

Logic

Boolean logic has a range of applications, and is based on three operators:

AND condition

The AND truth table is:

Input 1	Input 2	Output
False	False	False
True	False	False
False	True	False
True	True	True

OR condition

The OR truth table is:

Input 1	Input 2	Output
False	False	False
True	False	True
False	True	True
True	True	True

NOT condition

The NOT truth table is:

Input 1	Output
False	True
True	False

Logic equations

We can combine together logical inputs to produce more complex equations, and fill in truth tables based on these.

E.g. A AND (NOT B)

A	B	Output
False	False	False
True	False	True
False	True	False
True	True	False

Question 1. Fill in the following logic table for this expression:
 (NOT A) OR B

A	B	Output
False	False	
True	False	
False	True	
True	True	

We can also have logic equations containing three terms. E.g. A OR (B AND C). This creates a larger logic table, as follows:

A	B	C	Output
False	False	False	False
True	False	False	True
False	True	False	False
True	True	False	True
False	False	True	False
True	False	True	True
False	True	True	True

True	True	True	True
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Question 2. Fill in the following logic table for this expression:
A AND (B OR C)

A	B	C	Output
False	False	False	
True	False	False	
False	True	False	
True	True	False	
False	False	True	
True	False	True	
False	True	True	
True	True	True	

Question 3. Fill in the following logic table for this expression:
A OR (NOT(B) AND C)

A	B	C	Output
False	False	False	
True	False	False	
False	True	False	
True	True	False	
False	False	True	
True	False	True	
False	True	True	
True	True	True	

We can also connect Boolean logic to what we write in code. If statements frequently contain Boolean logic within them, e.g.

If NOT(Gender = male AND Age = 18)

This could be expressed in a truth table as follows:

Gender = male	Age = 18	Output
False	False	True
True	False	True
False	True	True
True	True	False

Question 4. Complete the truth table for the following expression:

If (Year = 11 OR NOT(Form = AG))

Year = 11	Form = AG	Output
False	False	
True	False	
False	True	
True	True	

Question 5. Complete the truth table for the following expression:

If (NOT(Year = 13) AND (Late > 5 OR RedCard >3))

Year = 13	Late >5	RedCard >3	Output
False	False	False	
True	False	False	
False	True	False	
True	True	False	
False	False	True	
True	False	True	
False	True	True	
True	True	True	

Express the meaning of this logical expression words:

Logic Circuits

Real life problems can be solved using logic. Electronics systems often have an underlying logic, which we can express with Boolean values. E.g. imagine an alarm system which has two sensors and a master switch. If either of the sensors is activated then the alarm should go off, unless the master switch is set to off, in which case the alarm should not be sounded.

We can write this as a Boolean expression, where S is the switch, A is the first sensor, B is the second sensor, and O is the outcome (alarm on or not):

$$O = (A \text{ OR } B) \text{ AND } S$$

The truth table for this piece of logic is as follows:

A	B	S	Output
False	False	False	False
True	False	False	False
False	True	False	False
True	True	False	False
False	False	True	False
True	False	True	True
False	True	True	True
True	True	True	True

Question 6. A shop's cash register should give a discount to shoppers who swipe a membership card (M) or who have both Business card (B) and have spent (S) over £500. Fill in the truth table for this set-up.

M	B	S>500	Output
False	False	False	
True	False	False	
False	True	False	
True	True	False	
False	False	True	
True	False	True	

False	True	True	
True	True	True	

Question 7. A laser cutter will operate if the Power is on (P), and if either the AutoPattern is switched on (AP) or the FreeCut button (FC) is pressed. Fill in the truth table for this set-up.

P	AP	FC	Output
False	False	False	
True	False	False	
False	True	False	
True	True	False	
False	False	True	
True	False	True	
False	True	True	
True	True	True	