**Binary Worksheet (32 points)**

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**1. Binary Addition**

Math on binary digits work just like in decimal, except there’s only 4 possible results instead of 100!

Adding 0 + 0 = 0, 0 + 1 = 1, 1 + 0 = 1, and 1 + 1 = 10. So 100 + 11 = 111. 1010 + 11 = 1101, etc.

|  |  |  |
| --- | --- | --- |
| Question # | Add the following... | Answer: |
| 00001 | 1 + 1 = | 10 |
| 00010 | 10 + 10 = |  |
| 00011 | 11 + 10 = |  |
| 00100 | 100 + 11 = |  |
| 00101 | 100 + 111 = |  |
| 00110 | 10 + 10 + 10 = |  |
| 00111 | 1 + 11 + 111 = |  |
| 01000 | 1000 + 111 = |  |
| 01001 | 111011 + 1 = |  |
| 01010 | 000111 + 111000 = |  |

|  |  |  |
| --- | --- | --- |
| 01011 | 11011 + 01111 = | . |
| 01100 | 11100 + 11001 = |  |
| 01101 | 1111 + 1 = |  |
| 01110 | 000001 + 1 = |  |
| 01111 | 11001 + 11000 = |  |
| 10000 | 100000001 + 11 = |  |
| 10001 | 1101111 + 10110 = |  |
| 10010 | 100011 + 011110 = |  |
| 10100 | 1010101 + 0101010 = |  |
| 10101 | 111000111 + 111100 = |  |

**2. Converting from Binary to Decimal**

The number 547 in decimal is 5 x 102 (the “hundreds digit”) + 4 x 101 (the “tens digit”) + 7 x 100.

This is called “Base 10” numbers because the value of each digit is 10 times the one to the right.

Binary is called “Base 2” numbers because there’s only 2 digits: 0 and 1.

So following the same pattern as above, the number 1101 in binary is 1 x 23 (the “eights digit”) + 1 x 22 (the “fours digit”) + 0 x 21 (the “twos digit”) + 1 x 20 (the “ones digit”) = 8 + 4 + 0 + 1 = 13.

Here’s another way - use this handy chart to convert from binary to decimal. Write the 1s and 0s in the chart below, then add up all the numbers above 1s. For example, to convert 1000110011 we write:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 512 | 256 | 128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |

We add up all the numbers above the 1s, and get: 512 + 32 + 16 + 2 + 1 = 563

Convert the following numbers from binary to decimal:

|  |  |  |
| --- | --- | --- |
| Question # | Binary | Decimal: |
| 10110 | 1111 | 15 |
| 10111 | 1010 |  |
| 11000 | 1110 |  |
| 11001 | 1111 |  |
| 11010 | 0 |  |
| 11011 | 101010 |  |
| 11100 | 010101 |  |
| 11101 | 111111 |  |
| 11110 | 1000110011 |  |
| 11111 | 1111111110 |  |
| 00000 | 1111111111 |  |