

Squeaky Hinge

STEAM Clown™

Binary Numbers

Art without Engineering is dreaming. Engineering without Art is calculating.

- Steven K. Roberts

Aug, 2016

Let's Play A Game...

- I Need A Volunteer...
- Pick A Number Between "0" And "64"
 - So Not "0" Or "64", But Some Number Between...
- Write It Down
- Show It Around... But Don't Let Me See It
- Place it Face Down On Your Table
- Now, Tell Me "Yes" Or "No" If Your Number Is On The Next 6 Cards
- Ready...



Is your number on this card?

| | | | | | | | |
|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 1 | 3 | 5 | 7 | 9 | 11 | 13 | 15 |
| 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 |
| 33 | 35 | 37 | 39 | 41 | 43 | 45 | 47 |
| 49 | 51 | 53 | 55 | 57 | 59 | 61 | 63 |

Is your number on this card?

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Is your number on this card?

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Is your number on this card?

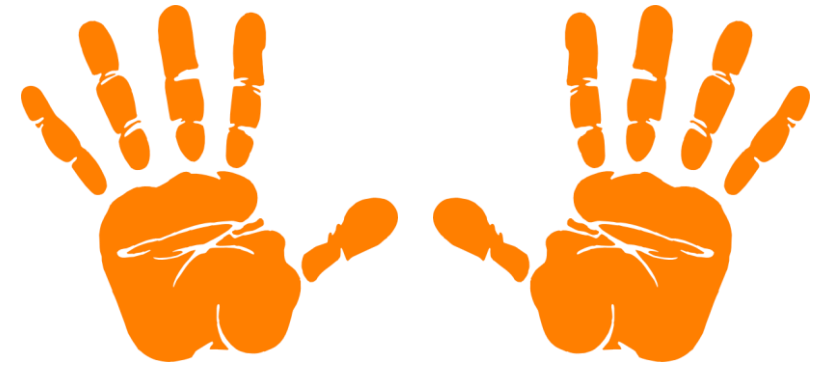
| | | | | | | | |
|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
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Squeaky Hinge

Your Number IS.....

Why Do We Count To 10?

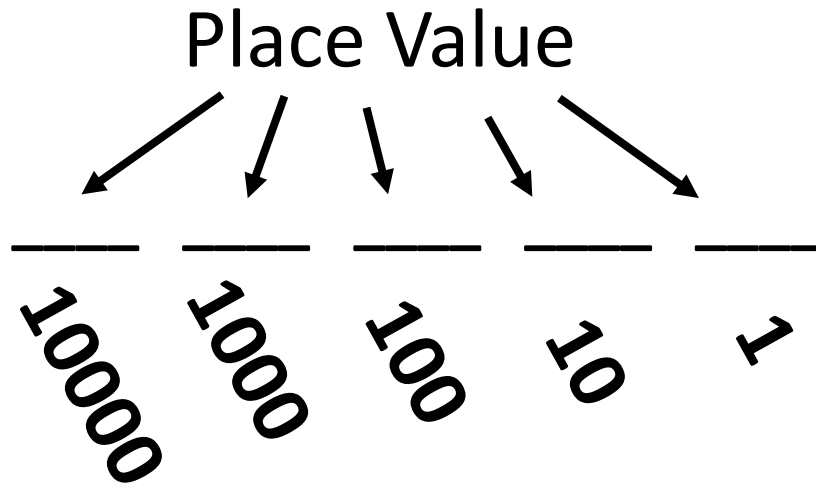
- Because We Have 10 Fingers...
- What If We Had 3 fingers?
- How About If We Only Had 1?



Lets Learn About The Binary (Base 2) Number System,
But First, Lets Review The Decimal (Base 10) Number System

Base 10 Number System - Place Value

- Which Number is bigger?
39 or 93



$$\begin{array}{cc} \underline{3} & \underline{9} \\ 10 & 1 \end{array} \qquad \begin{array}{cc} \underline{9} & \underline{3} \\ 10 & 1 \end{array}$$

