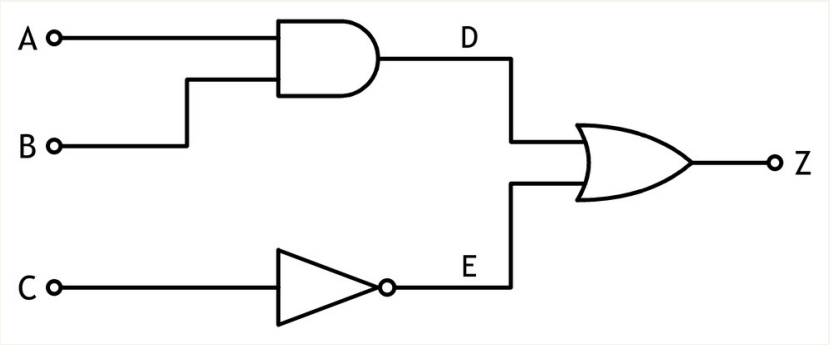
Boolean Expressions

One line of letters can describe a whole circuit.



National 5 Engineering Science

Daily Review

1	**State** how many rows for **3** inputs.	8
2	**State** what **D** labels on a diagram.	First gate's output
3	**OR**: A = 1, B = 0. **State** Z.	1
4	**State** the voltage of **logic 0**.	Near 0 V
5	**Name** the output device that makes **movement**.	Motor

PART 1

Writing Boolean

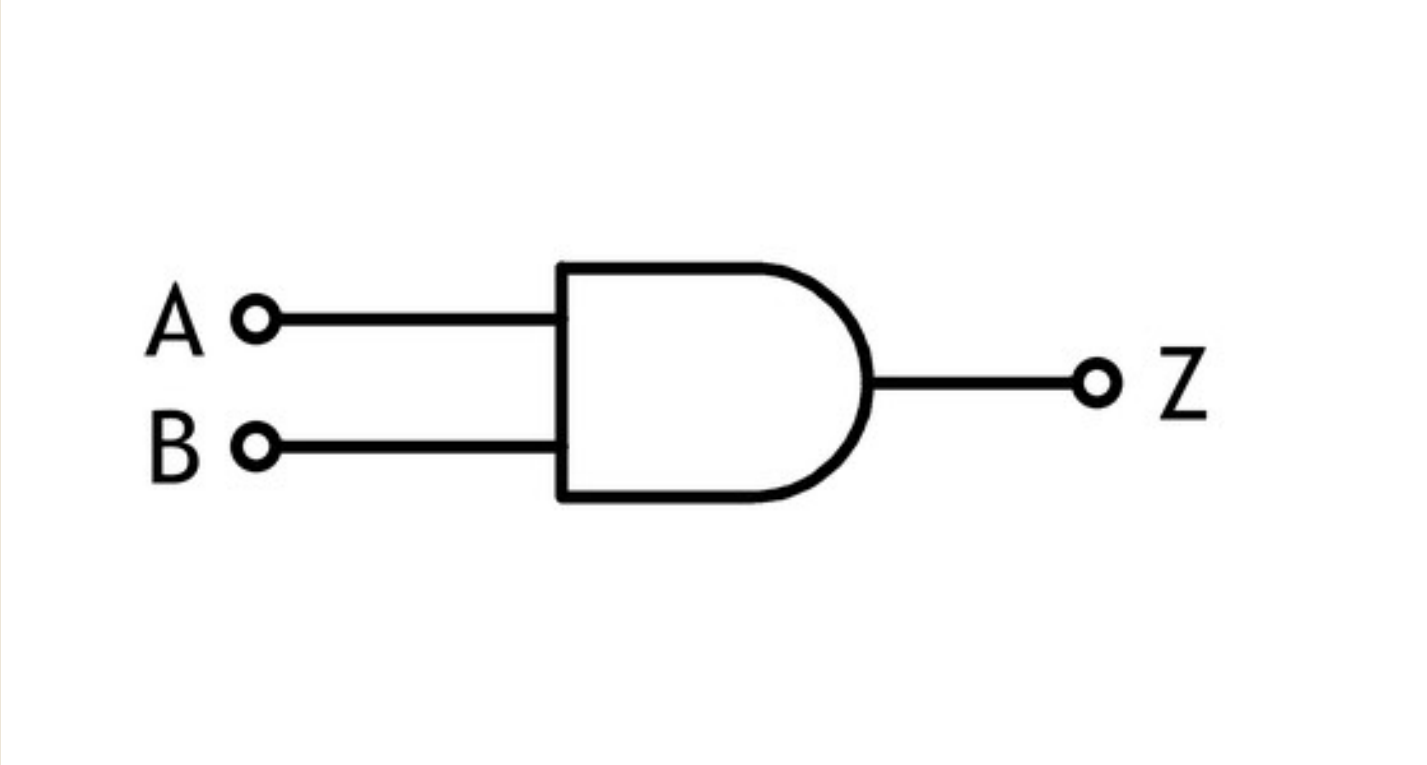
We are learning to write a Boolean expression from words or from a logic diagram.

By the end of this part…



1. I can **write** the Boolean for **AND**, **OR** and **NOT**
2. I can **write** a Boolean expression from **words**
3. I can **write** a Boolean expression from a **diagram**

Start button AND guard in place. How could you write that in one line?



