How to convert between the numeric systems

Note: the subscript specifies which numeric system that number is in

**To convert decimal to binary:**

Given the number 105010

First: look at the chart and find the largest number you can subtract from the given number – 1050. For this case, it will be 1024. Put a one on that spot, meaning you used this bit.

1050 – 1024 = 26

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | 1 |  |  |  |  |  |  |  |  |  |  |
| 32768 | 16384 | 8192 | 4096 | 2048 | 1024 | 512 | 256 | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| 215 | 214 | 213 | 212 | 211 | 210 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 |

Second: look at the chart and find the largest number you can subtract from the “leftover” number, which is 26. For all the numbers you cannot use, put a zero in that spot, meaning you did not use that bit.

26 – 16 = 10

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | 1 | 0 | 0 | 0 | 0 | 0 | 1 |  |  |  |  |
| 32768 | 16384 | 8192 | 4096 | 2048 | 1024 | 512 | 256 | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| 215 | 214 | 213 | 212 | 211 | 210 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 |

Keep repeating until the “leftover” number is zero.

10 – 8 = 2

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |  |  |  |
| 32768 | 16384 | 8192 | 4096 | 2048 | 1024 | 512 | 256 | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| 215 | 214 | 213 | 212 | 211 | 210 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 |

2 – 2 = 0

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| 32768 | 16384 | 8192 | 4096 | 2048 | 1024 | 512 | 256 | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| 215 | 214 | 213 | 212 | 211 | 210 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 |

The top row is the number, 105010, in binary, 100 0001 10102.

**To convert binary to decimal:**

Given the number 1001 0100 11012

First: take each 1 and 0 from the number and place them onto the chart, starting at the right.

1001 0100 1101

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1 |
| 32768 | 16384 | 8192 | 4096 | 2048 | 1024 | 512 | 256 | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| 215 | 214 | 213 | 212 | 211 | 210 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 |

1001 0100 1101

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | 0 | 1 |
| 32768 | 16384 | 8192 | 4096 | 2048 | 1024 | 512 | 256 | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| 215 | 214 | 213 | 212 | 211 | 210 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 |

Until all 1s and 0s are put into the corresponding bit.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 |
| 32768 | 16384 | 8192 | 4096 | 2048 | 1024 | 512 | 256 | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| 215 | 214 | 213 | 212 | 211 | 210 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 |

Second: add together all the 1 bit marked values, this means that bit was utilized in representing that number.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 |
| 32768 | 16384 | 8192 | 4096 | 2048 | 1024 | 512 | 256 | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| 215 | 214 | 213 | 212 | 211 | 210 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 |

2048 + 256 + 64 + 8 + 4 + 1 = 2381

The result is the number, 1001 0100 11012, in decimal, 238110.

**To convert binary to HEX**

Given the number 1001 0000 1111 01012

First: Take the right 4 grouping (1s and 0s), and match it to the chart to get the hex representation and mark that down.

0101 is 5 in HEX

|  |  |
| --- | --- |
| **HEXADECIMAL**  **(HEX)** | **BINARY** |
| 0 | 0000 |
| 1 | 0001 |
| 2 | 0010 |
| 3 | 0011 |
| 4 | 0100 |
| 5 | 0101 |
| 6 | 0110 |
| 7 | 0111 |
| 8 | 1000 |
| 9 | 1001 |
| A | 1010 |
| B | 1011 |
| C | 1100 |
| D | 1101 |
| E | 1110 |
| F | 1111 |

Repeat with the next 4 grouping.

1111 is F in HEX

|  |  |
| --- | --- |
| **HEXADECIMAL**  **(HEX)** | **BINARY** |
| 0 | 0000 |
| 1 | 0001 |
| 2 | 0010 |
| 3 | 0011 |
| 4 | 0100 |
| 5 | 0101 |
| 6 | 0110 |
| 7 | 0111 |
| 8 | 1000 |
| 9 | 1001 |
| A | 1010 |
| B | 1011 |
| C | 1100 |
| D | 1101 |
| E | 1110 |
| F | 1111 |

Keep doing this until all 4 groupings are assigned a corresponding value in hex, keeping the numbers in order.

