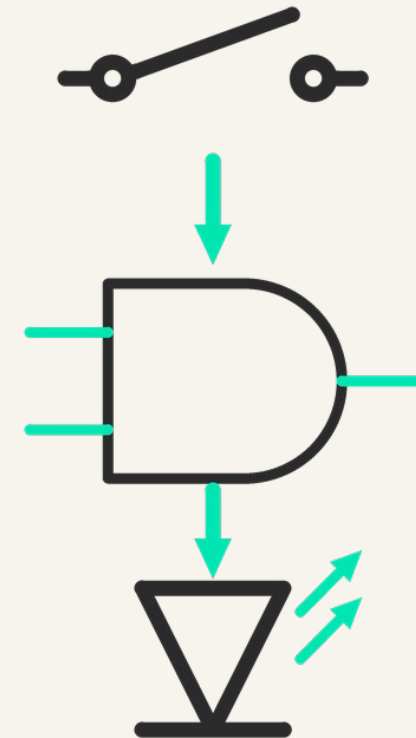


The Systems Approach

Start with the problem, not the circuit. The gates come last.

National 5 Practical Electronics



LEARNING INTENTION

To design a logic circuit from a specification using the six-step systems approach.

Daily Review

SHOW ME BOARDS

- 1 A circuit has three inputs. How many rows does its table need?
- 2 Which column do you complete first — D or Z?
- 3 How do you work out a NAND column?
- 4 When is an OR gate's output logic 1?
- 5 Name the gate that is 1 only when its two inputs differ.

By the end of this lesson...

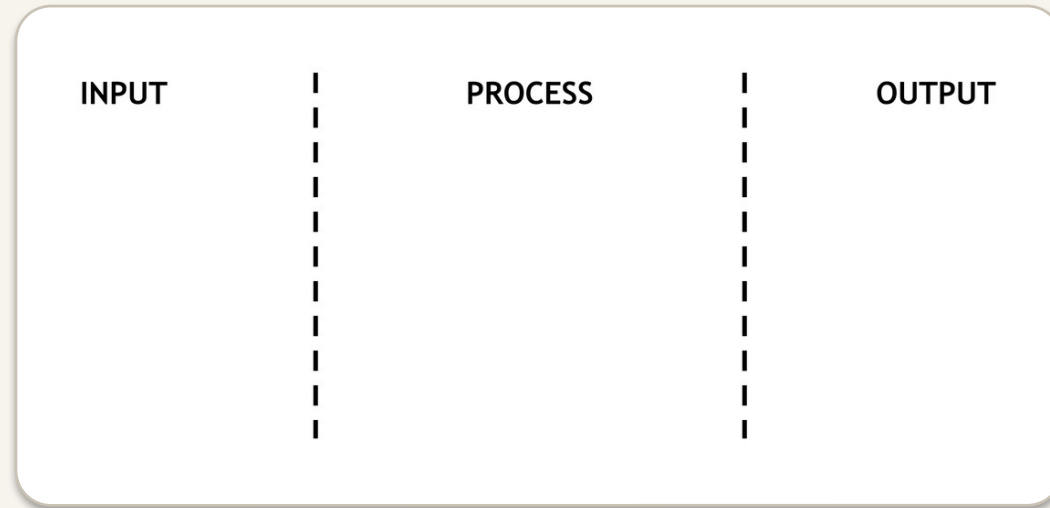
- 1 I can identify the input, process and output stages of a system.
- 2 I can draw a block diagram with the three sections separated.
- 3 I can choose the correct gates to solve a design problem.
- 4 I can check my design by building it in Yenka.

Three sections

Booklet section 4 — split every design problem this way.

Section	What it does	Typical parts
INPUT	detects what is happening	switches, sensors
PROCESS	decides what should happen	logic gates
OUTPUT	makes something happen	LED, buzzer, motor, relay

What a block diagram must show



Boxes joined by arrows, in the direction the signal travels.

- Separate the three sections with lines, and label them.
- Join the boxes with arrows. Never just list the elements.
- Say what the process section actually does.

Show Me — Which section?