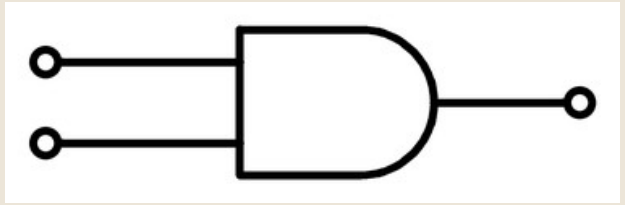
Boolean for Each Gate

AND is a **dot**: A • B

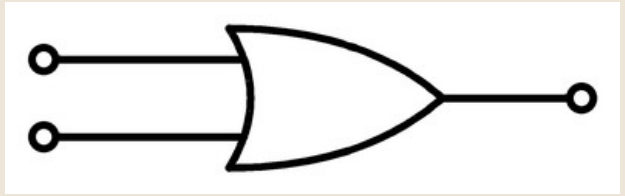
OR is a **plus**: A + B

NOT is a **bar**: $\overline{A}$

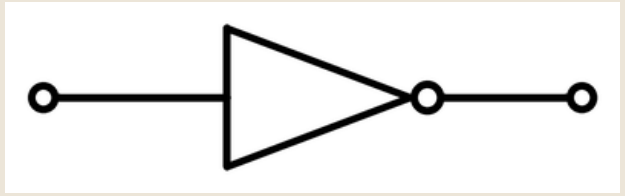
Your booklet writes **A.B.**



$Z = A \bullet B$

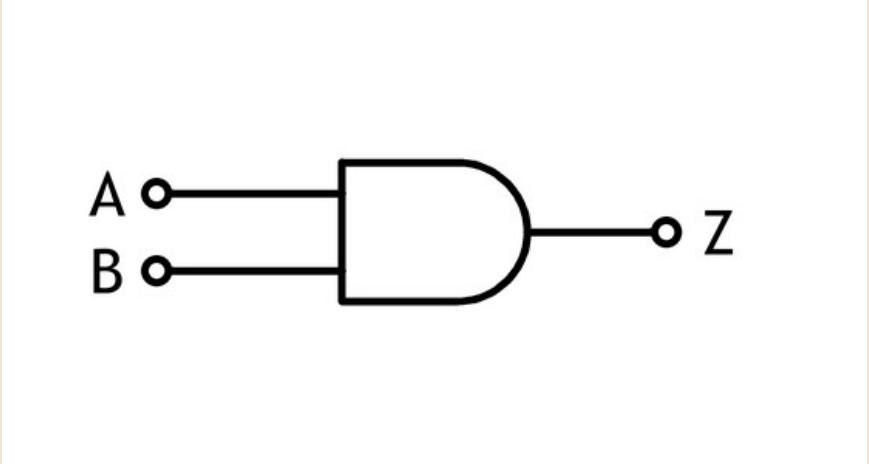


$Z = A + B$



$Z = \overline{A}$

From Words to Boolean



A **motor** turns on when the **start button** is pressed **and** the **guard** is in place.

1 A = start button, B = guard.

2 'and' means **AND**: •

3 **Z = A • B**

Show Me: Write the Boolean

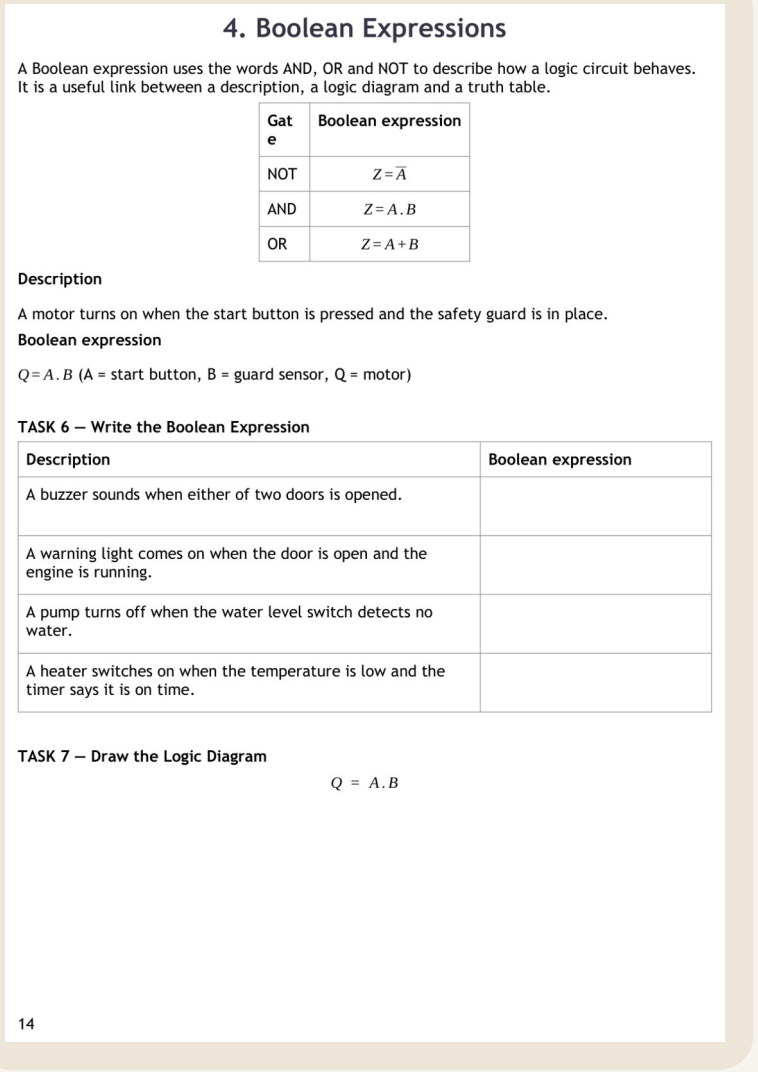
1	Lamp on when **A or B** is pressed.	$Z = A + B$
2	Fan on when hot (A) **and** window shut (B).	$Z = A \bullet B$
3	Light on when it is **not** bright (A).	$Z = \overline{A}$
4	Alarm when door A, B **or** C opens.	$Z = A + B + C$
5	Heater on when **A** on **and** window **B not** open.	$Z = A \bullet \overline{B}$

Task 6 (B4a-L4-p14)

Task 6

Write the Boolean expression for each **description**.

Name your inputs **A**, **B** first.



4. Boolean Expressions

A Boolean expression uses the words AND, OR and NOT to describe how a logic circuit behaves. It is a useful link between a description, a logic diagram and a truth table.

Gate	Boolean expression
NOT	$Z = \overline{A}$
AND	$Z = A.B$
OR	$Z = A + B$

Description

A motor turns on when the start button is pressed and the safety guard is in place.

Boolean expression

$Q = A.B$ (A = start button, B = guard sensor, Q = motor)

TASK 6 — Write the Boolean Expression

Description	Boolean expression
A buzzer sounds when either of two doors is opened.	
A warning light comes on when the door is open and the engine is running.	
A pump turns off when the water level switch detects no water.	
A heater switches on when the temperature is low and the timer says it is on time.	

TASK 7 — Draw the Logic Diagram

$$Q = A.B$$

14

Answers: Task 6

Description	Boolean
Buzzer: **either** of two doors	$Q = A + B$
Warning light: door open **and** engine on	$Q = A \bullet B$
Pump off: **no** water detected	$Q = \overline{A}$
Heater: temperature low **and** timer on	$Q = A \bullet B$

