Decimal Numbers

Base 10

Each digit can hold 10 distinct values

0-9

Each additional digit position is 10x

1000's	100's	10's	1's
5	4	6	2

The value of 5462 is:

5x1000	5000
4x100	400
6x10	60
2x1	2
	5462

		Binary Numbers					
		Base 2					
		Each digit can hold 2 distinct values					
		0-1					
		Each additional digit position is 2x					
128's	**64's**	**32's**	**16's**	**8's**	**4's**	**2's**	**1's**
1	0	1	0	1	1	0	1

The value of 10101101 is:

1x128	128
0x64	0
1x32	32
0x16	0
1x8	8
1x4	4
0x2	0
1x1	1
	173

	Octal Numbers			
	Base 8			
	Each digit can hold 8 distinct values			
	0-7			
	Each additional digit position is 8x			
512's	**64's**	**8's**	**1's**	
3	4	6	1	

The value of 3461 is:

3x512	1536
4x64	256
6x8	48
1x1	1
	1841

Hexadecimal Numbers					Hex Digits	
Base 16					0	
Each digit can hold 16 distinct values					1	
0-9 A-F					2	
Each additional digit position is 16x					3	
					4	
4096's	**256's**	**16's**	**1's**		5	
1	2	C	E		6	
					7	
The value of 12CE is:					8	
1x4096		4096			9	
2x256		512			A	(10)
12x16		192			B	(11)
14x1		14			C	(12)
		4814			D	(13)
					E	(14)
					F	(15)

Converting Binary to Decimal

Write out the binary digit values across the top

Starting with the least significant digit being 1 and multiplying by 2 for each digit.

Add up the digit values that have a digit of 1

256	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**
1	0	1	1	1	0	0	1	1
256								
64								
32								
16								
2								
1								
371		101110011 in Binary = 371 in Decimal						
		Example A						

Converting Binary to Decimal

Write out the binary digit values across the top

Starting with the least significant digit being 1 and multiplying by 2 for each digit.

Add up the digit values that have a digit of 1

128	64	32	16	8	4	2	1		
1	0	1	1	0	1	1	0		
128									
32									
16									
4									
2									
182									
		10110110 in Binary = 182 in Decimal							
		Example B							

Converting Decimal to Binary

Write out the binary digit values across the top											473
Starting with the least significant digit being 1 and multiplying by 2 for each digit.											-256
Write out the binary digit values until you write a number larger than the decimal value to be converted											217
Starting with the most significant digit, subtract the digit value from the remaining decimal value											-128
If the subtraction results in a negative enter a 0 for that digit position, if it is positive enter a 1											89
											-64
To convert the decimal number 473…											25
											-16
512	**256**	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**		9
0	1	1	1	0	1	1	0	0	1		-8
			1								1
473 in Decimal = 111011001 in Binary											-1
(You can discard leading zero's)											0
	Example A										

Converting Decimal to Binary

Write out the binary digit values across the top										377
Starting with the least significant digit being 1 and multiplying by 2 for each digit.										<u>-256</u>
Write out the binary digit values until you write a number larger than the decimal value to be converted										121
Starting with the most significant digit, subtract the digit value from the remaining decimal value										<u>-64</u>
If the subtraction results in a negative enter a 0 for that digit position, if it is positive enter a 1										57
										<u>-32</u>
To convert the decimal number 377...										25
										<u>-16</u>
512	**256**	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**	9
0	1	0	1	1	1	1	0	0	1	<u>-8</u>
										1
377 in Decimal = 101111001 in Binary										<u>-1</u>
(You can discard leading zero's)										0
	Example B									

Converting Octal to Binary

It takes 3 binary digits to represent all of the possible Octal digits.

Starting with the least significant digit write out each octal digit using 3 binary digits

Be sure to use all 3 binary digits including leading zero's

To convert the octal number 6472...

		4	2	1
0		0	0	0
1		0	0	1
2		0	1	0
3		0	1	1
4		1	0	0
5		1	0	1
6		1	1	0
7		1	1	1

6	4	7	2
110	100	111	010

6472 in Octal = 110100111010 in Binary

Example A

Converting Octal to Binary

It takes 3 binary digits to represent all of the possible Octal digits.

Starting with the least significant digit write out each octal digit using 3 binary digits

Be sure to use all 3 binary digits including leading zero's

To convert the octal number 1530...

								4	2	1
							0	0	0	0
	1	5	3	0			1	0	0	1
	001	101	011	000			2	0	1	0
							3	0	1	1
			1530 in Octal = 001101011000 in Binary				4	1	0	0
	(You can now drop the leading zero's)						5	1	0	1
							6	1	1	0
	Example B						7	1	1	1

Converting Binary to Octal

It takes 3 binary digits to represent all of the possible Octal digits.

Starting with the least significant digits chunk the binary number into 3 binary digit pieces.

Convert each chunk of 3 binary digits to an octal digit.

