

# General License Course

## Metric System and Math Review

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What we will look at:



# What we will look at:

- \* **Metric system review**

- \* MHz, kHz, Hz

- \* **Adding or removing zeros**

- \*  $1230.45 = 00001230.450000$

- \* **Equations**

- \* Variables and constants
- \* Math operators ( + - x ÷ )
- \* Squaring and square roots
- \* Logarithms

- \* **Powers of 10**

- \*  $10^3$   $10^6$

- \* **Numbers expressed as fractions or decimals**

- \*  $\frac{3}{4} = 0.75$

- \* **Negative numbers**

# The Metric System

**Table 2-1**

**International System of Units (SI)—Metric Units**

<i>Prefix</i>	<i>Symbol</i>	<i>Multiplication Factor</i>
Tera	T	$10^{12} = 1,000,000,000,000$
Giga	G	$10^9 = 1,000,000,000$
Mega	M	$10^6 = 1,000,000$
Kilo	k	$10^3 = 1000$
Hecto	h	$10^2 = 100$
Deca	da	$10^1 = 10$
Deci	d	$10^{-1} = 0.1$
Centi	c	$10^{-2} = 0.01$
Milli	m	$10^{-3} = 0.001$
Micro	$\mu$	$10^{-6} = 0.000001$
Nano	n	$10^{-9} = 0.000000001$
Pico	p	$10^{-12} = 0.000000000001$

# A Quick Look at the Metric System

- \* **The metric system is a shorthand for expressing numbers, particularly useful for:**
  - \* Very large numbers
  - \* Very small numbers
- \* **Examples:**
  - 1 meter = 1 m
  - 1000 meters = 1 kilometer = 1 km
  - 16000 meters = 16 kilometers = 16 km
  - 1,000, 000 meters = 1 Megameters = 1 Mm
  - kilo is like multiplying by 1000
  - Mega is like multiplying by 1,000,000

# The Important Ones

Prefix - Abbreviation	Meaning	Number	Power of Ten
Giga - <b>G</b>	One billion	1,000,000,000	$10^9$
Mega - <b>M</b>	One million	1,000,000	$10^6$
Kilo - <b>k</b>	One thousand	1,000	$10^3$
Hecta-	One hundred	100	$10^2$
Deca	Ten	10	$10^1$
(none)	<b>Basic unit</b>	1	$10^0$
Deci-	One tenth	0.1	$10^{-1}$
Centi-	One hundredth	0.01	$10^{-2}$
Milli - <b>m</b>	One thousandth	0.001	$10^{-3}$
Micro - <b>u</b>	One millionth	0.000001	$10^{-6}$
Nano - <b>n</b>	One billionth	0.000000001	$10^{-9}$
Pico - <b>p</b>	One trillionth	0.000000000001	$10^{-12}$

# Moving the Decimal Point

- \* All numbers have decimals points
- \*  $3 = 3. = 3.0 = 3.00 = 3.000000 = 000000003.$
- \* The Metric System lets us move the decimal point to the left or to the right make the number easier to write.
  - $4000. = 4.\overset{\leftarrow}{000}k = 4.k = 4k$
  - **k** means we moved the decimal point 3 places to the left
  - $6,000,000. = 6M$
  - **M**  $\overset{\leftarrow}{000,000}$  means we moved the decimal point 6 places to the left

# Metric System Usage

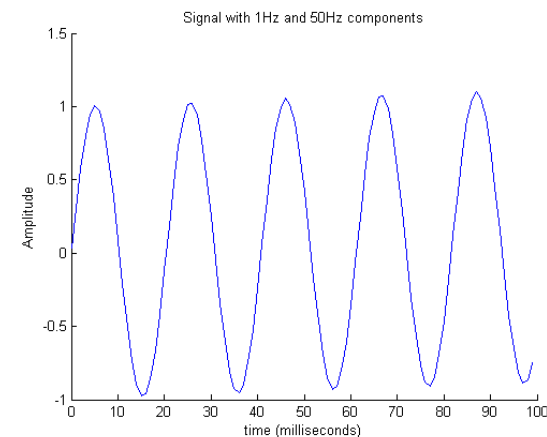
- Very large numbers (300 million meters)
- Very small numbers (2 millionths of a second)
- Common Units of Measure: Meter, gram, liter
- Electronics: Hertz, Ohm, Farad, Henry, seconds



# Moving the Decimal Point

## - Very Large Numbers -

- $6,000,000. = 6000k = 6M$
- $6,450,000. = 6.45M$
  
- Hertz (Hz) is a unit of measure for frequency
  - **28 MHz**
  - = 28,000,000 Hz
  - = 28,000 kH



# Moving the Decimal Point

## - Very Small Numbers -

➤ Light travels at the speed of 300,000,000 meters every second.

