Gate 2	

(b) The inputs are A = 0, B = 0 and C = 1. State the value of P and the value of X. **[2]**

P = ... **X =** .....

2 **Total: 4 marks**

Fig. 2 shows a logic circuit.

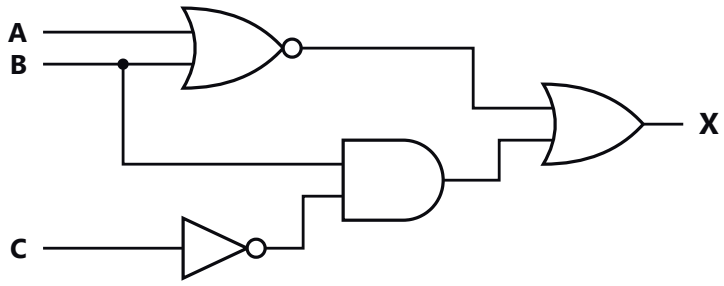


Fig. 2

(a) Complete the truth table for the logic circuit in Fig. 2. **[4]**

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		

3 **Total: 3 marks**

Fig. 3 shows a logic circuit.

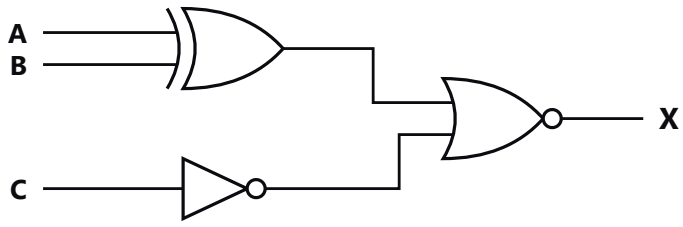


Fig. 3

(a) Write the logic expression for the logic circuit in Fig. 3. Do **not** attempt to simplify the logic expression. **[3]**

X = ...

4 **Total: 3 marks**

Fig. 4 shows two different logic circuits. Each circuit uses one OR gate and one NOT gate.



Fig. 4

(a) The inputs to both circuits are A = 1 and B = 1. State the output P of circuit 1 and the output Q of circuit 2. **[2]**

P = ... **Q =** .....

(b) Identify the **single** logic gate that gives the same output as circuit 1 for every combination of inputs. **[1]**

.....

5 **Total: 4 marks**

A fan in a print workshop is controlled by the logic circuit in Fig. 5.

Input / output	Meaning
D (dust sensor)	1 = dust level high, 0 = dust level normal
T (temperature sensor)	1 = too hot, 0 = not too hot
M (maintenance switch)	1 = switched on, 0 = switched off
F (output)	1 = fan on, 0 = fan off

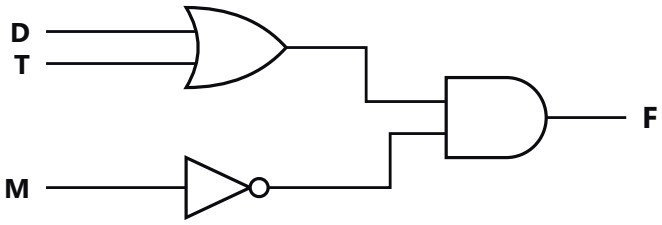


Fig. 5

(a) The dust level is high, the workshop is not too hot and the maintenance switch is on. State the value of F. **[1]**

.....

(b) Describe the conditions that make the fan switch on. **[3]**

.....

.....

.....

6 **Total: 3 marks**

Fig. 6 shows another logic circuit.

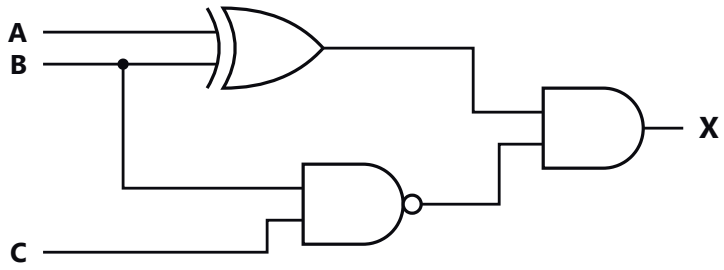


Fig. 6

An engineer says: "Whenever inputs A and B are different, the output X is 1."