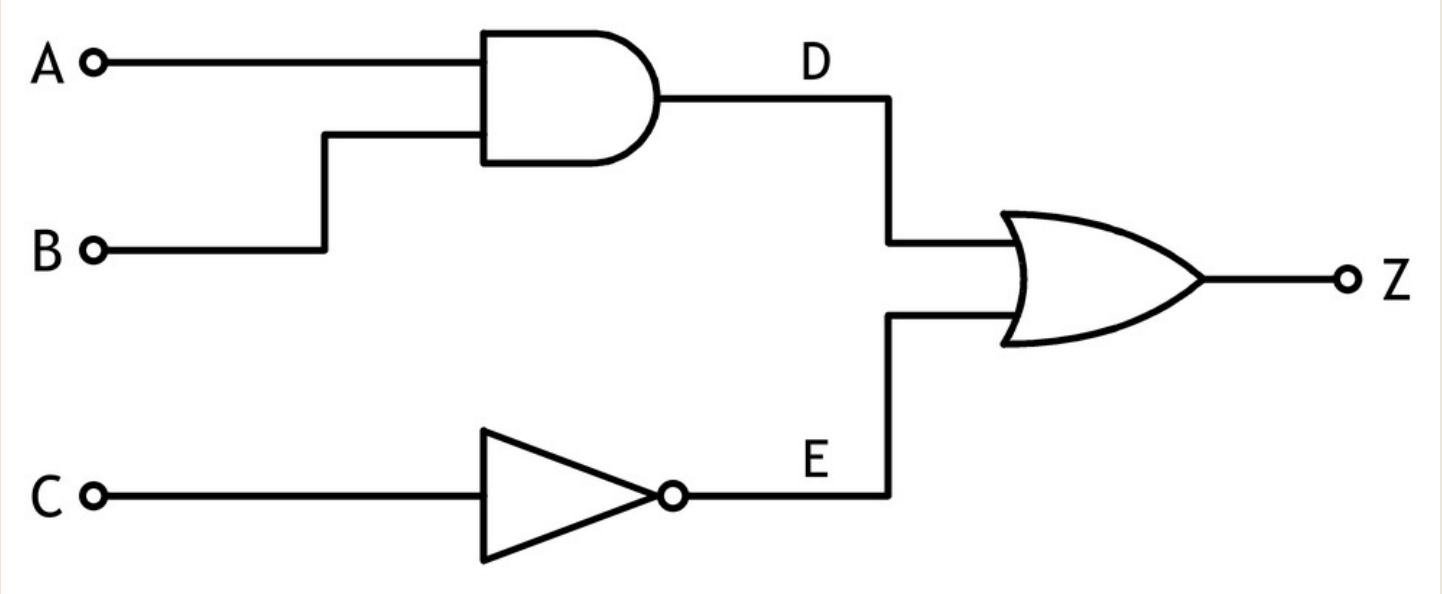
From a Diagram to Boolean

Label each first gate: **D**, **E**.

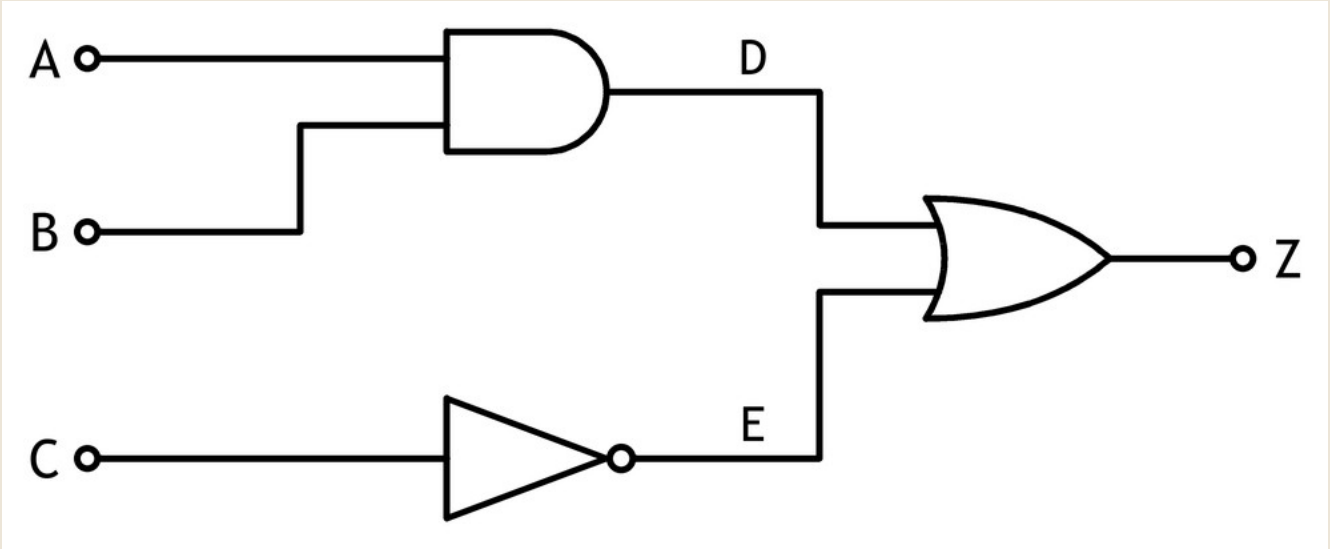
Write each one.

The **last** gate **joins** them.

Brackets round each first gate.



