

Everyone can participate in these puzzles, compare notes, and share solutions. *Enjoy!*

Bits and Bytes of Computer Language

We use the **decimal number system** for counting and arithmetic. The base number for decimals is ten. When we write numbers, we have a numeral for every number from one to nine. When we reach ten, we use place-value columns and the numeral for zero to show that we have a group of ten. For numbers higher than ten, we continue to use the numerals 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and place-value columns to show any number we need. Our way of writing numbers is known as the Hindu-Arabic system.

1. People haven't always used the Hindu-Arabic numeral system to write numbers. Conduct a safe search on the Internet or visit your local library to learn more about counting systems through history, especially Roman numerals.
2. Can you think of a reason why ten and the decimal system are a logical choice for people to use for counting?
3. What do the first six place-value columns in the decimal system show?

Not everything in the world is described in groups of tens. Some situations call for using numbers other than 10 as the base. For example, when we tell time, 60, 24, and 7 are the important numbers that relate seconds, minutes, hours, days, and weeks.

Another example that uses numbers other than ten as the base is computer language. Early computer designers knew they needed to find a language with which they could communicate with machines. The world-changing solution was found in **the binary number system** with two as the base. Computers are electrical and contain networks of circuits that either let the electricity pass through or stop the flow of electricity. Imagine a light switch in your home; you can turn the lights on (let the electricity flow) or off (stop the flow).

Fast forward to today's world in which we take a lot about computers for granted. People can speak to computers like they speak to another person. The words, however, are still translated into binary code in order for the computer to do what we want. The binary number system only uses digits for zero and one. Place value shows groups of twos.

Bits and **bytes** are terms used in the world of computers for names of binary numbers. A bit is a binary digit, the basic unit of computer code. A byte is a group of bits read together by a computer; usually eight bits make a byte. The memory capacity of computers today is measured in kilobytes (thousands of bytes), megabytes (millions of bytes), gigabytes (billions of bytes), and terabytes (trillions of bytes).

The table shows the binary numbers for the quantities one through nine, as we know them.

Decimal	1	2	3	4	5	6	7	8	9	10
Binary	1	10	11	100	101	110	111	1000	1001	1010

4. What do the first six place-value columns in the binary system show?
5. Write the binary number for these decimal numbers: 16, 25, 36, 49
6. Write the decimal number for these binary numbers: 1111, 11110, 10101, 101010

Walk Like a Robot

Computer programmers create **coding languages** to instruct computers to perform specific tasks. Coding has its own grammar and sentence structure that enables programmers to use words and decimal numbers that get translated into binary numbers inside the machine.

Explore coding on your own. Visit the [Why Learning to Code Benefits Kids, Regardless of Future Career Choice page](#) on the Connections Academy website. This provides great information and links to several fun student-coding projects.

Bits and Bytes of Computer Language Answers

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1. People haven't always used the Hindu-Arabic numeral system to write numbers. Conduct a safe search on the Internet or visit your local library to learn more about counting systems through history, especially Roman numerals.

Answer: The Egyptian, Babylonian, and Roman numeration systems were widely used through history. The Roman system only has numbers for 1, 5, 10, 50, 100, 1,000, etc.

2. Can you think of a reason why ten and the decimal system are a logical choice for people to use for counting?

Answer: Since people have ten fingers and ten toes, the number lent itself well to counting.

3. What do the first six place-value columns in the decimal system show?

Answer: Going right to left, the columns show ones, tens, hundreds, thousands, ten-thousands, and hundred-thousands. The columns are all powers of ten.

Not everything in the world is described in groups of tens. Some situations call for using numbers other than 10 as the base. For example, when we tell time, 60, 24, and 7 are the important numbers that relate seconds, minutes, hours, days, and weeks.

Another example that uses numbers other than ten as the base is computer language. Early computer designers knew they needed to find a language with which they could communicate with machines. The world-changing solution was found in **the binary number system** with two as the base. Computers are electrical and contain networks of circuits that either let the electricity pass through or stop the flow of electricity. Imagine a light switch in your home; you can turn the lights on (let the electricity flow) or off (stop the flow).

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The table shows the binary numbers for the quantities one through nine, as we know them.

Decimal	1	2	3	4	5	6	7	8	9	10
Binary	1	10	11	100	101	110	111	1000	1001	1010

- One is the same in both systems
- Two = 1 two + 0 ones
- Three = 1 two + 1 one
- Four = 1 four + 0 twos + 0 ones
- Five = 1 four + 0 twos + 1 one
- Six = 1 four + 1 two + 0 ones
- Seven = 1 four + 1 two + 1 one
- Eight = 1 eight + 0 fours + 0 twos + 0 ones
- Nine = 1 eight + 0 fours + 0 twos + 1 one
- Ten = 1 eight + 0 fours + 1 two + 0 ones

4. What do the first six place-value columns in the binary system show?

Answer: Going right to left, the columns show ones, twos, fours, eights, sixteens, and thirty-twos. The columns are all powers of two.

5. Write the binary number for these decimal numbers: 16, 25, 36, 49

Answer: Decimal number = 16

Binary place value	32	16	8	4	2	1
		1	0	0	0	0

Answer: Decimal number = 25

Binary place value	32	16	8	4	2	1
		1	1	0	0	1

Answer: Decimal number = 36

Binary place value	32	16	8	4	2	1
	1	0	0	1	0	0

Answer: Decimal number = 49

Binary place value	32	16	8	4	2	1
	1	0	0	1	0	0

6. Write the decimal number for these binary numbers: 1111, 11110, 10101, and 101010

Answer:

Binary place value	32	16	8	4	2	1
			1	1	1	1

Decimal number = $8 + 4 + 2 + 1 = 15$

Binary place value	32	16	8	4	2	1
		1	1	1	1	0

Decimal number = $16 + 8 + 4 + 2 + 0 = 30$

Binary place value	32	16	8	4	2	1
		1	0	1	0	1

Decimal number = $16 + 0 + 4 + 0 + 1 = 21$

Binary place value	32	16	8	4	2	1
	1	0	1	0	1	0

Decimal number = $32 + 0 + 8 + 0 + 2 + 0 = 42$

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