

# Texas Bio-Science Institute

I love computers...  
in a computer, numbers make colors;  
therefore, I love math

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# Making a web page

```
<html>  
<head><title>My First Web Page</title></head>  
<body  
  bgcolor="white"  
  text="black">  
<h2>Hi</h2>  
</body>  
</html>
```

# Word colors

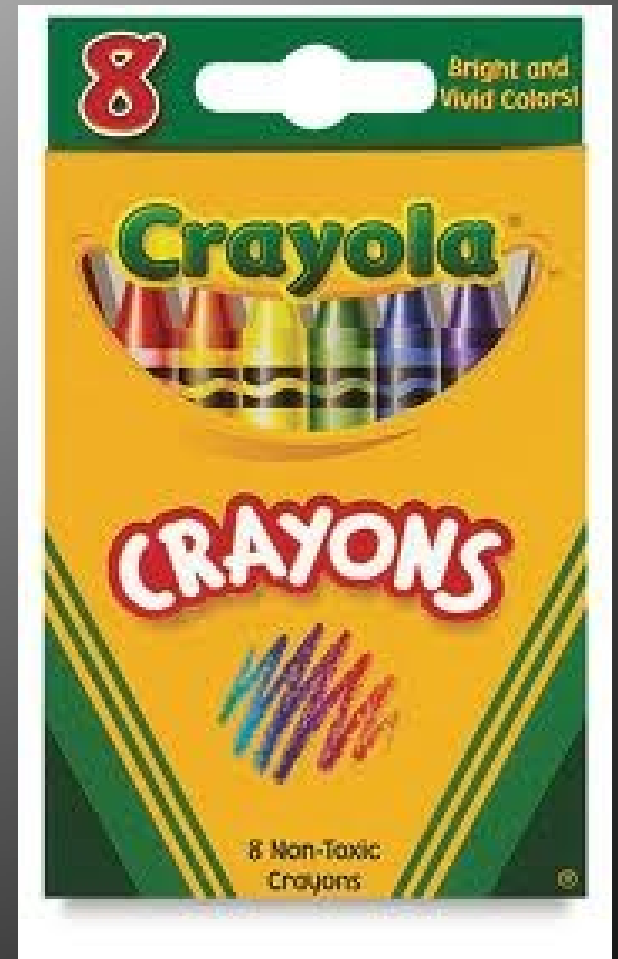
- Black
- White
- Red
- Green
- Blue
- Yellow ...