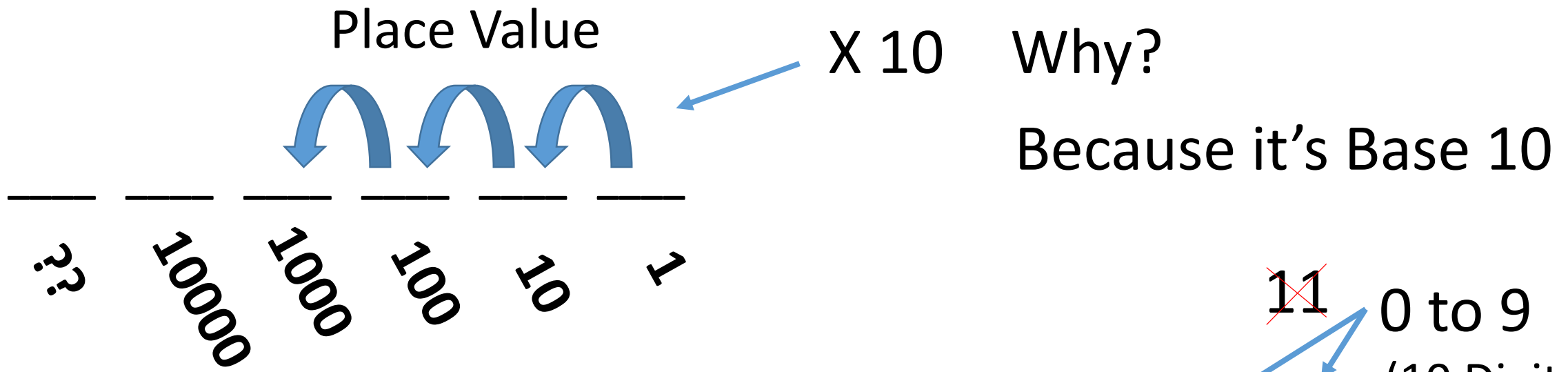
$$\begin{array}{l} 3 \times 10 + 9 \times 1 \\ 30 + 9 \end{array}$$

$$\begin{array}{l} 9 \times 10 + 3 \times 1 \\ 90 + 3 \end{array}$$

$$\begin{array}{cccc} \underline{5} & \underline{6} & \underline{3} & \underline{9} \\ 1000 & 100 & 10 & 1 \end{array}$$

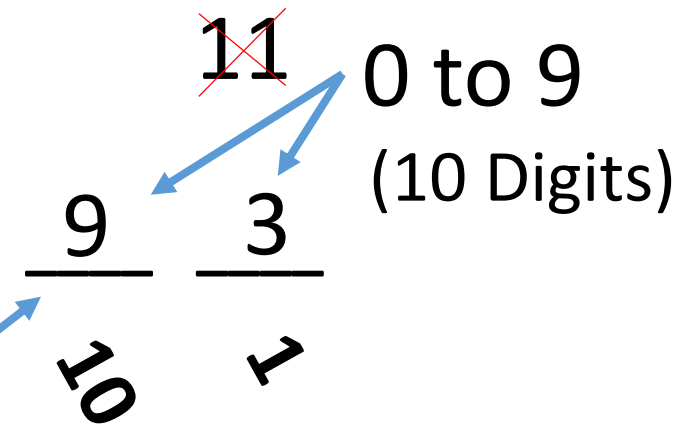
Base 10 Number System - Place Value

- How Do You move from one Place Value to the next?