➤ Or 186000 miles per second

How long does it take a radio signal to travel 300m (about 1000 ft)?

➤ A radio wave will travel a distance of about 300m in about one millionth of a second.

➤ Expressed mathematically:

➤ 0.000001 s

➤ Moving the decimal point to the right 6 places

➤ 0.000001s

➤ 1s



# The Important Ones

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**G M k -- m u n p**  
**Good Men know -- many useful national proverbs**

# Adding or Removing Zeros

\*  $3 = 3. = 3.0 = 3.00 = 3.000000 = 000000003.$

\*  $1230.45 = 000001230.45 = 1230.4500000 = 00001230.4500000$

\*  $00001230.4500000$

\* We can not add or remove zeros within the significant figures

Significant Figures

\*  $67800.0$  The Decimal point can be thought of as part of the significant figure

\* We can not add or remove zeros within the significant figures

Significant Figures

$0.0987$

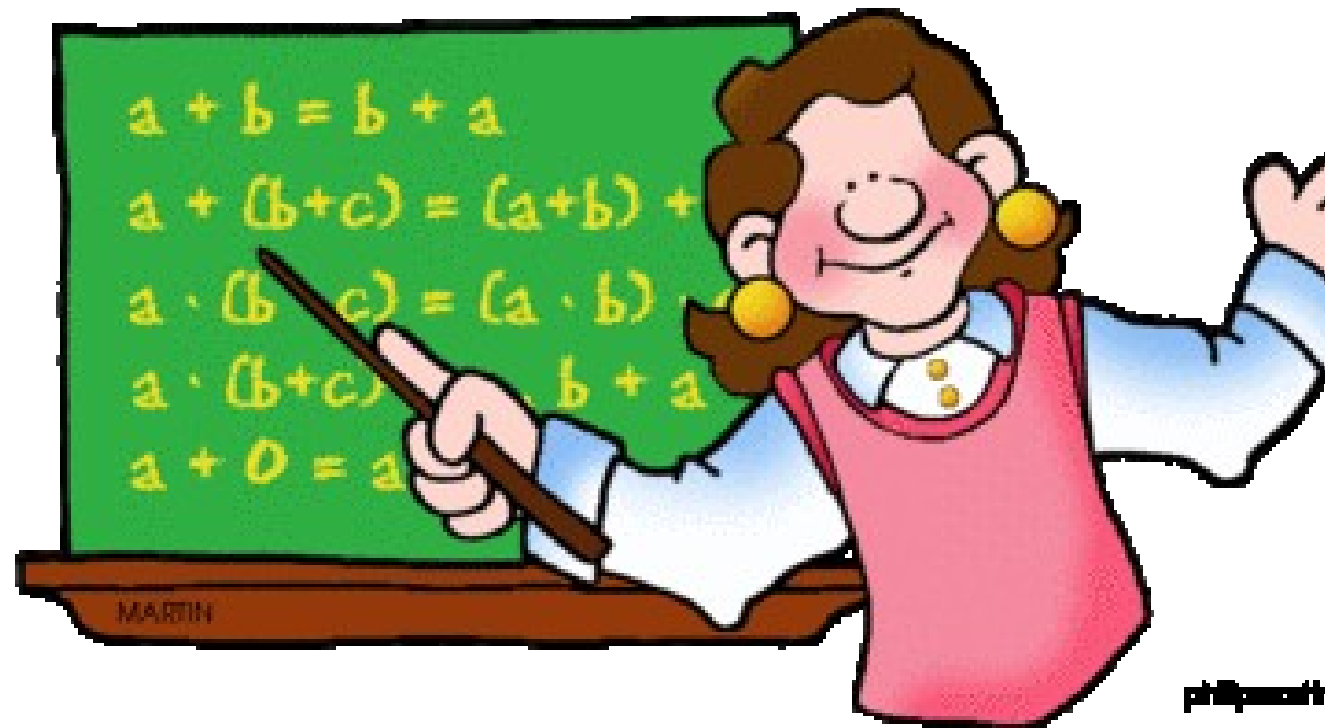
Significant Figures

# Remember your school days?

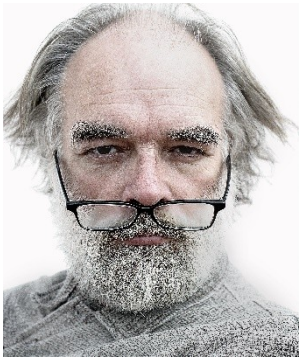
English Class!



Math class!



# Let's Make a Simple Equation



Old Man



Young Lady

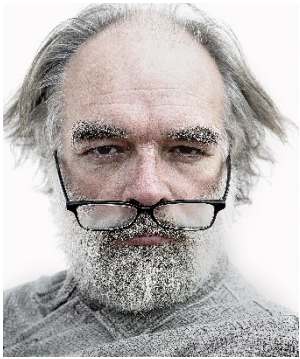
\* Total Participants = OM students + YL students + Instructors

$$* P_T = S_{OM} + S_{YL} + I$$

↑   ↑   ↑  
Variables

Subscript

# Let's Make Use of the Simple Equation



Old Man



Young Lady

$$P_T = S_{OM} + S_{YL} + I$$

$$P_T = 8 + 4 + 5$$

$$P_T = 17$$

