

# Number Systems

# Review

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## PEMDAS

- Parentheses
- Exponents (Square root, Squares etc)
- Multiplication
- Division
- Addition
- Subtraction

# Review

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$$(15 \div 3 + 4) - (3^2 - 7 \times 2)$$

Option 1:  $(15 \div 7) - (2 \times 2)$

Option 2:  $(5 + 4) - (9 - 14)$

Option 3:  $(15 \div 7) - (6 - 14)$

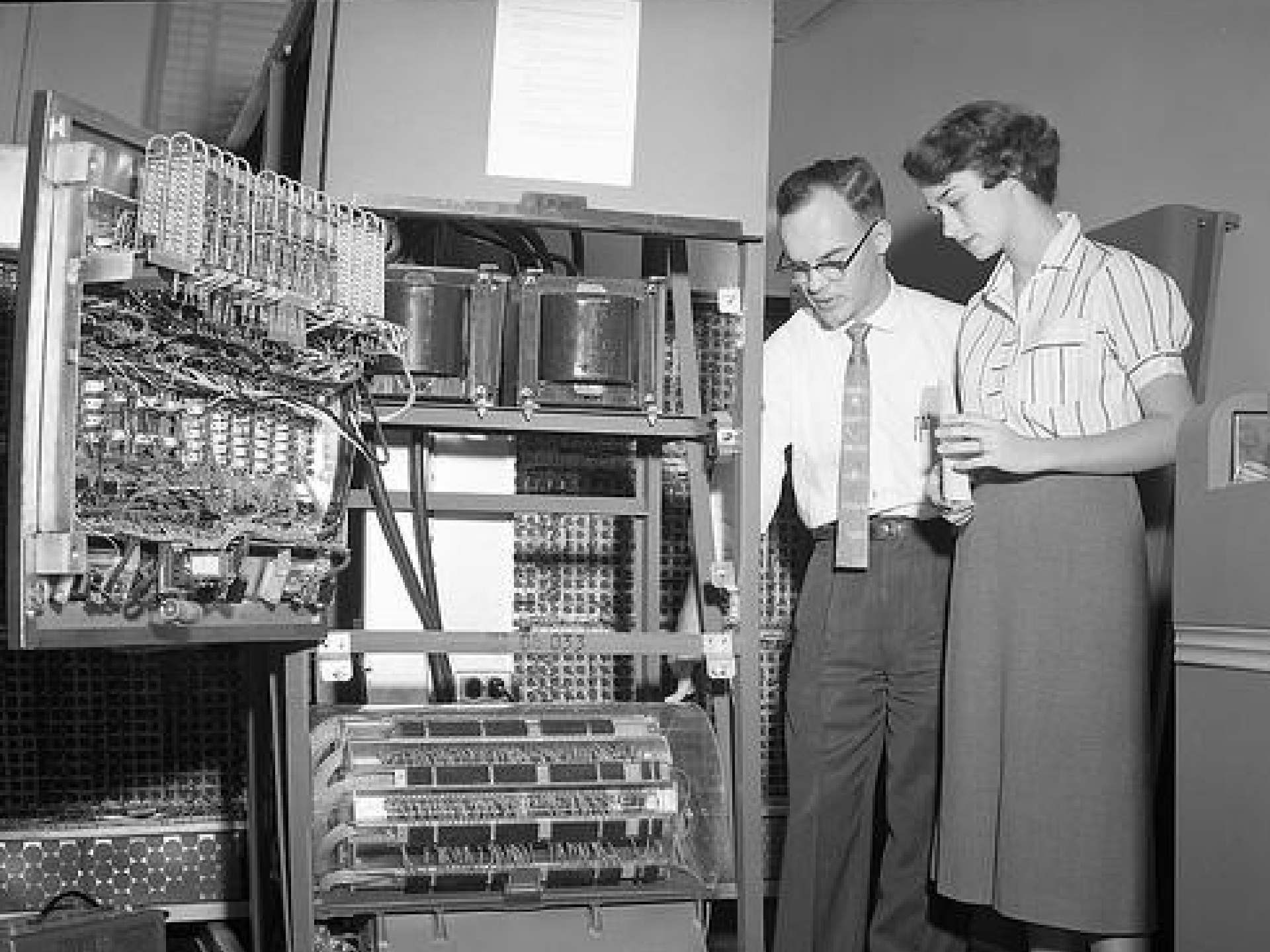
Option 4:  $(5 + 4) - (2 \times 2)$

# Review

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111 x 111

		111
	x	111
		<hr/>
		111
		111x
		111xx
		<hr/>
		12321



# Processing Data

Five senses

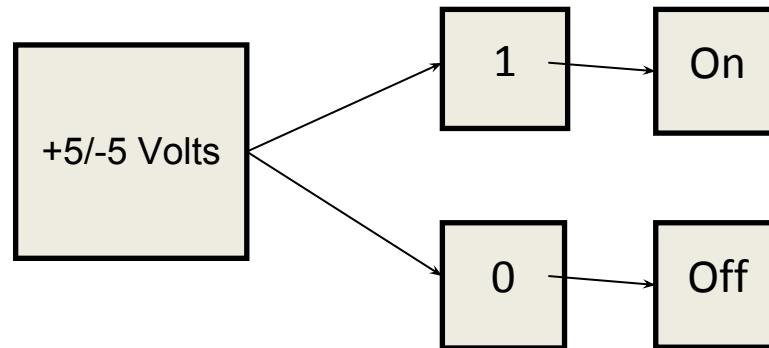
