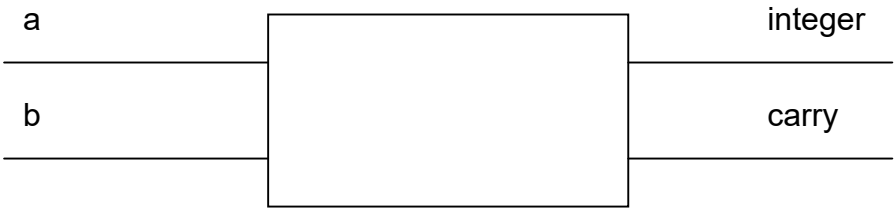
The half adder

With binary inputs at **a** and **b**, we want to be able to add two single digits. This means we need a two-digit output, since one plus one is two, and two in binary is represented as 10 [That's "one zero" **not** "ten"!!!]



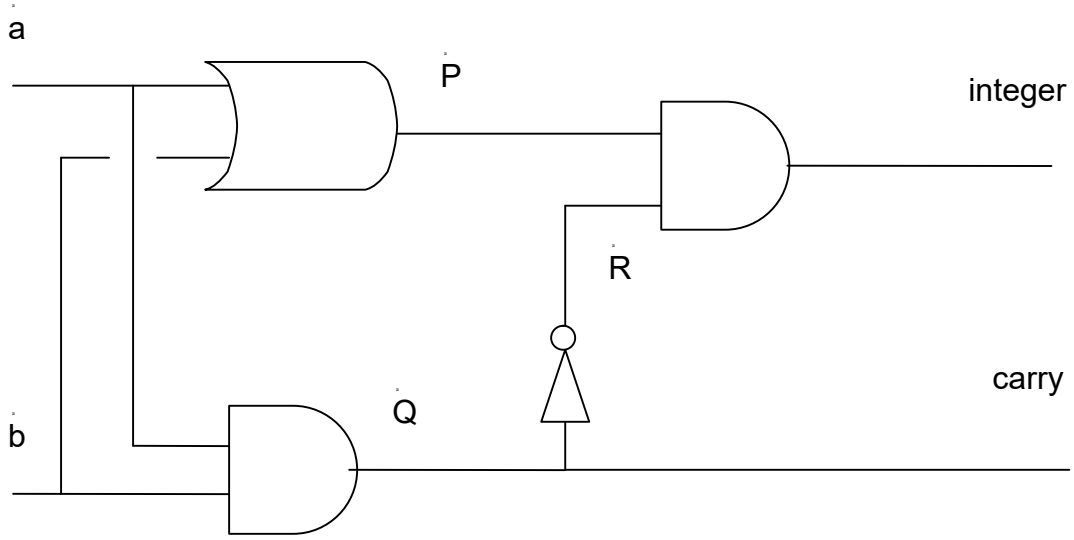
So our **truth table** for this device needs to look like this:

a	b	Carry	integer
0	0	0	0
1	0	0	1
0	1	0	1
1	1	1	0

If we know a little Boolean logic, we can see that the **carry** digit is nice and easy: It's a simple **a AND b**.

Our **integer** value is a little more complicated. It's like **a OR b** except that we want it to be zero when a and b are both true. [The technical term for this is an "exclusive OR"]. That means we want something that is true when **a OR b** are true, but **NOT** when **a AND b** are true.

When both are true, the binary value is two. Since we can only use the digits 1 and 0 in binary, then two requires us to carry a digit and represent it as 10
[Remember that's "one zero" **not** "ten"!]

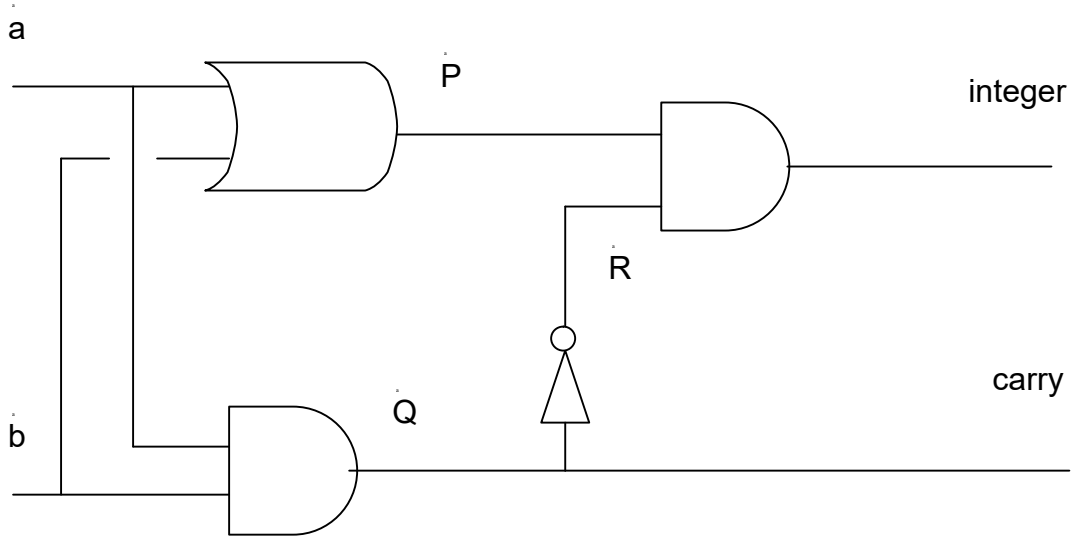


How does it work?

OK, it looks pretty enough - let's see what's going on.

Its sometimes difficult to work out what's happening in these logic circuits all in one go, so here's the trick:

I have labelled each of the points where something has "happened" - P, Q and R. Now if we write a bigger truth table, we can break this thing down into smaller parts, and really start to understand what's going on:



a	b	P [a OR b]	Q [a AND b]	R [NOT Q]	integer [P AND R]	carry (same as Q)
0	**0**					
1	**0**					
0	**1**					
1	**1**					

Follow it through a line at a time.

So the integer is **(a OR b) AND (NOT (a AND b))**

Tip:

Please familiarise yourself with this diagram and how to work it out from basic understanding of the three types of gate, **AND**, **OR** and **NOT**.

As well as often coming up in the exam, this kind of logical thinking will help you enormously in your analysis, design and programming skills.

[It's also a great way to figure out what's going on in some of the more advanced computer games!]