From a description to a logic circuit

LEARNING INTENTION

We are learning to turn a written description into a logic circuit with labelled input devices.

SUCCESS CRITERIA — I CAN

- ☐ pick out the inputs, output and key words from a description
- ☐ write the Boolean expression
- ☐ draw the logic circuit with labelled input devices
- ☐ suggest a modification that fixes a stated problem

Reading a description

both / all → AND	either / any → OR	not / unless → NOT
Every condition must be true.	At least one must be true.	The condition must be false.

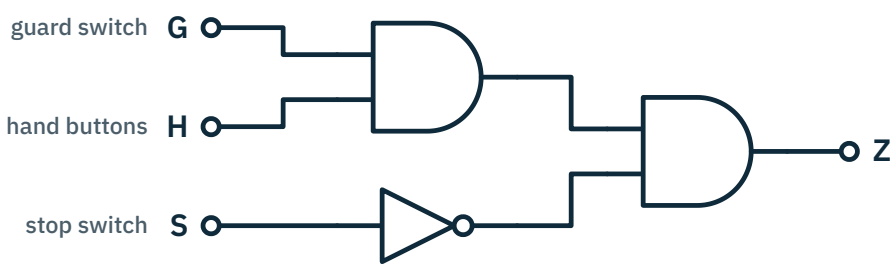
Underline each input and give it a letter. Underline the output (Z). Circle the key words.

Worked design

WORKED EXAMPLE Machine safety interlock

1 GIVEN	2 FIND	3 FORMULA	4 SUBSTITUTE	5 ANSWER + UNIT
a press runs when the guard is closed (G) AND both hands are on the buttons (H) and the stop switch (S) is NOT pressed	Boolean and diagram	'and' → AND 'not' → NOT label every input	$G \cdot H$ $\overline{S}$ $(G \cdot H) \cdot \overline{S}$	$Z = (G \cdot H) \cdot \overline{S}$ 3 gates

Each input is a switch labelled G, H or S, matching the description.



Interlock with labelled input devices

From a description to a logic circuit

G	H	S	Z
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	0

SHORT CIRCUIT

× WHAT EXAMINERS SAW

Some candidates did not include suitable input devices, or did not label the inputs, so the logic circuit could not be tested.

√ THE FIX

Give each input a device (switch, sensor circuit) and the label from the task (G, H, S). Label the output too.

Course report 2026 Tasks 4a–c.

Modifying a design

SHORT CIRCUIT

× WHAT EXAMINERS SAW

Asked for a modification, many suggested a change that did not fix the problem named in the task.

√ THE FIX

Read the problem. Your change must fix it: e.g. 'The press can run with the stop switch pressed' → add a NOT on S into the AND gate.

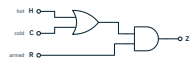
Course reports 2024 (Task 5c) and 2025 (Tasks 2d, 5c).

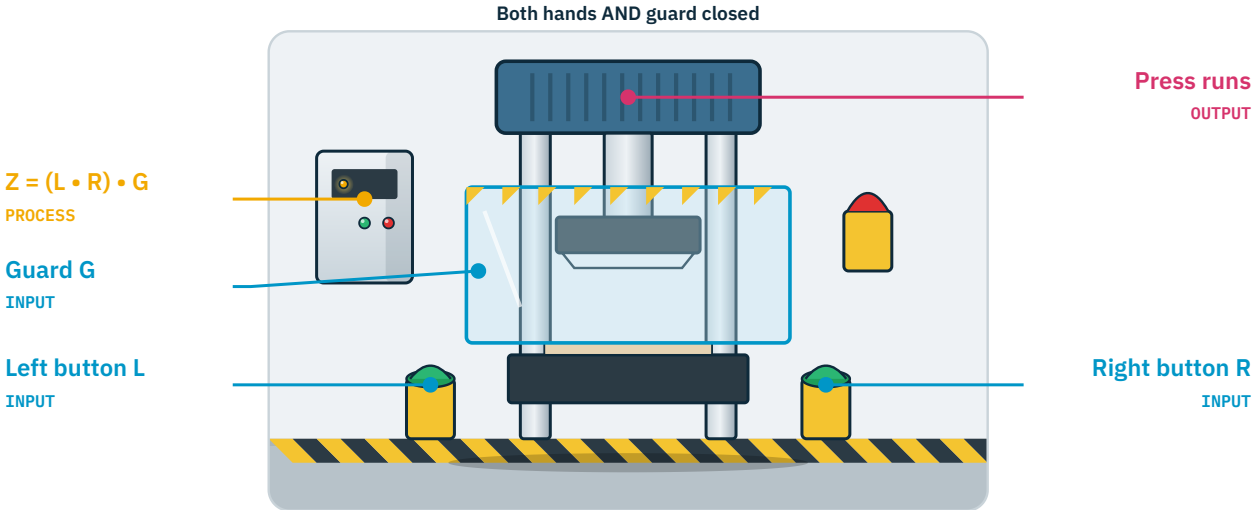
Example: a supervisor wants a key switch K that can also stop the press. Add K into the final AND gate through a NOT: $Z = (G \bullet H) \bullet \overline{S} \bullet \overline{K}$.

From a description to a logic circuit

From words to gates

FROM WORDS TO GATES

1. both · all → AND — Key words: AND
2. either · or → OR — Key words: OR
3. not · unless → NOT — Key words: NOT
4.  — Build it, label every input



WORKED EXAMPLE **Three-input alarm from a description**

1 GIVEN	2 FIND	3 FORMULA	4 SUBSTITUTE	5 ANSWER + UNIT
a greenhouse alarm sounds if it is too hot (H) or too cold (C), but only when the alarm is armed (R)	Boolean	'or' → OR 'only when' → AND	H + C (H + C) • R	**Z = (H + C) • R**

From a description to a logic circuit

WORKED EXAMPLE **Modification that fixes the issue**

1 GIVEN	2 FIND	3 FORMULA	4 SUBSTITUTE	5 ANSWER + UNIT
issue: the press can run with one hand off the buttons current design Z = (L + R) • G	fix	both hands → AND, not OR	replace OR with AND: L • R	Z = (L • R) • G

The change must fix the issue named.

WRONG

(L + R) • G: one hand is enough

OR lets the press run with one hand free: unsafe.

RIGHT

(L • R) • G: both hands needed

Fix uses AND for 'both'.

REAL ENGINEERING · INVERBRAE MACHINE WORKS

Inverbrae (fictional) engineers design every guard interlock as a logic circuit first, test it in simulation against a truth table, then build it.

Any modification after an incident must fix the cause identified in the incident report.

PROBE · QUICK CHECKS

1. Key word 'either' → which gate? _____
2. Key word 'unless' → which gate? _____
3. What must every input have? _____

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EXAM READY · 9 MARKS

1 A porch light (Z) comes on when it is dark (D) and the door is opened (O) or a sensor detects movement (M). **Complete** the Boolean expression. **[2]**

2 **Complete** the logic circuit for Q1. Label all inputs. **[3]**

3 The owner wants the light to stay off when a holiday switch (H) is on. **Describe** a modification to the circuit. **[2]**

4 **Complete** the truth table for Q1. **[2]**

D	O	M	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	