A diagram illustrating the process of data processing in the brain. A central blue brain is shown with numerous glowing blue lines radiating from it, representing neural connections. Two large white arrows with black outlines are positioned horizontally. The left arrow points towards the brain and is labeled 'Five senses'. The right arrow points away from the brain and is labeled 'Converted to electrical signals in the brain'. The background is dark with some glowing blue points and lines, suggesting a digital or neural network environment.

Converted to  
electrical signals in  
the brain

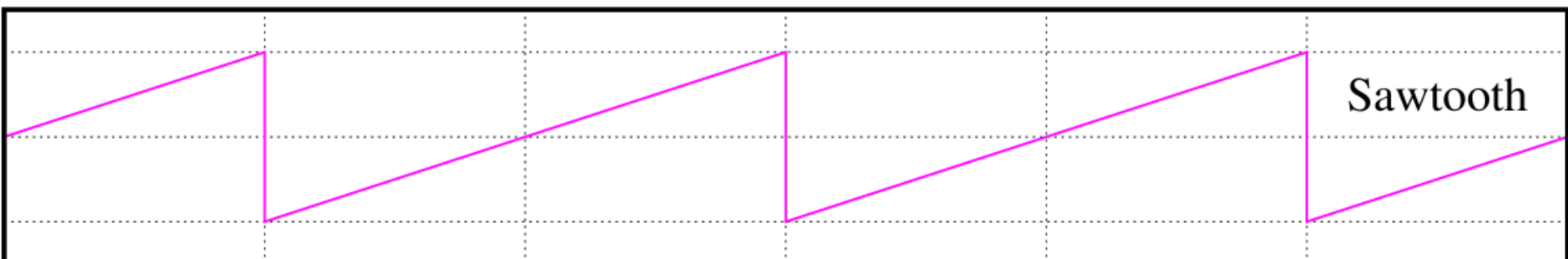
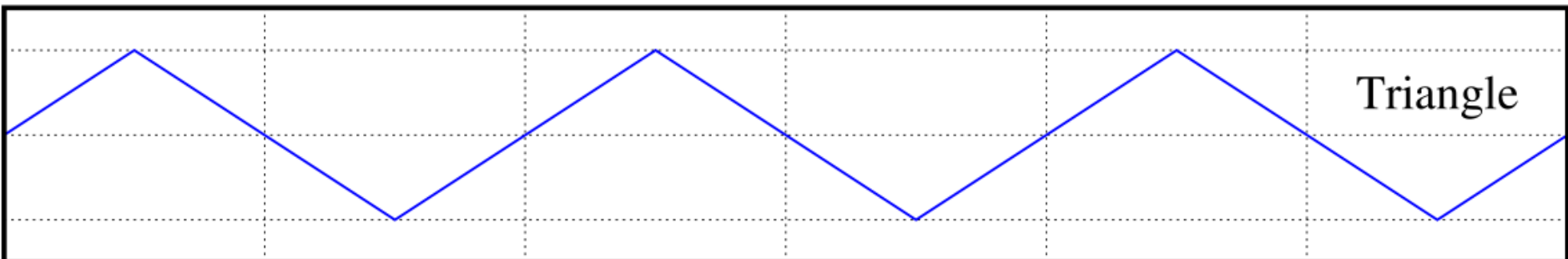
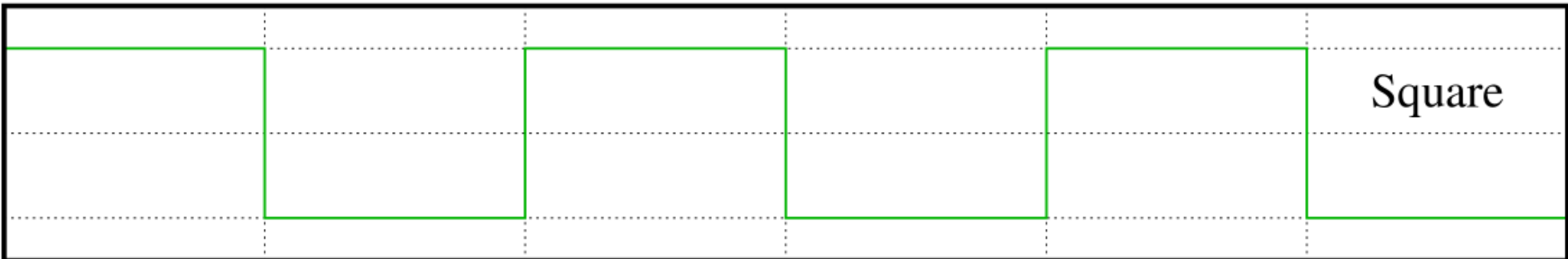
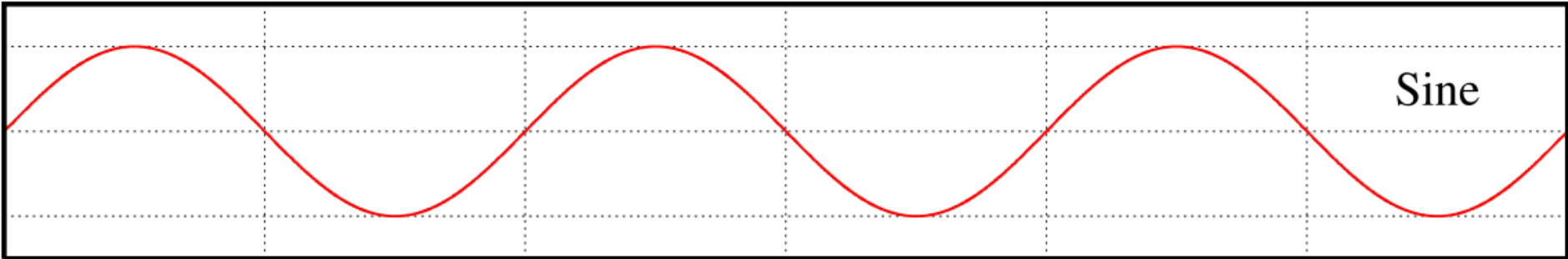
# How do machines process data

