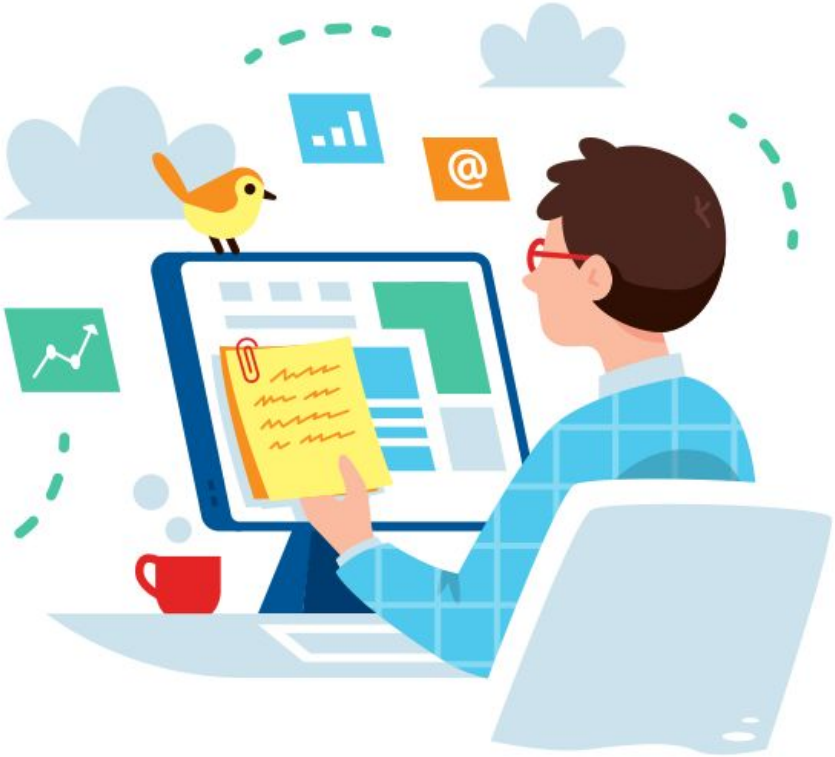
DEEP DIVING INTO BINARY

RECAP

How to expand a number system that has three digits - H, I, J?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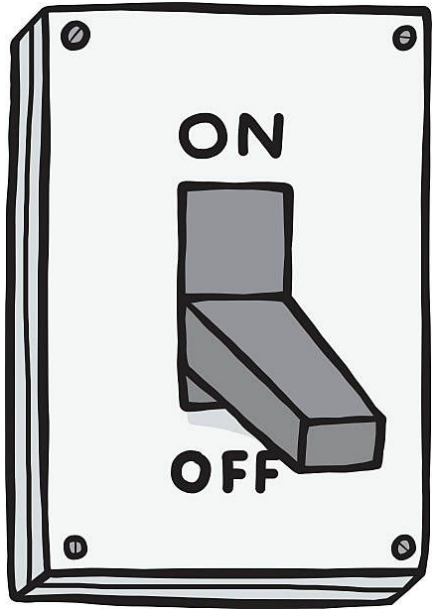

ON
OFF

A Computer understands only two symbols -

A Computer understands only two symbols -

0 1

The Binary System

```
for(i=0;i<20;i++)
{
print("This is my computer");
}
```

```
01100110 01101111 01110010 00101000 01101001 00111101 00110000
00111011 01101001 00111100 00110010 00110000 00111011 01101001
00101011 00101011 00101001 00001101 00001010 01111011 00100000
00001101 00001010 01110000 01110010 01101001 01101110 01110100
00101000 00100010 01010100 01101000 01101001 01110011 00100000
01101001 01110011 00100000 01101101 01111001 00100000 01100011
01101111 01101101 01110000 01110101 01110100 01100101 01110010
00100010 00101001 00111011 00001101 00001010 01111101
```

Why don’t we give it instructions by entering only 0’s and 1’s?

PATTERN I - EVEN/ODD

DECIMAL	BINARY
2	1**0**
4	10**0**
6	11**0**
8	100**0**
10	101**0**

DECIMAL	BINARY
3	1**1**
5	10**1**
7	11**1**
9	100**1**
11	101**1**

Can you identify a pattern that can be observed over different binary numbers?

PATTERN II - POWER OF 2's

Number	1	2	4	8	16	32
Power of 2	2^0	2^1	2^2	2^3	2^4	2^5
Binary	1	10	100	1000	1000	100000

What pattern do you notice in the binary representation of numbers that are powers of two?

PRACTICE

Classify the following Binary numbers as even/odd.

1010	1001	110	1111	1110	10
1011	11110	1000	1	101	100

PATTERN III - DIGIT PLACES

	Binary			
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0

	Binary			
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1
16	1	0	0	0

What patterns do you notice in the last digit column?

What patterns do you notice in the second-last digit column?

