Binary & Hexadecimal Numbers

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Numbers in different bases

“Normal” numbers are base 10

- The numbers in one “place” go from 0-9 and once you reach ten you go over to the next one

Binary is base 2

- The numbers in one “place” go from 0-1 and once you reach two you go over to the next one

Hexadecimal is base 16

- The numbers is one “place” go from 0-15 and once you reach 16 you go over to the next one
    - once you reach 10 the numbers get converted into letters, so 10 = A, 11 = B, etc

“Places”

The “places” for Binary

The base for a number determines what the starting point for the “places” are and places are just different powers of the starting point. So, since binary is base 2 its places are…

… 2^5 2^4 2^3 2^2 2^1 2^0

And the power just keeps going up as you move towards larger numbers.

Binary doesn’t have a “10s place” or “100s place” instead it has a “2s place” and a “4s place”

The “places” for Hexadecimal (aka hex)

Since hex is base 16 its places are…

… 16^5 16^4 16^3 16^2 16^1 16^0

And the power just keeps going up as you move towards larger numbers.

Hex doesn’t have a “10s place” or “100s place” instead it has a “16s place” and a “256s place”

Converting Between Bases

Base 10 to Binary

Divide original number by 2 repeatedly, along the way keep track of the remainder of the division and prepend it to the binary number you build up along the way.

Continue to divide by 2 until the answer is 0.

Base 10 to Binary: Conversion Demo

Original Number: 34

Conversion:

```
34 / 2 = 17 + 0
17 / 2 = 8 + 1
 8 / 2 = 4 + 0
 4 / 2 = 2 + 0
 2 / 2 = 1 + 0
 1 / 2 = 0 + 1
```

answer in binary if you go from the bottom up

Answer: 100010

Binary to Base 10

Looking at each “place” in the binary number add together the correct power of 2 for the places that have ones in them.

Binary to Base 10: Conversion Demo

Binary:	1	0	0	1	1	0	1	
	2^6	2^5	2^4	2^3	2^2	2^1	2^0	
conversion:	64	+		8	+ 4	+	1	= 77

answer in base 10

Base 10 to Hex

Divide original number by 16 repeatedly, along the way keep track of the remainder of the division and prepend it to the hex number you build up along the way.

Continue to divide by 16 until the answer is 0.

Remember: numbers over 9 become letters so
10 = A, 11 = B, 12 = C etc.

Base 10 to Hex: Conversion Demo

Original Number:
5915337

Conversion:

```
5915337 / 16 = 369708 + 9
 369708 / 16 = 23106 + C
  23106 / 16 = 1444 + 2
   1444 / 16 = 90 + 4
     90 / 16 = 5 + A
      5 / 16 = 0 + 5
```

answer in hex if you go from the bottom up

Answer: 5A42C9

Hex to Base 10

Looking at each “place” in the hex number multiply by the correct power of 16 for that place and then add together the results of all the multiplications.

Hex to Base 10: Conversion Demo

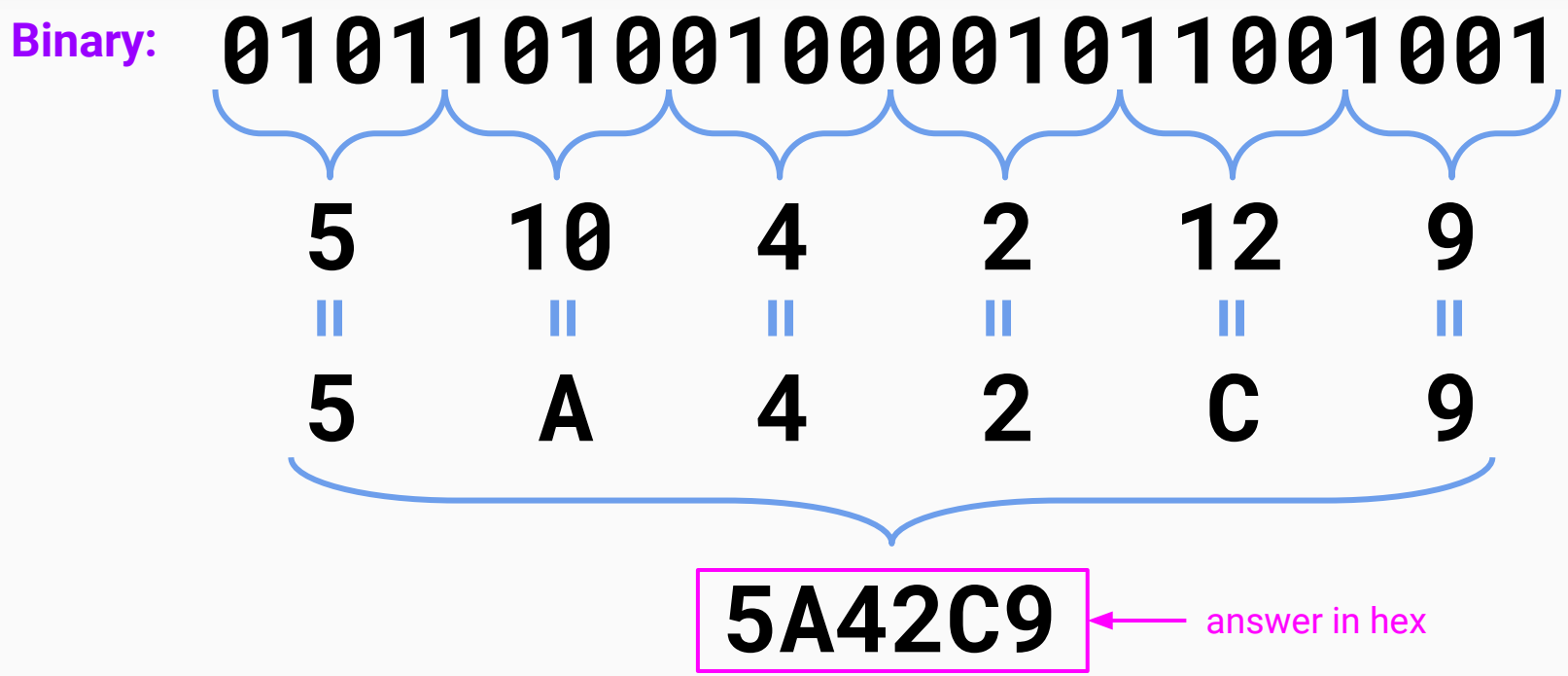
Hex:	5	A	4	2	C	9
	$\times 16^5$	$\times 16^4$	$\times 16^3$	$\times 16^2$	$\times 16^1$	$\times 16^0$
conversion:	5,242,880	+ 655,360	+ 16,384	+ 512	+ 192	+ 9