# Remember when...



# EIGHT?

- Only 8?
- I need more colors
- Not 24
- Not 64

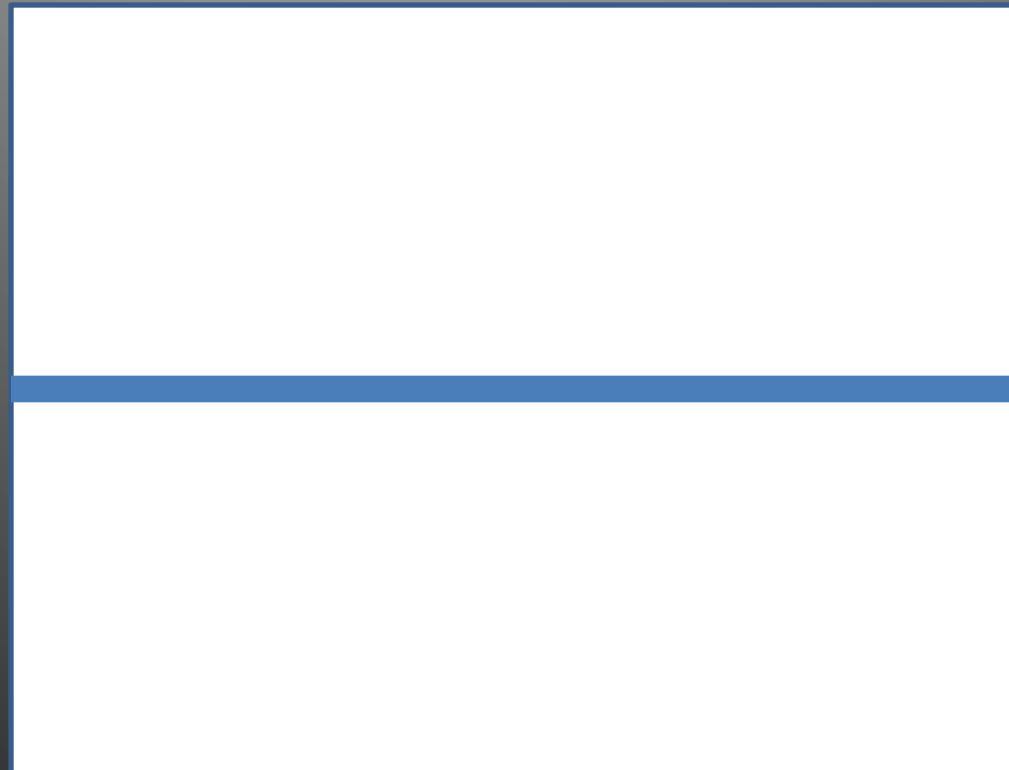


I want

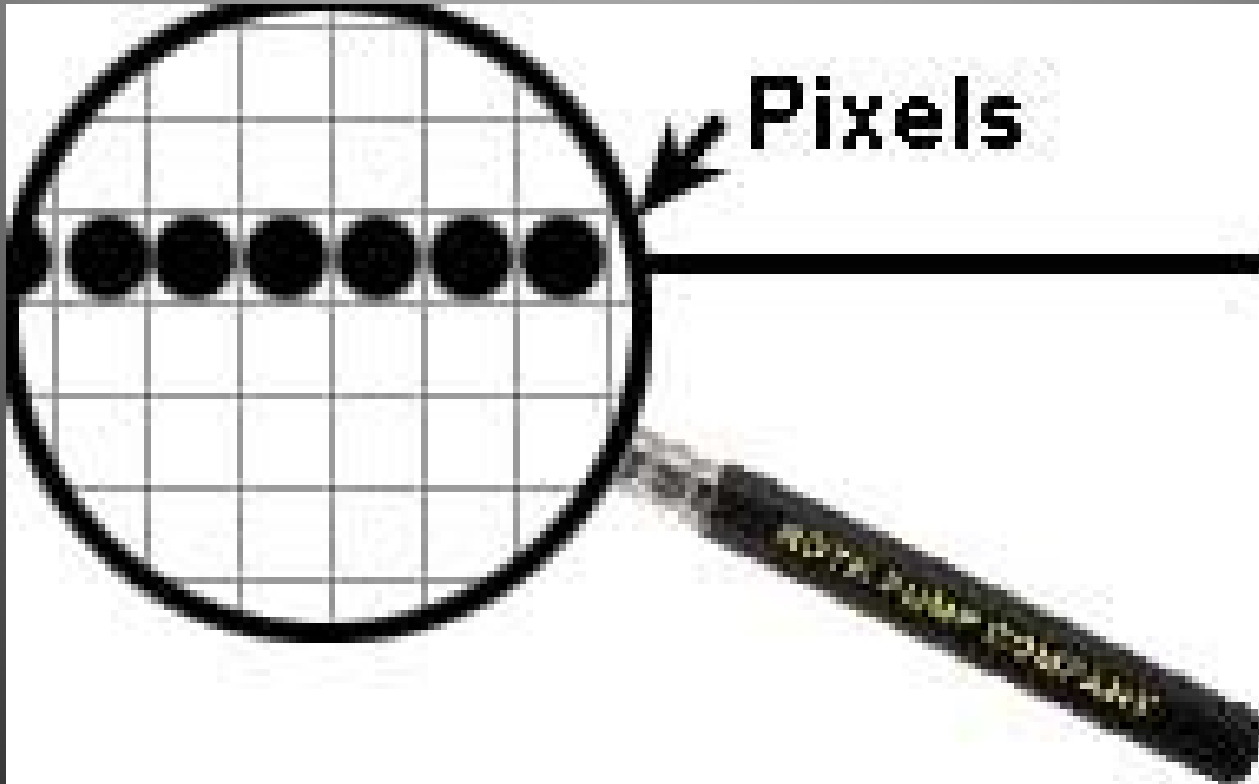
- **16,777,216 colors!**

# Some background

- Look at your monitor; see that line?

