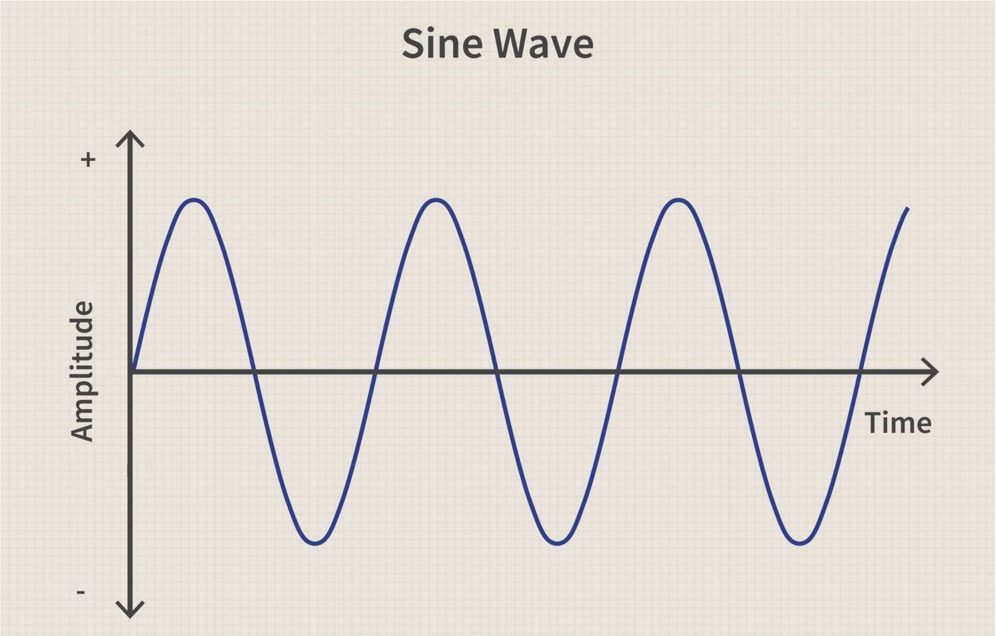
Sinusoidal waveforms

YORK COLLEGE & UNIVERSITY CENTRE

Sinusoidal Waveform

- A sinusoidal waveform oscillates smoothly between positive and negative values
- These sinusoidal waves are most used to display both amplitude and voltage
- Understanding Sinusoidal waveforms is very important for understanding AC power



Equation for a sinusoidal waveform

- The equation for a sinusoidal is:

  - $y(t) = A\sin(\omega t + \Phi)$

  - A = Amplitude of the wave
  - ω = Angular frequency, related to the wave's frequency/period
  - t = Time
  - θ = Phase angle, which determines the wave's horizontal displacement.

Converting between values

- Period/Wavelength:
  - We can convert between period and angular frequency using the equation:

$$\omega = \frac{2\pi}{T}$$

T = Period
ω = Angular Frequency

- Wave Speed:
  - We can work out the speed of a wave using frequency and wavelength:

$$v = f\lambda$$

f = Frequency
λ = Wavelength

- Frequency:
  - We can work out frequency from angular frequency using

$$\omega = 2\pi f$$

f = Frequency
ω = Angular Frequency

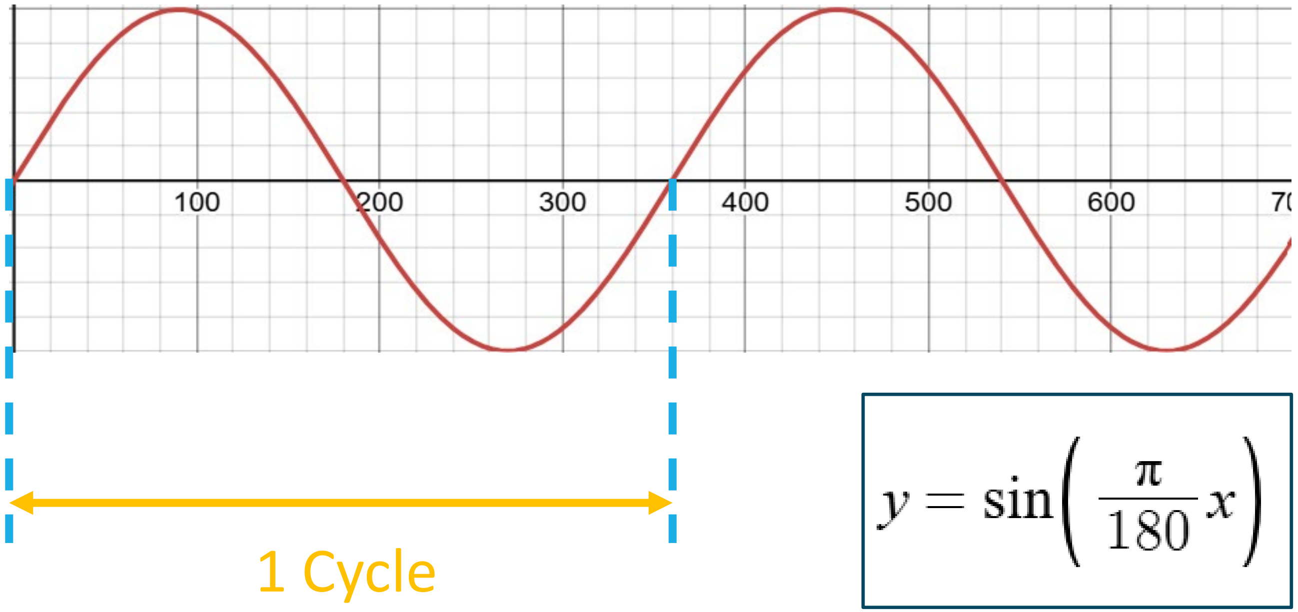
Understanding Sinusoidal waveforms

- A cycle is the section of the waveform from where the waveform starts to when it repeats itself

- The length of a cycle is affected by the **frequency** of the wave and thus affected by Angular frequency

- The length of a cycle will often be in radians rather than degrees, so you must convert it using pi/180

- 1 **Period/Wavelength** = the horizontal distance over which one complete cycle of the sine graph is completed