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Machines interpret electrical signals as 1s and 0s – **binary digits** or **bits**



Data in computers are represented by bits





# Numbers

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Natural Numbers

Integers

Negative Numbers

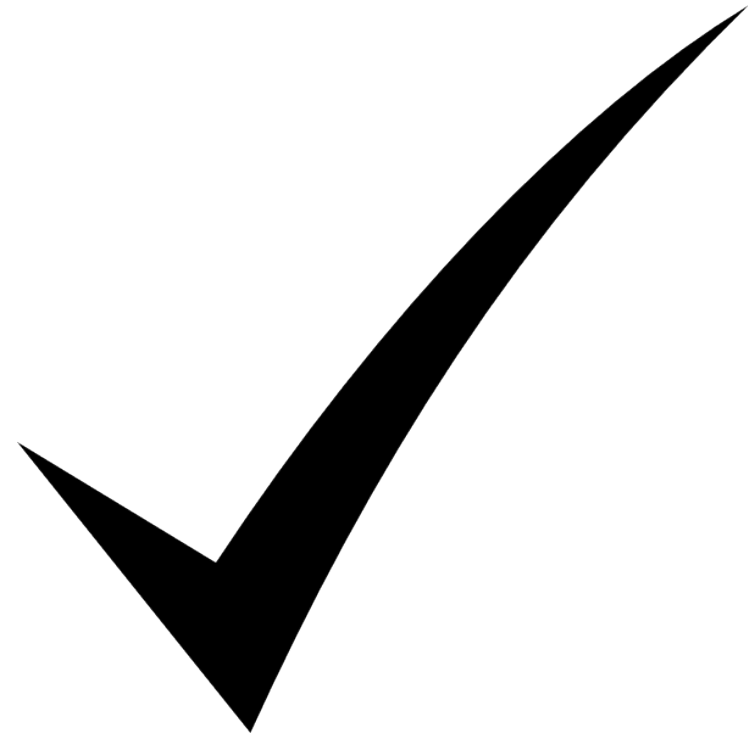
Rational Numbers

Irrational Numbers

But what is a **number**?