SHOW ME BOARDS

- 1 A push switch. Which section?
- 2 An AND gate. Which section?
- 3 A buzzer. Which section?
- 4 A light sensor. Which section?
- 5 Which section decides what should happen?

Which section?

SHOW ME BOARDS

EXTRA PRACTICE

- 1 A relay. Which section?
- 2 A NOT gate. Which section?
- 3 A guard switch. Which section?
- 4 A motor. Which section?
- 5 Which section is always made of logic gates?

The six steps

Work through these in order, every time.

- List the inputs. Letter them A, B, C.
- List the output and call it Z.
- For each input, decide whether you want logic 1 or logic 0.
- Decide how the inputs must be combined.
- Draw the block diagram, then the logic diagram, then the table.
- Check it in Yenka before you build anything.

Reading the specification

The word in the problem tells you the gate.

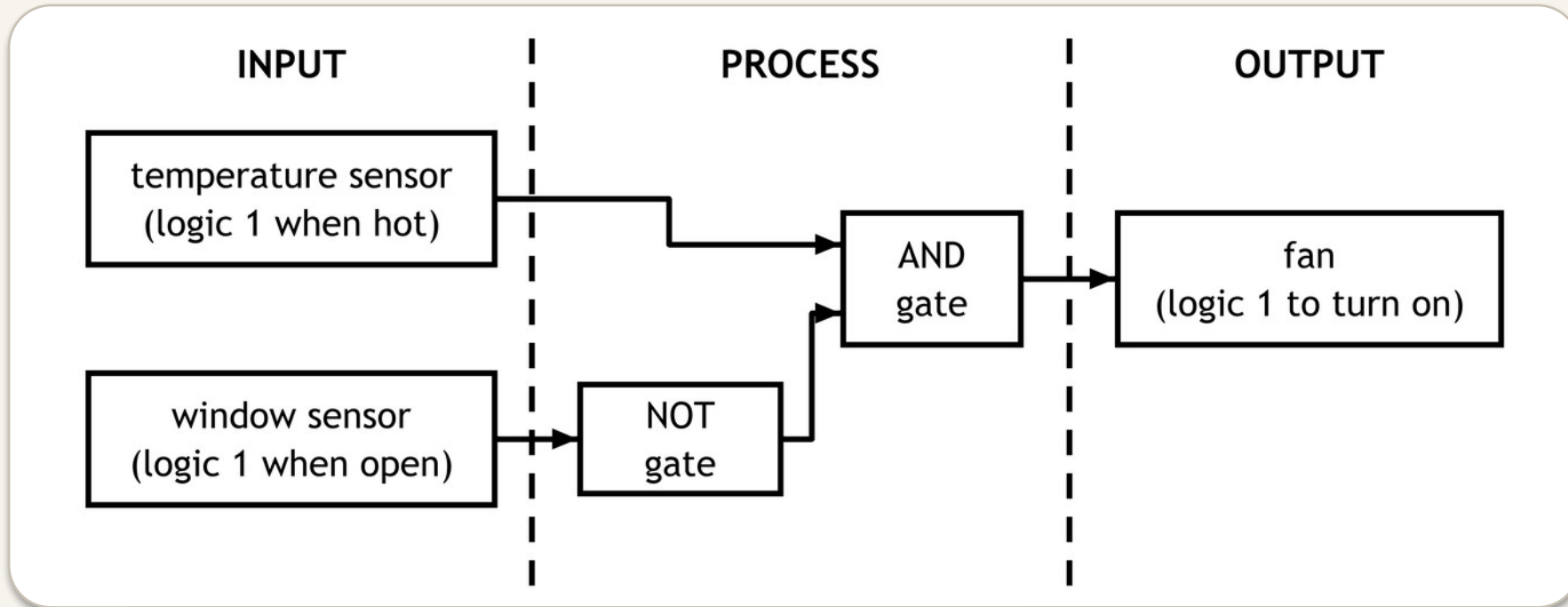
The specification says...	Use this gate
both	AND
either, or both	OR
different	XOR
the condition you want is logic 0	a NOT gate on that input

Only two-input gates

Booklet section 4.

- The 74 series chips hold two-input gates only.
- Three inputs to combine? Use two gates.
- Combine two first, then combine that result with the third.

