**Number Systems Used In Computers**

Complete the following table:

|  |  |  |  |
| --- | --- | --- | --- |
| **Number System** | **Number Base** | **Digits Used** | **Purpose** |
| Decimal | Base 10 | 0 to 9 | Used for communicating with human users |
| Binary |  |  |  |
| Octal |  |  |  |
| Hexadecimal |  |  |  |

**Decimal vs. Binary System**

Write down the definition of a **Bit** in computer terminology:

Complete the following table:

|  |  |  |
| --- | --- | --- |
|  | **Decimal System** | **Binary System** |
| Uses Digits |  |  |
| Addition Examples |  |  |
| Powers of 10 |  |  |
| Evaluate 111 |  |  |

**Powers of 2**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Power  of 2** | **Decimal Value** | **Integer Range** | **Number  of Bits** | **Computer Binary** |
| 21 | 2 | 0 - 1 | 1 | 0001 |
| 22 | 4 | 0 - 3 | 2 | 0011 |
| 23 |  |  |  | 0111 |
| 24 |  |  |  | 1111 |
| 25 |  |  |  | 0001 1111 |
| 26 |  |  |  | 0011 1111 |
| 27 |  |  |  | 0111 1111 |
| 28 | 256 | 0 - 255 | 8 | 1111 1111 |
| 29 |  |  |  | 0001 1111 1111 |
| 210 |  |  |  | 0011 1111 1111 |
| 211 |  |  |  | 0111 1111 1111 |
| 212 |  |  |  | 1111 1111 1111 |
| 213 |  |  |  | 0001 1111 1111 1111 |
| 214 |  |  |  | 0011 1111 1111 1111 |
| 215 |  |  |  | 0111 1111 1111 1111 |
| 216 | 65,536 | 0 – 65,535 | 16 | 1111 1111 1111 1111 |

**Conversions**

Convert the following binary numbers to decimal:

11 binary =

101 binary =

1010 binary =

Convert the following decimal numbers to binary:

6 decimal =

13 decimal =

**Binary Addition**

Add the following binary numbers. (verify your answers using decimal)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  | | --- | --- | | **0101** | **(decimal 5)** | | **+ 0010** | **(decimal 2)** | |  |  | | |  |  | | --- | --- | | **0101** | **(decimal 5)** | | **+ 1010** | **(decimal 10)** | |  |  | |
| |  |  | | --- | --- | | **0011** | **(decimal 3)** | | **+ 0010** | **(decimal 2)** | |  |  | | |  |  | | --- | --- | | **0110** | **(decimal 6)** | | **+ 0011** | **(decimal 3)** | |  |  | |

**Prefixes**

* Kilo (K) means \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Multiply by x\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Mega (M) means \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Multiply by x\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Giga (G) means \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Multiply by x\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Tera (T) means \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Multiply by x\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Examples**

1. 64 Kbps (Kilo-bits per seconds) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ bps (bits per second)
2. 256 Giga-bytes = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ bytes
3. 256 Giga-bytes = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ bits

**Computer Memory Structures**

|  |  |  |  |
| --- | --- | --- | --- |
| **Structure** | **Number of Bits** | **Largest Value** | **Used For...** |
| Bit |  |  |  |
| Byte |  |  |  |
| Word |  |  |  |
| Short Integer |  |  |  |
| Double Word |  |  |  |
| Long Integer |  |  |  |
| Memory Address |  |  |  |

**Memory Organization**

Bit (Binary Digit)

* One bit can have a value of \_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_
* Or a Boolean logic value of \_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | | |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | | |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | | |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | |

Byte (8 bits)

* One byte has a size of \_\_\_\_\_\_\_\_ bits
* A byte has an unsigned integer value range from 0 to \_\_\_\_\_\_\_\_\_

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | | |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | | |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | | |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | |

Word (2 bytes or 16 bits)

* One word has a size of \_\_\_\_\_\_\_\_ bits
* One word has a size of \_\_\_\_\_\_\_\_ bytes
* A byte has an unsigned integer value range from 0 to \_\_\_\_\_\_\_\_\_

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | | |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | | |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | | |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | |
|  | |  | |

Long or Double Word (4 bytes or 32 bits)

* One Long word has a size of \_\_\_\_\_\_\_\_ words
* A Long word has an unsigned integer value range from 0 to \_\_\_\_\_\_\_\_\_