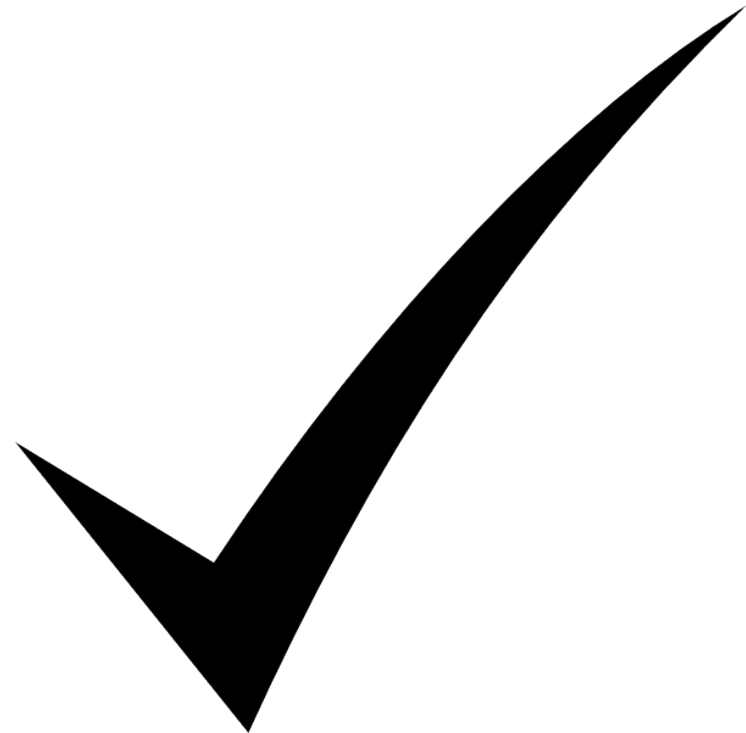
$$1 + 1 = 2$$

$$1 + 1 = 2$$



$$1 + 1 = 10$$

$$1 + 1 = 10$$





# Numbers

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Numbers are written using positional notation

Arranging and encoding numbers in succession

Every number system has a base

# Numbers

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Base dictates the value of position



# Numbers

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11

# Decimal number system

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943<sub>10</sub>



$10^4$   $10^3$   $10^2$   $10^1$   $10^0$   
                  **9**   **4**   **3**



$$\begin{aligned} &10^2 \times \mathbf{9} + 10^1 \times \mathbf{4} + 10^0 \times \mathbf{3} \\ &= \mathbf{100} \times \mathbf{9} + \mathbf{10} \times \mathbf{4} + \mathbf{1} \times \mathbf{3} \\ &= 900 + 40 + 3 = 943_{10} \end{aligned}$$

# Binary number system

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111<sub>2</sub>



2<sup>4</sup> 2<sup>3</sup> 2<sup>2</sup> 2<sup>1</sup> 2<sup>0</sup>

1 1 1



$$2^2 \times 1 + 2^1 \times 1 + 2^0 \times 1$$

$$= 4 \times 1 + 2 \times 1 + 1 \times 1$$

$$= 4 + 2 + 1 = 7_{10}$$

Converted a  
binary number  
to a decimal  
number

# We can have other number systems!

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Octal – Base 8

Hexadecimal – Base 16

# Convert from Binary to Decimal

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1011<sub>2</sub>



2<sup>4</sup> 2<sup>3</sup> 2<sup>2</sup> 2<sup>1</sup> 2<sup>0</sup>

8 4 2 1

1 0 1 1



$$8 + 0 + 2 + 1 = 11_{10}$$

# Convert from Binary to Decimal

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11110001<sub>2</sub>



$2^7$	$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
128	64	32	16	8	4	2	1
1	1	1	1	0	0	0	1



$$128 + 64 + 32 + 16 + 0 + 0 + 0 + 1 = 241_{10}$$

# Your turn

Convert  $101011_2$  to a decimal number

*Please show all steps!*

*To aid you:*

$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
64	32	16	8	4	2	1

# Convert from Decimal to Binary

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93<sub>10</sub>



$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
64	32	16	8	4	2	1
1	0	1	1	1	0	1



Verify

$$64 \times 1 + 16 \times 1 + 8 \times 1 + 4 \times 1 + 1 \times 1 = 93$$



# Your turn

Convert  $56_{10}$  to a binary number

*Please show all steps!*

*To aid you:*

$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
64	32	16	8	4	2	1

# Binary Addition

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- Informal rules..

$$1 + 0 = 1_2$$

$$0 + 1 = 1_2$$

$$1 + 1 = 10_2$$

$$1 + 1 + 1 = 11_2$$

$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
64	32	16	8	4	2	1

# Binary Addition

$$\begin{array}{r} \phantom{+} 10110 \\ + 10111 \\ \hline 101101 \end{array}$$

$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
64	32	16	8	4	2	1

$$\begin{array}{r} \phantom{+} 1011 \\ + 111 \\ \hline 101101 \end{array}$$

# Your turn

Add  $101_2 + 111_2 + 011_2$

*Please show all steps!*

*To aid you:*

$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
64	32	16	8	4	2	1



# Your turn

Multiply  $111_2 \times 111_2$

*Please show all steps!*

*To aid you:*

$2^6$	$2^5$	$2^4$	$2^3$	$2^2$	$2^1$	$2^0$
64	32	16	8	4	2	1