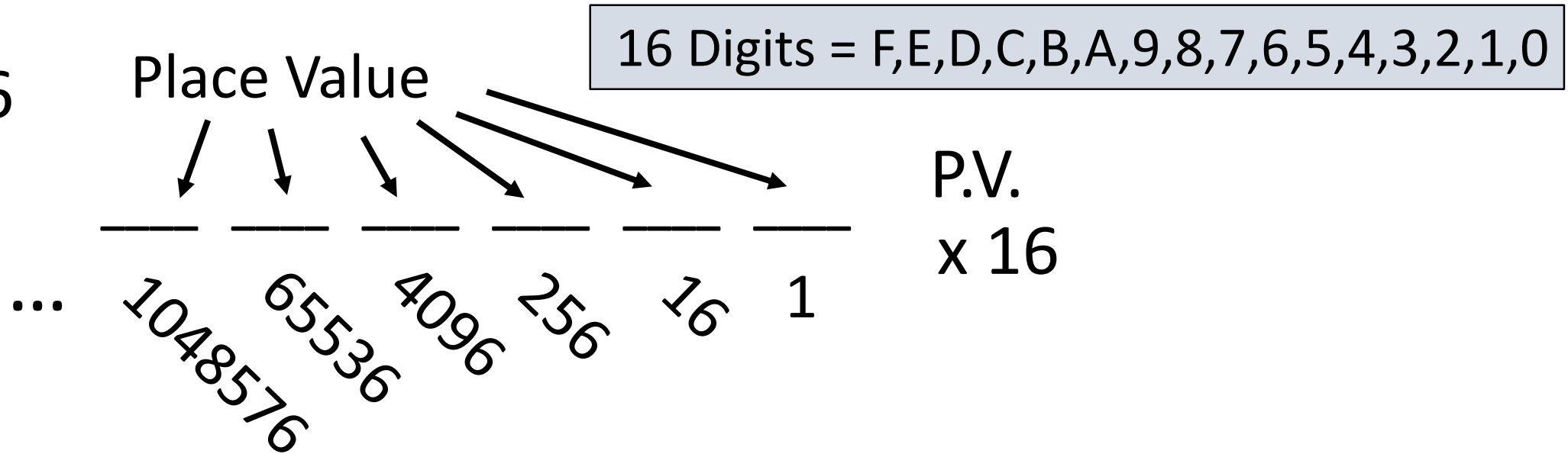
- What Digits are allowed for each Place Value?

Only Allowed One Digit Per Place Value

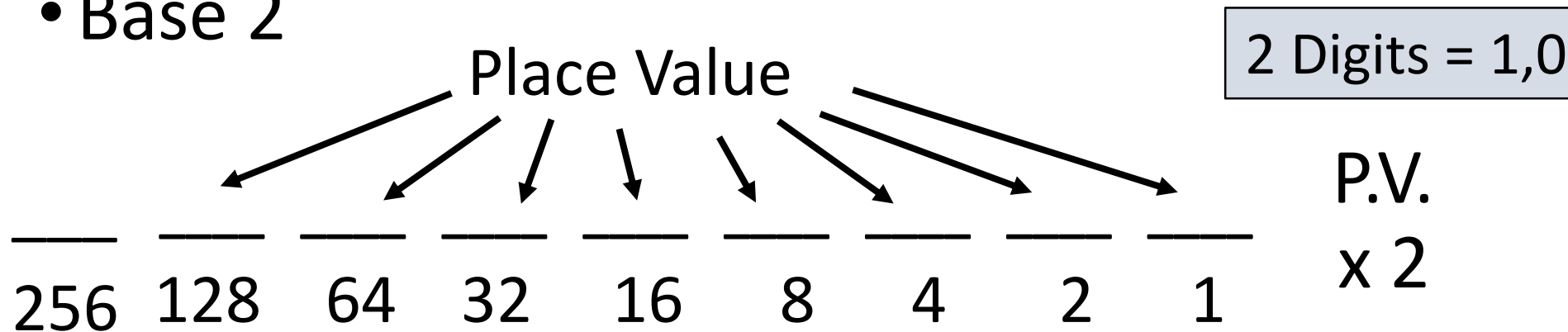


Figuring Out Other Base Number Systems

- Base 16

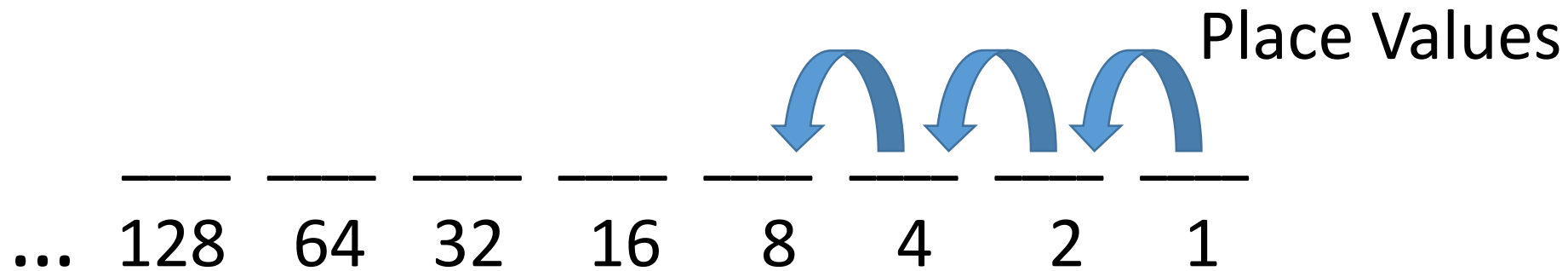


- Base 2



Base 2 Number System - Place Value

- How Do You move from one Place Value to the next?
- In Other Words, How Do You Count In Binary

