OCR GCSE Computer Science

Your notes

Boolean Logic Diagrams

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Boolean Logic Diagrams
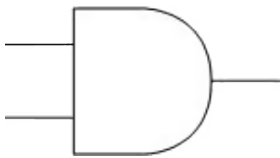
What is Boolean logic?

- Boolean logic is used in computer science and electronics to make **logical decisions**

- Boolean operators are either **TRUE** or **FALSE**, often represented as **1** or **0**

- Inputs and outputs are given **letters to represent them**

- To define Boolean logic we use **special symbols** to make **writing expressions** much **easier**

AND Gates, OR Gates & NOT Gates

What are logic gates?

- Logic gates are a **visual way** of representing a **Boolean expression**

- The logic gates covered in this course are:

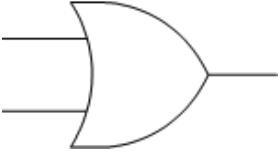   - **AND**

    - **OR**

    - **NOT**

AND (Conjunction)

Symbol	Circuit symbol	Explanation
$A \land B$		Returns TRUE only if **both** inputs are TRUE **TRUE** AND **TRUE** = **TRUE** Otherwise = FALSE

OR (Disjunction)
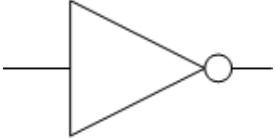
Symbol	Circuit symbol	Explanation

A ∨ B		Returns TRUE if **either** input is TRUE **TRUE** OR **FALSE** = **TRUE** **FALSE** OR **FALSE** = **FALSE**

NOT (Negation)

Symbol	Circuit symbol	Explanation
¬ A		**Reverses** the input value NOT **TRUE** = **FALSE** NOT **FALSE** = **TRUE**

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>
> **Examiner Tips and Tricks**
>
> In the exam you can use any valid notation in Boolean expression question.
>
> T/F or 1/0 or V for OR etc...
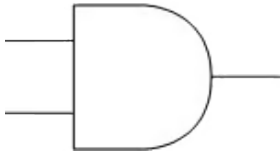
What is a truth table?

- A truth table is a tool used in logic and computer science to **visualise** the **results** of **Boolean expressions**

- They represent **all possible inputs** and the **associated outputs** for a **given Boolean expression**

AND (Conjunction)

Circuit symbol	Truth Table

	A	B	A ^ B
	0	0	0
	0	1	0
	1	0	0
	1	1	1

OR (Disjunction)
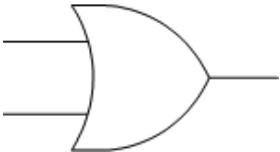
Circuit symbol	Truth Table

A	B	A ∨ B
0	0	0
0	1	1
1	0	1
1	1	1

NOT (Negation)

Circuit symbol	Truth Table

Your notes
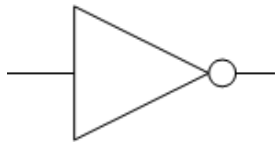
A	¬A
0	1
1	0

Worked Example

Describe the purpose of a truth table **[2]**

Answer

- To show **all possible inputs** (to the logic circuit)
- ...and the **associated/dependant** output (for each input)

Guidance

- Must be clear that the output is linked to the input values given
- "*All possible combinations of inputs and outputs*" only gets 1 mark

Combining Boolean Operators

Combining Boolean Operators

- Boolean operators can be **combined** to produce more **complex** expressions

- The combination of two or more Boolean operators forms a **logic expression**

- **Brackets** are used to clarify the **order** of operations

- A logic diagram is a **visual representation** of combinations of Boolean operators within a logic circuit

- An example would be **Q = NOT(A OR B)**
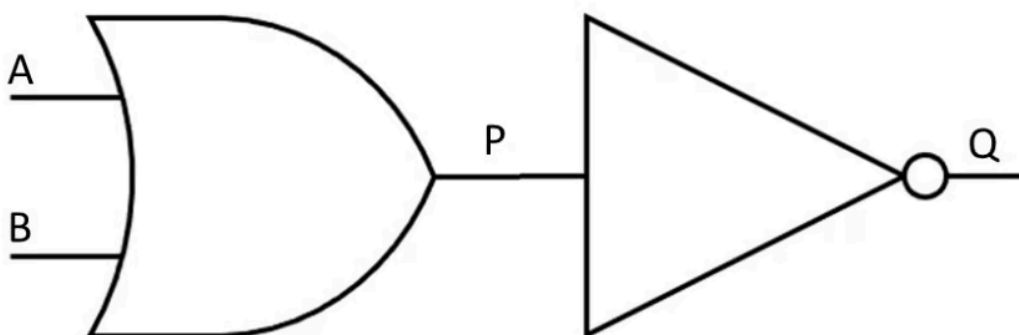
- In the diagram above, the **inputs** are represented by **A and B**