# Variables and Constants

- \*  $\lambda = c/f$

- \*  $\lambda = 300 / f$   $\lambda = 300 / 146 \text{ MHz}$

- \*  $\lambda = 2.05 \text{ meters}$

- $\lambda$  is the wavelength (Distance in meters covered by 1 cycle)
- $c$  (constant). The speed of light is 300 million meters per second
- $f$  is a variable, in this case the frequency is expressed in MHz

# Math Vocabulary (Operators)

- \* Addition:  $+$ 
  - \* Example:  $5 + 3$
- \* Subtraction:  $-$ 
  - \* Example:  $5 - 3$
- \* Multiplication:  $\times$  ;  $*$  ; **R1 R2**
  - \* Examples:  $5 \times 3$  ;  $5 * 3$
- \* Division:  $\div$  ;  $/$  ;  $\frac{\quad}{\quad}$ 
  - \* Examples:  $5 \div 3$  ;  $5/3$  ;  $\frac{5}{3}$

- \* Equal:  $=$ 
  - \* Example:  $5 = 5$

MC	MR	M+	M-	MS	M <sup>+</sup>
%	$\sqrt{\quad}$	$x^2$		$1/x$	
CE	C	$\leftarrow \boxtimes$		$\div$	
7	8	9		$\times$	
4	5	6		$-$	
1	2	3		$+$	
$\pm$	0	.		$=$	

# Other Math Operations

## \* Square: $E^2$

\* This means:  $E \times E$

\* Example:  $E = 5$

$5^2$

Five squared  
Five to the second power

\* Example:  $5 \times 5 = 25$

## \* Square root: $\sqrt{E}$

\* Examples:  $E = 9$

\*  $\sqrt{9} = 3$

\*  $9 = 3 \times 3$

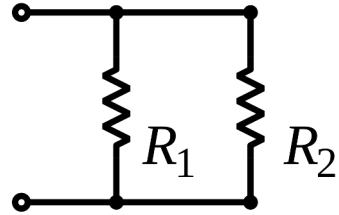
## Reciprocals:

$$\frac{1}{E} \quad E = 10 \quad \frac{1}{10} = 0.1$$

MC	MR	M+	M-	MS	M*
%	$\sqrt{\quad}$	$x^2$	$\frac{1}{x}$		
CE	C	$\langle \boxtimes \rangle$	$\div$		
7	8	9	$\times$		
4	5	6	-		
1	2	3	+		
$\pm$	0	.	=		