1001 = 9

0000 = 0

1111 = F

0101 = 5

The result is the number, 1001 0000 1111 01012, in hex 90F516.

**To convert HEX to Binary**

Given the number A14CF016

First: Take each letter and match it to the chart, keeping the order of the number.

A is 1010 in Binary

|  |  |
| --- | --- |
| **HEXADECIMAL**  **(HEX)** | **BINARY** |
| 0 | 0000 |
| 1 | 0001 |
| 2 | 0010 |
| 3 | 0011 |
| 4 | 0100 |
| 5 | 0101 |
| 6 | 0110 |
| 7 | 0111 |
| 8 | 1000 |
| 9 | 1001 |
| A | 1010 |
| B | 1011 |
| C | 1100 |
| D | 1101 |
| E | 1110 |
| F | 1111 |

Keep doing this to all the letters in the hex number.

A14CF0 – A = 1010, 1 = 0001, 4 = 0100, C = 1100, F = 1111, 0 = 0000

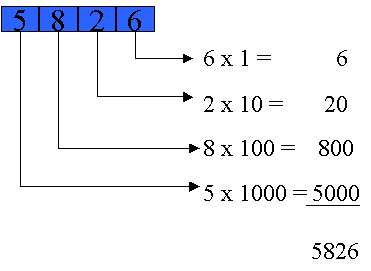
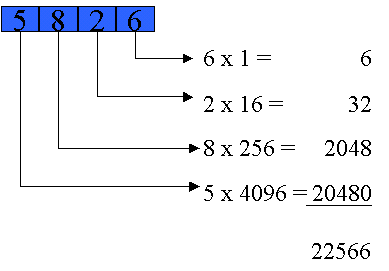
|  |  |
| --- | --- |
| **HEXADECIMAL**  **(HEX)** | **BINARY** |
| 0 | 0000 |
| 1 | 0001 |
| 2 | 0010 |
| 3 | 0011 |
| 4 | 0100 |
| 5 | 0101 |
| 6 | 0110 |
| 7 | 0111 |
| 8 | 1000 |
| 9 | 1001 |
| A | 1010 |
| B | 1011 |
| C | 1100 |
| D | 1101 |
| E | 1110 |
| F | 1111 |

The result is the number, A14CF016, in Binary, 1010 0001 0100 1100 1111 00002

**To Convert from Hex to decimal:**

Hexadecimal operates the same way as we use the decimal system. Each digit is "weighted" by a "multiplier," then the results are all added together. The multipliers in both systems are the powers of the system base (10 or 16). The powers of 10 are 1, 10, 100, 1000, etc. while those of 16 are 1, 16, 256, 4096, etc.

Decimal to Decimal Conversion Hex to Decimal Conversion

**To Convert from Decimal to Hex:**

**EXAMPLE CONVERSION - DECIMAL TO HEX**

|  |  |
| --- | --- |
| Decimal | Hex Equivalent |
| 39,619 | 9AC3 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Hex=Decimal | Comment | Divide decimal number successively by 16 | Remainder still in decimal | Hex Equivalent of remainder | | | |
| 0=0 1=1 2=2 3=3 4=4 5=5 6=6 7=7 8=8 9=9 A=10 B=11 C=12 D=13 E=14 F=15 |  |  |  | col 3 | col 2 | col 1 | col 0 |
| divide decimal number to be converted by 16 and put the remainder in col 0 | 39619 ÷ 16 = 2476 | \* rem 3 |  |  |  | 3 |
| divide answer from row above by 16 and put the remainder in col 1 | 2476 ÷ 16 = 154 | rem 12 |  |  | C |  |
| divide answer from row above by 16 and put the remainder in column 2 | 154 ÷ 16 = 9 | rem 10 |  | A |  |  |
| divide answer from row above by 16 and put the answer in column 3 | 9 ÷ 16 = 0 | rem 9 | 9 |  |  |  |
| Write out the answer, starting with column 3 and going through to column zero. | Answer is Hex 9AC3 | | | | | |