
GCSE
OCR
Computer Science
J277
1
Logic diagrams and truth tables
Unit 8
Logic and languages
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Objectives

- Construct truth tables for the following logic gates:
  - NOT
  - AND
  - OR
- Construct truth tables for simple logic circuits
- Interpret the results of truth tables
- Create, modify and interpret simple logic circuit diagrams

Starter

- Consider a safe with two keys
- If both keys are used, the safe will open

```
if key1 AND key2 then
    safeOpen = True

else
    safeOpen = False
```

- What are the only possible values that key1 and key2 can be?
  - What values must they be to open the safe?

Starter

Answers

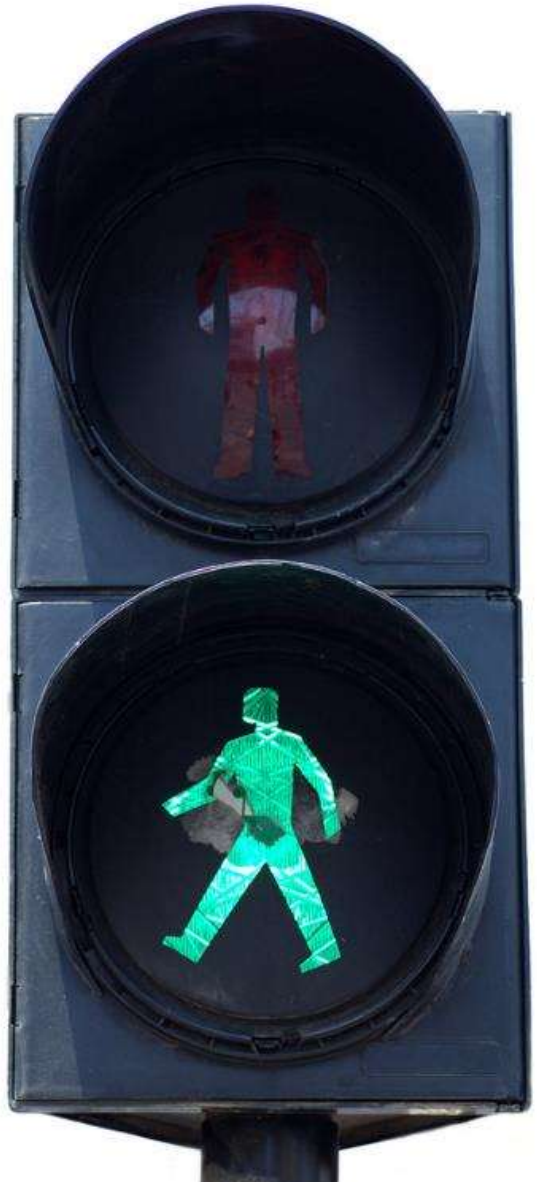
```
if key1 AND key2 then
    safeOpen = True

else
     safeOpen = False
```

- What are the only possible values that key1 and key2 can be?
  - Key1 and key2 can only be True or False (lock or unlock)
- What values must they be to open the safe?
  - They must both be True to open the safe

Binary situations

- Binary situations are common in daily life and can refer to things that can be in only one of two states:
  - Stop or Go
  - Pass or Fail
  - On or Off
- In computing terms
  - A binary 1 can represent True
  - A binary 0 can represent False



Booleans in loops

- Booleans used in IF statements and loops

```
while doorOpen
    turnOnLight()
endwhile
```

True or False?

Unlocking a smartphone:

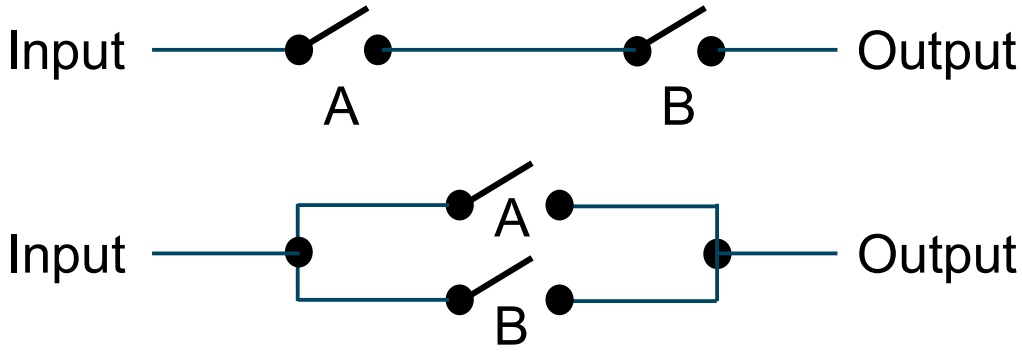
- using a known fingerprint **or**
- using a correct PIN code?

```
if fingerprint OR correctPIN then
    unlock = True

else
    unlock = False
```