# Chapter 4's Math

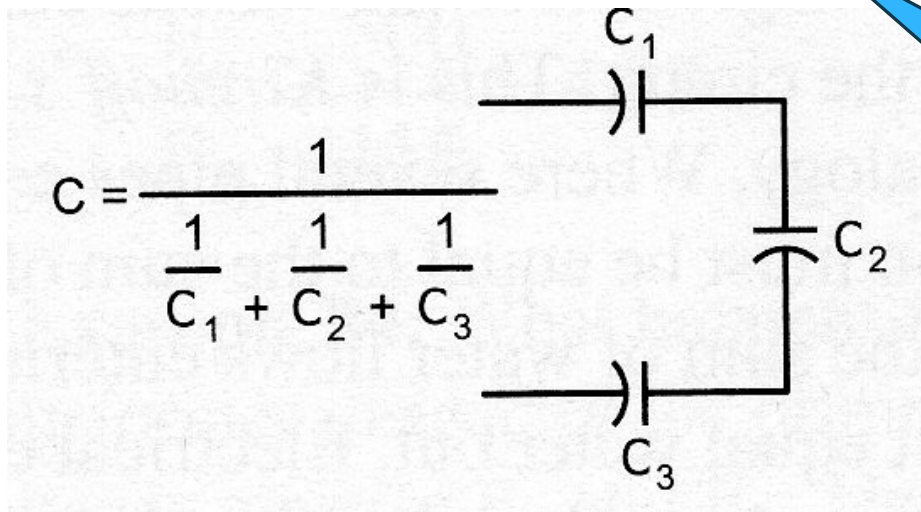
$$* R_{\text{EQU}} = \frac{R1 \times R2}{R1 + R2}$$