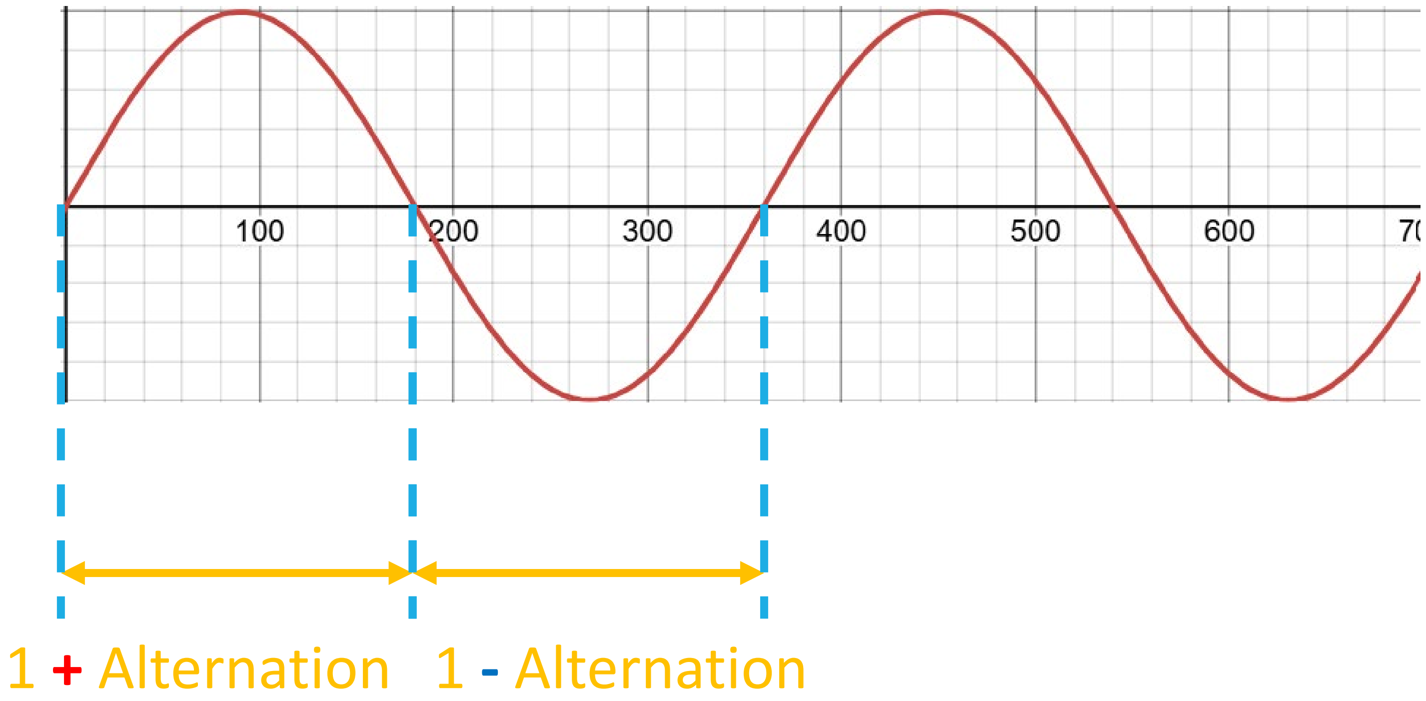


$$y = \sin\left(\frac{\pi}{180}x\right)$$

Equation to get this sine wave using degrees instead of radians

Understanding Sinusoidal waveforms

- An alternation is half of the cycle
- Alternations can be either positive or negative
- Both the length and height of an alteration are equal to all the other alternations

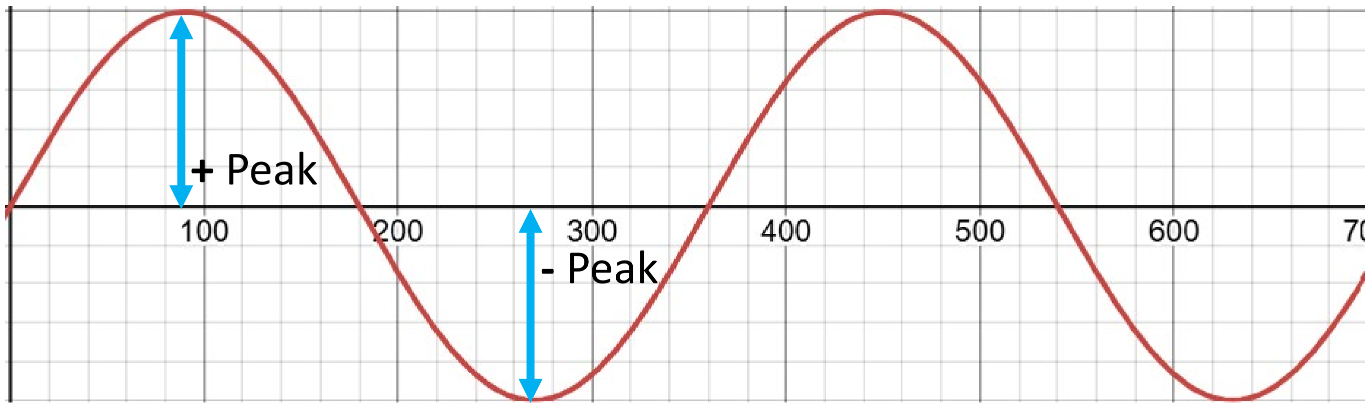


Understanding Sinusoidal waveforms

- A peak value is the top of the waveform it is determined by the **amplitude**

- At a peak, the conductor is creating the **most amount of voltage** that the circuit is going to get

- A **peak to peak** is the distance between the two peaks **in either way** so it's either the horizontal distance or 2*Peak