(a) Explain, using the circuit in Fig. 6, whether the engineer is correct. **[3]**

Total for this worksheet: 21 marks

MODULE Q BOOLEAN LOGIC · Q5

Completing a truth table for a logic circuit

Original practice questions · 21 marks · ~25 minutes · Cambridge 0478 syllabus 10.2, 10.3(b)

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. Use 1 and 0 for the inputs and outputs. Shaded cells have been filled in for you. The working space columns are not marked. The marks for each part are shown in brackets [ ]. The total for this worksheet is **21 marks**.

1

Total: 2 marks

(a) A logic circuit has three inputs and one output. State the number of rows of input values needed in its truth table. **[1]**

(b) Complete columns B and C of this truth table so that every possible combination of the inputs A, B and C appears exactly once. **[1]**

A	B	C
0		
0		
0		
0		
1		
1		
1		
1		

2 Total: 4 marks

Consider the logic circuit in Fig. 1.

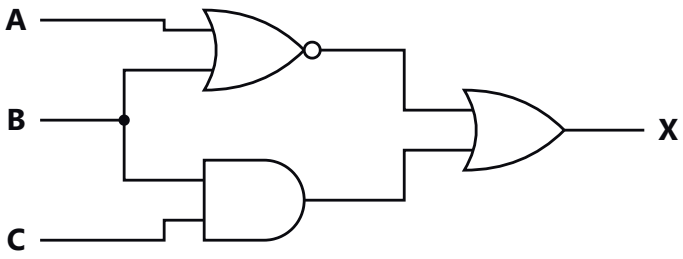


Fig. 1

Complete the truth table for the logic circuit in Fig. 1. **[4]**

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		

3 Total: 4 marks

Consider this logic expression:

`Z = (A XOR C) NOR (B AND C)`

Complete the truth table for the logic expression. **[4]**

A	B	C	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		

4 **Total: 4 marks**

A water tank at a factory is filled by two pumps. A monitoring system gives a warning (W = 1) when:
• the water level is low **and** neither pump is running
or
• both pumps are running.

Input	Description	Binary value 1	Binary value 0
P	Pump 1	Running	Not running
Q	Pump 2	Running	Not running
L	Water level	Low	Not low

Complete the truth table for this problem statement. **[4]**

P	Q	L	Working space	W
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 Total: 3 marks

A technician completed the truth table for the logic circuit in Fig. 2. **Three** of the values in column X are incorrect.

Circle the **three** incorrect values in column X. **[3]**

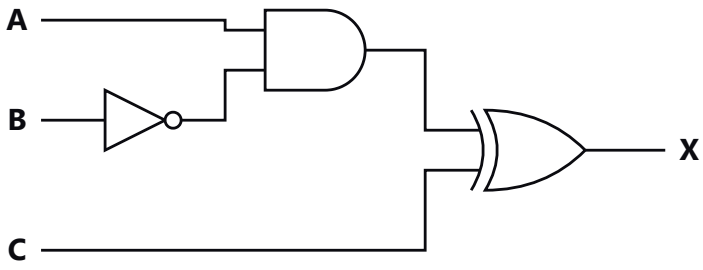


Fig. 2

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

6 Total: 4 marks

Consider the logic circuit in Fig. 3. It has two inputs, A and B.

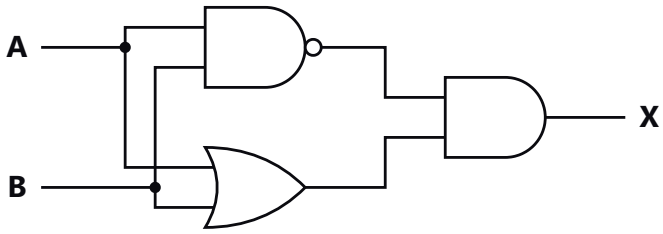


Fig. 3

(a) Complete the truth table for the logic circuit in Fig. 3. **[3]**

A	B	A NAND B	A OR B	X
0	0			
0	1			
1	0			
1	1			

(b) Identify the **single** logic gate that gives the same output as the whole circuit in Fig. 3. **[1]**

Total for this worksheet: 21 marks

MODULE Q BOOLEAN LOGIC · Q6

Logic expressions: writing them and drawing them

Original practice questions · 22 marks · ~25 minutes · Cambridge 0478 syllabus 10.1, 10.2, 10.3(a), 10.3(b), 10.3(c)

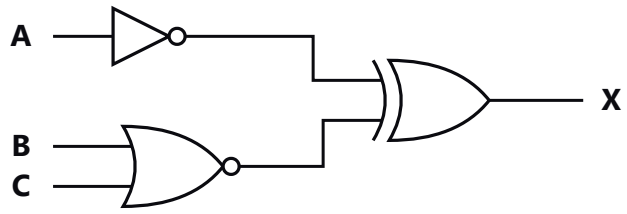
Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **22 marks**. Logic expressions may use NOT, AND, OR, NAND, NOR and XOR. Draw logic circuits in pencil with the standard logic gate symbols. All scenarios are made up.