Worked Example: Diagram to Boolean



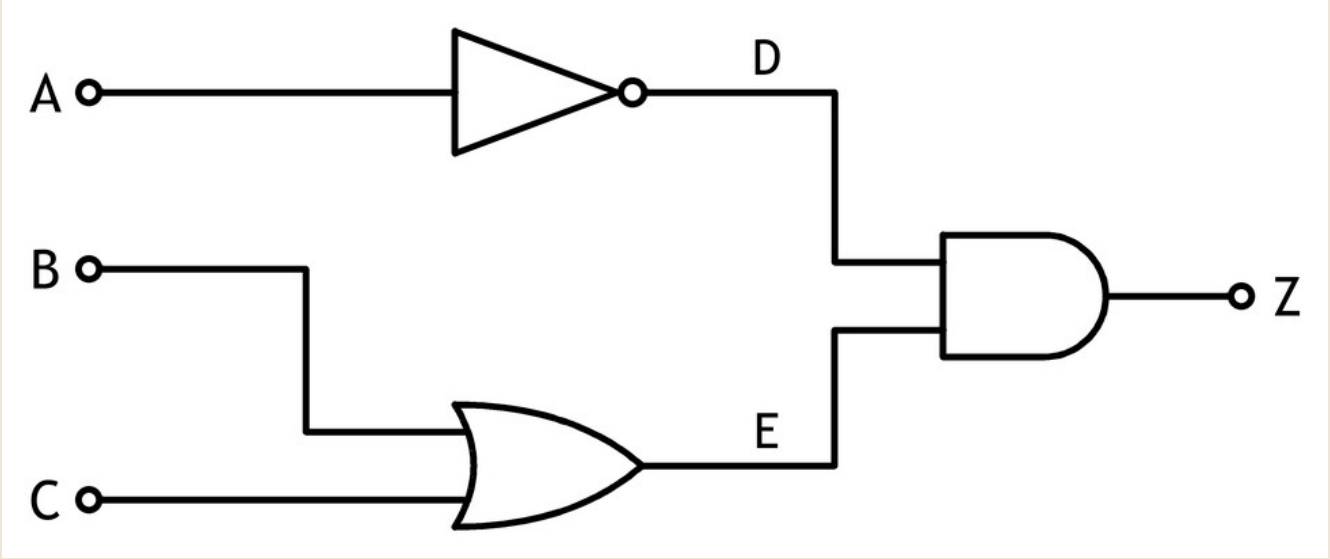
$D = A \bullet B$

$E = \overline{C}$

$Z = D + E$

$Z = (A \bullet B) + \overline{C}$

Show Me: Your Turn



$D = \overline{A}$

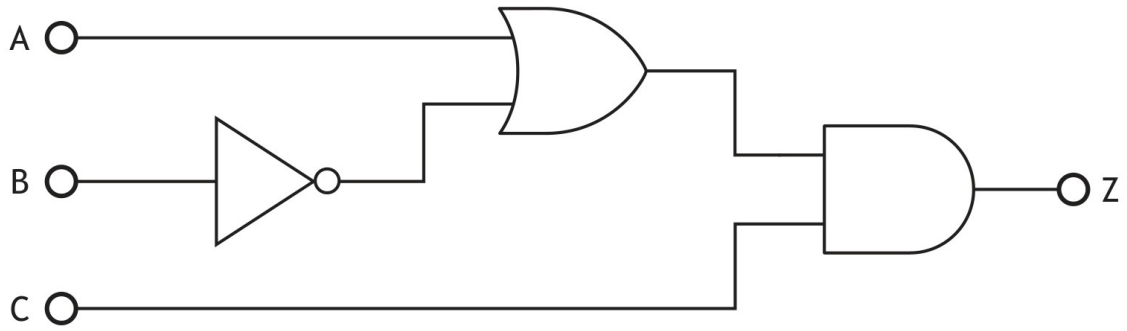
$E = B + C$

$Z = D \bullet E$

$Z = \overline{A} \bullet (B + C)$

2026 Section 1 Question 5

5. A logic diagram is shown.



Complete the Boolean equation for output Z in terms of inputs A, B and C. **3**

Z = _____

3 marks: one for **each gate.**
Label D and **E** first.

Marking: 2026 Section 1 Question 5

Question	Expected response	Max mark	Additional guidance
5	$Z = (A + \overline{B}) \bullet C$	3	**1 mark** for A OR B. **1 mark** for NOT B. **1 mark** for AND C.

Checkpoint



1. **State** the Boolean symbol for **OR**.

   +

2. **Explain** the brackets in (A • B) + C.

   A • B first, **so** one gate

3. **Write** the Boolean for **NOT B**.

   $\overline{B}$

Look back — by the end of this part…



1. I can **write** the Boolean for **AND**, **OR** and **NOT**
2. I can **write** a Boolean expression from **words**
3. I can **write** a Boolean expression from a **diagram**

Daily Review



1	$Z = A \cdot B$. **Name** the gate.	AND
2	$Z = A + B$. **Name** the gate.	OR
3	**State** what the bar in $\overline{B}$ means.	NOT B
4	$Z = A \cdot B$: $A = 1$, $B = 1$. **State** Z.	1
5	**State** how many rows for **2** inputs.	4

PART 2

Drawing from Boolean

We are learning to draw the logic diagram for a Boolean expression.

By the end of this part...



1. I can **draw** a diagram from a Boolean expression
2. I can **start** with the **brackets**
3. I can **draw** every **input** and **output** line

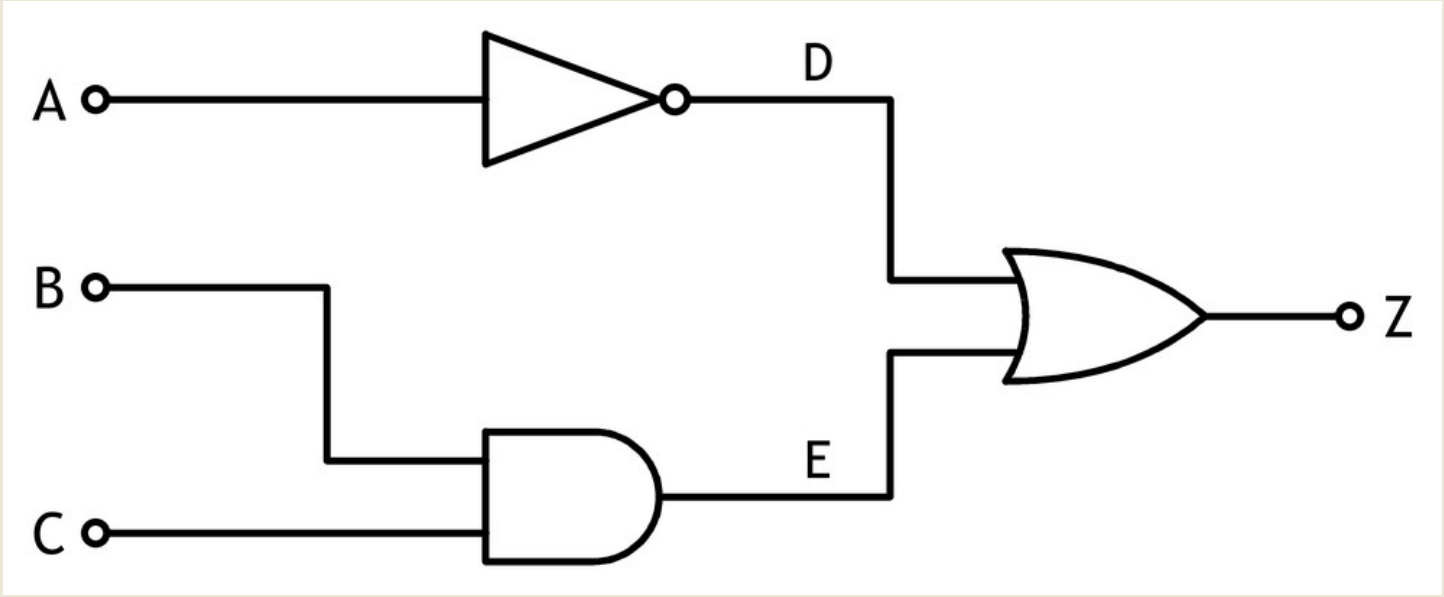
From Boolean to a Diagram

Inputs left, **Z** right.