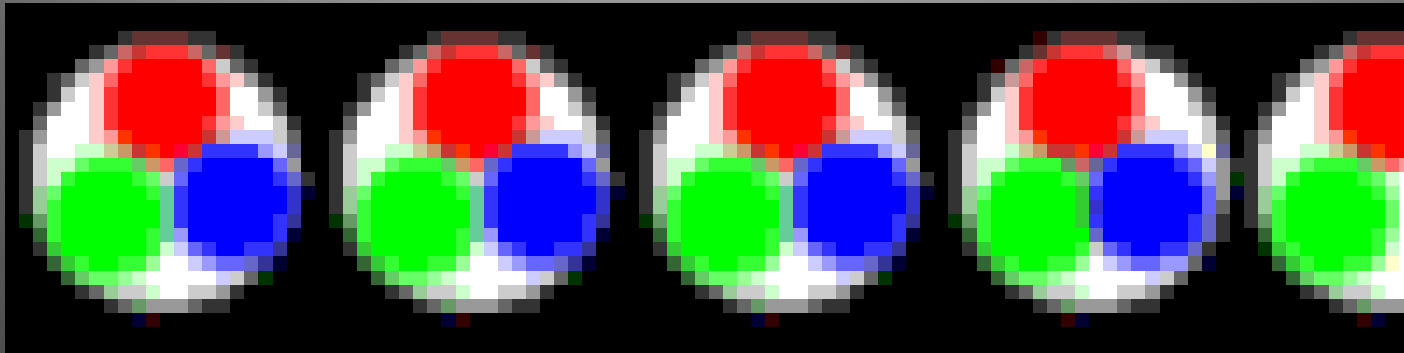


# Look closer





# Really look at the pixels



- 24 *1s and 0s* for Red and green & blue

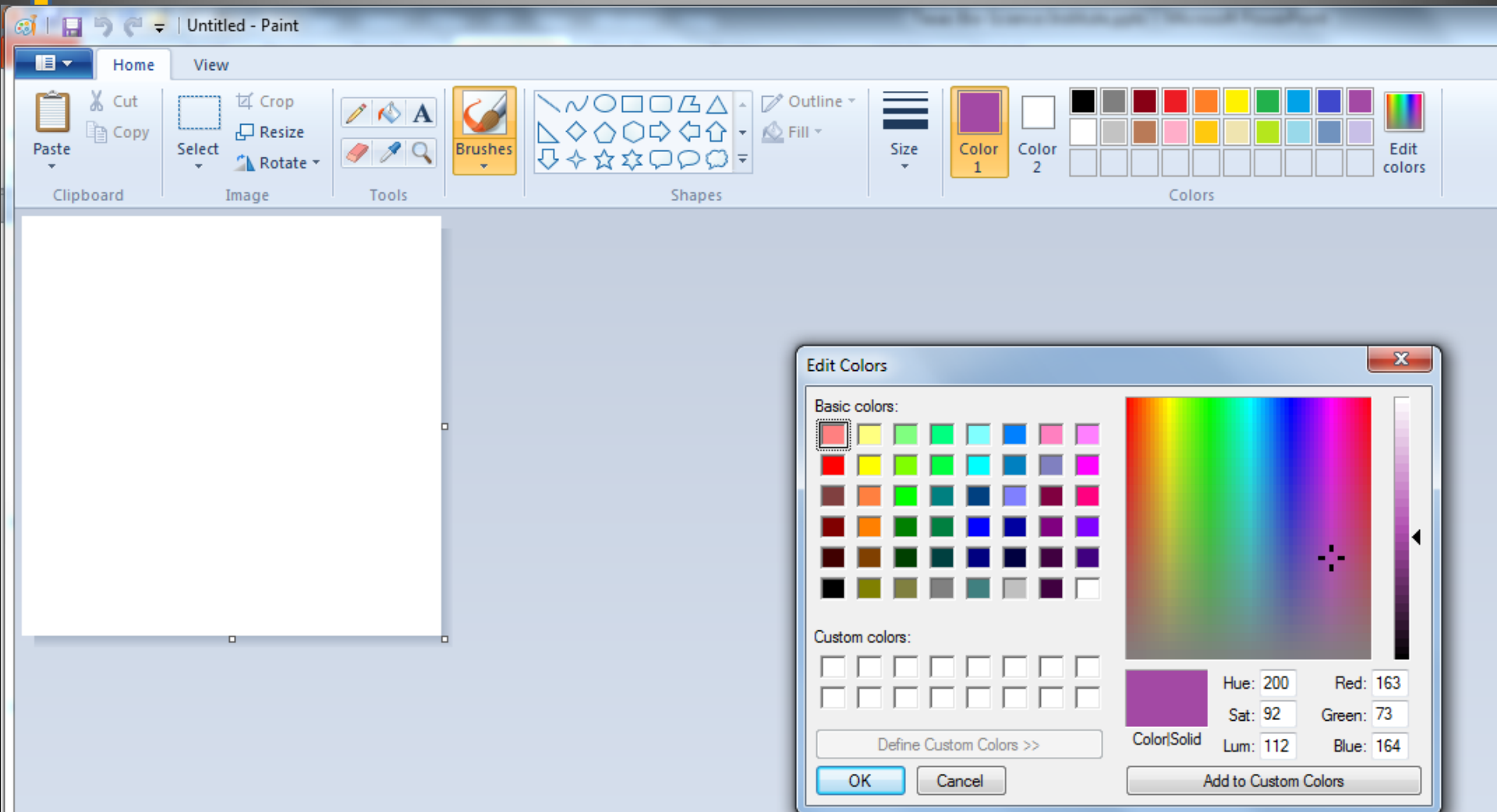
# It turns out

- Your monitor can display
- 256 shades of red
- 256 shades of green, and
- 256 shades of blue, or
- $2^8 \times 2^8 \times 2^8 = 2^{24}$
- or 16,777,216 colors

