

# INTRODUCTION

This hand out will demonstrate how to convert between different bases. It will cover the following conversions:

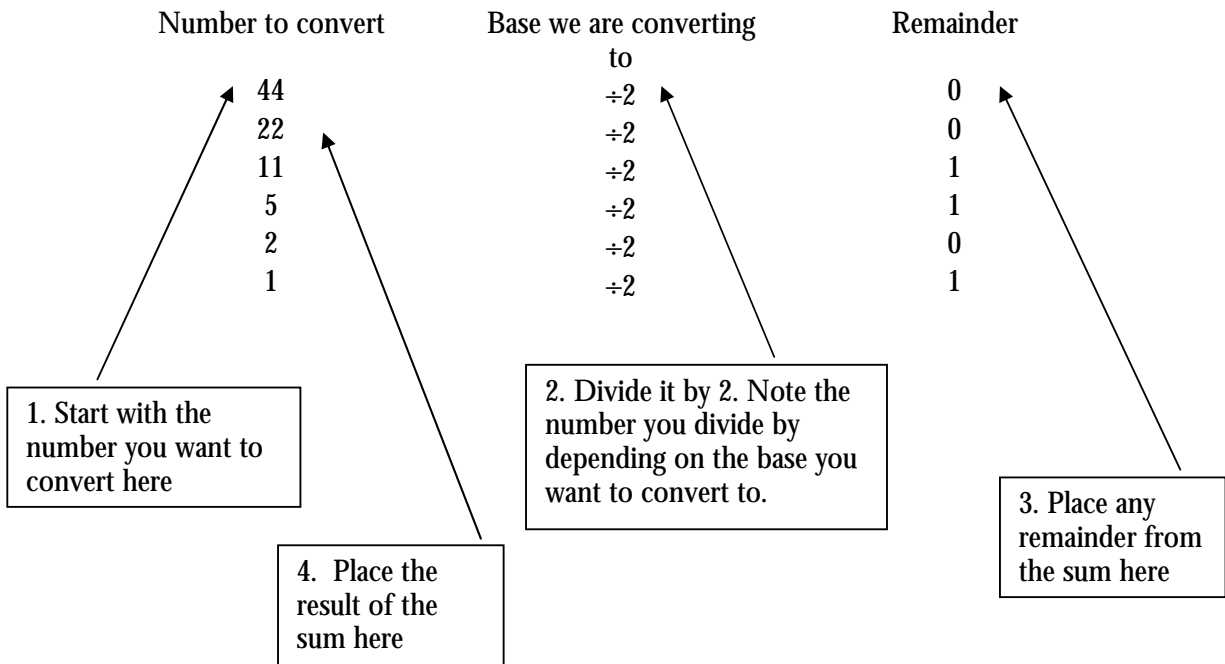
Denary            Base 10  
 Binary            Base 2  
 Hexadecimal    Base 16

Denary → Binary                      Binary → Denary  
 Denary → Hexadecimal            Hexadecimal → Denary  
 Binary → Hexadecimal            Hexadecimal → Binary

## DENARY → BINARY

This is converting base 10 whole numbers into Binary numbers, to do this carry out the following.

This example will convert the number 44 into binary.



Repeat these four steps until you have nothing left to divide. Once you have done this, the convert number can be read from the remainder column, **from bottom to top**.

Thus  $44_{10}$  in Binary is  $101100_2$

## BINARY → DENARY

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To convert Binary into Denary, some background information first.

Denary or Base 10

$10^3$	$10^2$	$10^1$	$10^0$
Thousands	Hundreds	Tens	Units
1	3	4	5

The above would give us

- 1 thousand or  $1 \times 10^3$
- 3 hundred or  $3 \times 10^2$
- 4 tens or  $4 \times 10^1$
- 5 units or  $5 \times 10^0$

Which gives **one** thousand, **Three** hundred and **forty-five**

It works the same for binary (and any other base) just change the 10 to a 2, so the table would look something like this

$2^3$	$2^2$	$2^1$	$2^0$
Eights	Fours	Twos	Units
1	1	0	1

So in the above example **1101** would have

- 1 x eight or  $1 \times 2^3$
- 1 x fours or  $0 \times 2^2$
- 0 x two or  $1 \times 2^1$
- 1 unit or  $1 \times 2^0$

So if we wanted to convert 1101 to Denary all we would have to do is add the above up like

$$8 + 4 + 1 = 13$$

## DENARY → HEXADECIMAL

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The first thing you need to remember with Hex is when we count using this base we use letters for the numbers from 10 to 15

Hex	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Denary	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

To convert 2314 to Hexadecimal do the following

Number to convert	Base we are converting to	Remainder
2314	÷16	10 or A
144	÷16	0
9	÷16	9

You will notice that we have carried out the same operation as when we converted Denary into Binary the only difference is we have divided by 16 instead of 2.

So  $2314_{10}$  is  $90A_{16}$

## HEXADECIMAL → DENARY

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To convert Hex into Denary we carry out the same operation as we did when we converted Binary into Denary the only difference is the table, which looks like this

$16^3$	$16^2$	$16^1$	$16^0$
4096s	256s	16s	Units
1	F	4	B

The above example gives us

1 x 4096 or 1 x  $16^3$   
 F x 256 or F x  $16^2$   
 4 x 16 or 4 x  $16^1$   
 B units or B x  $16^0$

So we would have in Denary

$$\begin{array}{rcccccccc}
 (1 \times 4096) & + & (15 \times 256) & + & (4 \times 16) & + & 11 & \\
 4096 & + & 3840 & + & 64 & + & 11 & 
 \end{array}$$

Which make  $1F4B_{16}$  in Hex,  $8011_{10}$  in Denary

## BINARY → HEXADECIMAL

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To convert Binary into Hex we take our Binary number and split into groups of four digits from the right so the. The reason we do this is because the most one group of four numbers can total is 15, this is the same as the total value that can go into any only column when counting in Hex.

It works something like this.

101110111011101

Becomes

101                    1101                    1101                    1101

You then convert each of the groups into denary

101                    1101                    1101                    1101  
5                        13                        13                        13

You then change any of the numbers that are above 9 into their corresponding letters

101                    1101                    1101                    1101  
5                        13                        13                        13  
5                        D                         D                         D

So  $101110111011101_2$  is  $5DDD_{16}$

## HEXADECIMAL → BINARY

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To convert Hexadecimal into Binary you do the above but in reverse, however instead of grouping four hex digits you take one digit and convert it into a four digit binary number.