= **5,915,337** ← answer in base 10

Binary to Hex

Split the binary number into sets of 4 bits each. Covert each set into base 10 and then from base 10 into hex, each should be a single hex digit. All those hex digits together form the final hex number.

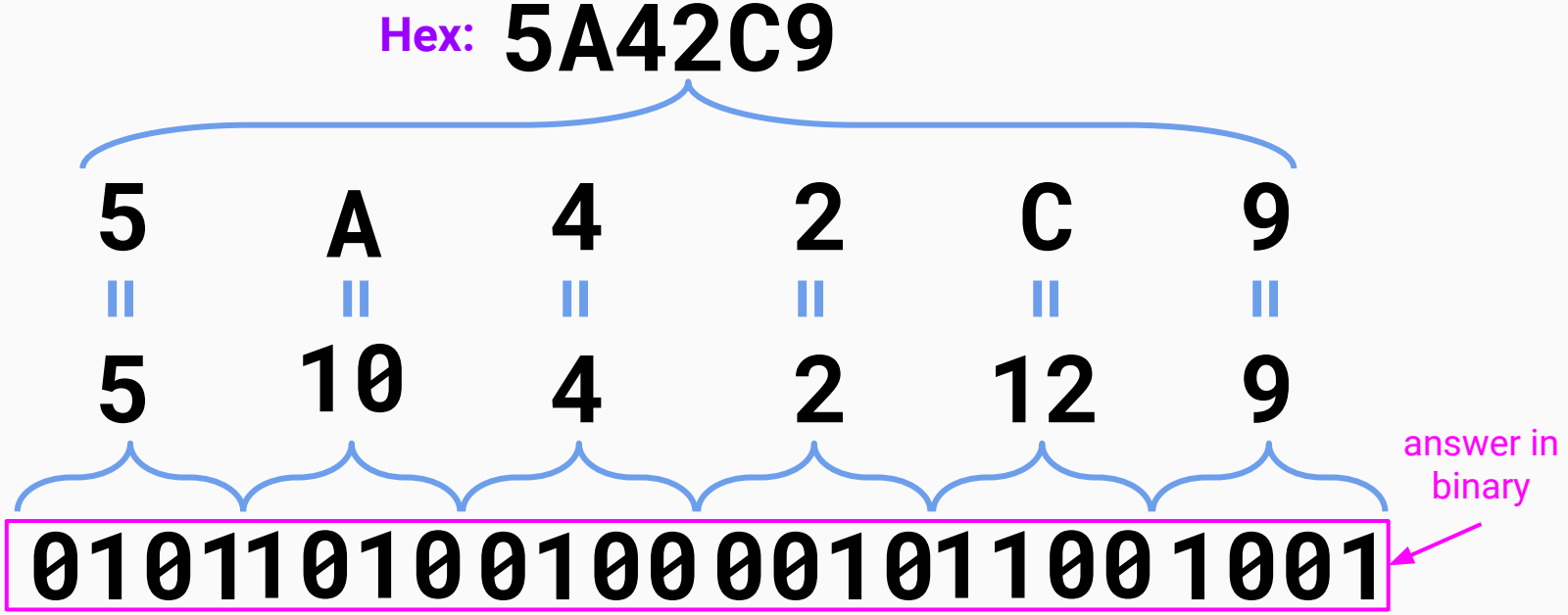
Binary to Hex: Conversion Demo



Hex to Binary

Convert each digit in the hex number to base 10 separately and then into binary, padding to 4 bits when necessary. Put all those sets of 4 bits together to form the final binary number.

Binary to Hex: Conversion Demo



The End