

INTEGRATING MATHEMATICS**● Converting Binary Numbers**

You may have heard that computers use a binary number system. In our decimal, or base 10, number system, each place represents an increasing power of 10. The far right place indicates 10^0 (units), the place immediately to the left indicates 10^1 (tens), the next place indicates 10^2 (hundreds), and so on. In the binary, or base two, number system, each place represents an increasing power of 2. The far right place is 2^0 (units), then 2^1 (twos), followed by 2^2 (fours), 2^3 (eights), 2^4 (sixteens), and so forth. In the binary system, the only symbols are 1s and 0s.

Converting Binary to Decimal

As an example, convert the binary number 101001 to a decimal number: 1×2^0 (1×1), plus 0×2^1 (0×2), plus 0×2^2 (0×4), plus 1×2^3 (1×8), plus 0×2^4 (0×16), plus 1×2^5 (1×32). Simplifying these numbers, we get $1 + 0 + 0 + 8 + 0 + 32 = 41$. So, the base two number 101001 equals the base 10 number 41.

Converting Decimal to Binary

To convert the base 10 number 83 into a binary number, first determine the highest power of 2 that is *less* than the number. In this case, 2^6 (64) is the highest power of 2 that is less than 83. Now subtract this number from your original number: $83 - 2^6 = 19$. Find the highest power of 2 that is less than your answer, and subtract it: $19 - 2^4 = 3$. Repeat this process until your answer is 0: $3 - 2^1 = 1$; $1 - 2^0 = 0$

Look at the powers of 2 that you used to reduce your number to 0; the numbers were 2^6 , 2^4 , 2^1 , 2^0 . Recall that in binary numbers, each numbered place indicates a certain power of 2, starting from 2^0 on the right side. In our example, the 2^0 will have a 1, the 2^1 place will have a 1, the 2^2 place will have a 0 (we did not use 2^2), and so on, all the way up to the 2^6 place. So, the decimal number 83 in binary form is 1010011.

Your Turn to Think

1. Convert the following binary numbers to decimal: 100, 1, 10101.
2. Convert the following decimal numbers to binary numbers: 3, 18, 77.