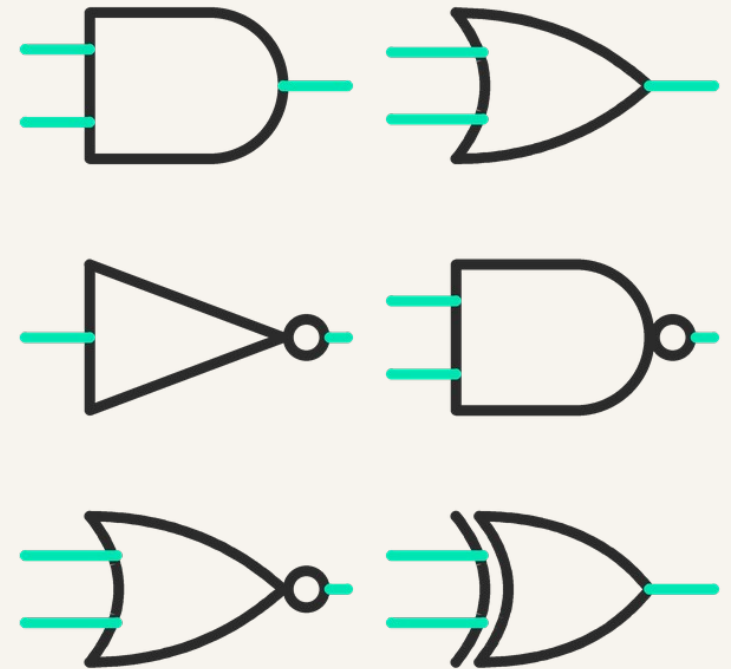


The Six Logic Gates

Six symbols that make every decision a circuit ever takes.

National 5 Practical Electronics



LEARNING INTENTION

To identify the six logic gates from their symbols and complete the truth table for each.

Daily Review

SHOW ME BOARDS

- 1 How many values can a digital signal take?
- 2 State the voltage for logic 1 in a 5 V system.
- 3 Give another name for logic 0.
- 4 Name two digital output devices.
- 5 Analogue or digital: the voltage across an LDR?

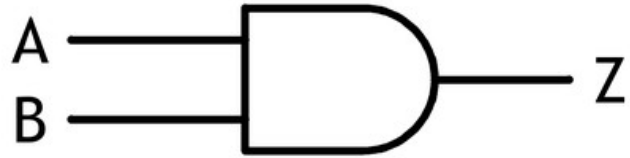
By the end of this lesson...

- 1 I can identify the six logic gates from their ANSI symbols.
- 2 I can identify a two-input logic gate from its truth table.
- 3 I can complete the truth table for any of the six gates.
- 4 I can describe the function of each gate in words.

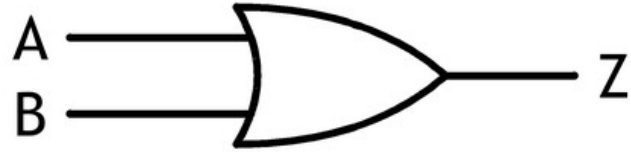
What a logic gate does

- A logic gate takes one or two inputs and gives one output.
- The inputs are labelled A and B. The output is labelled Z.
- A truth table lists every input combination and its output.
- These are the ANSI symbols — the ones the exam uses.

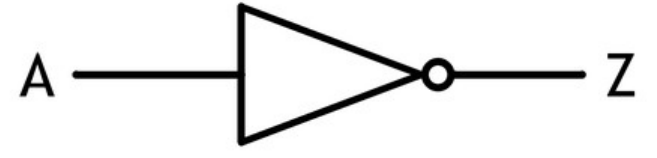
The six symbols



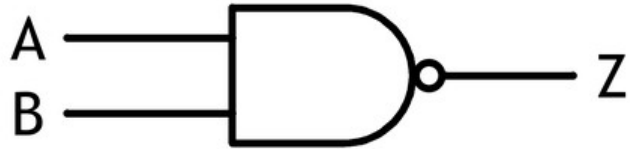
AND 7408



OR 7432



NOT 7404



NAND 7400



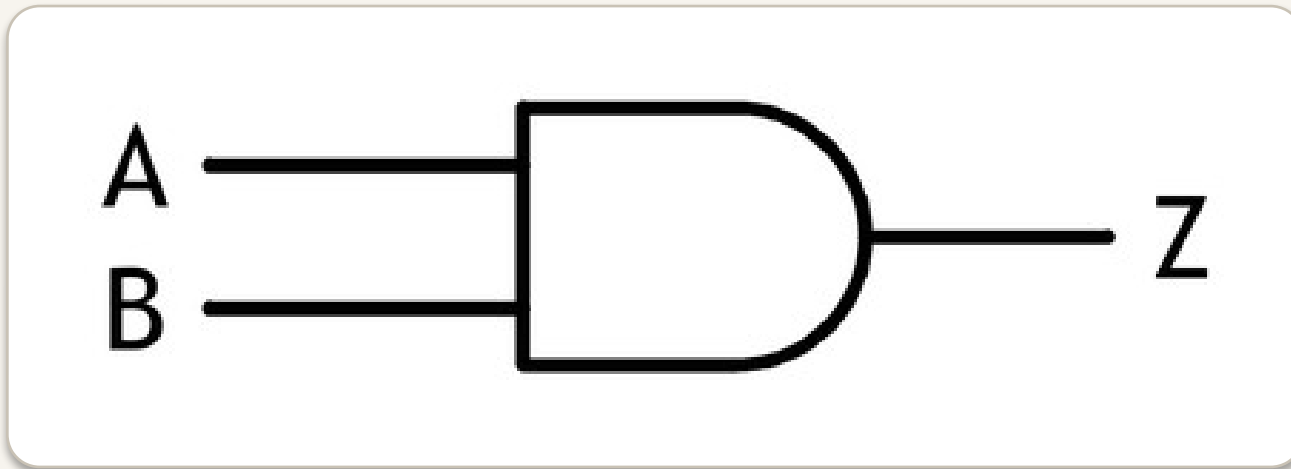
NOR 7402



XOR 7486

How to read a truth table

Every input combination gets a row. The AND gate is the example — you will find the other five yourself.