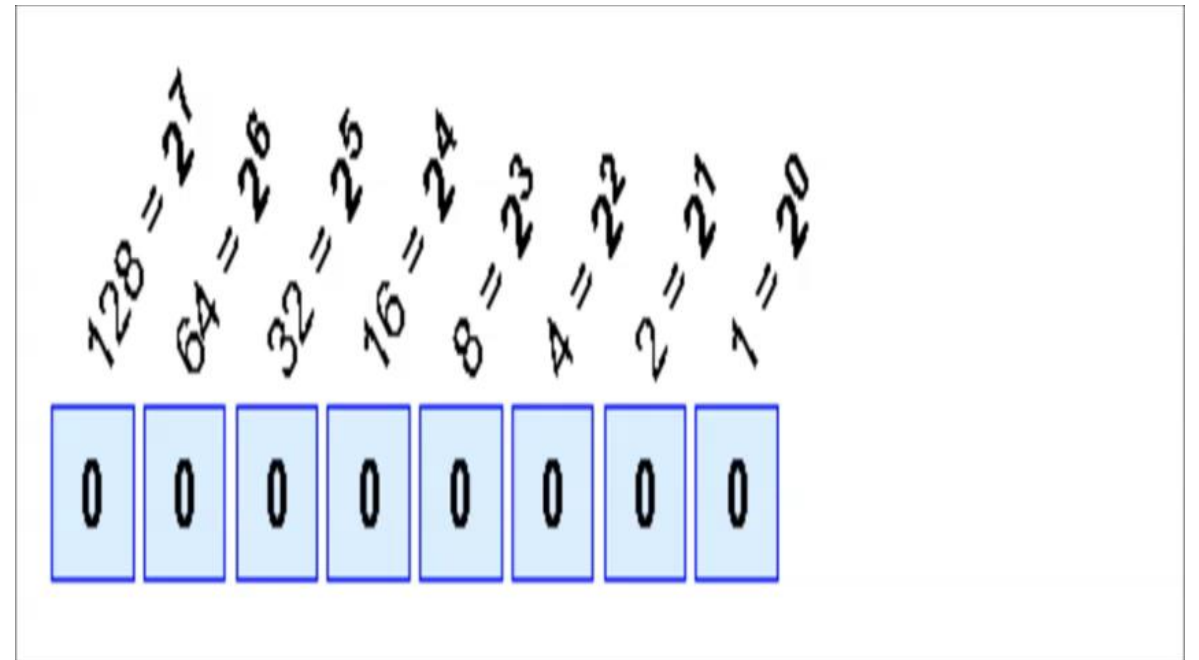


You Use The Same Rules As Decimal (Base 10)... Just In Binary (Base 2)

Counting In Binary

- Remember Binary Numbers are made of **0**s and **1**s
- Here Is An Example Of A Binary Number: **101011**
 - Binary Number can only be made from the Digits **0-1**
 - There is no **2,3,4,5,6,7,8** or **9** in Binary
- Lets Start Counting...