Boolean functions

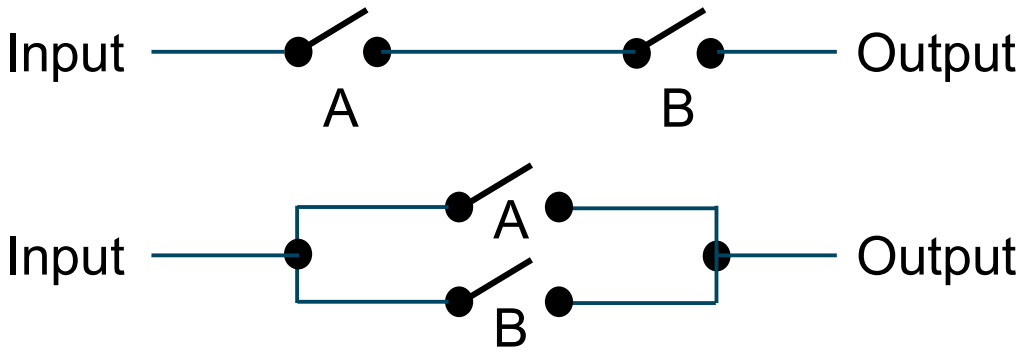
- AND, OR and NOT are Boolean operators
- A computer can calculate the results of **A AND B**, **A OR B**, or **NOT A**
  - What do these two circuit diagrams represent?



Boolean functions

Answers

- What do these two circuit diagrams represent?



AND
Both switches must be down to complete the circuit

OR
Either switch needs to be down to complete the circuit

Truth tables

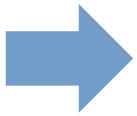
- A **truth table** shows the output from all possible combinations of inputs from a Boolean expression
- If there are two inputs A AND B, there are four possible combinations of TRUE and FALSE
  - Both A and B must be True for the output to be True

Input A	Input B	A AND B
False	False	False
False	True	False
True	False	False
True	True	True

Boolean function – AND

- It is also possible to use 1 and 0 to represent True and False
  - The below truth tables represent: IF a lift is on the correct floor **AND** the call button has been pressed THEN open the lift door
  - What are the values for *Open Life Door* and *P* below

Lift on correct floor	Button Pressed	Open Lift Door
False	False	?
False	True	?
True	False	?
True	True	?



A	B	P
0	0	?
0	1	?
1	0	?
1	1	?