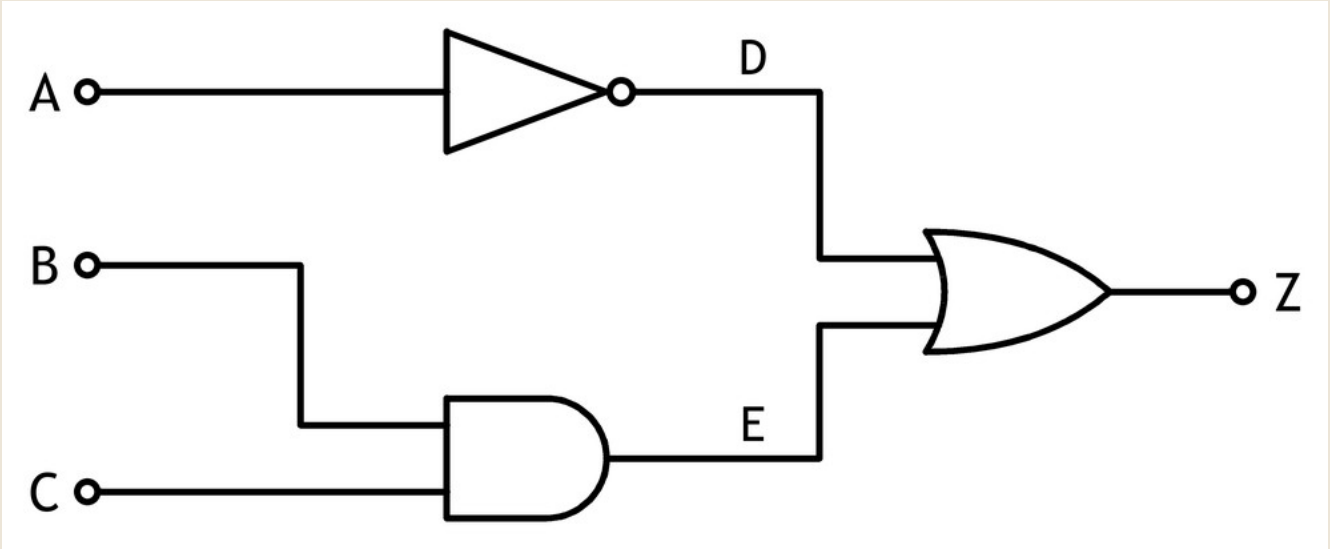
Each **bracket**: one gate, **first**.

A **bar**: a **NOT** gate.

Last gate joins them.



Worked Example: Boolean to Diagram



$Z = \overline{A} + (B \bullet C)$

1 A, B, C on the left.

2 Bracket: B • C, an **AND** gate.

3 $\overline{A}$: a **NOT** gate.

4 + outside: an **OR** gate.

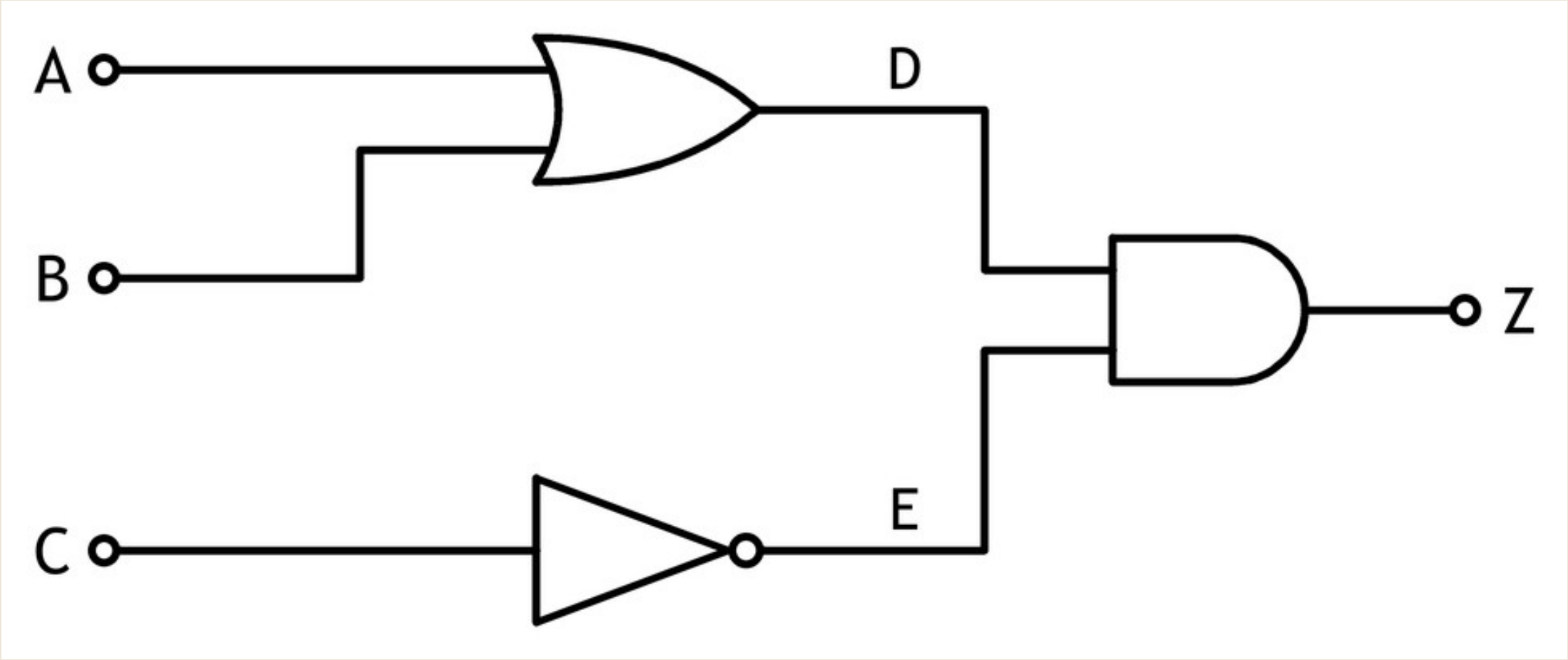
Show Me: Draw It

1 **Draw** the diagram for $Z = (A + B) \cdot \overline{C}$.

