Decimal → Binary

Binary is the base 2 number system that deals with zeros and ones where zero equals "off" and one equals "on." Binary is read from right to left where each digit increments in powers of 2: 2^0, 2^1, 2^2, 2^3, and so on. If the digit is a 1, you include that number. If it's a 0, you don't. Below is a chart with the powers of two, read from right to left like binary.

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1

It doesn't stop here, though. Binary digit places can go on infinitely. To convert from decimal to binary, you'll start with the highest power of 2 that can fit in the number you are converting. Put a 1 in that place, then subtract that number from your original number. Then, you'll choose the highest power of 2 that can fit in your remainder and put a 1 in that place. If you skip a power of 2 because it's too big to fit in your remainder, put a 0 in that place. Do this until your remainder is zero. Here are some examples:

Decimal Number: 10

The highest power of 2 that can fit in 10 is 8. So we know that we will have a 4 digit binary sequence.

$2^3 = 8$	$2^2 = 4$	$2^1 = 2$	$2^0 = 1$
1			

10 - 8 = 2. 4 doesn't fit in 2, so we put a zero in that place.

$2^3 = 8$	$2^2 = 4$	$2^1 = 2$	$2^0 = 1$
1	0		

2 - 2 = 0. Put a 1 in the 2 place and a 0 in the 1 place because we don't have a remainder.

$2^3 = 8$	$2^2 = 4$	$2^1 = 2$	$2^0 = 1$
1	0	1	0

Decimal Number: 92

The highest power of 2 that can fit in 92 is 64, so we have a 7 digit binary sequence. 92 - 64 = 28. 28 - 16 = 12. 12 - 8 = 4. 4 - 4 = 0. Fill in the rest of the spaces with zeros.

$2^6 = 64$	$2^5 = 32$	$2^4 = 16$	$2^3 = 8$	$2^2 = 4$	$2^1 = 2$	$2^0 = 1$
1	0	1	1	1	0	0

Decimal → Hexadecimal

Hexadecimal is a base 16 number system. Like binary, individual bits in a hexadecimal sequence are read from right to left. Unlike binary, each digit in a sequence can be a number from 0 - 15, where A = 10, B = 11, C = 12, D = 13, E = 14, and F = 15 so as to keep each place a single "digit." Since there are 16 options for what each digit will be, the way to convert decimal to hex is by dividing your number by 16, recording the modulo remainder in hex, then dividing the quotient by 16 again, recording that modulo remainder in hex, and so on until your quotient is zero. Here are some examples:

Decimal Number: 78

78 % 16 - Q = 4, R = 14

Our first digit is E.

4 % 16 - Q = 0, R = 4

Our second digit is 4. So, our final hexadecimal number is E4.

Decimal Number: 80

80 % 16 - Q = 5, R = 0

5 % 16 - Q = 0, R = 5

Hexadecimal Conversion: 50

Decimal → Octal

Decimal to octal conversions are the same as decimal to hexadecimal, except instead of doing modulo division with 16, you do it with 8, and there are no letters involved. Here are some examples:

Decimal Number: 78
78 % 8 - Q = 9, R = 6
Our first digit is 6.
9 % 8 - Q = 1, R = 1
Our second digit is 1.
1 % 8 - Q = 0, R = 1
Our third digit is 1. So, our final octal number is 116.

Decimal Number: 80
80 % 8 - Q = 10, R = 0
10 % 8 - Q = 1, R = 2
1 % 8 - Q = 0, R = 1
Octal Conversion: 120

Binary → Decimal

Binary is the base 2 number system that deals with zeros and ones where zero equals “off” and one equals “on.” Binary is read from right to left where each digit increments in powers of 2: 2^0, 2^1, 2^2, 2^3, and so on. If the digit is a 1, you include that number. If it’s a 0, you don’t. Below is a chart with the powers of two, read from right to left like binary.

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1

It doesn’t stop here, though. Binary digit places can go on infinitely. For the sake of simplicity, we will just stop at 8 digits. Here are a few examples:

The top row is binary: 10111010. Remember, we read it from right to left. The bottom row is what the digit in that placement is equal to. Remember, if the binary digit is a zero, we don’t include it in the total.