				To convert the binary number 110100101…		**4**	**2**	**1**	
					0	0	0	0	
	110	100	101		1	0	0	1	
	6	4	5		2	0	1	0	
					3	0	1	1	
			110100101 in Binary = 645 in Octal		4	1	0	0	
					5	1	0	1	
					6	1	1	0	
	Example A				7	1	1	1	

Converting Binary to Octal							

It takes 3 binary digits to represent all of the possible Octal digits.

Starting with the least significant digits chunk the binary number into 3 binary digit pieces.

Convert each chunk of 3 binary digits to an octal digit.

						4	**2**	**1**
To convert the binary number 10110101111…								
					0	0	0	0
010	**110**	**101**	**111**		**1**	0	0	1
2	6	5	7		**2**	0	1	0
					3	0	1	1
10110101111 in Binary = 2657 in Octal					**4**	1	0	0
I added a leading zero to the last chunk to make it 3 digits					**5**	1	0	1
					6	1	1	0
Example B					**7**	1	1	1

Octal to Decimal -- Decimal to Octal

The easiest way to convert Octal to Decimal and Decimal to Octal is to convert to Binary as an intermediate step.

(Unless of course you use a calculator)

Converting Binary to Hexadecimal

			8	4	2	1
It takes 4 binary digits to represent all of the possible hexadecimal digits.						
Starting with the least significant digits chunk the binary number into 4 binary digit pieces.	0		0	0	0	0
Convert each chunk of 4 binary digits to a hexadecimal digit	1		0	0	0	1
	2		0	0	1	0
To convert the binary number 100111010011…	3		0	0	1	1
	4		0	1	0	0
1001 1101 0011	5		0	1	0	1
9 D 3	6		0	1	1	0
	7		0	1	1	1
100111010011 in Binary = 9D3 in Hexadecimal	8		1	0	0	0
	9		1	0	0	1
	A (10)		1	0	1	0
Example A	B (11)		1	0	1	1
	C (12)		1	1	0	0
	D (13)		1	1	0	1
	E (14)		1	1	1	0
	F (15)		1	1	1	1

Converting Binary to Hexadecimal

					8	4	2	1
It takes 4 binary digits to represent all of the possible hexadecimal digits.					**8**	**4**	**2**	**1**
Starting with the least significant digits chunk the binary number into 4 binary digit pieces.				**0**	0	0	0	0
Convert each chunk of 4 binary digits to a hexadecimal digit				**1**	0	0	0	1
				2	0	0	1	0
To convert the binary number 100111010011101…				**3**	0	0	1	1
				4	0	1	0	0
0100 **1110** **1001** **1101**				**5**	0	1	0	1
4 E 9 D				**6**	0	1	1	0
				7	0	1	1	1
100111010011101 in Binary = 4E9D in Hexadecimal				**8**	1	0	0	0
I added a leading zero to the last chunk to make it 4 digits				**9**	1	0	0	1
				A (10)	1	0	1	0
Example B				**B (11)**	1	0	1	1
				C (12)	1	1	0	0
				D (13)	1	1	0	1
				E (14)	1	1	1	0
				F (15)	1	1	1	1

Converting Hexadecimal to Binary

		8	4	2	1
It takes 4 binary digits to represent all of the possible hexadecimal digits.					
Starting with the least significant digit write out each hexadecimal digit using 4 binary digits	0	0	0	0	0
Be sure to use all 4 binary digits including leading zero's	1	0	0	0	1
	2	0	0	1	0
To convert the hexadecimal number D58A...	3	0	0	1	1
	4	0	1	0	0
D 5 8 A	5	0	1	0	1
1101 0101 1000 1010	6	0	1	1	0
	7	0	1	1	1
D58A in Hexadecimal = 1101010110001010 in Binary	8	1	0	0	0
	9	1	0	0	1
	A (10)	1	0	1	0
Example A	B (11)	1	0	1	1
	C (12)	1	1	0	0
	D (13)	1	1	0	1
	E (14)	1	1	1	0
	F (15)	1	1	1	1

Converting Hexadecimal to Binary

													8	4	2	1	
It takes 4 binary digits to represent all of the possible hexadecimal digits.													**8**	**4**	**2**	**1**	
Starting with the least significant digit write out each hexadecimal digit using 4 binary digits												**0**	0	0	0	0	
Be sure to use all 4 binary digits including leading zero's												**1**	0	0	0	1	
												2	0	0	1	0	
To convert the hexadecimal number C29B…												**3**	0	0	1	1	
												4	0	1	0	0	
			C	2	9	B						**5**	0	1	0	1	
			1100	0010	1001	1011						**6**	0	1	1	0	
												7	0	1	1	1	
	C29B in Hexadecimal = 1100001010011011 in Binary											**8**	1	0	0	0	
												9	1	0	0	1	
												A (10)	1	0	1	0	
	Example B											**B (11)**	1	0	1	1	
												C (12)	1	1	0	0	
												D (13)	1	1	0	1	
												E (14)	1	1	1	0	
												F (15)	1	1	1	1	

Hexadecimal to Decimal
Decimal to Hexadecimal

The easiest way to convert Hexadecimal to Decimal and Decimal to Hexadecimal is to convert to Binary as an intermediate step.

(Unless of course you use a calculator)