OR and NOT, then AND

Answer: Draw It

$Z = (A + B) \bullet \overline{C}$

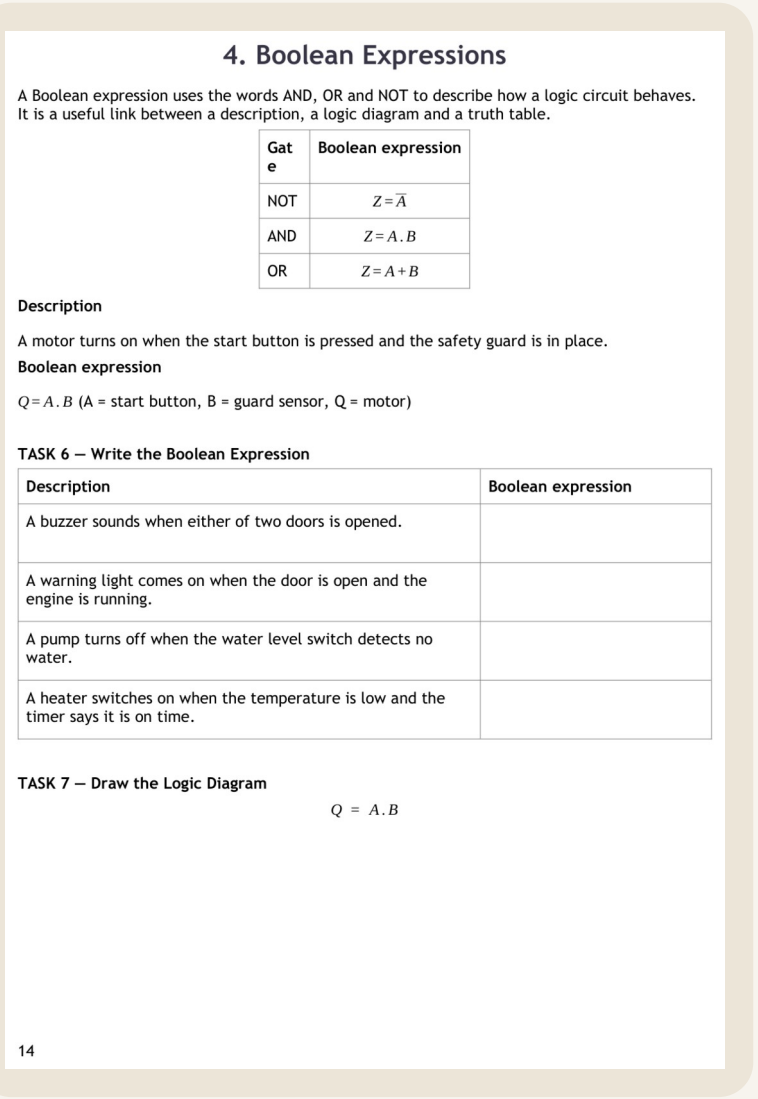


Task 7 (B4a-L4-p14)

Task 7

Draw the logic diagram for each expression.

Pages **14** and **15**.



4. Boolean Expressions

A Boolean expression uses the words AND, OR and NOT to describe how a logic circuit behaves. It is a useful link between a description, a logic diagram and a truth table.

Gate	Boolean expression
NOT	$Z = \overline{A}$
AND	$Z = A.B$
OR	$Z = A + B$

Description

A motor turns on when the start button is pressed and the safety guard is in place.

Boolean expression

$Q = A.B$ (A = start button, B = guard sensor, Q = motor)

TASK 6 — Write the Boolean Expression

Description	Boolean expression
A buzzer sounds when either of two doors is opened.	
A warning light comes on when the door is open and the engine is running.	
A pump turns off when the water level switch detects no water.	
A heater switches on when the temperature is low and the timer says it is on time.	