- Start with 0
- Then count to 1
- Then ?? There is not symbol for 2



Place Values

How To Convert From Binary or Decimal

Computer Humc

- Binary is as easy as 1, 10, 11

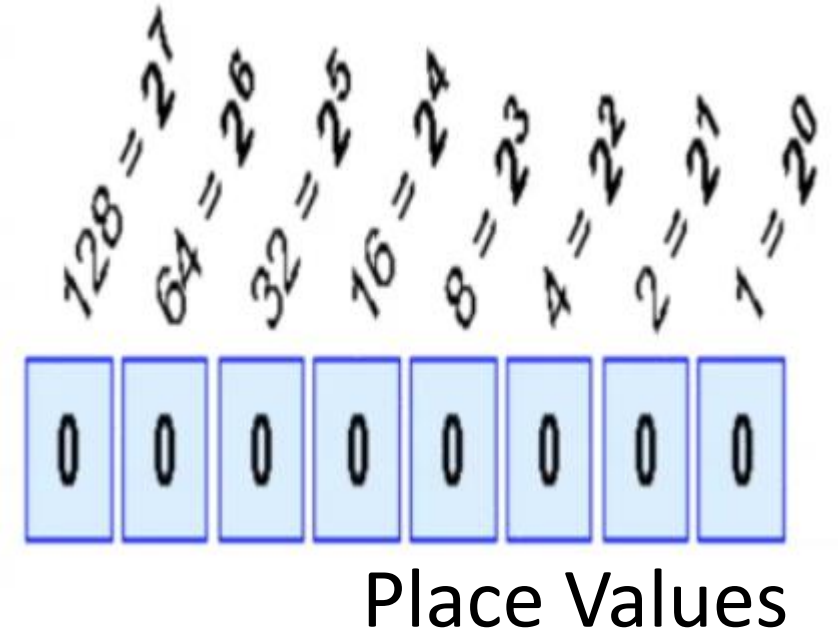
Convert the Following Binary Numbers:

$$0011 = ? \quad 1 \times 2 + 1 \times 1 = 3$$

$$1011 = ? \quad 1 \times 8 + 0 \times 4 + 1 \times 2 + 1 \times 1 = 11$$

$$10101 = ? \quad 1 \times 16 + 0 \times 8 + 1 \times 4 + 0 \times 2 + 1 \times 1 = 21$$

$$110011 = ? \quad 1 \times 32 + 1 \times 16 + 0 \times 8 + 0 \times 4 + 1 \times 2 + 1 \times 1 = 51$$



All Six Cards

| | | | | | | | |
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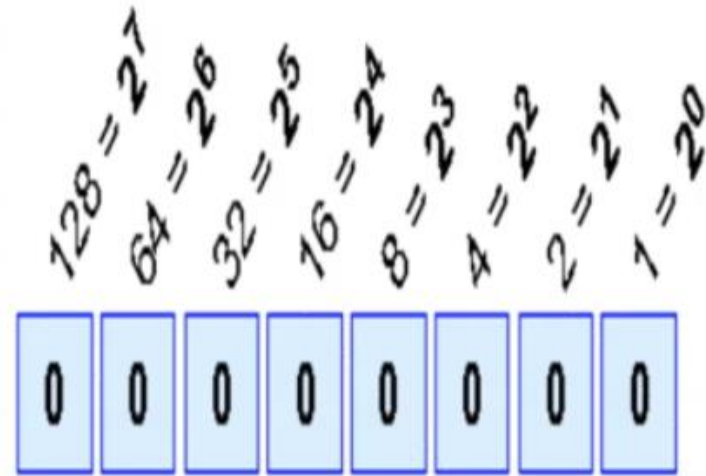
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| Decimal (Base 10) | Binary (Base 2) |
|-------------------|-----------------|
| 0 | 0000 0000 |
| 1 | 0000 0001 |
| 2 | 0000 0010 |
| 3 | 0000 0011 |
| 4 | 0000 0100 |
| 5 | 0000 0101 |
| 6 | 0000 0110 |
| 7 | 0000 0111 |
| 8 | 0000 1000 |
| 9 | 0000 1001 |
| 10 | 0000 1010 |
| 11 | 0000 1011 |
| 12 | 0000 1100 |
| 13 | 0000 1101 |
| 14 | 0000 1110 |
| 15 | 0000 1111 |
| 16 | 0001 0000 |