Worked example – a greenhouse fan



- Inputs: A temperature (1 when hot), B window (1 when open).
- We want the window input to be 0, so B needs a NOT gate.
- Both conditions must hold, so combine them with an AND.

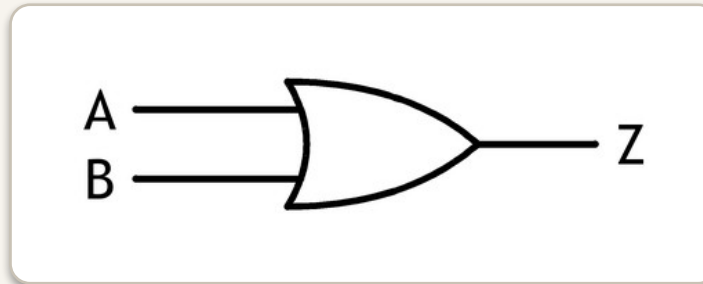
Your turn

Work Problem 1 through all six steps.
Block diagram, logic diagram, truth table.
Then build it in Yenka and test every combination.

Problem 1 – Smart Doorbell

Problem 1 – Answers

A notification is sent if the camera sees movement OR the bell is pressed.



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

One OR gate – a single 7432.

PERIOD 2 STARTS HERE

Two harder designs

An inverted input, and a system that needs two gates from one chip.



<https://mrstewartphysics.co.uk/classes/electronics/block-diagram-builder.html#q1>

Daily Review

SHOW ME BOARDS

- 1 Name the three sections of a system.
- 2 Which section holds the logic gates?
- 3 What must separate the three sections on a block diagram?
- 4 The specification says 'both'. Which gate?
- 5 You want an input's condition to be logic 0. What do you add?

Show Me — Choose the gate

SHOW ME BOARDS

- 1 A lift moves only when both doors are shut.
- 2 An alarm sounds if either sensor is triggered.
- 3 A warning shows when two dials disagree.
- 4 A pump runs when the tank is NOT full.
- 5 A light comes on when it is dark and the switch is on.

Choose the gate

SHOW ME BOARDS

EXTRA PRACTICE

- 1 A heater runs when it is cold and the timer is on.
- 2 A buzzer sounds if either door or window opens.
- 3 A motor runs when the two encoders read differently.
- 4 A fan runs while the lid is NOT closed.
- 5 A gate opens when the card is valid and the barrier is down.

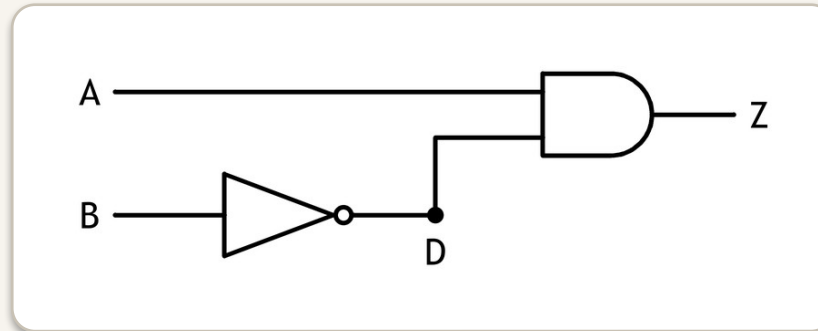
Your turn

Work Problems 2 and 3 through the six steps.
Watch step 3 on Problem 2 – read the sensor carefully.
Build each one in Yenka for part (d).

Problems 2 and 3

Problem 2 – Answers

D is the NOT gate's output – logic 1 when the gemstone is gone.