Truth table – AND

Answers

- IF both inputs are **TRUE** then the output is **TRUE**

Lift on correct floor	Button Pressed	Open Lift Door
0	0	0
0	1	0
1	0	0
1	1	1

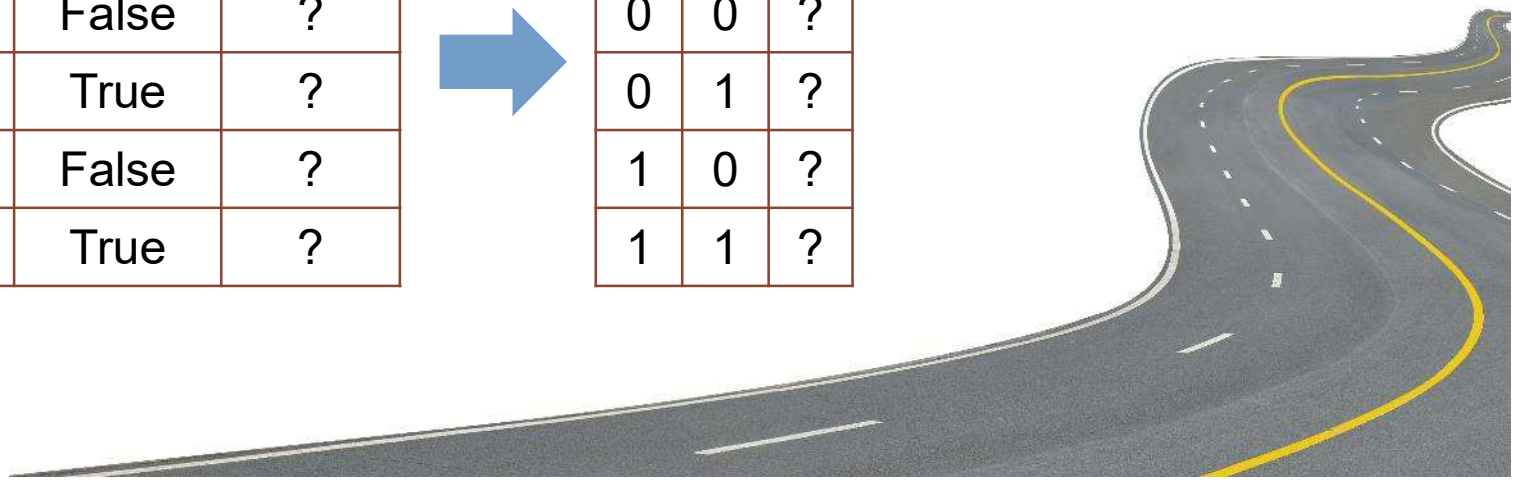
A	B	P
0	0	0
0	1	0
1	0	0
1	1	1

Boolean function – OR

- IF lane1Open OR lane2Open
  - If lane one is open OR lane 2 is open then you can drive down the road
  - What is P?

lane1 Open	Lane2 Open	P
False	False	?
False	True	?
True	False	?
True	True	?

A	B	P
0	0	?
0	1	?
1	0	?
1	1	?



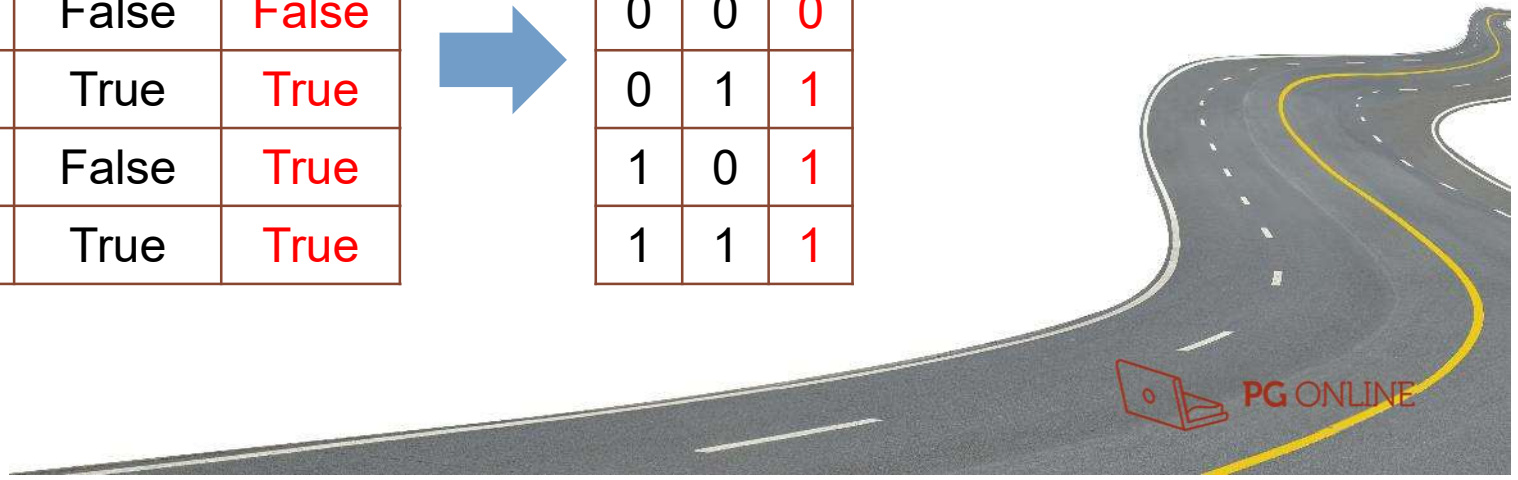
Boolean function – OR

Answers

- IF lane1Open OR lane2Open
  - If lane one is open OR lane 2 is open then you can drive down the road
  - What is P?

lane1 Open	Lane2 Open	P
False	False	False
False	True	True
True	False	True
True	True	True

A	B	P
0	0	0
0	1	1
1	0	1
1	1	1



Boolean function – NOT

- IF the input is **True** then the output is **False**
- IF the input is **False** then the output is **True**

