**Number Systems**

1. **Decimal**

Decimal is a base 10 number system. It has ten digits: 0 to 9 . The decimal system is **a place-value system**. In such a system, the value of a digit depends on which place it is in.

For example, the numbers 25 and 52 are not the same value. The first number is read as “2 tens plus 5“ (twenty five) and the second is “5 tens plus 2“ (fifty two).

In the decimal system, each place grows in value by a factor of 10 . The number 2222 means “two thousand two hundred and twenty two”

**2222 = (2x1000) + (2x100) + (2x10) + (2x1)**

Each column factor can also be considered as a power of 10:

**2222 = 2x103 + 2x102 + 2x101 + 2x100**

1. **Binary**

Binary is a base 2 number system. It has only two digit characters: 0 and 1 . Each of these characters is called a bit. The word “bit” is short for **b**inary un**it**.

In Binary, each column grows in value by a factor of 2:

**1111 = 1x8 + 1x4 + 1x2 + 1x1 =**

Or, using exponential notation:

**1111 = 1x23 + 1x22 + 1x21 + 1x20 =**

Exercise: Convert to decimal:

1. 1101
2. 1001
3. 0111
4. 1111 1111

A group of 8 bits is called a byte . Bits are usually arranged in groups of 4 to make it easier to read. A group of 4 bits (half a byte) is called a nibble .

Sometimes two bytes together are called a bit .

1. **Hexadecimal**

Hexadecimal is base . The digits go from 0 to 9 and then to .

Hexadecimal is used as a convenient bridge between binary (what the computer understands) and decimal (what humans understand). It is convenient because it can store larger numbers with fewer digits. Fill in the following table:

| Decimal | Binary | Hexadecimal |
| --- | --- | --- |
| 0 | 0000 0000 | 00 |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |
| 6 |  |  |
| 7 |  |  |
| 8 |  |  |
| 9 |  |  |
| 10 |  |  |
| 11 |  |  |
| 12 |  |  |
| 13 |  |  |
| 14 |  |  |
| 15 |  |  |
| 16 |  |  |
| 17 |  |  |
| 18 |  |  |
| 19 |  |  |
| 20 |  |  |
| 21 |  |  |
| 22 |  |  |
| 23 |  |  |
| 24 |  |  |
| 25 |  |  |
| 26 |  |  |
| 27 |  |  |
| 28 |  |  |
| 29 |  |  |
| 30 |  |  |
| 31 |  |  |

**Questions**

1. How many bits in a

a) byte? 8 b) a nibble? 4

1. What is the highest number you can represent using 4 bits? Write this number in:
2. binary
3. decimal
4. hexadecimal
5. What is the value of 24?
6. What is the highest number you can represent with 8 bits? Write this number in:
7. binary
8. decimal
9. hexadecimal
10. What is the value of 28?
11. How many bits are needed to represent every letter in the English alphabet, including upper and lower case?
12. Open the colour menu in this word processor and choose a custom colour. How many shades of red are possible?
13. How many bits are used to represent a complete RGB (red, green and blue) colour code on this computer?
14. What is the RGB code for:
15. black?
16. white?
17. What is this computer's IP address? (Hint: ask Google)
18. An IP address is composed of four 1-byte blocks written in decimal. Each block is separated by a decimal point, for example 155.128.32.1. What is the highest IP address possible, written in:
19. decimal
20. binary
21. hexadecimal
22. How many IP addresses can this system represent?
23. Convert 255 to: a) binary b) hex
24. Convert 49 to a) binary b) hex

**In decimal:**

1. What is the highest number you can have using one digit?
2. What is the highest number you can have using two digits?
3. What is the highest number you can have using three digits?
4. If I want to represent letters of the alphabet using a numerical code (say A=0, B=1, etc.) how many digits would I require?
5. How many phone numbers can you have in one area code?
6. Ottawa has a new area code (343). Why is this?

**In hexadecimal:**

1. What is the highest number you can have using one hex digit? What is this in decimal?
2. What is the highest number you can have using two digits? What is this in decimal?
3. What is the highest number you can have using three digits? What is this in decimal?
4. What is the highest number you can have using four digits? What is this in decimal?

**In binary:**

1. What is the highest 4-bit number? What is this in decimal?
2. What is the highest 8-bit number? What is this in decimal?
3. What is the highest 16-bit number? What is this in decimal?