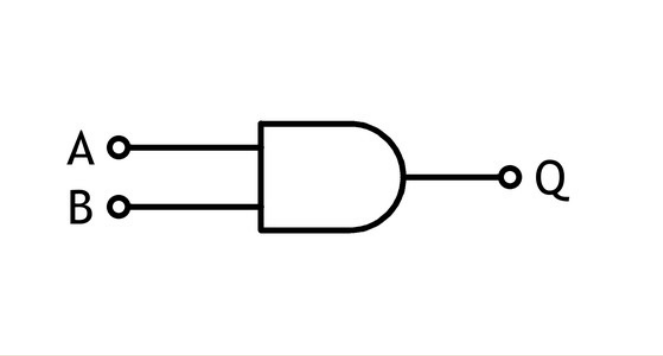
TASK 7 — Draw the Logic Diagram

$$Q = A.B$$

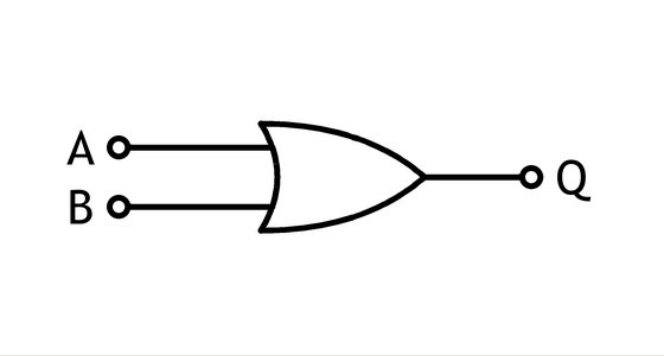
14

Answers: Task 7

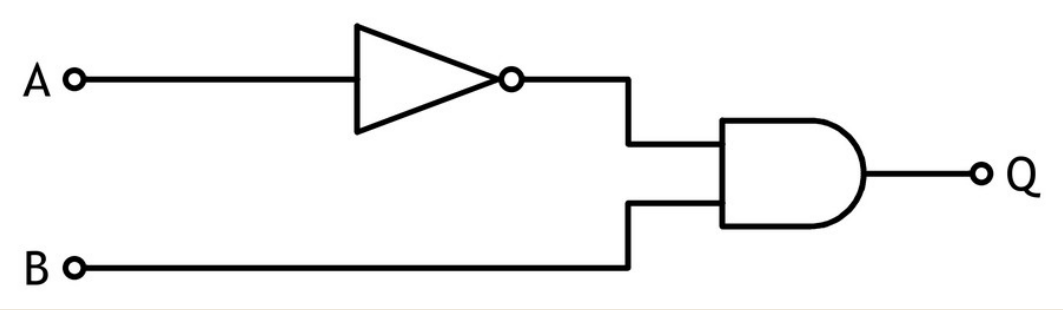
$Q = A.B$



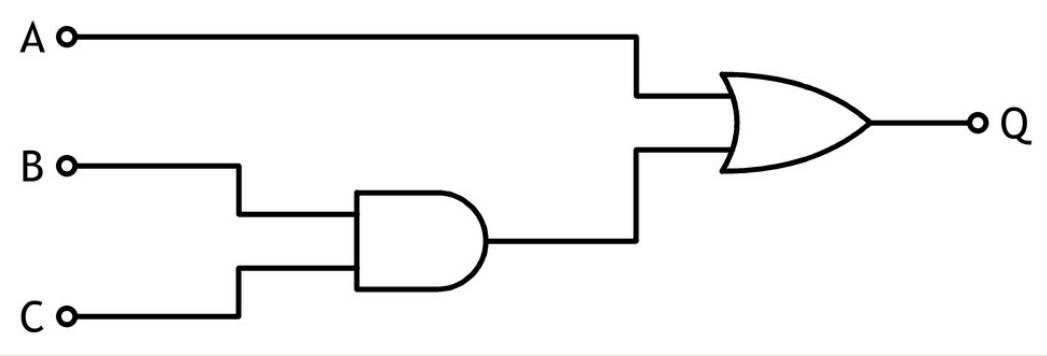
$Q = A + B$



$Q = \overline{A}.B$



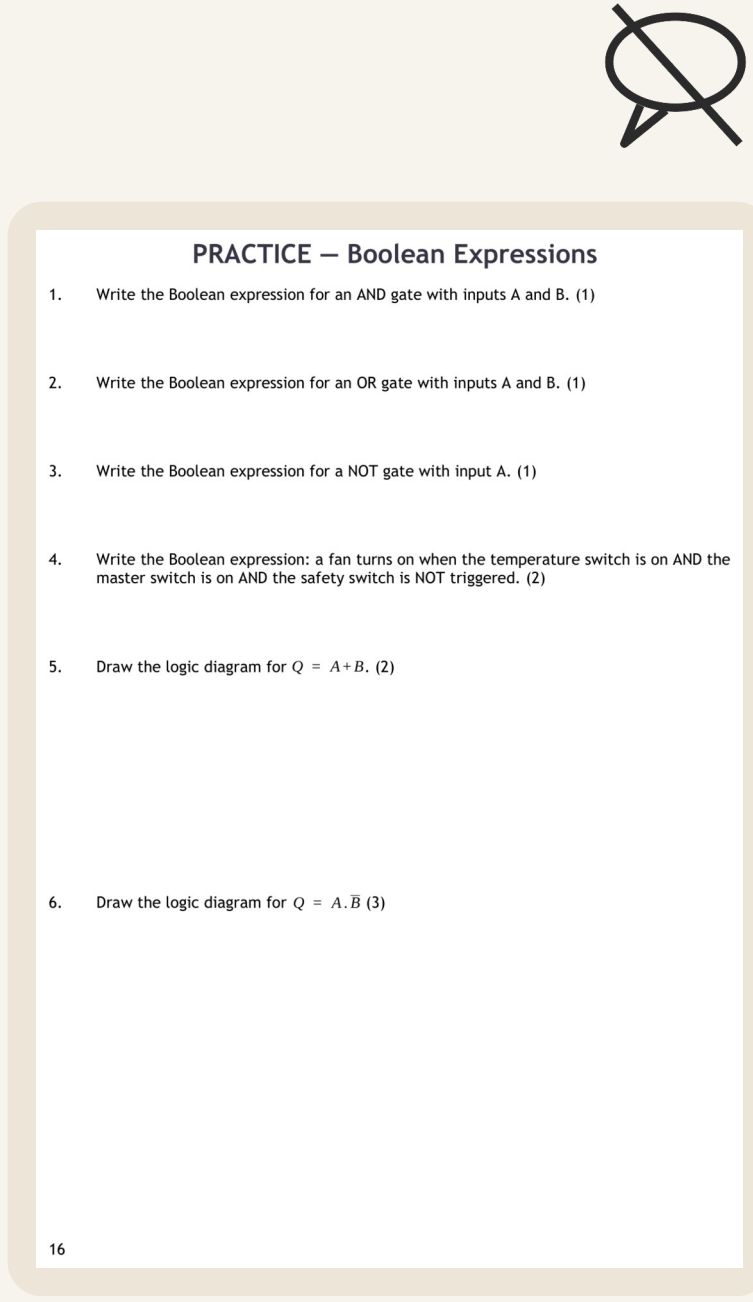
$Q = A + (B.C)$



Review Questions (Booklet pages 16–17)

Review Questions

Answer Questions **1** to **10** on your own.
Questions **7** to **10** are on **page 17**.



PRACTICE — Boolean Expressions

1. Write the Boolean expression for an AND gate with inputs A and B. (1)

2. Write the Boolean expression for an OR gate with inputs A and B. (1)

3. Write the Boolean expression for a NOT gate with input A. (1)

4. Write the Boolean expression: a fan turns on when the temperature switch is on AND the master switch is on AND the safety switch is NOT triggered. (2)

5. Draw the logic diagram for $Q = A + B$. (2)

6. Draw the logic diagram for $Q = A.\overline{B}$ (3)

16

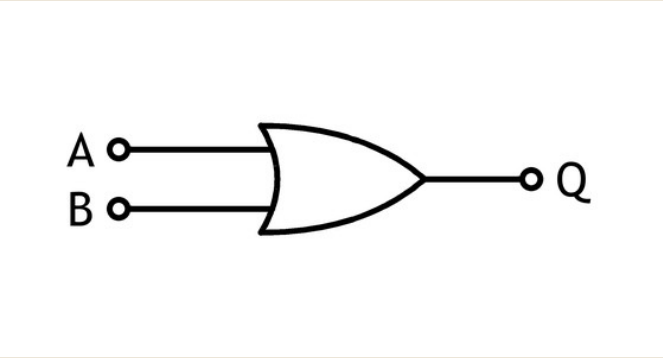
Answers: Review Questions (1 of 2)



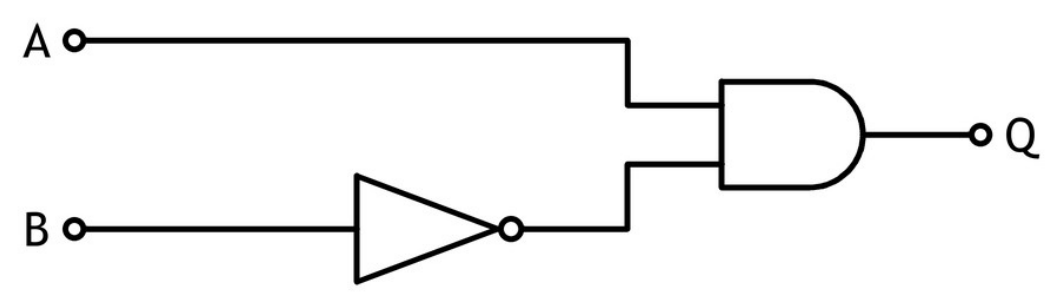
Q	Answer
1	$Q = A \bullet B$
2	$Q = A + B$
3	$Q = \overline{A}$
4	$Q = A \bullet B \bullet \overline{C}$
8	$Q = (A \bullet B) + C$
9	$Q = A + (B \bullet C)$

Answers: Review Questions (2 of 2)