Input A	Output P = NOT A
False	True
True	False

More logic

Which of the following statements are **True?**

- (4 > 3) AND (5 > 7)
- (2 < 8) OR (8 > 10)
- NOT (5 * 7 > 30)
- ((7 DIV 3) >= 2) OR ((7 DIV 3) < 2)
- ((12 MOD 5) < 2) AND ((12 MOD 5) == 2)
  - DIV gives the integer division (the result of division without any fractional component)
  - MOD gives the remainder after a division

More logic

Answers

Which of the following statements are **True?**

- (4 > 3) AND (5 > 7) False
- (2 < 8) OR (8 > 10) True
- NOT (5 * 7 > 30) False
- ((7 DIV 3) >= 2) OR ((7 DIV 3) < 2) True
- ((12 MOD 5) < 2) AND ((12 MOD 5) == 2) False

Worksheet 1

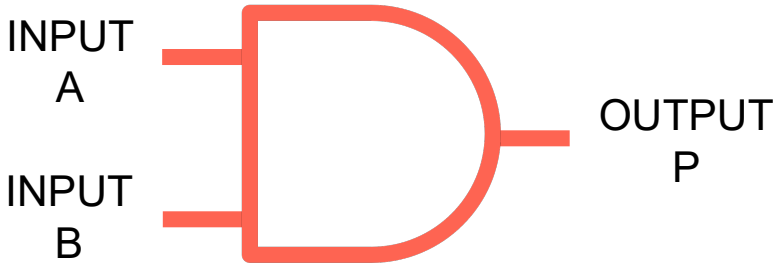
- Now complete **Task 1** on **Worksheet 1**

From truth tables to logic gates

- Physical computer circuits are built using logic gates
- The first three fundamental gates used to build circuits are:
  - AND gate
  - OR gate
  - NOT gate

Binary logic – AND gate

- If both inputs are 1 (True) then the output is 1 (True)
- Otherwise the output is 0 (False)



Logic statement: P = A AND B

Logic Diagram

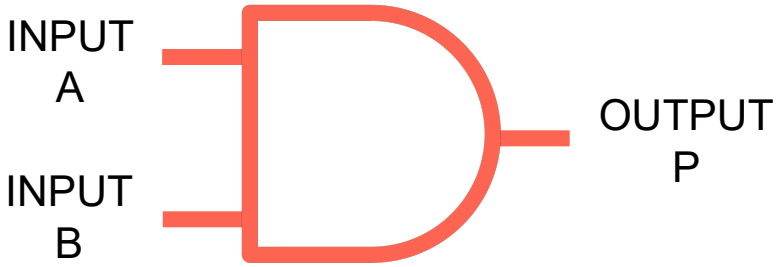
A	B	P
0	0	?
0	1	?
1	0	?
1	1	?

Truth Table

Binary logic – AND gate

Answers

- If both inputs are 1 (True) then the output is 1 (True)
- Otherwise the output is 0 (False)



Logic statement: P = A AND B

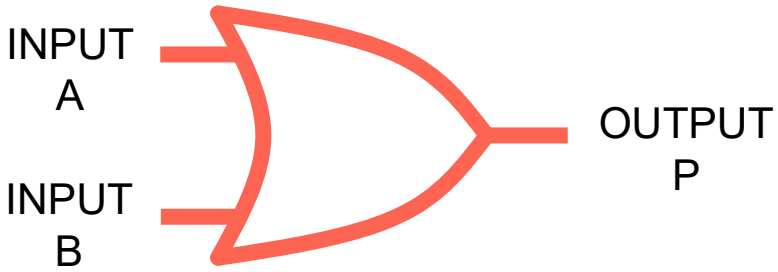
Logic Diagram

A	B	P
0	0	0
0	1	0
1	0	0
1	1	1

Truth Table

Binary logic – OR gate

- If either input is 1 (True) then the output is 1 (True)
- Otherwise the output is 0 (False)



Logic statement: P = A OR B

Logic Diagram

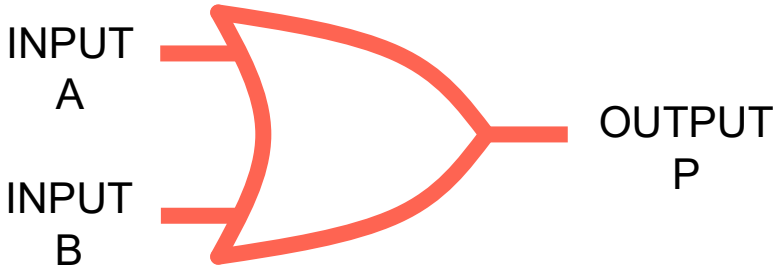
A	B	P
0	0	?
0	1	?
1	0	?
1	1	?