## Logarithmic Functions

### \* Decibel Formula

$$* C_{\text{EQU}} = 1 / (1/C1 + 1/C2 + 1/C3)$$

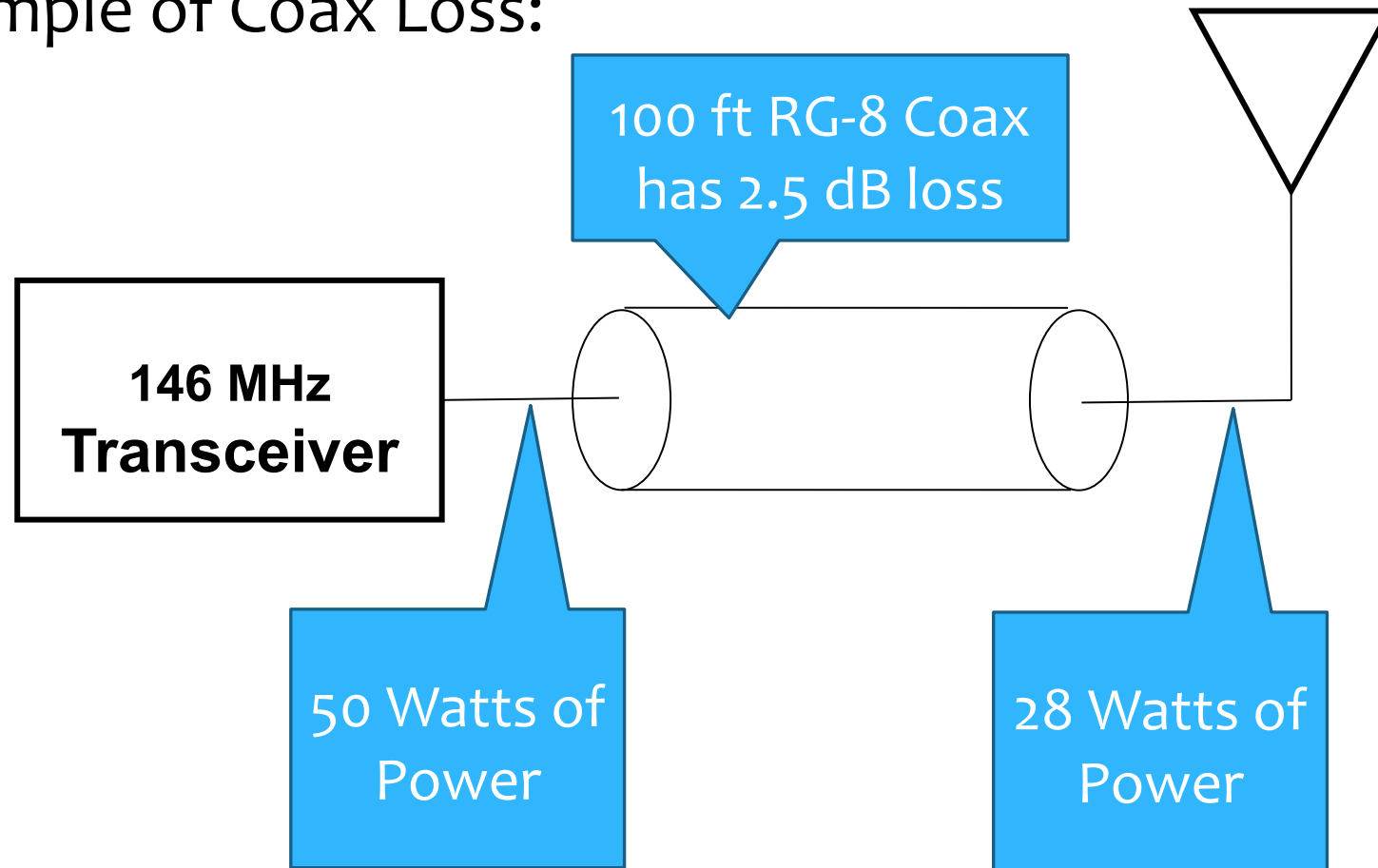


$$\text{dB} = 10 \log_{10} \left( \frac{P_{\text{MEAS}}}{P_{\text{REF}}} \right) = 20 \log_{10} \left( \frac{V_{\text{MEAS}}}{V_{\text{REF}}} \right)$$

Perform the calculations  
in ( ) first

# Coax Feed Lines Loss

Example of Coax Loss:



# The Decibel Formula Uses Several More Advanced Math Concepts

$$P_1 = 28 \text{ W}$$

$$P_2 = 50 \text{ W}$$

$$\text{dB} = 10 \log(P_1/P_2)$$

$$\text{dB} = 10 \log(28/50)$$

$$\text{dB} = 10 \log(0.56)$$

$$\text{dB} = 10 (-0.2518)$$

$$\text{dB} = -2.518$$

or about -2.5 dB

Scientific  
Calculator



# Logs!

- \* Logarithms (logs for short) are math techniques for handling very large and very small numbers within the same formula without losing resolution.
- \* **Logs are not trivial math techniques** and it is going to take some thought, patience, and practice to master the use of logarithms.

$$\log_{10} N = L$$

Scientific  
Calculator



# Linear vs. Logarithmic Scale



# Decimal Numbers

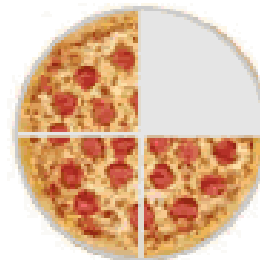
Decimal numbers tend to be used in electronics:

\* Fraction:  $\frac{1}{2}$

\* Decimal: .5 or 0.5

\*  $\frac{1}{2} = .5$  or 0.5

$$\frac{1}{4} = 0.25$$
$$\frac{3}{4} = 0.75$$



$$\frac{3}{4}$$

← Numerator

← Denominator

# Decimal Numbers

It is common for a rain gauge to divide each inch up into 10 sections, with each division the same size.

- \* Each division represents  $\frac{1}{10}$  (0.1) of an inch
- \* The green arrow marks five 0.1" divisions, or **0.5"**
- \* The purple arrow marks two full inches plus four 0.1" divisions, or **2.4** inches.