1

Total: 3 marks

This logic circuit is part of the control system in a commercial washing machine.



(a) Write the logic expression for the logic circuit. Do not attempt to simplify the logic expression. **[3]**

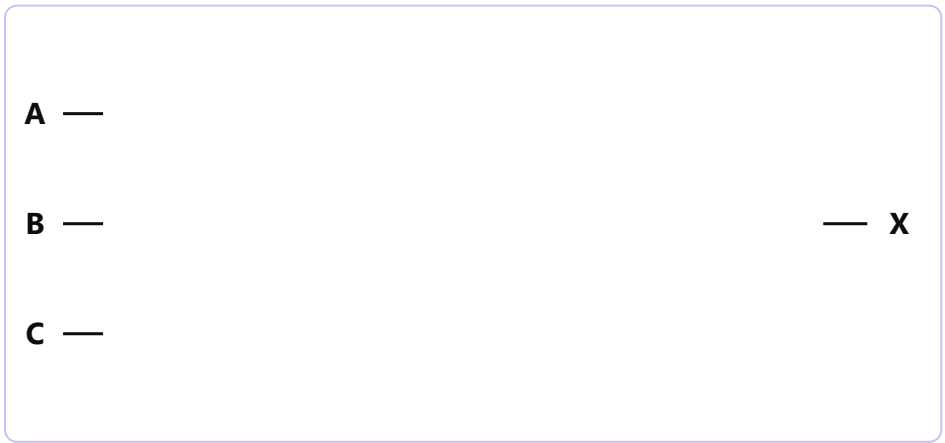
2

Total: 4 marks

Consider the logic expression:

```
X = ((NOT A) AND B) NOR (A XOR C)
```

(a) Draw a logic circuit for this logic expression. **[4]**
Each logic gate must have a maximum of **two** inputs.
Do not simplify this logic expression.



3 **Total: 3 marks**

A logic circuit gives this truth table.

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

(a) Write a logic expression for this truth table. You do not need to simplify it. **[3]**

4 **Total: 3 marks**

A grain silo has two level sensors fitted at the same height. A fault light (X) shows when the two sensors disagree. The system uses the inputs in the table.

Input	Binary value	Meaning
A	1	Level sensor A detects grain
	0	Level sensor A does not detect grain
B	1	Level sensor B detects grain
	0	Level sensor B does not detect grain
C	1	Conveyor is running
	0	Conveyor is not running

The fault light comes on (X = 1) when:

- one level sensor detects grain but the other does not
- **and** the conveyor is not running.

(a) Write the logic expression for this problem statement. Do not attempt to simplify the logic expression. **[3]**

5

Total: 5 marks

Two logic expressions use the same inputs:

```
X = NOT (A OR B)
Y = (NOT A) OR B
```

(a) Complete the truth table for **both** logic expressions. **[4]**

A	B	X	Y	Working space
0	0			
0	1			
1	0			
1	1			

(b) Identify the **single** logic gate that gives the same output as X. **[1]**

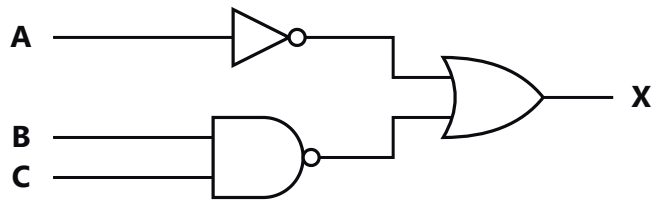
6

Total: 4 marks

A technician was asked to draw a logic circuit for this logic expression:

```
X = (B NAND C) AND (NOT A)
```

This is the circuit the technician drew. It contains **one** error.