Truth Table

Binary logic – OR gate

Answers

- If either input is 1 (True) then the output is 1 (True)
- Otherwise the output is 0 (False)



Logic statement: P = A OR B

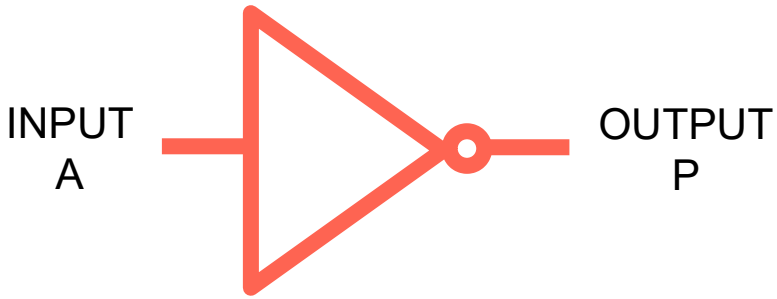
Logic Diagram

A	B	P
0	0	0
0	1	1
1	0	1
1	1	1

Truth Table

Binary logic – NOT gate

- If 0 is input it outputs 1 (True)
- If 1 is input it outputs 0 (False)



Logic statement: P = NOT A

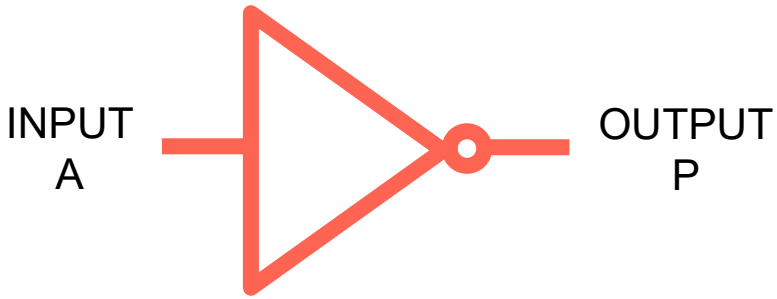
A	P
0	?
1	?

Logic Diagram **Truth Table**

Binary logic – NOT gate

Answers

- If 0 is input it outputs 1 (True)
- If 1 is input it outputs 0 (False)