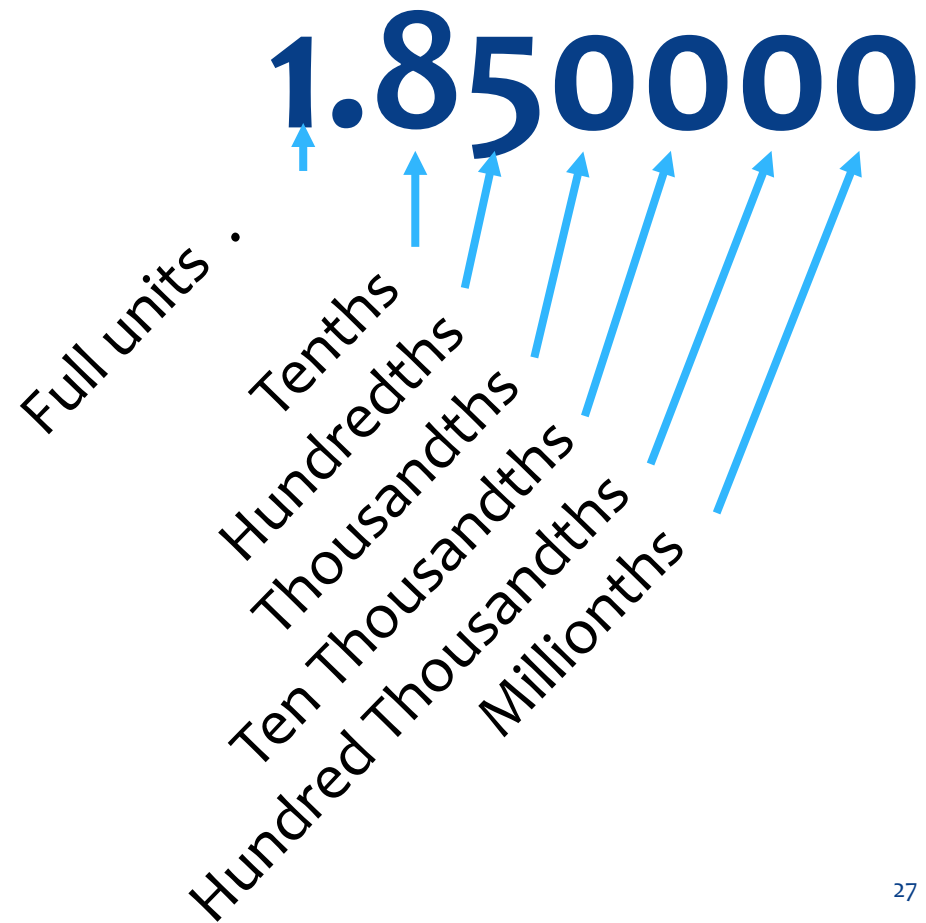
# Decimal Numbers

Although the rain gauge may be divided into 0.1” divisions, many people will use their eye and their mind to subdivide each 0.1 division into 10 additional divisions. These smaller “imagined” divisions represent 0.01 inches, or  $1/100^{\text{th}}$  of an inch.

- \* The red arrow marks one full inch plus about 85 of the 0.01” divisions, or about **1.85** inches.