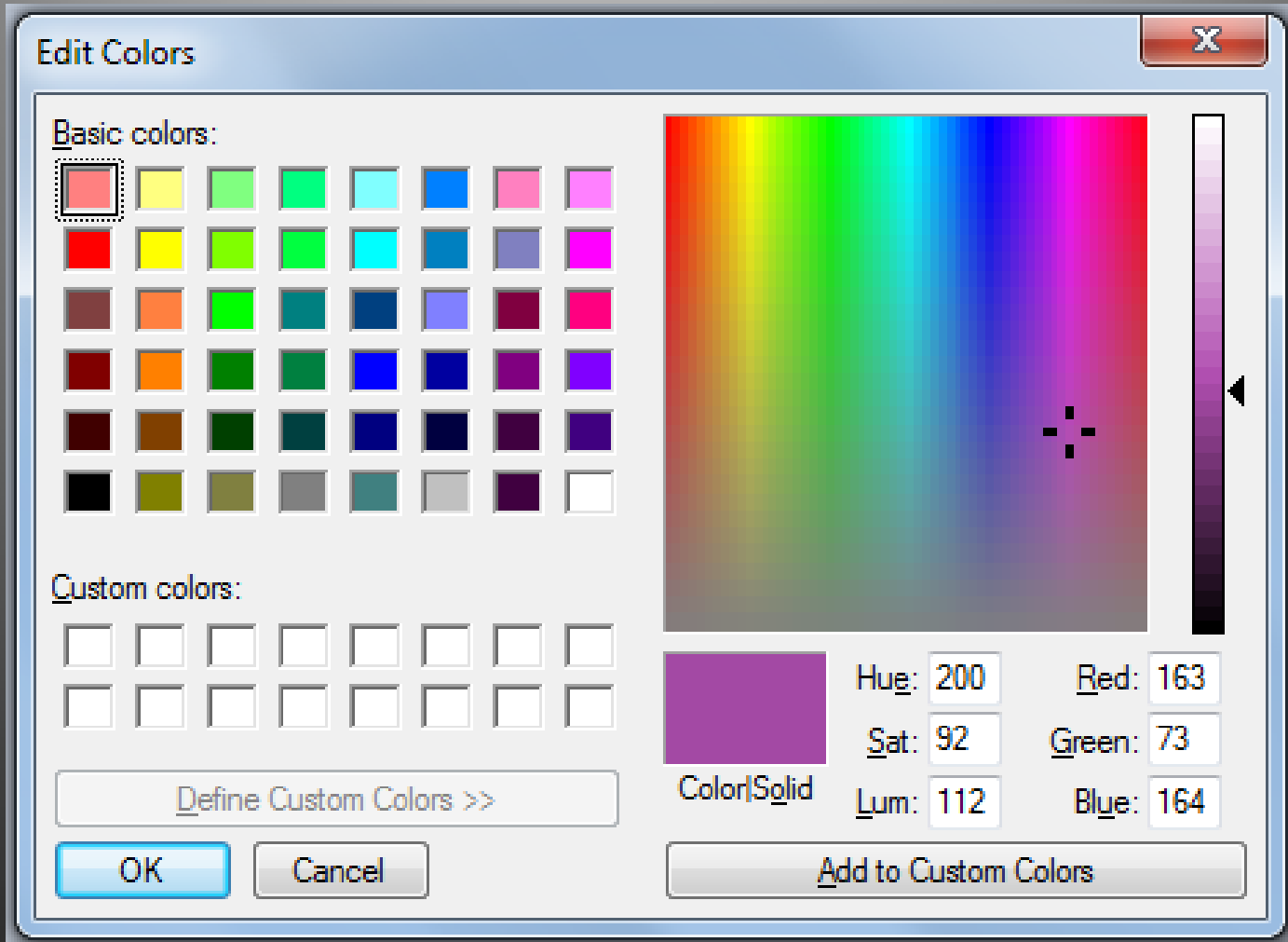
# Why $2^8$ ? Why $2^{24}$ ?

- Everything in a computer is a 1 or 0
- Bits
- Yes or no
- True or false
- On or off...
- All can be represented with 1 or 0

# Take a look at colors in Paint



# Again, up to 256 each



for a total 16 16,777,216 possible...

## But computers...

- Use different numbers than we do

**Binary base 2**

**Decimal base 10**

**Hexidecimal base 16**

# Counting: you can count, right?

- Start with
- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

# Three rules of counting

- Modern numbering systems start with 0
- The number of symbols is determined by the base
- 5 to us is actually  $5_{10}$  (Why base 10?)
- When you run out of numbers, you add a decimal to the left and start over



# Count like a computer

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 0
- 1
- 10
- 11
- 100
- 101
- 110
- 111
- 1000
- 1001
- 1010

# Can you guess

- What the next number that ends with all zeros is in binary, base 2?

|    |      |
|----|------|
| 0  | 0    |
| 1  | 1    |
| 2  | 10   |
| 3  | 11   |
| 4  | 100  |
| 5  | 101  |
| 6  | 110  |
| 7  | 111  |
| 8  | 1000 |
| 9  | 1001 |
| 10 | 1010 |

# Can you guess

- What the next number that ends with all zeros is in binary, base 2?

|    |      |
|----|------|
| 0  | 0    |
| 1  | 1    |
| 2  | 10   |
| 3  | 11   |
| 4  | 100  |
| 5  | 101  |
| 6  | 110  |
| 7  | 111  |
| 8  | 1000 |
| 9  | 1001 |
| 10 | 1010 |

|    |       |
|----|-------|
| 0  | 0     |
| 1  | 1     |
| 2  | 10    |
| 3  | 11    |
| 4  | 100   |
| 5  | 101   |
| 6  | 110   |
| 7  | 111   |
| 8  | 1000  |
| 9  | 1001  |
| 10 | 1010  |
| 11 | 1011  |
| 12 | 1100  |
| 13 | 1101  |
| 14 | 1110  |
| 15 | 1111  |
| 16 | 10000 |

# Problem

- Paint will give you the decimal number, but the computer wants something else
- You can't even remember a 7 digit phone number, no way you can remember a 24 digit number to represent a color...
- We need something shorter

**Binary base 2**

**Decimal base 10**

**Hexidecimal base 16**

|    |       |
|----|-------|
| 0  | 0     |
| 1  | 1     |
| 2  | 10    |
| 3  | 11    |
| 4  | 100   |
| 5  | 101   |
| 6  | 110   |
| 7  | 111   |
| 8  | 1000  |
| 9  | 1001  |
| 10 | 1010  |
| 11 | 1011  |
| 12 | 1100  |
| 13 | 1101  |
| 14 | 1110  |
| 15 | 1111  |
| 16 | 10000 |