	Binary			
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1
16	1	0	0	0

GUIDED PRACTICE

	Binary						
120	1	1	1	1	0	0	0
121	1	1	1	1	0	0	
122	1	1		1	0	1	
123	1	1	1		0		1
124	1		1	1	1		0
125	1	1	1	1		0	
126	1	1	1	1	1	1	0

PATTERN IV - THE LAST DIGIT

1010

In decimal, what number is this?

What number does it become if you remove the last digit?

PATTERN IV - THE LAST DIGIT

1100

This is the number 12

110

When we remove the last digit, it becomes 6.

IN ODD NUMBERS...

111

What number is this?

11

When we remove the last digit, what does it become?

SUMMARY

EVEN

Removing last digit gives us the half.

ODD

Removing last digit gives the integer of it's half.

What happens if we ADD '0' or '1' as a last digit in each cases?

GUIDED PRACTICE

Match the given numbers in Column ‘A’ with their halves in Column ‘B’

COLUMN ‘A’	COLUMN ‘B’
1. 101010	a. 100100
2. 1001000	b. 100001
3. 1000010	c. 10101
4. 1100110	d. 110011

CONVERT DECIMAL NUMBERS TO BINARY

CONVERT 156 TO BINARY

STEP 1 - KEEP DIVIDING THE NUMBER BY 2 TILL NUMBER IS NO LONGER DIVISIBLE.

STEP 2 - FOR EVERY STEP NOTE DOWN THE REMAINDER IN A SEPERATE COLUMN

STEP 3 - ONCE THE DIVISION IS DONE, WRITE THE REMAINDER IN REVERSE ORDER

GUIDED PRACTICE

A. Let’s take another example - 139, and write it down in Binary together.

METHOD 2 - GREEDY METHOD

CONVERT 89 TO BINARY

128	64	32	16	8	4	2	1

Write '1' under the BIGGEST number that can fit inside 89

Subtract that number from 89

Repeat Steps 1 & 2 for the leftover number

We write 1 below 64

89 - 64 = 25

For 25, where will you put the next one?

128	64	32	16	8	4	2	1
	1						

Under 16

128	64	32	16	8	4	2	1
	1		**1**				

25 - 16 = 9

For 9, where will you put the next one?

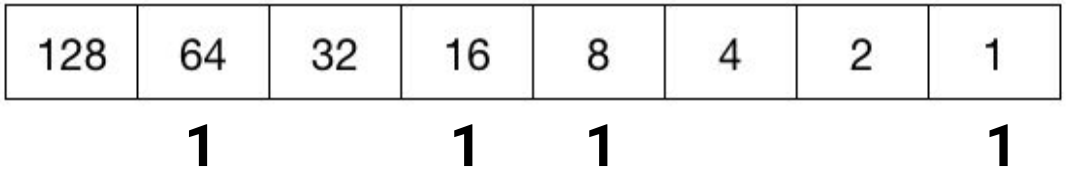
Under 8

128	64	32	16	8	4	2	1
	1		**1**	**1**			

9 - 8 = 1

For 1, where will you place the ‘1’ symbol?

Under 1



Fill up all the empty spaces with ‘0’ and this is your binary number

1011001

INDEPENDENT PRACTICE

Convert the following Decimal numbers to Binary numbers by Long division method

37	64	72	9	111

Convert 145 in Binary using the activity and not the long division method.

CONVERTING BINARY TO DECIMAL

Convert 10011011 to Decimal

Step 1 -Write the digits in a proper table and below each of them, we write the powers of two in a descending order

1	0	0	1	1	0	1	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

CONVERTING BINARY TO DECIMAL

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1	0	0	1	1	0	1	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

Step 2 - multiply each binary digit with the corresponding power of two.

1	0	0	1	1	0	1	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
$1x2^7$	$0x2^6$	$0x2^5$	$1x2^4$	$1x2^3$	$0x2^2$	$1x2^1$	$1x2^0$

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1	0	0	1	1	0	1	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
$1x2^7$	$0x2^6$	$0x2^5$	$1x2^4$	$1x2^3$	$0x2^2$	$1x2^1$	$1x2^0$

Step 3 - Sum up all the products we get in the multiplication step.

(1x128) + (0x64) + (0x32) + (1x16) + (1x8) + (0x4) + (1x2) + (1x1) = **155**

GUIDED PRACTICE

Step 1 -Write the digits in a proper table and below each of them, we write the powers of two in a descending order

Step 2 - multiply each binary digit with the corresponding power of two.

Step 3 - Sum up all the products we get in the multiplication step.

Convert 10100110 to decimal

INDEPENDENT PRACTICE

Convert the following to Binary

1101101	11000	1100011

Correctly fill up the missing gaps

1. 150 - 1 0 _ _ 0 1 _ 0
2. 144 - 1 0 _ 1 0 _ _ 0
3. 167 - 1 0 _ 0 _ 1 _ 1