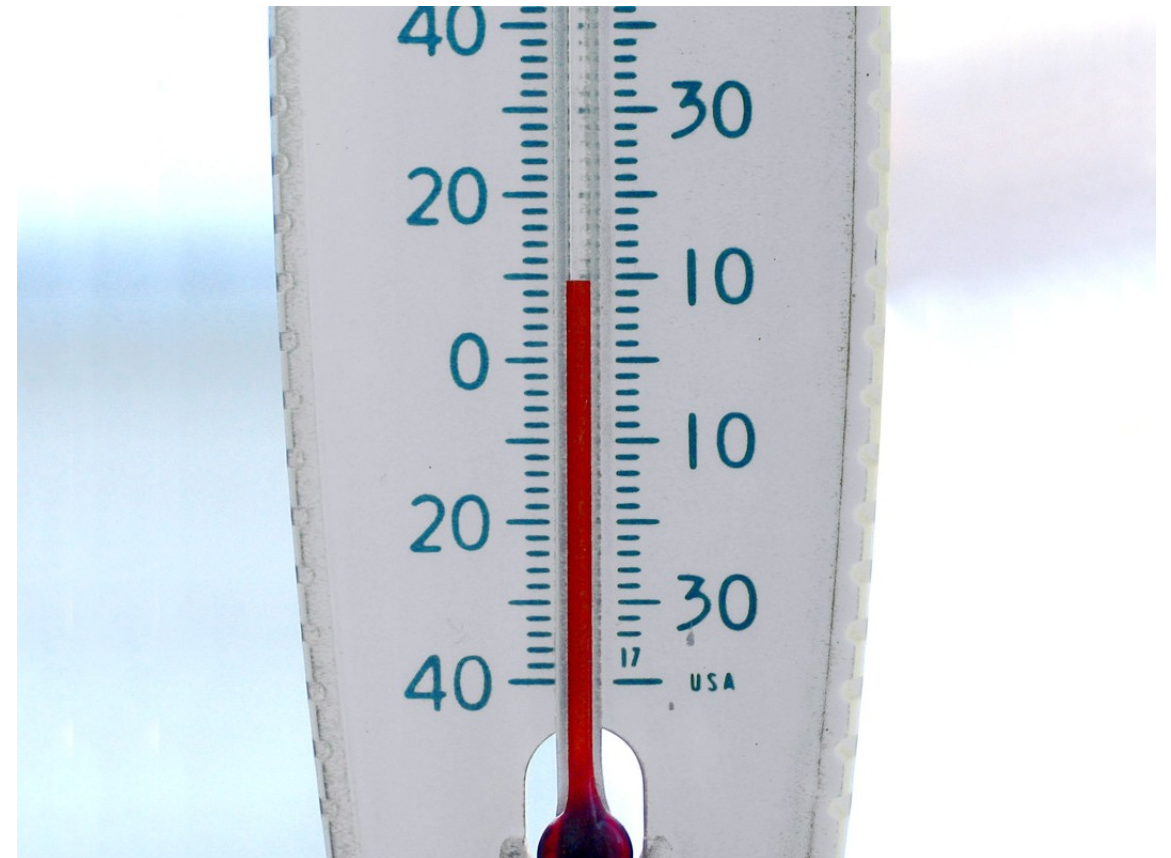


# Decimal Numbers



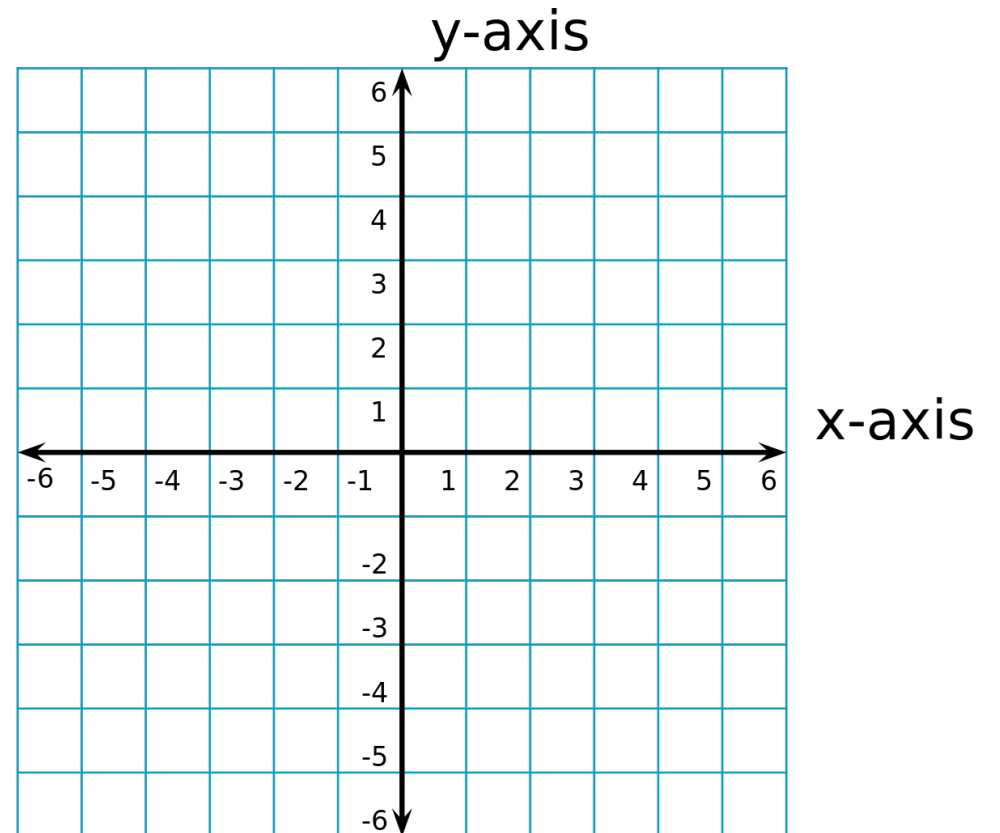
# Positive and Negative Numbers

- \* Positive counting: 1, 2, 3, 4, 5, 6, ...
- \* Negative counting: -1, -2, -3, -4, -5, -6, ...



# Positive and Negative Numbers

- \* Positive counting: 1, 2, 3, 4, 5, 6, ...
- \* Negative counting: -1, -2, -3, -4, -5, -6, ...



# Math