0  
1  
2  
3  
4  
5  
6  
7  
8  
9

|    |       |    |
|----|-------|----|
| 0  | 0     | 0  |
| 1  | 1     | 1  |
| 2  | 10    | 2  |
| 3  | 11    | 3  |
| 4  | 100   | 4  |
| 5  | 101   | 5  |
| 6  | 110   | 6  |
| 7  | 111   | 7  |
| 8  | 1000  | 8  |
| 9  | 1001  | 9  |
| 10 | 1010  | A  |
| 11 | 1011  | B  |
| 12 | 1100  | C  |
| 13 | 1101  | D  |
| 14 | 1110  | D  |
| 15 | 1111  | F  |
| 16 | 10000 | 10 |



| Decimal (base 10) | Binary (Base 2) | Hexadecimal (Base 16) |
|-------------------|-----------------|-----------------------|
| 0                 | 0               | 0                     |
| 1                 | 1               | 1                     |
| 2                 | 10              | 2                     |
| 3                 | 11              | 3                     |
| 4                 | 100             | 4                     |
| 5                 | 101             | 5                     |
| 6                 | 110             | 6                     |
| 7                 | 111             | 7                     |
| 8                 | 1000            | 8                     |
| 9                 | 1001            | 9                     |
| <b>10</b>         | <b>1010</b>     | <b>A</b>              |
| 11                | 1011            | B                     |
| 12                | 1100            | C                     |
| 13                | 1101            | D                     |
| 14                | 1110            | E                     |
| 15                | 1111            | F                     |
| 16                | 10000           | 10                    |

- Remember the doubling
- When looking at 1 followed by nothing?  
ie 1, 10, 100

| Decimal (base 10) | Binary (Base 2) | Hexadecimal (Base 16) |
|-------------------|-----------------|-----------------------|
| 0                 | 0               | 0                     |
| 1                 | 1               | 1                     |
| 2                 | 10              | 2                     |
| 3                 | 11              | 3                     |
| 4                 | 100             | 4                     |
| 5                 | 101             | 5                     |
| 6                 | 110             | 6                     |
| 7                 | 111             | 7                     |
| 8                 | 1000            | 8                     |
| 9                 | 1001            | 9                     |
| <b>10</b>         | <b>1010</b>     | <b>A</b>              |
| 11                | 1011            | B                     |
| 12                | 1100            | C                     |
| 13                | 1101            | D                     |
| 14                | 1110            | E                     |
| 15                | 1111            | F                     |
| 16                | 10000           | 10                    |

# Remember the doubling?

- This leads to the powers of 2 number line

|          |       |       |       |       |       |       |       |       |       |       |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| $2^{10}$ | $2^9$ | $2^8$ | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
| 1024     | 512   | 256   | 128   | 64    | 32    | 16    | 8     | 4     | 2     | 1     |

- Notice  $2^8$  is 256

# Let's start to convert

- 3 rules for decimal-binary
- Always write out the powers of 2 number line
- $x_{10}$  to  $x_2$  is subtracting  
 $x_2$  to  $x_{10}$  is adding
- We'll use only 1s and 0s, they go under the number line

# Example $52_{10}$ to $?_2$

|          |       |       |       |       |       |       |       |       |       |       |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| $2^{10}$ | $2^9$ | $2^8$ | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
| 1024     | 512   | 256   | 128   | 64    | 32    | 16    | 8     | 4     | 2     | 1     |

- What is the largest number you can subtract from 52?
- 32

# Example $52_{10}$ to $?_2$

|          |       |       |       |       |       |       |       |       |       |       |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| $2^{10}$ | $2^9$ | $2^8$ | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
| 1024     | 512   | 256   | 128   | 64    | 32    | 16    | 8     | 4     | 2     | 1     |

1

- What is the largest number you can subtract from 52?
- 32, put a 1 under the number line
- Do the math  $52-32=20$

# Example $52_{10}$ to $?_2$

| $2^{10}$ | $2^9$ | $2^8$ | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1024     | 512   | 256   | 128   | 64    | 32    | 16    | 8     | 4     | 2     | 1     |

1

- We have 20
- Can you subtract the next one, 16?
- 1 means yes, 0 means no

# Example $52_{10}$ to $?_2$

| $2^{10}$ | $2^9$ | $2^8$ | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1024     | 512   | 256   | 128   | 64    | 32    | 16    | 8     | 4     | 2     | 1     |

1 1

- We have 20
- Can you subtract the next one, 16?
- 1 means yes, 0 means no
- Do the math  $20-16=4$



# Example $52_{10}$ to $?_2$

| $2^{10}$ | $2^9$ | $2^8$ | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1024     | 512   | 256   | 128   | 64    | 32    | 16    | 8     | 4     | 2     | 1     |

1 1

- We have 4
- Can you subtract the next one, 8?
- 1 means yes, 0 means no

# Example $52_{10}$ to $?_2$

| $2^{10}$ | $2^9$ | $2^8$ | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1024     | 512   | 256   | 128   | 64    | 32    | 16    | 8     | 4     | 2     | 1     |

1 1 0

- We have 4
- Can you subtract the next one, 4?
- 1 means yes, 0 means no

# Example $52_{10}$ to $?_2$

| $2^{10}$ | $2^9$ | $2^8$ | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1024     | 512   | 256   | 128   | 64    | 32    | 16    | 8     | 4     | 2     | 1     |

1 1 0 1

- We have 4
- Can you subtract the next one, 4?
- 1 means yes, 0 means no
- Do the math,  $4-4=0$

# Example $52_{10}$ to $?_2$

| $2^{10}$ | $2^9$ | $2^8$ | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1024     | 512   | 256   | 128   | 64    | 32    | 16    | 8     | 4     | 2     | 1     |