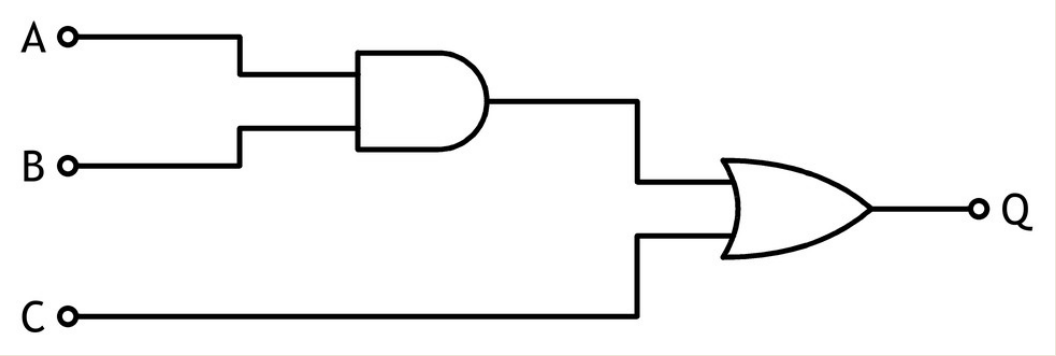
Q5



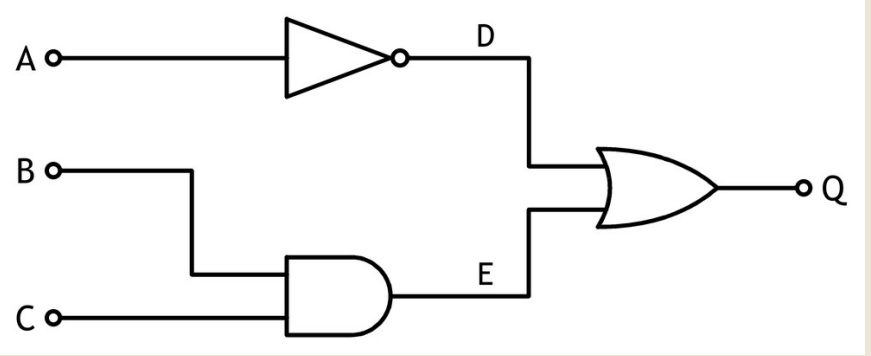
Q6



Q7



Q10



2023 Section 1 Question 3

3. A Boolean equation is shown.

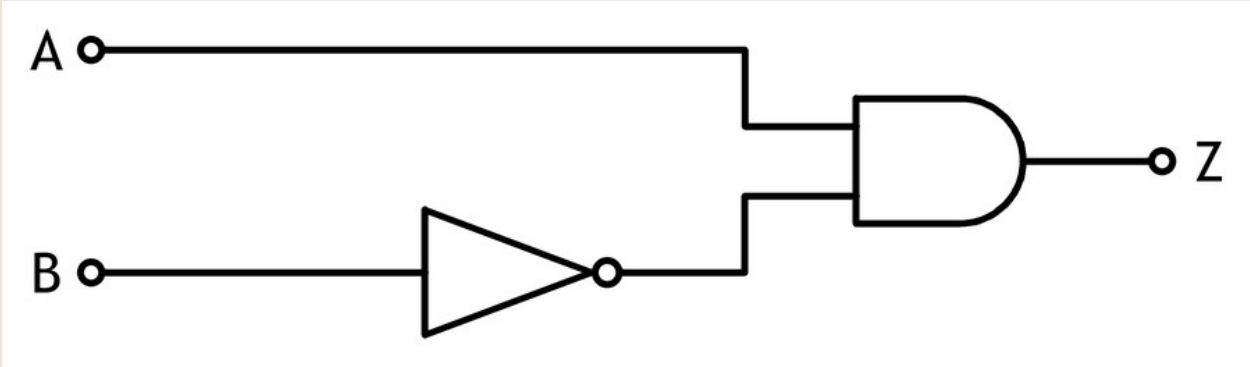
$$A \bullet \overline{B} = Z$$

Draw the logic diagram for this Boolean equation. **2**



2 marks.
Draw every **input** and **output** line.

Marking: 2023 Section 1 Question 3



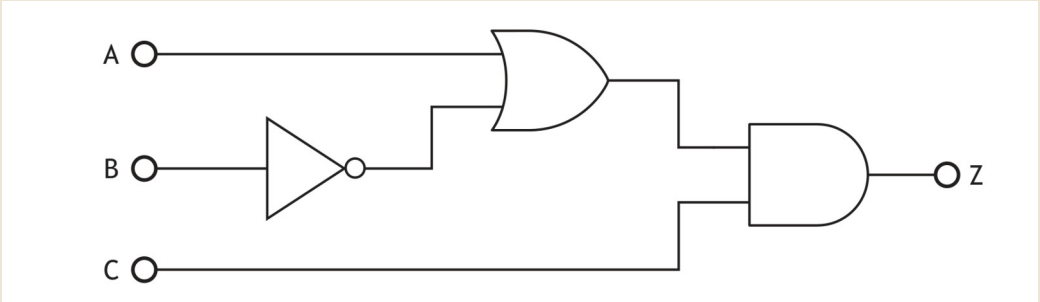
1 mark for B wired to NOT gate.

1 mark for AND gate with inputs and output connections.

Boolean in the Exam

Year	Questions	Marks
2026	S1 Q5	3
2024	S2 Q12(c)	4
2023	S1 Q3	2
2022	S2 Q12(b)	3
2021	S2 Q8(f)	3

Scan the QR for every past paper by topic.



2026 S1 Q5

Checkpoint

1. $Z = \overline{A} \bullet B$. **State** how many **gates**.

   2

2. **Explain** why every line is drawn.

   Marks need it, **so** draw all

3. **State** which gate to draw **first**.

   The bracket's gate

Look back — by the end of this part…



1. I can **draw** a diagram from a Boolean expression
2. I can **start** with the **brackets**
3. I can **draw** every **input** and **output** line

Extension



1. **Draw** $Z = (\overline{A} + B) \bullet (\overline{B} + C)$.

2. **Complete** the truth table for $Z = A \bullet \overline{B}$.

Course Specification — 1 of 1

Digital electronic control systems

- AND, OR and NOT gates and combinations with up to three inputs, using truth tables, logic diagrams and Boolean expressions

Credits

Drawings: Gate symbols, logic diagrams and circuits drawn by R Stewart; booklet pages from Booklet 4a, Logic and Digital Control.

2026 Section 1 Question 5: © Qualifications Scotland (SQA). 2026 National 5 Engineering Science Section 1, Q5

Marking: 2026 S1 Q5: © Qualifications Scotland (SQA). 2026 National 5 Engineering Science Section 1, Q5 marking instructions

2023 Section 1 Question 3: © Qualifications Scotland (SQA). 2023 National 5 Engineering Science Section 1, Q3

Marking: 2023 S1 Q3: © Qualifications Scotland (SQA). 2023 National 5 Engineering Science Section 1, Q3 marking instructions

Boolean in the Exam: © Qualifications Scotland (SQA). National 5 Engineering Science 2021-2026 question papers; figure 2026 Section 1, Q5

Course specification: © Qualifications Scotland (SQA). N5 Engineering Science course specification v2.0, p.5

R Stewart - November 2026