

# 1.1 Decimal and Octal

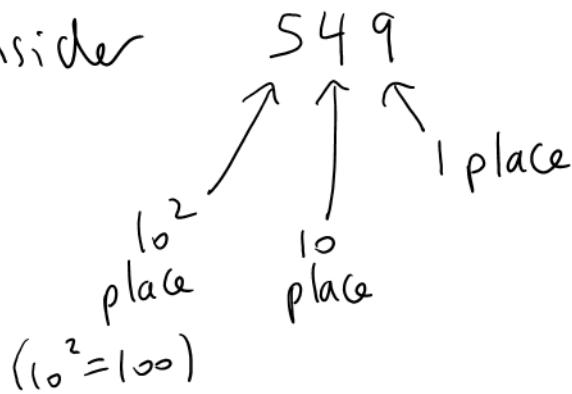
Decimal : base 10

Allowed digits : 0, 1, 2, ..., 9

Decimal numbers :

0  
1  
2  
3  
⋮  
9  
10 ← 1 ten and 0 ones  
11 ← 1 ten and 1 one  
12 ← 1 ten and 2 ones  
⋮  
⋮

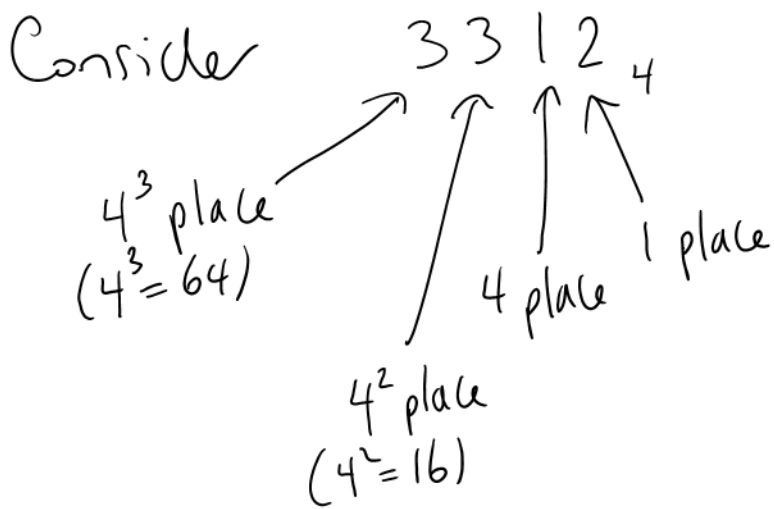
Consider



549 is 5 hundreds and 4 tens  
and 9 ones.

In base 4 the allowed digits are 0, 1, 2, 3

Decimal (Base 10)	Base 4
0	$0_4$
1	$1_4$
2	$2_4$
3	$3_4 \leftarrow 3 \text{ ones}$
4	$10_4 \leftarrow 1 \text{ four}$
5	$11_4$
6	$12_4 \leftarrow 1 \text{ four and } 2 \text{ ones}$
⋮	
15	$33_4 \leftarrow 3 \text{ fours and } 3 \text{ ones}$
16	$100_4 \leftarrow 1 \text{ sixteen}$
17	$101_4 \leftarrow 1 \text{ sixteen and } 1 \text{ one}$



Notation: The base is written as a subscript. If there is no base then base 10 (decimal) is assumed.

$$27 = 27_{10}$$

$$7 = 13_4$$

$$7_{10} = 13_4$$

Ex: Convert to decimal

$$\begin{aligned}
 \text{a) } 123_4 &= 1 \times 4^2 + 2 \times 4^1 + 3 \times 4^0 \\
 &= 1 \times 16 + 2 \times 4 + 3 \times 1 \\
 &= 27
 \end{aligned}$$

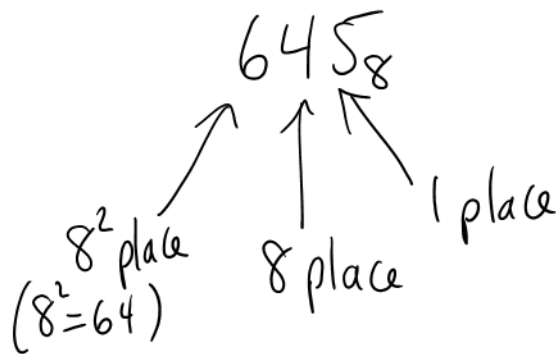
$$\begin{aligned}
 \text{b) } 3012_4 &= 3 \times 4^3 + 0 \times 4^2 + 1 \times 4^1 + 2 \times 4^0 \\
 &= 3 \times 64 + 1 \times 4 + 2 \times 1 \\
 &= 198
 \end{aligned}$$

Octal: Base 8

Allowed digits: 0, 1, ..., 7

Decimal	Octal
0	$0_8$
1	$1_8$
2	$2_8$
⋮	
7	$7_8$
8	$10_8$
9	$11_8$
10	$12_8$
⋮	
63	$77_8$
64	$100_8$

Consider



Ex: Convert to decimal

$$\begin{aligned} \text{a) } 5604_8 &= 5 \times 8^3 + 6 \times 8^2 + 0 \times 8^1 + 4 \times 8^0 \\ &= 5 \times 512 + 6 \times 64 + 4 \times 1 \\ &= 2948 \end{aligned}$$

$$\begin{aligned} \text{b) } 212_3 &= 2 \times 3^2 + 1 \times 3^1 + 2 \times 3^0 \\ &= 2 \times 9 + 1 \times 3 + 2 \times 1 \\ &= 23 \end{aligned}$$

Ex: What's wrong with writing  $218_3$  ?  
8 is not an allowed digit  
in base 3.