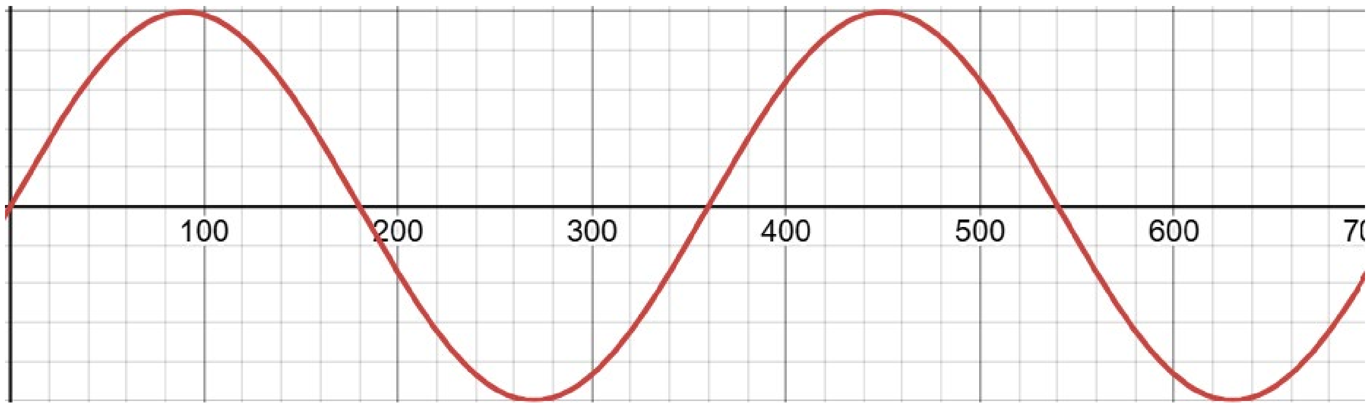


Understanding Sinusoidal waveforms

- An average is just the sum of all the values divided by the number of times you added them

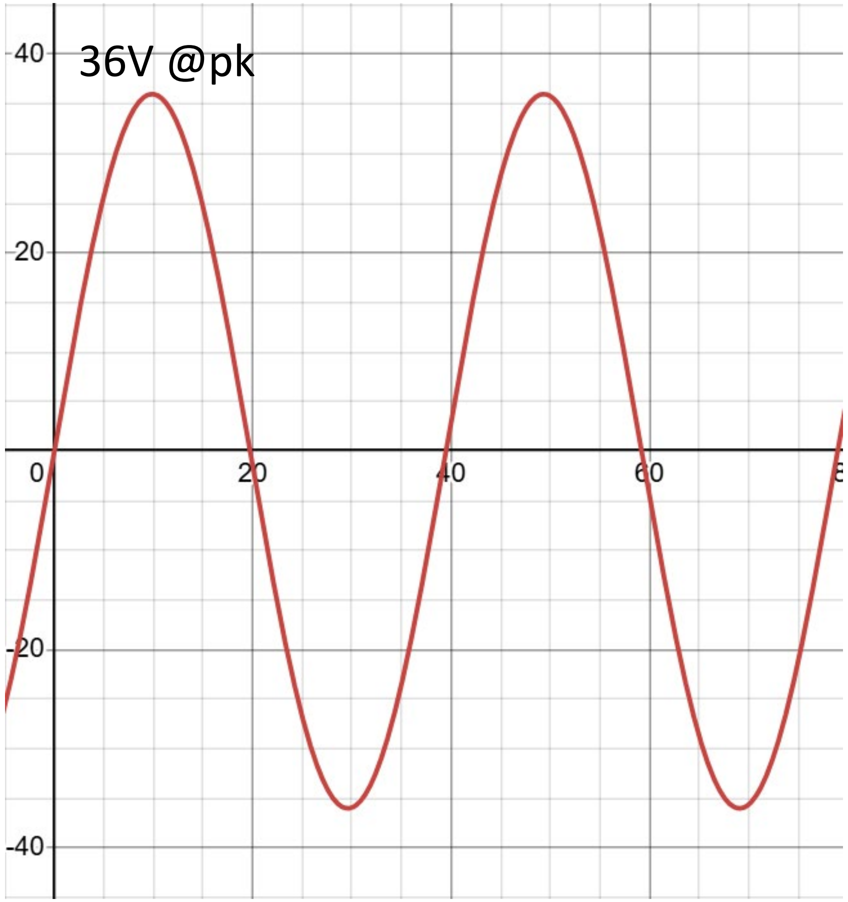
- With a full Cycle the average will be 0 as both the positive and negative alternation cancel out

