Base Eight Number System

The base eight number system is called the octal system.

The only digits in this system are zero through seven (eight digits, the largest is one less than the base.)

In base ten (Decimal System) we can count up to ten and then our hands are full, so we have to use a marker and start over. If spiders were the dominant intelligent life on this planet, they would use the Octal System.

In base ten, the numbers to the left of the decimal point represent, in order, ones (10^0), tens (10^1), hundreds (10^2), thousands (10^3), ten-thousands (10^4), and so on.

Base 10

$$\overline{10^6}\ \overline{10^5}\ \overline{10^4}\ \overline{10^3}\ \overline{10^2}\ \overline{10^1}\ \overline{10^0}\ \overline{10^{-1}}\ \overline{10^{-2}}\ \overline{10^{-3}}\ \overline{10^{-4}}\ \overline{10^{-5}}\ \overline{10^{-6}}$$

In base eight, the numbers to the left of the "binary" point represent, in order, ones (8^0), eights (8^1), sixty-fours (8^2), five hundred twelves (8^3), four thousand ninety-sixes (8^4), 32,768s (8^5), 262,144s (8^6), etc.

Base Eight

$$\overline{8^6}\ \overline{8^5}\ \overline{8^4}\ \overline{8^3}\ \overline{8^2}\ \overline{8^1}\ \overline{8^0}\ \overline{8^{-1}}\ \overline{8^{-2}}\ \overline{8^{-3}}\ \overline{8^{-4}}\ \overline{8^{-5}}\ \overline{8^{-6}}$$

Counting in base two would look like this:

1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16…

One, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, fourteen…

So what would fifteen be? It would be one 8 and seven 1's, or 17 (Read, "one seven, base eight.") So sixteen will be 20 (this is read, "two, zero, base eight.")

Going the other direction (which we seldom do in non-decimal bases), the place values in base ten are tenths, hundredths, thousandths, and so on. In other words, each place value to the right of the decimal point is one over some power of ten.

In base eight, the place values to the right of the binary point are eighths, sixty-fourths, five-hundred-twelfths, and so on, with the denominator increasing by a power of eight each time.

In base ten, 0.07042 would be "seven thousand forty-two hundred-thousandths." In base eight, the same symbol would be "one thousand, eight hundred nine sixteen thousand three hundred eighty-fourths." You have no eighths, <u>one sixty-fourth</u>, no five-hundred twelfths, <u>one four-thousand-ninety-sixth</u>, and <u>one thirty-two thousand, seven hundred sixty-eighth</u>. Now add $\frac{7}{64} + \frac{4}{4096} + \frac{2}{32,768}$. That's $\frac{3584}{32,768} + \frac{32}{32,768} + \frac{2}{32,768} = \frac{3618}{32,768}$, or $\frac{1809}{16,384}$.