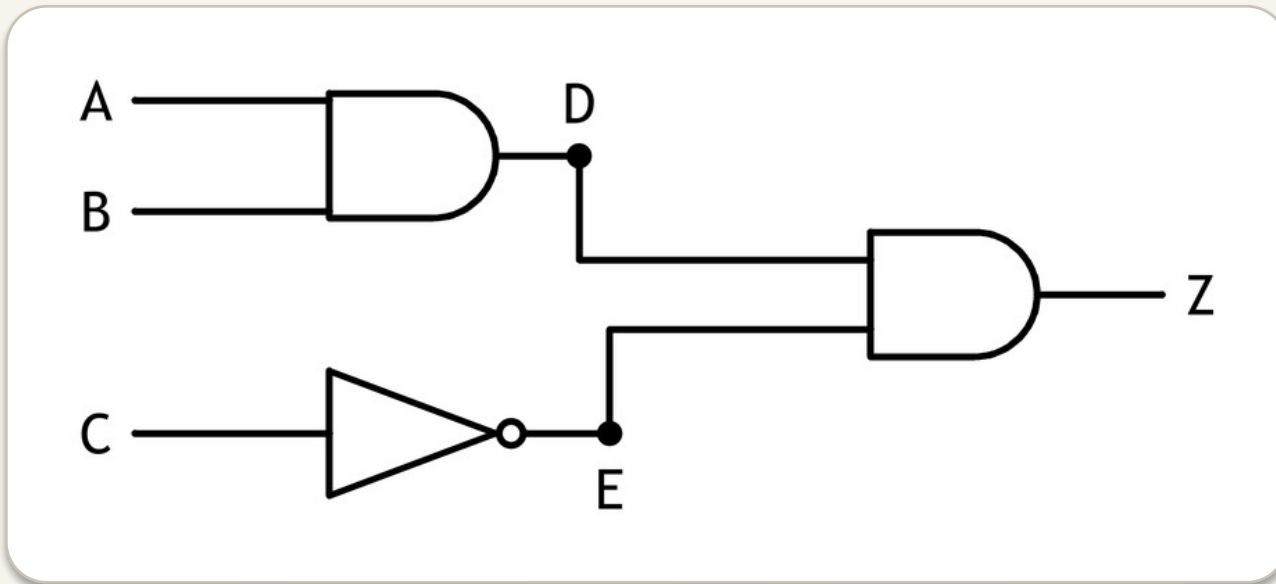


A	B	D	Z
0	0	1	0
0	1	0	0
1	0	1	1
1	1	0	0

One NOT gate (7404) and one AND gate (7408).

Problem 3 – Answers

D is the first AND gate (A and B); E is the NOT gate on C.



One 7404, and two ANDs from one 7408.

A	B	C	D	E	Z
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

Watch Out

The block-diagram question loses marks every year. Here is how.

THE MISTAKE

- The elements are listed down the page.
- No lines between the three sections.
- The process box just says 'logic'.

THE CORRECT ANSWER

- Join every box with an arrow, in signal order.
- Draw and label INPUT, PROCESS and OUTPUT.
- Name each gate the process actually uses.

Checkpoint

SHOW ME BOARDS

- 1 Name the three sections of a system, in order.
- 2 A sensor reads logic 1 when a door is shut, but you want it open. What do you add, and why?
- 3 A design must combine three inputs. How many two-input gates?

Exam Practice

Block-diagram questions. Bring the paper; the questions are not reproduced here.

Paper	Question	Marks	What it asks
N5 2025	10	6	Gas-leak system: block diagram from a list of elements
Specimen	10	6	Soil-moisture system: same task, same marks

LOOKING AHEAD

More design practice

Next: a switch that reads 0 when you press it, and a system with two outputs.

Plenary

SHOW ME BOARDS

- 1 Name the three sections of a system.
- 2 What letter is the output of a design given?
- 3 The specification says 'different'. Which gate?
- 4 What does the process section contain?
- 5 Which step of the six comes last?

Plenary

SHOW ME BOARDS

EXTRA PRACTICE

- 1 Which section detects what is happening?
- 2 What letters are the inputs of a design given?
- 3 The specification says 'either'. Which gate?
- 4 Name two parts you would find in an output section.
- 5 Why draw the block diagram before the logic diagram?

Extension

- 1 Problem 3 needs two AND gates. Why is one chip still enough?
- 2 Could Problem 2 be built with a single NAND gate instead? Explain.
- 3 A design has four inputs, all of which must be logic 1. How many gates, and how many chips?

Extension

EXTRA PRACTICE

- 1 Why does the course allow only two-input gates?
- 2 A specification says 'neither'. Which single gate does that?
- 3 Why check a design in Yenka before wiring it up?