1 1 0 1

- We have 0
- Can you subtract the next one, 2?
- 1 means yes, 0 means no

# Example $52_{10}$ to $?_2$

| $2^{10}$ | $2^9$ | $2^8$ | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1024     | 512   | 256   | 128   | 64    | 32    | 16    | 8     | 4     | 2     | 1     |

1 1 0 1 0

- We have 0
- Can you subtract the next one, 1?
- 1 means yes, 0 means no

# Example $52_{10}$ to $?_2$

| $2^{10}$ | $2^9$ | $2^8$ | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1024     | 512   | 256   | 128   | 64    | 32    | 16    | 8     | 4     | 2     | 1     |

1 1 0 1 0 0

- So  $52_{10}$  to  $?_2$
- **110100**
- Let's check with a calculator

### Calculator

View Edit Help

52

|      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|
| 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 0000 |
| 63   |      |      |      | 47   |      |      | 32   |
| 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 0011 | 0100 |
| 31   |      |      |      | 15   |      |      | 0    |

Hex

Dec

Oct

Bin

---

Qword

Dword

Word

Byte

|     |     |   |    |    |    |    |     |
|-----|-----|---|----|----|----|----|-----|
|     | Mod | A | MC | MR | MS | M+ | M-  |
| (   | )   | B | ←  | CE | C  | ±  | √   |
| RoL | RoR | C | 7  | 8  | 9  | /  | %   |
| Or  | Xor | D | 4  | 5  | 6  | *  | 1/x |
| Lsh | Rsh | E | 1  | 2  | 3  | -  | =   |
| Not | And | F | 0  | .  | +  |    |     |

### Calculator

View Edit Help

52

|      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|
| 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 0000 |
| 63   |      |      |      | 47   |      |      | 32   |
| 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 0011 | 0100 |
| 31   |      |      |      | 15   |      |      | 0    |

Hex  
 Dec  
 Oct  
 Bin ←

Qword  
 Dword  
 Word  
 Byte

Mod A MC MR MS M+ M-  
( ) B ← CE C ± √  
ROL ROR C 7 8 9 / %  
Or Xor D 4 5 6 \* 1/x  
Lsh Rsh E 1 2 3 - =  
Not And F 0 . +



### Calculator

View Edit Help

**110100**

|      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|
| 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 0000 |
| 63   |      |      |      | 47   |      |      | 32   |
| 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 0011 | 0100 |
| 31   |      |      |      | 15   |      |      | 0    |

Hex

Dec

Oct

Bin

---

Qword

Dword

Word

Byte

|     |     |   |    |    |    |    |     |
|-----|-----|---|----|----|----|----|-----|
|     | Mod | A | MC | MR | MS | M+ | M-  |
| (   | )   | B | ←  | CE | C  | ±  | √   |
| RoL | RoR | C | 7  | 8  | 9  | /  | %   |
| Or  | Xor | D | 4  | 5  | 6  | *  | 1/x |
| Lsh | Rsh | E | 1  | 2  | 3  | -  | =   |
| Not | And | F | 0  | .  | +  |    |     |

# Let's start to convert

- 3 rules for decimal-binary
- Always write out the powers of 2 number line
- $x_{10}$  to  $x_2$  is subtracting  
 $x_2$  to  $x_{10}$  is adding
- We'll use only 1s and 0s, they go under the number line

# Example $10111_2$ to $?_{10}$

|          |       |       |       |       |       |       |       |       |       |       |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| $2^{10}$ | $2^9$ | $2^8$ | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
| 1024     | 512   | 256   | 128   | 64    | 32    | 16    | 8     | 4     | 2     | 1     |

1 0 1 1 1

- The 1s and zeros go below
- We are adding
- Add all the 1s (yes, I cans)

# Example $10111_2$ to $?_{10}$

| $2^{10}$ | $2^9$ | $2^8$ | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1024     | 512   | 256   | 128   | 64    | 32    | 16    | 8     | 4     | 2     | 1     |

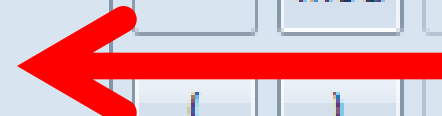
1 0 1 1 1

- The 1s and zeros go below
- We are adding
- Add all the 1s (yes, I cans)
- $16+4+2+1=23...$  back to calc!

View Edit Help

10111

|      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|
| 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 0000 |
| 63   |      |      |      | 47   |      |      | 32   |
| 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 0001 | 0111 |
| 31   |      |      |      | 15   |      |      | 0    |

|  |  |     |     |    |    |    |    |     |   |
|--|--|-----|-----|----|----|----|----|-----|---|
| <input type="radio"/> Hex              |  | Mod | A   | MC | MR | MS | M+ | M-  |   |
| <input type="radio"/> Dec              |  | (   | )   | B  | ←  | CE | C  | ±   | √ |
| <input type="radio"/> Oct              |  | RoL | RoR | C  | 7  | 8  | 9  | /   | % |
| <input checked="" type="radio"/> Bin   | Or   | Xor | D   | 4  | 5  | 6  | *  | 1/x |   |
| <input checked="" type="radio"/> Qword | Lsh  | Rsh | E   | 1  | 2  | 3  | -  | =   |   |
| <input type="radio"/> Dword            | Not  | And | F   | 0  | .  | +  |    |     |   |
| <input type="radio"/> Word             |  |     |     |    |    |    |    |     |   |
| <input type="radio"/> Byte             |  |     |     |    |    |    |    |     |   |