(a) Identify the error in the circuit and describe how to correct it. **[2]**

(b) Write the logic expression for the circuit **exactly as the technician drew it**. **[2]**

Total for this worksheet: 22 marks

MODULE Q BOOLEAN LOGIC · Q7

From problem statement to logic circuit

Original practice questions · 20 marks · ~25 minutes · Cambridge 0478 syllabus 10.2, 10.3

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. In every logic circuit, each gate must have a maximum of two inputs; do not simplify. The total for this worksheet is **20 marks**.

1

Total: 3 marks

Each phrase comes from a problem statement with two inputs, A and B. The output is 1 when the phrase is true. Identify the single logic gate that matches each phrase. **[3]**

Phrase	Logic gate
A or B, but not both	
neither A nor B	
not both A and B	

2

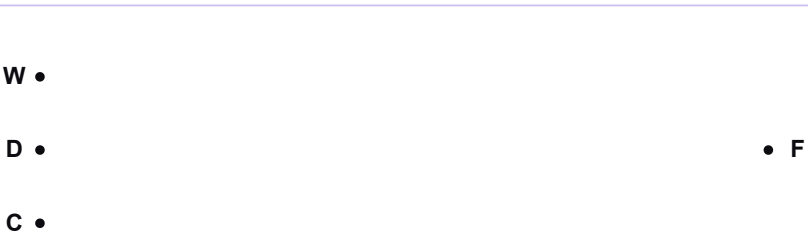
Total: 4 marks

A meeting room has a ventilation fan (F = 1 means the fan runs). It uses three sensors: W = 1 when the window is open, D = 1 when the door is open and C = 1 when the carbon dioxide level is high.
The fan runs when the carbon dioxide level is high **and** neither the window **nor** the door is open.

(a) Write the logic expression for this problem statement. **[2]**

F =

(b) Draw a logic circuit for this problem statement. **[2]**



3 **Total: 11 marks**

A bakery uses a monitoring system for its dough proving cabinet. The system has three inputs and lights a warning lamp (X = 1).

Input	Description	Input of 1 means	Input of 0 means
D	door sensor	the door is open	the door is closed
T	temperature sensor	the temperature is above 30 °C	the temperature is 30 °C or below
H	humidity sensor	the humidity is too low	the humidity is acceptable

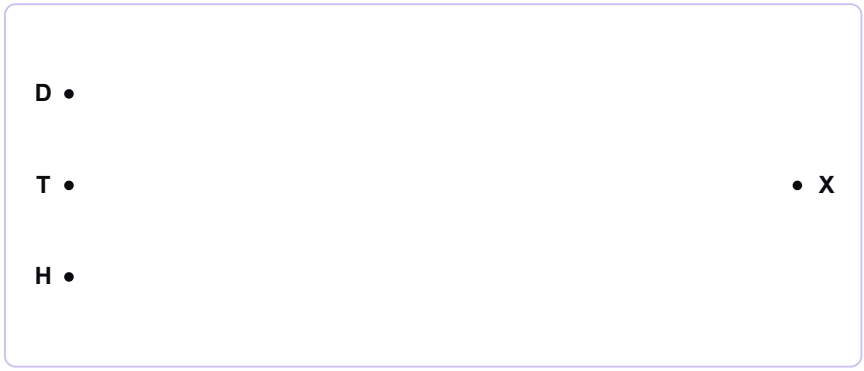
The warning lamp lights when:

- the door is open **and** the temperature is above 30 °C
- **or** the humidity is too low **and** the door is **not** open.

(a) Write the logic expression for this problem statement. **[3]**

X =

(b) Draw a logic circuit for this problem statement. **[4]**



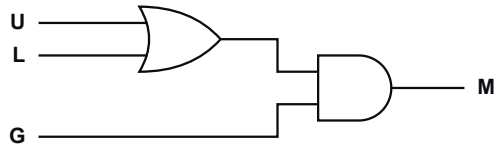
(c) Complete the truth table for this problem statement. **[4]**

D	T	H	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 **Total: 2 marks**

A goods lift has a button on each floor: U = 1 when the upper-floor button is pressed and L = 1 when the lower-floor button is pressed. G = 1 when the lift gate is closed.
The lift moves (M = 1) when the gate is closed **and** either the upper-floor button or the lower-floor button is pressed, **but not both**.

A technician drew this logic circuit for the lift.



(a) Give the values of U, L and G for which the technician's circuit gives the wrong output. **[1]**

U	L	G

(b) Identify the logic gate that should replace the OR gate in the technician's circuit. **[1]**

Total for this worksheet: 20 marks