

How Do Computers Count?

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Java

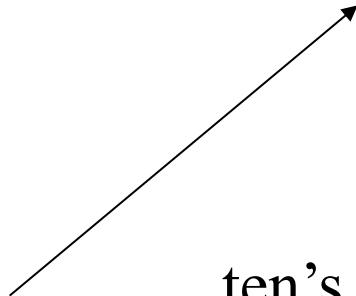
Counting in Base 10

0
1
2
3
4
5
6
7
8
9
10
11
12
.
.

$$\begin{array}{c} \underline{1} \quad \underline{2} \end{array} = 1 \times 10 + 2 \times 1$$

ten's digit

one's digit



Counting in Base 10

How do you write out 1,324 in base 10?

Base 10 Digits

<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
10000	1000	100	10	1
10^4	10^3	10^2	10^1	10^0

Counting in Another Base

Base 10

0

1

2

3

4

5

6

7

8

9

10

11

12

.

.

Is there a single digit that represents 10 in base 10?



The diagram consists of a vertical list of base 10 digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, followed by two decimal points. A horizontal line extends from the question 'Is there a single digit that represents 10 in base 10?' to the right, then turns diagonally down and to the left, ending with an arrowhead pointing directly at the digit '10'.

Counting in Base 9

Base 10

Base 9

0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	10
10	11
11	12
12	13
.	.
.	.

nine in base ten is equal to one zero in base nine


$$(9)_{10} = (10)_9$$

Counting in Base 9

Base 10

Base 9

0

0

1

1

2

2

3

3

4

4

5

5

6

6

7

7

8

8

9

10

10

11

11

12

12

13

.

.

.

.

$$(13)_9 = 1 \times 9 + 3 \times 1 = (12)_{10}$$

nine's digit

one's digit

Counting in Another Base

How do you represent $(10)_{10}$ in base 10?

How do you represent $(9)_{10}$ in base 9?

How do you represent $(8)_{10}$ in base 8?

How do you represent $(7)_{10}$ in base 7?

Counting in Base 2

$$(\underline{1}\underline{2})_{10} = 1 \times 10 + 2 \times 1$$

$$(\underline{1}\underline{3})_9 = 1 \times 9 + 3 \times 1 = (12)_{10}$$

$$(\underline{1}\underline{0})_2 = 1 \times _ + 0 \times _ = (2)_{10}$$

What goes here?

Counting in Base 2

Base 10

Base 9

Base 2

0		0		0
1		1		1
2		2		10
3		3		11
4		4		100
5		5		101
6		6		110
7		7		111
8		8		1000
9		10		1001
10		11		1010
11	$\overline{1000} \quad \overline{100} \quad \overline{10} \quad \overline{1}$	12	$\overline{729} \quad \overline{81} \quad \overline{9} \quad \overline{1}$	1011 $\overline{8} \quad \overline{4} \quad \overline{2} \quad \overline{1}$
12		13		1100
.		.		.
.		.		.

What is $(10001101)_2$ in Base 10?

**Make up a problem for your
neighbor.....**

Who Cares About Base 2?

.....We do!...Why?

What about adding 2 base
2 digits?

$$\begin{array}{r}
 + (1001110)_{10} \\
 (1001110)_{10} \\
 \hline
 (\quad ? \quad)_{10}
 \end{array}$$

$$\begin{array}{r}
 _2 _2 \\
 _2 _2 \\
 \hline
 (10011100)_2
 \end{array}$$

Base 10	Base 2
0	0
1	1
2	10
3	11
4	100

$$\begin{array}{r}
 (11101)_2 \\
 + (11010)_2 \\
 \hline
 (\quad)_2
 \end{array}$$

**Make up a problem for your
neighbor.....**

$$\begin{array}{r}
 + \quad (1001110)_2 \\
 (1001110)_2 \\
 \hline
 (\quad ? \quad)_{10}
 \end{array}$$

2 Ways to Solve the Problem:

$$\begin{array}{rcl} & (1001110)_2 & \rightarrow (\quad)_{10} \\ + & (1001110)_2 & \rightarrow (\quad)_{10} \\ \hline (\quad ? \quad)_2 & \rightarrow & (\quad)_{10} \end{array}$$

Blue First

$$\begin{array}{r} (1001110)_2 \\ + (1001110)_2 \\ \hline (10011100)_2 \end{array} \rightarrow \overline{(\quad)}_{10}$$

We knew this from before

But, how do we do this?

Blue First (cont.)

$$(1\ 0\ 0\ 1\ 1\ 1\ 0\ 0)_2$$

$$\begin{array}{cccccccc} * & * & * & * & * & * & * & * \\ 128 & 64 & 32 & 16 & 8 & 4 & 2 & 1 \\ \hline \end{array}$$

$$\begin{array}{cccccccc} || & || & || & || & || & || & || & || \end{array}$$

$$128 + 0 + 0 + 16 + 8 + 4 + 0 + 0 = (156)_{10}$$

2 Ways to Solve the Problem:

$$\begin{array}{rcl} (1001110)_2 & \xrightarrow{\quad} & (\quad)_{10} \\ + (1001110)_2 & \xrightarrow{\quad} & + (\quad)_{10} \\ \hline (10011100)_2 & \xrightarrow{\quad} & (156)_{10} \end{array}$$

Now Red

$$(1001110)_2 \rightarrow (\quad)_{10}$$

$$(1\ 0\ 0\ 1\ 1\ 1\ 0)_2$$

$$\begin{array}{ccccccc} * & * & * & * & * & * & * \\ 2^6 & 2^5 & 2^4 & 2^3 & 2^2 & 2^1 & 2^0 \end{array}$$

$$\begin{array}{ccccccc} \hline || & || & || & || & || & || & || \\ \hline \end{array}$$

$$64 + 0 + 0 + 8 + 4 + 2 + 0 = (78)_{10}$$

2 Ways to Solve the Problem:

$$\begin{array}{rcl} (1001110)_2 & \rightarrow & (78)_{10} \\ + (1001110)_2 & \rightarrow & (78)_{10} \\ \hline (10011100)_2 & \rightarrow & (156)_{10} \end{array}$$

Now You Try....

$(110111000)_2$

$(100011011)_2$

$(\quad ? \quad)_{10}$

**Make up a problem for your
neighbor.....**