

Year 8

Computer Science 8.2 Data Representation

| Binary Digit (bit) | Electronic Charge | Electronic System |
|--------------------|-------------------|-------------------|
| 1 | ON | ON |
| 0 | OFF | OFF |

Binary a **base 2** number system which means it only has 2 numbers; 0 and 1. 1 = ON, 0 = OFF (Computers use binary).

Denary is a base 10 number system which means it only has 10 numbers; 0-9 (Humans use denary).

| DENARY | BINARY |
|--------|--------|
| 0 | 0 |
| 1 | 1 |
| 2 | 10 |
| 3 | 11 |
| 4 | 100 |
| 5 | 101 |
| 6 | 110 |
| 7 | 111 |
| 8 | 1000 |
| 9 | 1001 |
| 10 | 1010 |
| 11 | 1011 |
| 12 | 1100 |
| 13 | 1101 |
| 14 | 1110 |
| 15 | 1111 |

| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|-----|----|----|----|---|---|---|---|
| | | | | | | | |

Binary to Denary:

Question: Convert the 8 bit binary number 0011 0101 into denary.

| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|-----|----|----|----|---|---|---|---|
| 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 |

$$32 + 16 + 4 + 1 = 53$$

So 00110101 is 53 in denary

Denary to Binary:

Question: Convert the denary number 25 into binary.

| 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
|-----|----|----|----|---|---|---|---|
| 0 | 0 | 0 | 1 | | | | |

$$25 - 16 = 9$$

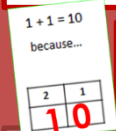
Which numbers can I use to make 9? - put a 1 under them

Which numbers don't I need? - put a 0 under them

There are only 10 types of people in the world: Those who understand binary and those who don't.

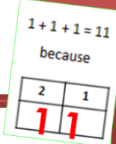
I ordered a book entitled "101 Binary Tips" I was very disappointed with the contents

As binary only uses 1s and 0s, $0+0=0$ works and $0+1=1$ works but $1+1$ CAN'T equal 2! (because there is no 2 in binary)



Instead in binary, $1+1 = 10$ 2 in denary = 10 in binary

And $1+1+1 = 11$ 3 in denary = 11 in binary



Rules for binary addition:

| | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |
|----------|---|---|---|---|---|---|---|---|---|
| Number 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | |
| Number 2 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | |
| Answer | | | | | | | | | |
| Carry | | | | | | | | | |

Sometimes when doing binary addition you get a result that requires more bits than we have space for.

This is called an **overflow error!**



Overflow errors result in **loss of data** and the results are **inaccurate!**

Logic gates are special **switches** built into computer circuits, used to make decisions.

- They receive binary data
- Apply a Boolean operation.
- Then output a binary result.

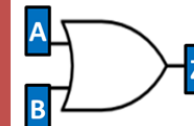
The 3 gates (switches):

AND gate



| INPUT A | INPUT B | OUTPUT Q Q=(A AND B) |
|---------|---------|-------------------------|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

OR gate



| INPUT A | INPUT B | OUTPUT Z Z=(A OR B) |
|---------|---------|------------------------|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

NOT gate



| INPUT A | OUTPUT R R=(NOT A) |
|---------|-----------------------|
| 0 | 1 |
| 1 | 0 |

1 AND 1 = 1 every other combination = 0

THE RULE

One OR more 1s going IN = 1 coming OUT.

THE RULE

If 1 goes in, it is NOT 1 when it comes out.

THE RULE

What I need to know / be able to do:

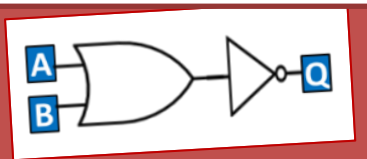
| |
|---|
| Define the term 'binary'. Which numbers can be used in the binary number system? |
| Define the term 'denary'. Which numbers can be used in the denary number system? |
| Convert any denary number between 0-255 into binary using the binary table. |
| Convert any binary number from 0000 0000 to 1111 1111 into denary using the binary table. |
| What is the rule for 1+1 in binary? <i>Why?</i> |
| What is the rule for 1+1+1 in binary? <i>Why?</i> |
| What is an overflow error? |
| What do over flow errors cause? |
| Create a binary addition sum that causes an overflow error and show how to deal with it. |
| What are logic gates? |
| What does a logic gate do? |
| Draw and label the 3 main logic gates. |
| Draw the AND gate and it's corresponding truth table. <i>What is the rule for the AND gate?</i> |
| Draw the OR gate and it's corresponding truth table. <i>What is the rule for the OR gate?</i> |
| Draw the NOT gate and it's corresponding truth table. <i>What is the rule for the NOT gate?</i> |

| | |
|--------------------------------------|--------------------------------------|
| 1001 1100 | 1010 0011 |
| 0110 1001 | 0110 0110 |
| 203 | 39 |
| 227 | 181 |
| 1010 0110 0100 1100 | 0011 0011 1101 0011 |
| 0100 1001 1011 1110 | 0111 1110 0001 1000 |
| 1101 1100 1001 0011 | 0101 1101 1111 0011 |
| 1001 0101 0110 1111 | 0110 1101 1010 0101 |
| 1011 1100 0101 1011 | 1011 1111 1111 1110 |

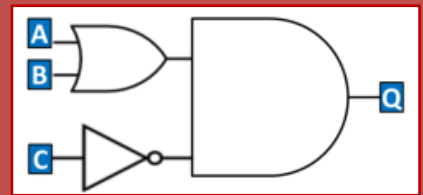
What is Q if A = 1 and B = 0?



What is Q if A = 1 and B = 0?



What is Q if A = 1 , B = 0 AND C=0?




Binary Fun
Binary Bonanza
Binary Tetris