- To work out the average of 1 alternation we do 0.637*Peak



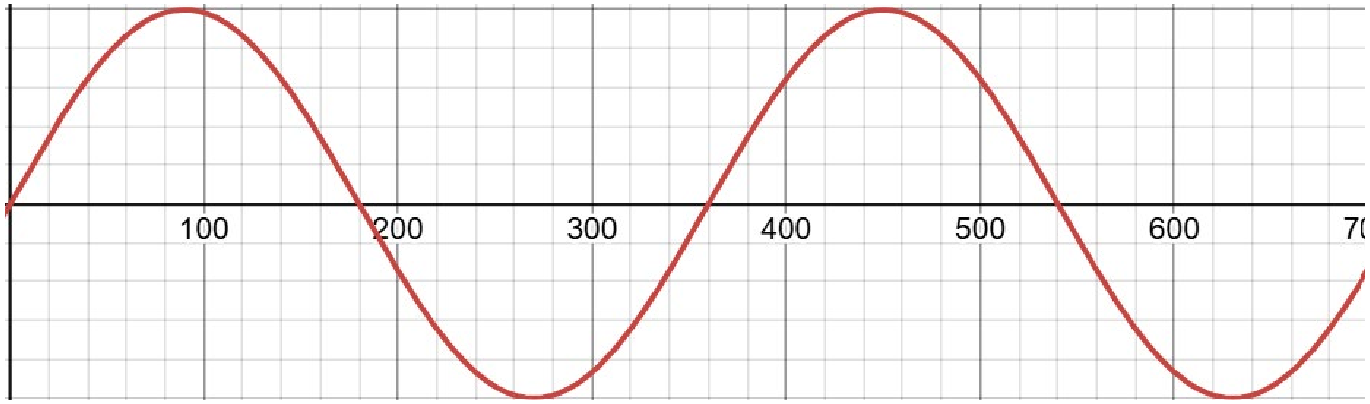
Example of calculating the average

- For the whole cycle, the average is 0
- For the first alteration the average is
  - 0.637*36 = 22.932



Understanding Sinusoidal waveforms

- An instantaneous is the value at a given point in the waveform
- To get the instantaneous we put the value of t into the equation
- t is the angle along the x axis (the number)



Example of solving an instantaneous

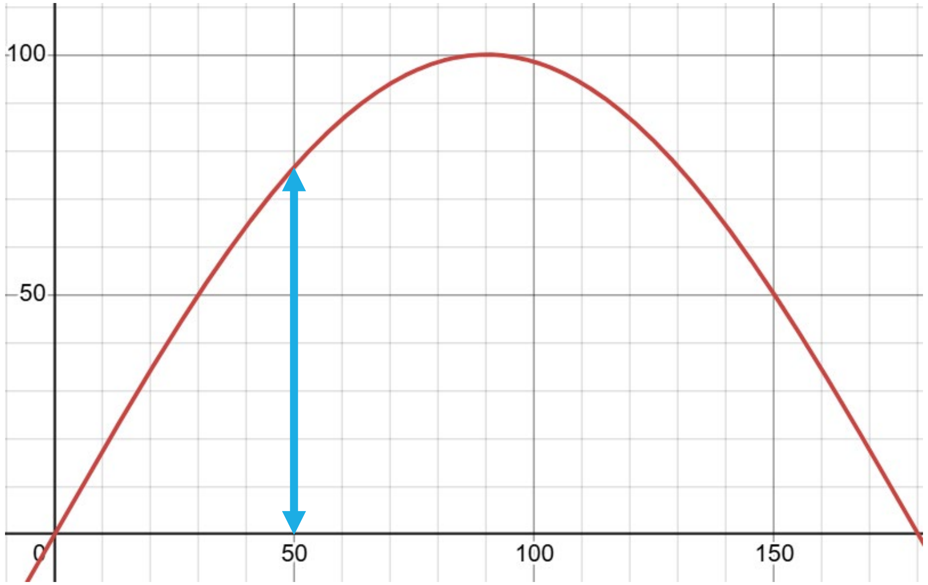
- To solve an instantaneous, we just plug in our value of x or t into the equation.

- For example, this graph has the equation

$$y = 100\sin\left(\frac{\pi}{180}t\right)$$

- If we put 50 in as t we get:

