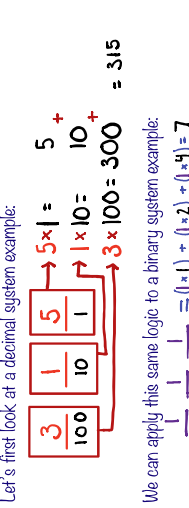


# ③ Onto some practice...

16 8 4 2 1 = 2<sup>4</sup> 2<sup>3</sup> 2<sup>2</sup> 2<sup>1</sup> 2<sup>0</sup> ... so 16 in binary is 10010  
8 = (0\*1) + (1\*2) + (0\*4) + (0\*8) + (1\*16) = 18  
4 = (1\*1) + (1\*2) + (1\*4) = 7



Let's first look at a decimal system example:  
We can apply the same logic to a binary system example:  
315 = 256 + 59  
100000000 + 1111011 = 10001111011

To understand binary, we should first know to convert between binary and decimal numbers.  
Binary numbers work like this: Just like decimal numbers have "places" (i.e. a "one's" place, a "ten's" place, etc.), binary numbers have "places." The places are the "one's" place, the "two's" place, the "four's" place, the "eight's" place, and so forth. Note the pattern... each "place" is a subsequent power of 2. So how do places work?

## Examples | Practice!

1. What is 1101 in decimal?  
 $\frac{1}{8} \frac{1}{4} \frac{0}{2} \frac{1}{1} = (1 \times 8) + (1 \times 4) + (0 \times 2) + (1 \times 1) = 13$

2. What is 86 in binary?  
 $\frac{1}{64} \frac{0}{32} \frac{1}{16} \frac{0}{8} \frac{1}{4} \frac{1}{2} \frac{0}{1} = 64 + 16 + 4 + 2 = 86$   
NOTE:  $\frac{1}{2^n} = 2^{-n}$   
NOTE:  $\frac{1}{2^n} = (1 \times 2^n) + (0 \times 2^{n-1}) + \dots + (0 \times 2^2) + (0 \times 2^1) + (0 \times 2^0)$

3. What is 100110 in decimal?  
 $\frac{1}{32} \frac{1}{16} \frac{0}{8} \frac{0}{4} \frac{1}{2} \frac{1}{1} = 16 + 2 + 1 = 19$

4. Using the ASCII key, write your name!  
Example: My name is ARIELLE.  
A: 1000001 L: 1001100  
R: 1010010 L: 1001100  
I: 1001010 E: 1000101  
M: 1001100 L: 1001100

# ②

What's binary and how do computers use it?  
Computers use binary because they can only represent two states: on and off. Binary is the language of computers.

Computers use bits (Binary digITS) to represent data. Eight bits make up a Byte. A byte can have values ranging from 0-255. Bytes represent many different values like...

Color: On a screen, images are composed of many many tiny points of color, called pixels. Pixels are given a red, green, and blue (RGB) value. The "amount" of each RGB color is represented by a Byte. Different amounts of red, green, and blue give rise to different colors.

American Standard Code for Information Interchange (ASCII) stands for the American Standard Code for Information Interchange. It's a standard for character encoding, designating each character to a byte (more on this later!).

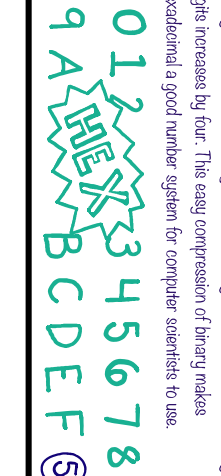
We normally use decimal numbers, which are numbers in a base ten system. A base ten system utilizes ten digits, 0-9.  
Binary numbers are a base TWO system, using two digits, 0 and 1.  
Computers rely on binary because of its simplicity. For example, this is important in computer processors, which are little devices in computers that translate inputs into outputs. Processors consist of transistors, which act like switches turned on and off by electronic signals. A binary system enables this by providing two distinct 'on' and 'off' or 'high' and 'low' states, represented by either 0 (off) or 1 (on).

## What's hexadecimal, and what's it got to do with computers?

Hexadecimal is a base sixteen system, (using sixteen digits), the conventional 0-9 digits as well as the letters A-F, which correspond to the decimal values 0-15.

You might have realized that a byte (8 bits) is not very easy to read and interpret. That's why we have hexadecimal. While computers rely on binary, we often represent binary numbers as hexadecimal numbers to make it easier for us as computer scientists to read. Two hexadecimal digits (rather than eight binary digits), can represent a byte. Hexadecimal can represent larger numbers in many fewer digits than binary, making it easier to read and compressing information (theory for consisns!).

So why do we not just use decimal instead to represent larger numbers? Decimal is a base ten system, which does not match up nicely with a base 16 system (i.e. four binary digits could be one OR two decimal digits). Since sixteen is a power of two, it always matches up nicely with binary — one hexadecimal digit is added every time the number of binary digits increases by four. This easy compression of binary makes hexadecimal a good number system for computer scientists to use.



# ①

How do you convert between binary and hexadecimal?  
We can apply the same techniques we learned from converting between binary and decimal to converting between hexadecimal and decimal.

Keep in mind the conversions of the digits:  
★ The standard 0-9 digits are the same.  
★ A = 10, B = 11, C = 12, D = 13, E = 14, F = 15  
Hexadecimal, being a base sixteen system has a "1's" place, a "16's" place, a "256's" place, and so forth. Notice again the pattern... each new place is a subsequent power of sixteen.

Let's look at some hexadecimal examples:  
 $\frac{A}{16} \frac{C}{1} = (12 \times 16) + (0 \times 16) = 172$   
 $\frac{1}{256} \frac{8}{16} \frac{3}{1} = (3 \times 1) + (8 \times 16) + (1 \times 256) = 387$



... A ZINE FOR ANYONE INTERESTED IN CS! NO KNOWLEDGE OF PROGRAMMING OR COMPUTERS REQUIRED! EVERYONE IS WELCOME!  
By: Arielle Tycko

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Hexadecimal can be tricky! 183 can also be a decimal number, so be careful about specifications in future practice problems!  
Speaking of practice...

# ⑧

Binary systems using BASE TWO digits  
Computers store and read information represented by binary digits (bits) set by color (RGB) (values) and ASCII code.  
Hexadecimal system, using BASE SIXTEEN digits  
Hexadecimal is binary rather than base 10, which is why we can work with it because we can represent binary digits rather than base 10 digits.

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## Examples | Practice!

What is decimal 87 in hexadecimal?  
 $\frac{5}{16} \frac{7}{1} = 80 + 7 = 87$

What is decimal 229 in binary?  
 $\frac{1}{128} \frac{1}{64} \frac{1}{32} \frac{1}{16} \frac{0}{8} \frac{1}{4} \frac{1}{2} \frac{0}{1} = 128 + 64 + 32 + 4 + 1 = 229$

Using the ASCII key and practice on page 4, write your name in hexadecimal!  
Same example: My name is ARIELLE.  
A: 41 L: 4C  
R: 52 L: 4C  
I: 49 L: 4C  
M: 65 L: 69