1	0	1	1	1	0	1	0
128	0	32	16	8	0	2	0

Now, just add up all of the numbers in the bottom row: 128 + 32 + 16 + 8 + 2 = 186.

0	1	1	0	1	0	0	1
0	64	32	0	8	0	0	1

64 + 32 + 8 + 1 = 105

Binary → Hexadecimal

Binary to Hexadecimal conversions are the same as binary to decimal, except you split the binary sequence into groups of 4, convert to decimal, and whatever your value is is your hexadecimal digit, where 10-15 is A-F respectively. Examples:

00011001

0001	1001
1	9

Hexadecimal Conversion: 19

10011100

1001	1100
9	12

Hexadecimal Conversion = 9C

Binary → Octal

Binary to octal conversions are the same as binary to hexadecimal, except you split the binary sequence into groups of 3, convert to decimal, and whatever your value is is your octal digit. Examples:

00011001

[0]00	011	001
0	3	1

Octal Conversion: 31

10011100

[0]10	011	100
2	3	4

Octal Conversion = 234

Hexadecimal → Decimal

To convert Hexadecimal to decimal, begin by converting each digit to decimal separately. Then, from right to left, multiply each digit by a power of 16 starting with 16^0, 16^1, 16^2, 16^3, and so on. Then, add the values up. Examples:

Hexadecimal Number: AF3

A	F	3
10	15	3

16^2	16^1	16^0
256	16	1

(10 * 256) + (15 * 16) + (3 * 1) = 2560 + 240 + 3 = 2803

Decimal Number: 2803

Hexadecimal Number: 1A7

1	A	7
1	10	7

16^2	16^1	16^0
256	16	1

(1 * 256) + (10 * 16) + (7 * 1) = 256 + 60 + 7 = 423

Decimal Number: 423

Hexadecimal → Binary
To convert hexadecimal to binary, compute each digit as a 4-digit binary sequence and put them together. Examples:

Hexadecimal Number: 19

1	9
0001	1001

Binary Sequence: 00011001 or 11001

Hexadecimal Number: 9C

9	C = 12
1001	1100

Binary Sequence: 10011100

Hexadecimal → Octal

To convert hexadecimal to octal, convert the hexadecimal number to binary, regroup the sequence in 3s, and then convert the binary to octal. Examples:

Hexadecimal Number: 19

1	9
0001	1001

Binary Sequence: 11001

Regroup and Convert:

[0]11	001
3	1

Octal Conversion: 31

Hexadecimal Number: 9C

9	C = 12
1001	1100

Binary Sequence: 10011100

Regroup and Convert:

[0]10	011	100
2	3	4

Octal Conversion: 234

Octal → Decimal

To convert octal to decimal, do the same thing you do to convert hexadecimal to decimal, except instead of multiplying by powers of 16, do powers of 8.

Octal Number: 352

8^2	8^1	8^0
64	8	1

(3 * 64) + (5 * 8) + (2 * 1) = 192 + 40 + 2 = 234

Decimal Number: 234

Octal Number: 567

8^2	8^1	8^0
64	8	1

(5 * 64) + (6 * 8) + (7 * 1) = 320 + 48 + 7 = 375

Decimal Number: 375

Octal → Binary

To convert octal to binary, do the same thing as converting from hex to binary, but do groups of 3 binary digits.

Octal Number: 17

1	7
001	111

Binary Sequence: 001111

Octal Number: 52

5	2
101	010

Binary Sequence: 101010

Octal → Hexadecimal

To convert octal to hexadecimal, convert the octal number to binary, regroup the sequence in 4s, and then convert the binary to hex. Examples:

Octal Number: 17

1	7
001	111

Binary Sequence: 001111

Regroup and Convert:

[00]00	1111
0	15

Hexadecimal Conversion: F

Hexadecimal Number: 52

5	2
101	010

Binary Sequence: 101010

Regroup and Convert:

0010	1010
2	10

Octal Conversion: 2A