$$y = 100 \cdot \sin\left(\frac{\pi}{180} \cdot 50\right) = 76.60444431$$

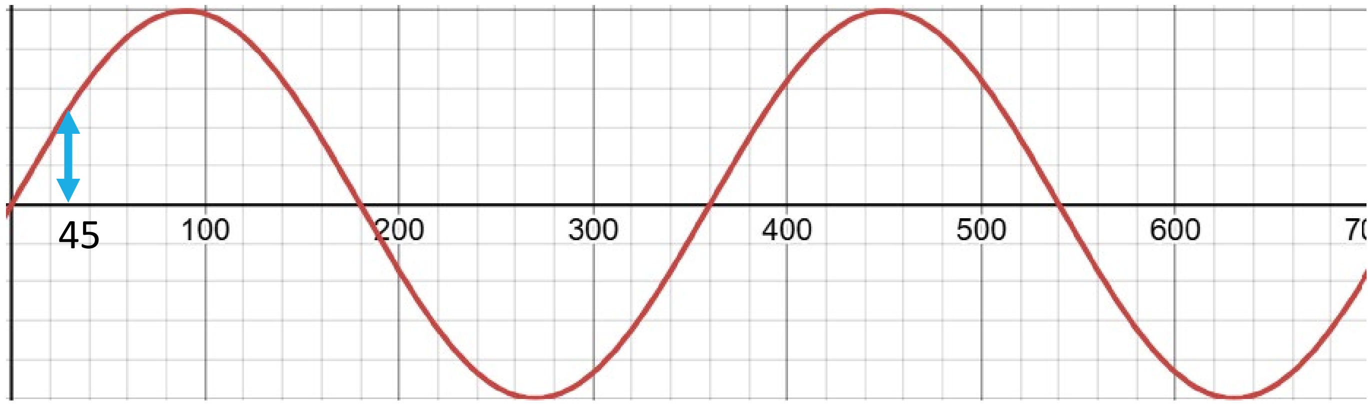


Understanding Sinusoidal waveforms

- An effective voltage is defined as the AC value that will give the same heating effect as an equivalent DC voltage

- An effective voltage is often referred to as the RMS or root means square

- To find the effective(RMS) value we can do 0.707*Peak



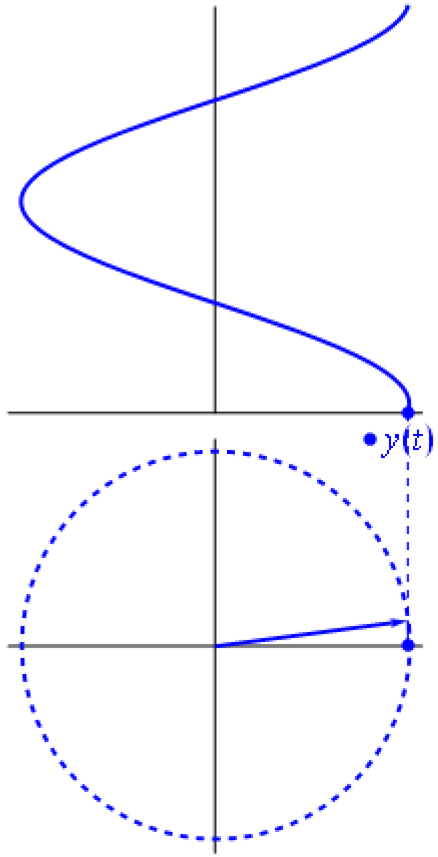
What is a Phasor?

- A Phasor is a rotating vector which can be used to map a sine wave

- The vector rotates at a speed of radians per second

- It allows us to draw out multiple waves easily & use vector math to work out a resultant wave

- It means you can simplify waves certain points in a wave into a more easily to understand format