AND

A	B	Z
0	0	0
0	1	0
1	0	0
1	1	1

Show Me — Reading the symbols

SHOW ME BOARDS

- 1 How many inputs does a NOT gate have?
- 2 What letter labels a gate's output?
- 3 Name the three symbols with a small circle on the output.
- 4 What does that small circle do?
- 5 Which symbol has two curved lines at its back?

Reading the symbols

SHOW ME BOARDS

EXTRA PRACTICE

- 1 How many inputs do the other five gates have?
- 2 What letters label the two inputs?
- 3 Which gate is drawn as a plain triangle plus a circle?
- 4 Which gate is drawn as a flat-backed D shape?
- 5 Why must you use the ANSI symbols in the exam?

Your turn

Build each gate on the logic board.
Set every input combination and record the output.
Complete all six truth tables in your booklet.

PRACTICAL TASK 1 – The six gates

PERIOD 2 STARTS HERE

From table to gate

You have the six tables. Now read them backwards.

Daily Review

SHOW ME BOARDS

- 1 What letter labels a gate's output?
- 2 Which chip contains AND gates?
- 3 How many inputs does a NOT gate have?
- 4 State the logic state of an input near 0 V.
- 5 Which gate's symbol has a small circle after a D shape?

PRACTICAL TASK 1 – Answers

Check your booklet against these.

AND

A	B	Z
0	0	0
0	1	0
1	0	0
1	1	1

OR

A	B	Z
0	0	0
0	1	1
1	0	1
1	1	1

NOT

A	Z
0	1
1	0

PRACTICAL TASK 1 – Answers

The three inverting gates.

NAND

A	B	Z
0	0	1
0	1	1
1	0	1
1	1	0

NOR

A	B	Z
0	0	1
0	1	0
1	0	0
1	1	0

XOR

A	B	Z
0	0	0
0	1	1
1	0	1
1	1	0

Each gate in words

Gate	The output Z is logic 1 when...	Chip
AND	both inputs are logic 1	7408
OR	either input is logic 1, or both	7432
NOT	the single input is logic 0	7404
NAND	the inputs are anything except both logic 1	7400
NOR	both inputs are logic 0	7402
XOR	the two inputs are different	7486

Show Me — Name that gate

SHOW ME BOARDS

- 1 The output is 1 only when both inputs are 1.
- 2 The output is 0 only when both inputs are 1.
- 3 The output is always the opposite of the input.
- 4 The output is 1 when the two inputs are different.
- 5 The output is 1 when either input is 1, or both.

Name that gate

SHOW ME BOARDS

EXTRA PRACTICE

- 1 A gate gives 1 for 0 0 and 0 for every other row.
- 2 A gate gives 0 for 0 0, then 1, 1, then 0 for 1 1.
- 3 A two-input gate gives 1 for the 1 1 row only.
- 4 A gate gives 0 for the 1 1 row only.
- 5 A gate gives 0 for 0 0 and 1 for the other three rows.

Watch Out

THE MISTAKE

- NAND and NOR do the same job.
- NAND gives logic 1 on one row only.
- The small circle inverts the inputs.

THE CORRECT ANSWER

- NOR gives logic 1 on one row only: 0 0.
- NAND gives logic 0 on one row only: 1 1.
- The small circle inverts the output.

Your turn

Core questions 1 to 5 in your jotter.
Then question 6 in Yenka: make a NOT gate from one
NAND.

PRACTICE – The six logic gates

PRACTICE – Answers

Core questions 1 to 5.

	Answer
1 Name the six gates shown	AND, NOR, NOT, XOR, NAND, OR (6)
2 Complete the NAND table	Z reads 1, 1, 1, 0
3 Quad two-input OR chip	7432
4 When is an XOR output 1?	When the two inputs are different.
5 Logic 1 only when both inputs are 0	NOR gate

PRACTICE — Answers

Question 6 — going further.

- Join the NAND gate's two inputs together as one input. (1)
- With both inputs the same, the output inverts that input. (1)
- So the NAND gate behaves as a NOT gate.

Checkpoint

SHOW ME BOARDS

- 1 Name the gate that gives 1 only when its inputs are different.
- 2 Which chip contains NOR gates?
- 3 A gate gives 1 on every row except 1 1. Name it, and say why.

LOOKING AHEAD

Combinational logic

Join the gates together, and the output of one becomes the input of the next.

Plenary

SHOW ME BOARDS

- 1 Name the six logic gates.
- 2 Which gate has only one input?
- 3 On your board: the truth table for an OR gate.
- 4 Describe in words when a NAND output is 0.
- 5 Which chip holds AND gates?

Plenary

SHOW ME BOARDS

EXTRA PRACTICE

- 1 Sketch the AND symbol.
- 2 Sketch the NOT symbol.
- 3 On your board: the truth table for a NOR gate.
- 4 Describe in words when an XOR output is 1.
- 5 Which chip holds XOR gates?

Extension

- 1 Why might a designer prefer a chip holding four identical gates?
- 2 Two NOT gates, one after the other. What is the output?
- 3 Could a NAND and a NOT together do the job of an AND gate?

Extension

EXTRA PRACTICE

- 1 Which gate detects that two switches disagree?
- 2 How many rows would a three-input gate's truth table need?
- 3 Why is an XOR sometimes called a difference detector?