Worksheet - Convert From Binary or Decimal

Convert the Following Binary Numbers:

$$\mathbf{11011} = \underline{\hspace{2cm}}$$

$$\mathbf{00011011} = \underline{\hspace{2cm}}$$

$$\mathbf{11101010} = \underline{\hspace{2cm}}$$

$$\mathbf{01111101} = \underline{\hspace{2cm}}$$

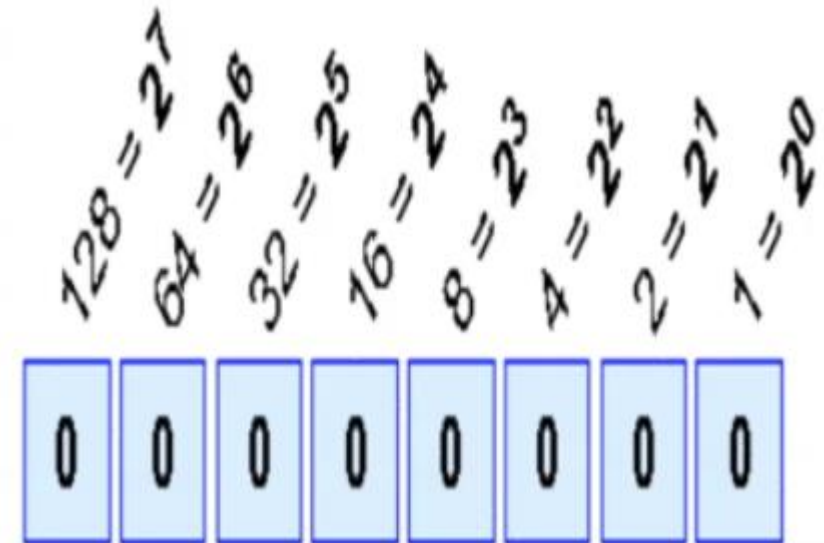
$$\mathbf{10101011} = \underline{\hspace{2cm}}$$

$$\mathbf{10101010} = \underline{\hspace{2cm}}$$

Extra Credit

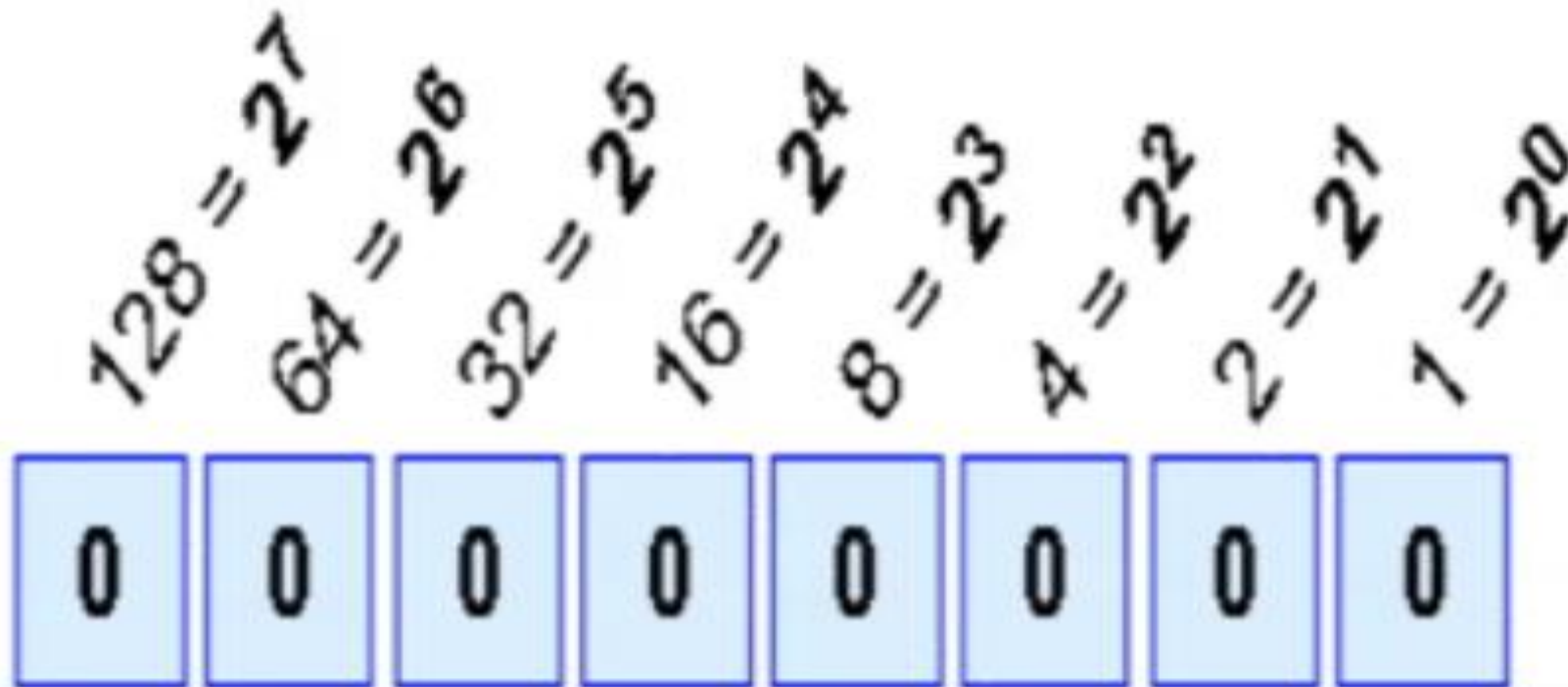
$$\mathbf{111110101011} = \underline{\hspace{2cm}}$$