- **P** is the **output** of the OR gate on the left and becomes the input of the NOT gate

- **Q** is the **final output** of the logic circuit

- This is a logic diagram for the Boolean expression **Q = NOT(A OR B)**
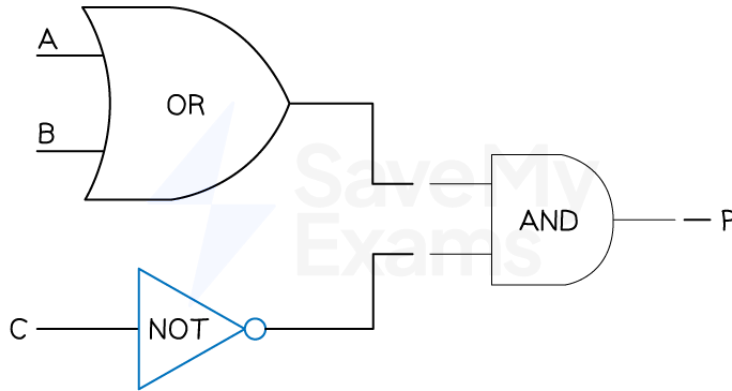
Examiner Tips and Tricks

You may be asked to draw a logic circuit from a logic statement or a Boolean expression **OR** write the logical expression that is expressed in the logic diagram

Logic circuits will be limited to a **maximum of three inputs and one output**

Example of combining Boolean operators

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- **P = (A OR B) AND NOT C**

Apply Logical Operators in Truth Tables

What is a truth table?

- A truth table is a tool used in logic and computer science to **visualise** the **results** of **Boolean expressions**

- They represent **all possible inputs** and the **associated outputs** for a **given Boolean expression**

- To create a truth table for the expression **P = (A AND B) AND NOT C**

  - Calculate the numbers of rows needed ($2^{number\ of\ inputs}$)

  - In this example there are 3 inputs (**A, B, C**) so a total of **8 rows** are needed (2^3)

  - To not miss any combination of inputs, start with **000** and **count** up in **3-bit binary (0-7)**

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

Your notes

0	1	1
1	0	0
1	0	1
1	1	0
1	1	1

- Add a new column to show the **results** of the brackets first (**A AND B**)

A	B	C	A AND B
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	1
1	1	1	1

- Add a new column to show the results of **NOT C**

A	B	C	A AND B	NOT C
0	0	0	0	1
0	0	1	0	0
0	1	0	0	1
0	1	1	0	0
1	0	0	0	1
1	0	1	0	0
1	1	0	1	1
1	1	1	1	0

- The last column shows the **result** of the Boolean expression by comparing **(A AND B) AND NOT C**

| A	B	C	A AND B	NOT C	(A AND B) AND NOT C
0	0	0	0	1	0
0	0	1	0	0	0
0	1	0	0	1	0
0	1	1	0	0	0
1	0	0	0	1	0
1	0	1	0	0	0
1	1	0	1	1	1
1	1	1	1	0	0

Examiner Tips and Tricks

It is possible to create a truth table when combining expressions that show only the inputs and the final outputs.

The inclusion of the extra columns supports the process but can be skipped if you feel able to do those in your head as you go.

Worked Example

Complete the truth table for the following logic diagram **[4]**
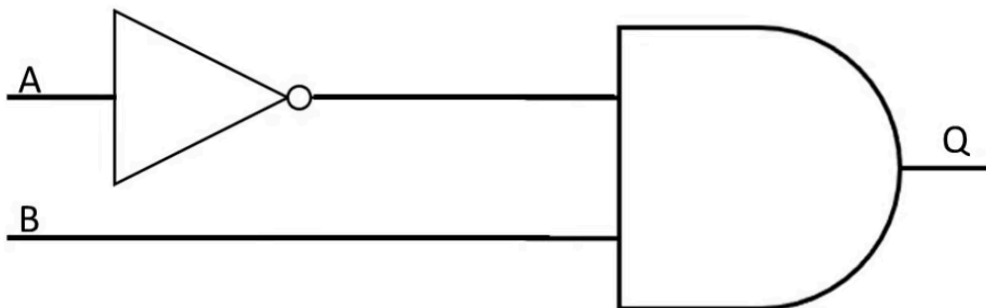
A	B	Q
0	0	0
0	1	1
	0	
1		

Answers

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