### Calculator

View Edit Help

23

|      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|
| 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 0000 |
| 63   |      |      |      | 47   |      |      | 32   |
| 0000 | 0000 | 0000 | 0000 | 0000 | 0000 | 0001 | 0111 |
| 31   |      |      |      | 15   |      |      | 0    |

Hex

Dec

Oct

Bin

---

Qword

Dword

Word

Byte

|     |     |   |    |    |    |    |     |
|-----|-----|---|----|----|----|----|-----|
|     | Mod | A | MC | MR | MS | M+ | M-  |
| (   | )   | B | ←  | CE | C  | ±  | √   |
| RoL | RoR | C | 7  | 8  | 9  | /  | %   |
| Or  | Xor | D | 4  | 5  | 6  | *  | 1/x |
| Lsh | Rsh | E | 1  | 2  | 3  | -  | =   |
| Not | And | F | 0  | .  | +  |    |     |

But

- what about hex?
- Instant

| Decimal (base 10) | Binary (Base 2) | Hexadecimal (Base 16) |
|-------------------|-----------------|-----------------------|
| 0                 | 0               | 0                     |
| 1                 | 1               | 1                     |
| 2                 | 10              | 2                     |
| 3                 | 11              | 3                     |
| 4                 | 100             | 4                     |
| 5                 | 101             | 5                     |
| 6                 | 110             | 6                     |
| 7                 | 111             | 7                     |
| 8                 | 1000            | 8                     |
| 9                 | 1001            | 9                     |
| <b>10</b>         | <b>1010</b>     | <b>A</b>              |
| 11                | 1011            | B                     |
| 12                | 1100            | C                     |
| 13                | 1101            | D                     |
| 14                | 1110            | E                     |
| 15                | 1111            | F                     |
| 16                | 10000           | 10                    |

# Hex seems BAD

- Hey, BAD is a hex number!