Show Your Work



Place Values

Remember the Place Value



Place Values

Squeaky Hinge

Appendix

Extra Credit

All Six Cards

| | | | | | | | |
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Worksheet - Convert From Binary or Decimal

Show Your Work



Convert the Following Binary Numbers:

$$\mathbf{11011} = \underline{\quad 27 \quad}$$

$$\mathbf{00011011} = \underline{\quad 27 \quad}$$

$$\mathbf{11101010} = \underline{\quad 234 \quad}$$

$$\mathbf{01111101} = \underline{\quad 125 \quad}$$

$$\mathbf{10101011} = \underline{\quad 171 \quad}$$

$$\mathbf{10101010} = \underline{\quad 170 \quad}$$

$$16+8+0+2+1$$

$$0+0+0+16+8+0+2+1$$

$$128+64+32+0+8+0+2+0$$

$$0+64+32+16+8+4+0+1$$

$$128+0+32+0+8+0+2+1$$

$$128+0+32+0+8+0+2+0$$

Extra Credit

$$\mathbf{111110101011} = \underline{\quad 4011 \quad}$$

$$2048+1024+512+256+128+0+32+0+8+0+2+1$$

Bits and Bytes?

- How does a computer count?
- It Uses The Binary (Base 2) number system?

You See the Number 3, The Computer Sees 0011

- Bits, Bytes, Words

$41_{10} = 0010\ 1001$
 $254_{10} = 1111\ 1110$
 $255_{10} = 1111\ 1111$
 $256_{10} = 0001\ 0000\ 0000$
└──────────┘
2 BYTES

BIT
 ↓
 0000 0000 0010 1001
└──────────┘
BYTE = 4 Bits
└──────────┘
WORD = 2 BYTES


 Int (Integer) = 2 BYTES

| Decimal (Base 10) | Binary (Base 2) | Hex (Base 8) |
|-------------------|-----------------|--------------|
| 0 | 0000 0000 | 0 |
| 1 | 0000 0001 | 1 |
| 2 | 0000 0010 | 2 |
| 3 | 0000 0011 | 3 |
| 4 | 0000 0100 | 4 |
| 5 | 0000 0101 | 5 |
| 6 | 0000 0110 | 6 |
| 7 | 0000 0111 | 7 |
| 8 | 0000 1000 | 8 |
| 9 | 0000 1001 | 9 |
| 10 | 0000 1010 | A |
| 11 | 0000 1011 | B |
| 12 | 0000 1100 | C |
| 13 | 0000 1101 | D |
| 14 | 0000 1110 | E |
| 15 | 0000 1111 | F |
| 16 | 0001 0000 | 10 |

Squeaky Hinge

Sources and References

Source Material & Credits

- Online Magic - http://avimagic.com/tricks/number_cards.php
- Binary Trick - [http://www.mathmaniacs.org/lessons/01-binary/Magic Trick/](http://www.mathmaniacs.org/lessons/01-binary/Magic%20Trick/)
- Work sheet - http://www.cse4k12.org/binary/magic_trick.html
- Magic Binary Cards - [http://www.northeastern.edu/seigen/11Magic/Binary/Magic binary cards.pdf](http://www.northeastern.edu/seigen/11Magic/Binary/Magic_binary_cards.pdf)
- Base 5 Number System – Basics - https://www.youtube.com/watch?v=qGi29E9q_f0
- Binary Number System - <https://www.mathsisfun.com/binary-number-system.html>