A	P
0	1
1	0

Logic statement: P = NOT A

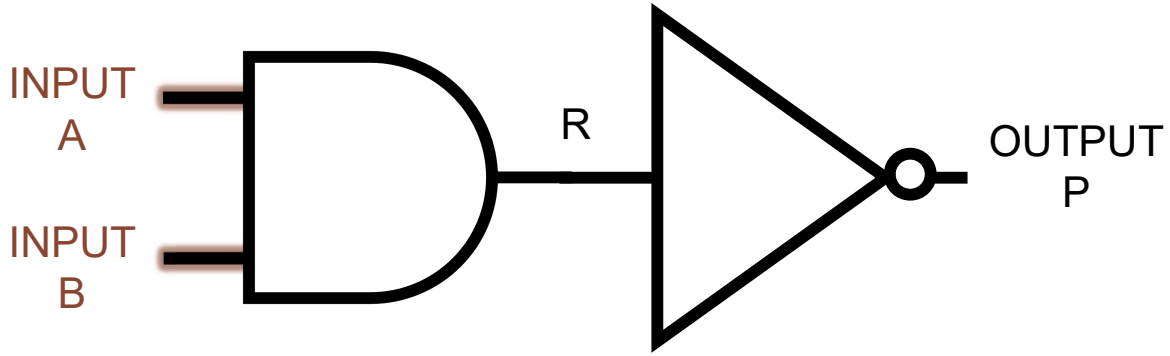
Logic Diagram **Truth Table**

Worksheet 1

- Now complete **Task 2** on **Worksheet 1**

Combining logic gates

- We can combine logic gates together to make more complex circuits

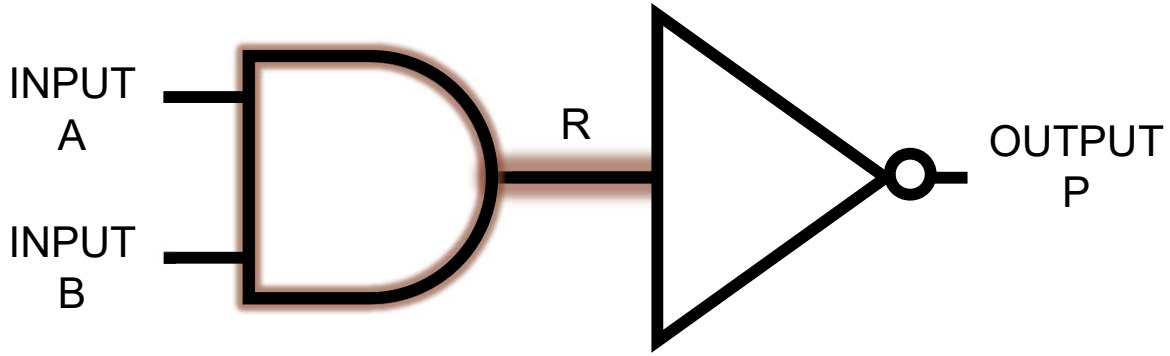


A	B	R = A AND B	P = NOT R
0	0		
0	1		
1	0		
1	1		

Logic statement:
P = NOT(A AND B)

Combining logic gates

- We can combine logic gates together to make more complex circuits



A	B	R = A AND B	P = NOT R
0	0	0	
0	1	0	
1	0	0	
1	1	1	

Logic statement:
P = NOT (A AND B)

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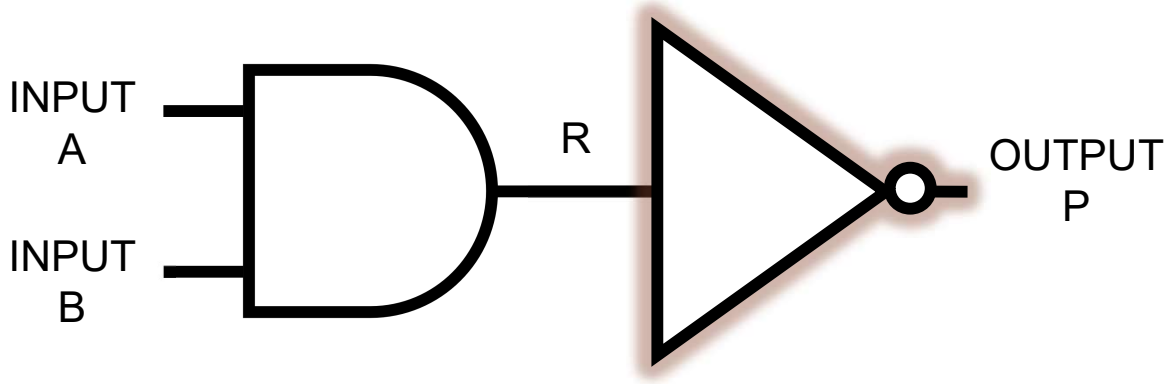
Combining logic gates

- We can combine logic gates together to make more complex circuits



A	B	R = A AND B	P = NOT R
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

Logic statement:
P = NOT (A AND B)

Modelling real life – security lighting

- What would the circuit diagram for this situation look like?
  - The security light must come on if it senses movement AND it is night time, OR if someone presses a manual override switch