Just look up B, and A, and D



So

- B is 1011

A is 1010

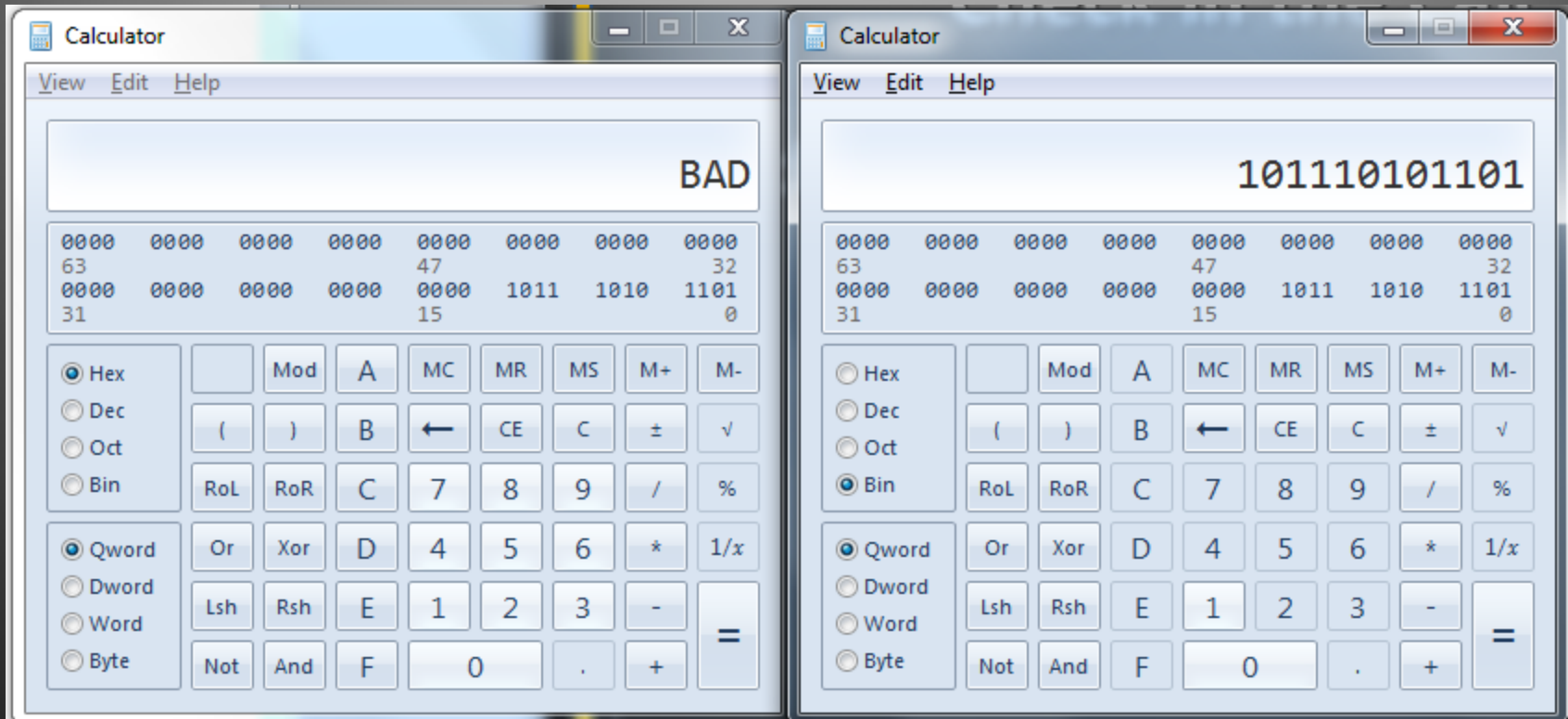
D is 1011

$BAD_{16} =$

$101110101011_2$

| Decimal (base 10) | Binary (Base 2) | Hexadecimal |
|-------------------|-----------------|-------------|
| 0                 | 0               | 0           |
| 1                 | 1               | 1           |
| 2                 | 10              | 2           |
| 3                 | 11              | 3           |
| 4                 | 100             | 4           |
| 5                 | 101             | 5           |
| 6                 | 110             | 6           |
| 7                 | 111             | 7           |
| 8                 | 1000            | 8           |
| 9                 | 1001            | 9           |
| 10                | 1010            | A           |
| 11                | 1011            | B           |
| 12                | 1100            | C           |
| 13                | 1101            | D           |
| 14                | 1110            | E           |
| 15                | 1111            | F           |
| 16                | 10000           | 10          |

# Check in the Calc



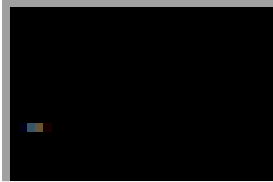
- You can go from binary to decimal or decimal to binary now, *right?*

# Experiment with colors

```
<html>
<head><title>My First Web Page</title></head>
<body
bgcolor="white"
text="black">
<h2>Hi</h2>
</body>
</html>
```

For now, 00 means none, FF means full, a lot

000000



0000FF



00FF00



00FFFF



FF0000



FF00FF



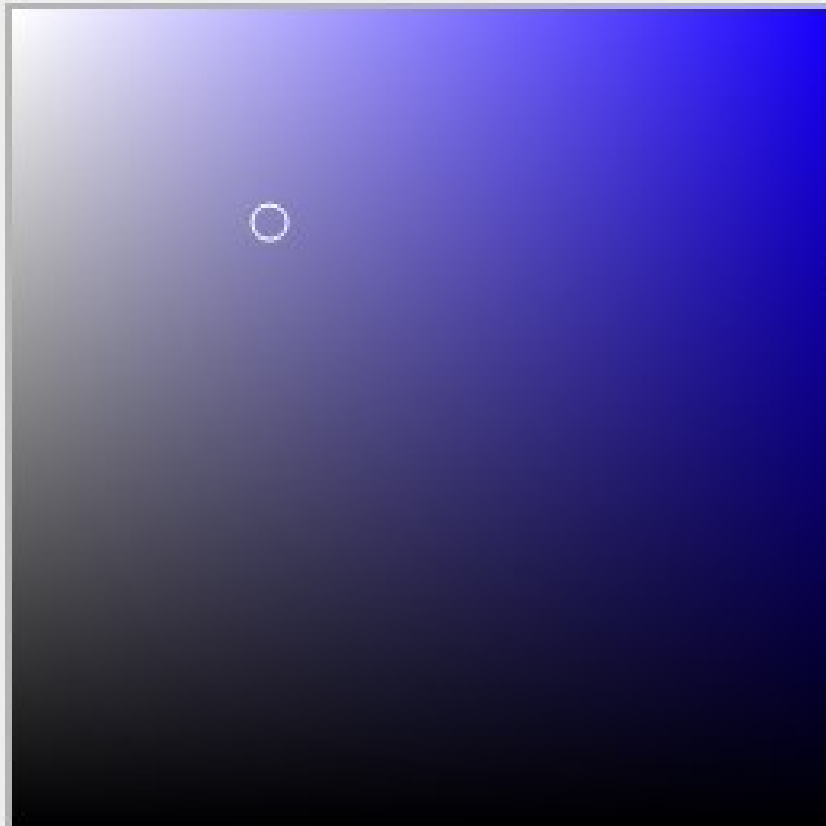
FFFFFF00



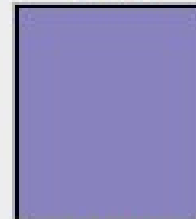
FFFFFF



Color Picker (Foreground Color)



new



current

- H: 246 °
- S: 32 %
- B: 74 %
- R: 135
- G: 129
- B: 189

- L: 56
- a: 13
- b: -31

- C: 50 %
- M: 50 %
- Y: 0 %
- K: 0 %

Only Web Colors

# 8781bd

OK

Cancel

Add to Swatches

Color Libraries

# Related material

- **You Tube on web pages**
  - [http://www.youtube.com/watch?v=Dx\\_\\_92GizG4](http://www.youtube.com/watch?v=Dx__92GizG4)
- **YouTube on Paint**
  - <http://www.youtube.com/watch?v=Ds1Qtfggt2w>
- **YouTube on Numbers**
  - <http://www.youtube.com/watch?v=HJbOG39IxuU>
- **YouTube on Calc**
  - <http://www.youtube.com/watch?v=UzYESAsNYY0>
- **YouTube on Photoshop**
  - [http://www.youtube.com/watch?v=rWO\\_DEH4KKI](http://www.youtube.com/watch?v=rWO_DEH4KKI)