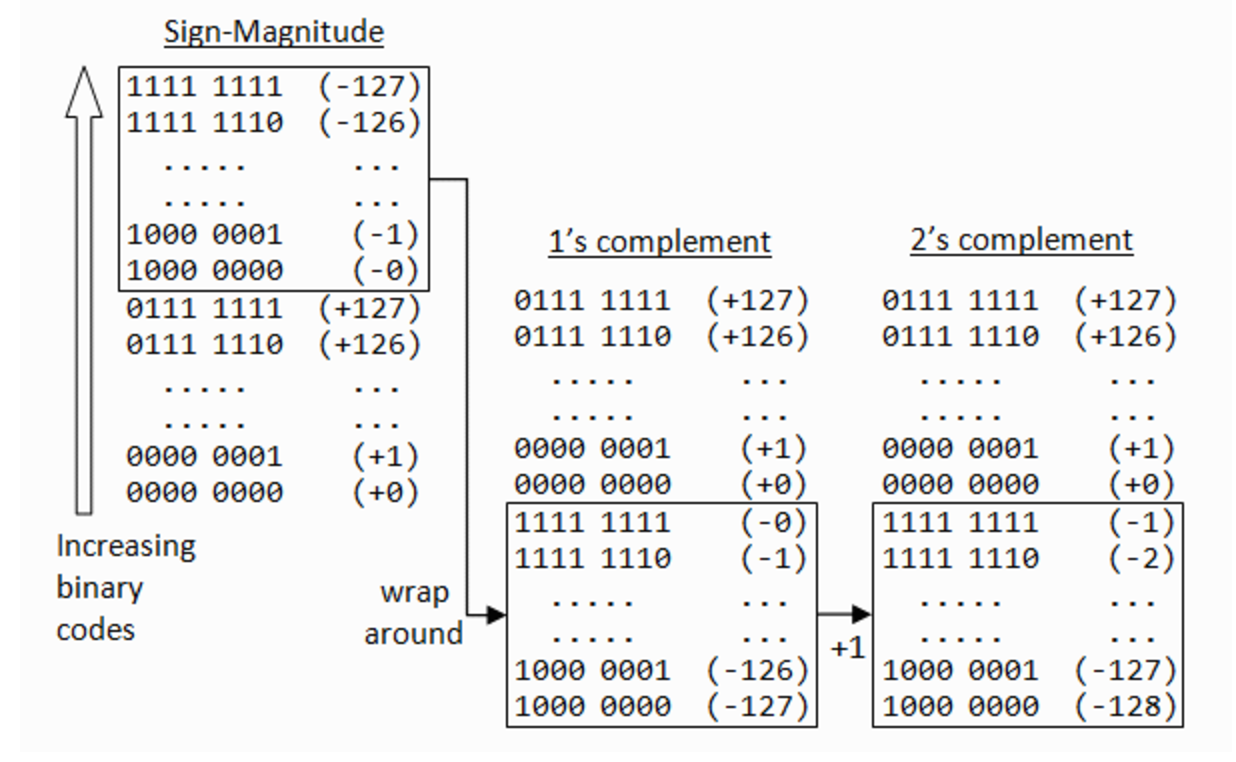
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | | |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | | |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | | |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | |
|  | |  | |
| |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | | |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | | |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | | |  |  |  |  | | --- | --- | --- | --- | | 0 | 0 | 0 | 0 | |
|  | |  | |

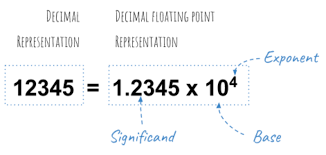
**Questions**

1. What is the smallest memory object that can represent a character of information?

A bit is the smallest object used to store data.

* 1. Think… How many upper case letters in the alphabet (A to Z)?
     1. 26
  2. Think… How many lower case letters in the alphabet (a to z)?
     1. 26
  3. Think… How many number digits (0 to 9)?
     1. 10
  4. Think… How many punctuation marks?
     1. 14
  5. Add them all up
     1. 76

1. Research the ASCII characters set. What is it and how is it related to computer memory?
   1. The ASCII characters are used to communicate ideas and messages which are found on a keyboard. The ASCII character set relates to computer memory because characters and words both take up a number of bits in a computer.
2. How are strings of characters (Google “String”) represented in computer memory?
   1. Strings of characters take up one byte of data
3. How are negative integers represented in computer memory? (Include a diagram)
   1. Negative integers are represented by long and short integer data types in a computer’s memory.   
      
4. How are decimal numbers (Google “Floating Point”) represented in computer memory? (Include a diagram)
   1. In memory, a floating point number is represented similarly: One bit has the sign, some bits form the factor as a fixed-precision number (“mantissa”), the remaining bits form the exponent.



1. A Pixel is computer memory structure used to store image information. How is a Pixel represented in memory? (Include a diagram).
   1. Each pixel is represented by a binary value. We call this representation of colors a “bit-plane”. Each bit doubles the number of available colors i.e. 1-bit would give us 2 colors, 2-bits would give us 4 colors and 3-bits would give us 8 colors etc.