Modelling real life

Answers

Sensor detects movement = TRUE

AND

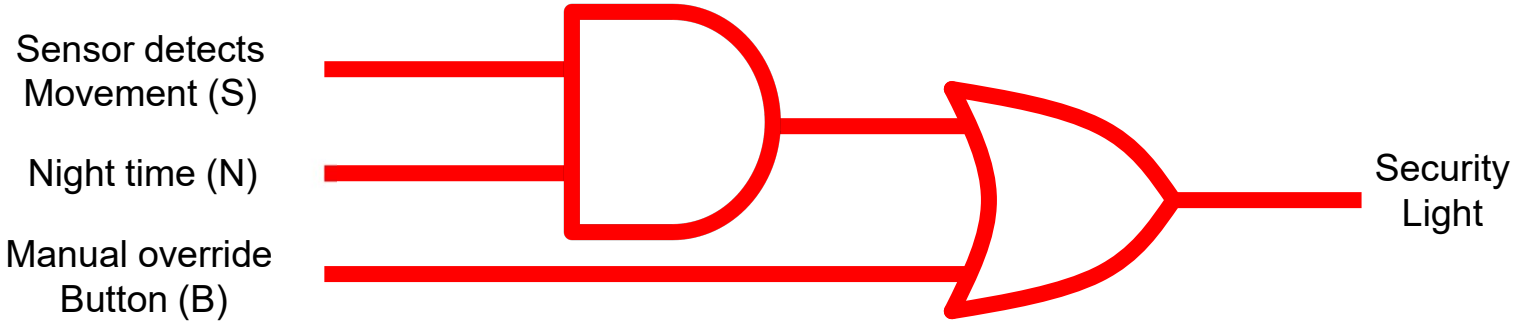
Night time = TRUE

OR

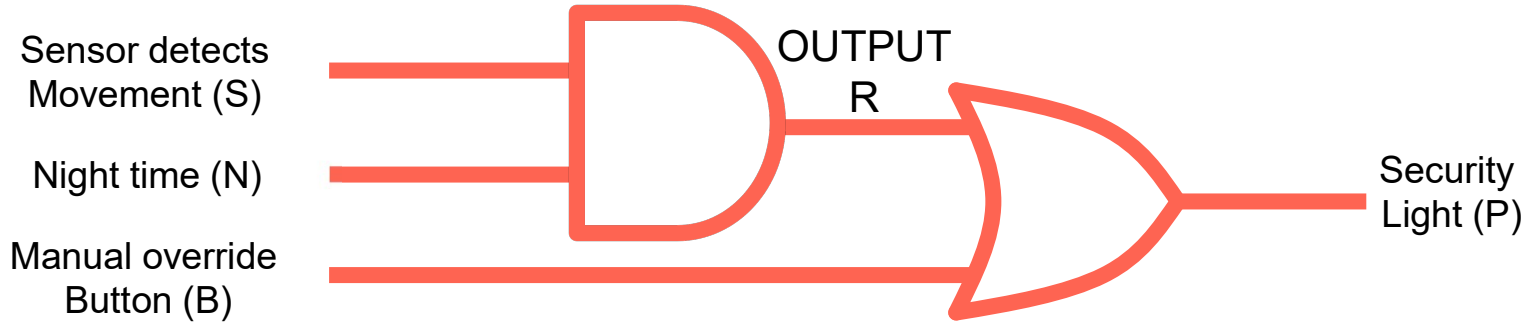
Manual override Button = TRUE

=

Security Light On



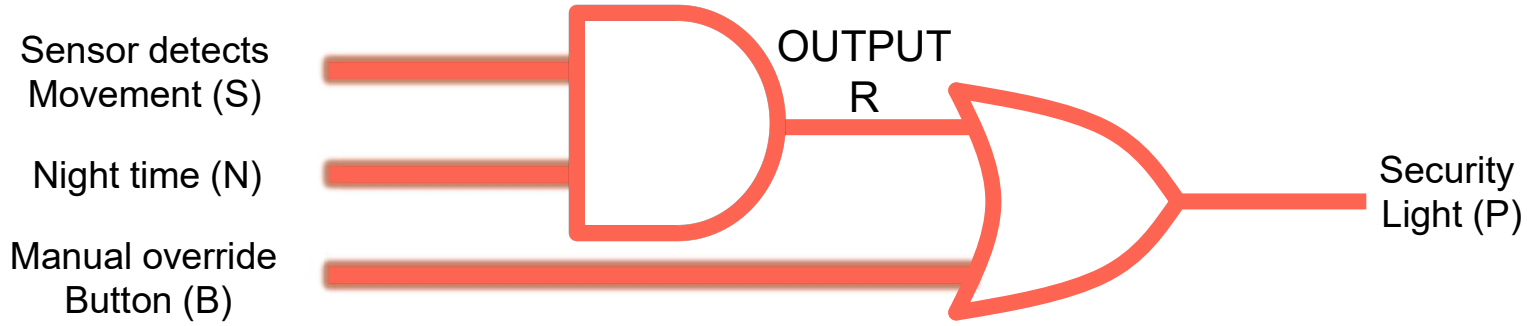
The truth table



S	N	B	R = S AND N	P = R OR B

Logic statement:
P = (S AND N) OR B

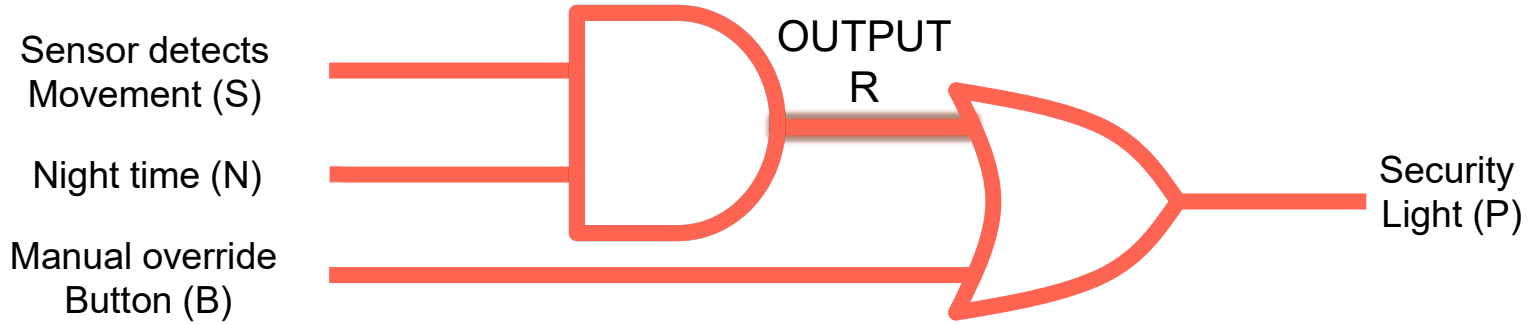
The truth table



S	N	B	R = S AND N	P = R OR B
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

Logic statement:
P = (S AND N) OR B

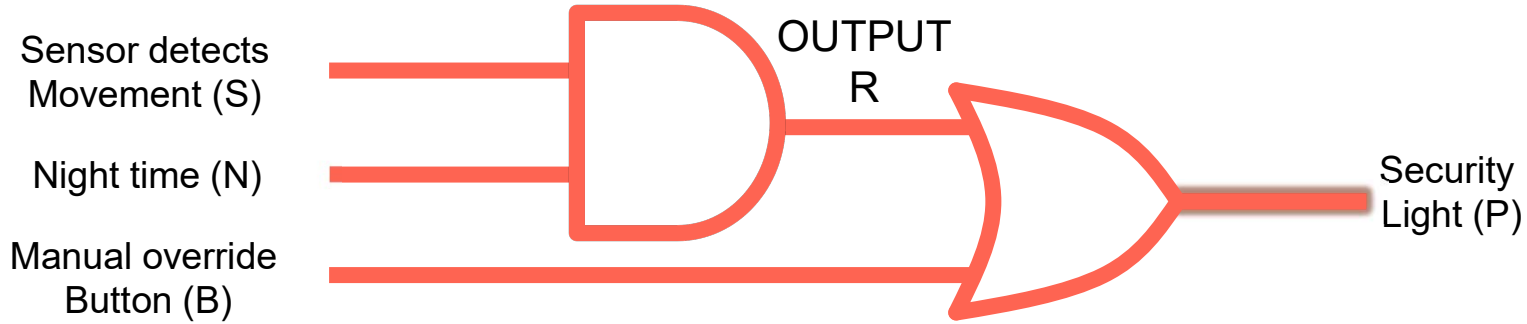
The truth table



S	N	B	R = S AND N	P = R OR 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	

Logic statement:
P = (S AND N) OR B

The truth table



S	N	B	R = S AND N	P = R OR B
0	0	0	0	0
0	0	1	0	1
0	1	0	0	0
0	1	1	0	1
1	0	0	0	0
1	0	1	0	1
1	1	0	1	1
1	1	1	1	1

Logic statement:
P = (S AND N) OR B

Worksheet 1

- Now complete **Task 3** on **Worksheet 1**

Plenary

- Answer the following questions with a partner:
  1. What are the three basic logic gates?
  2. What are the symbols for each of the logic gates?
  3. Explain what each logic gate does
  4. What is a truth table?

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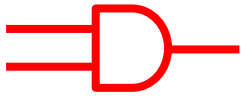
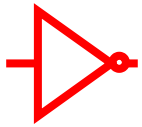
Plenary

Answers

1. What are the three basic logic gates?
   - AND, OR, NOT
2. What are the symbols for each of the logic gates?
   - AND  OR  NOT 
3. Explain what each logic gate does
   - AND – Both inputs must be True for output to be True
   - OR – At least one input must be True for output to be True
   - NOT – The output is opposite to the input
4. What is a truth table?
   - It shows all possible combinations of inputs and the outputs they create

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