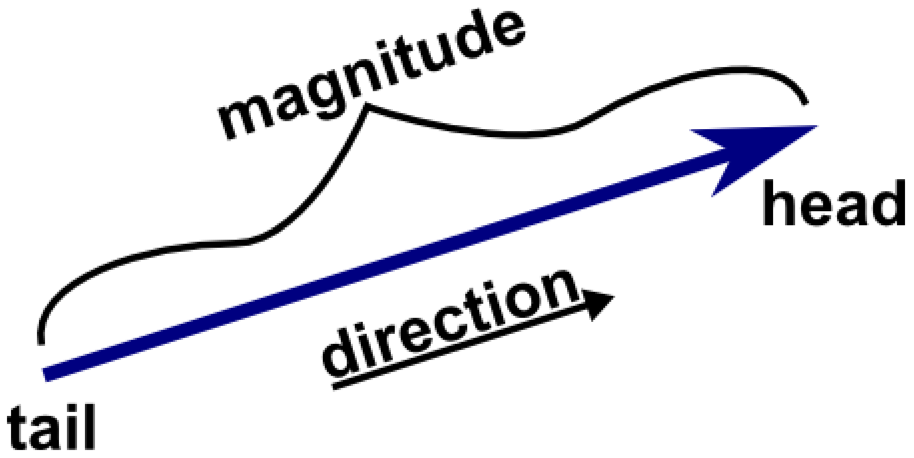


Vectors

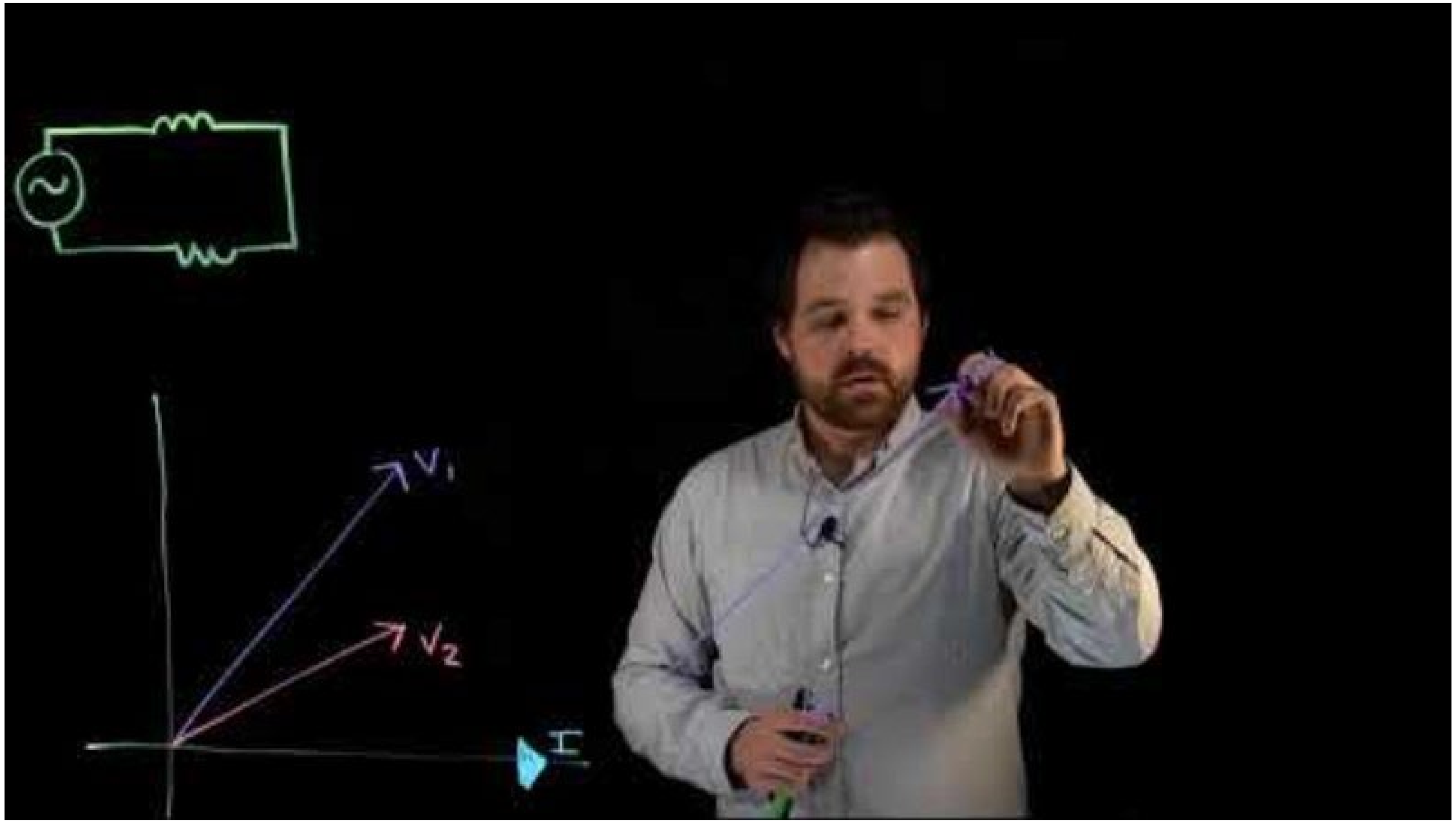
- A vector is a quantity with both magnitude (size) and direction, commonly represented as an arrow

- In a coordinate system, it's expressed as an ordered list of numbers (e.g., v=[x,y,z]v=[x,y,z] in 3D).

- Used in physics, engineering, and computer graphics to represent forces, velocities, and spatial positions.



Adding Phasors



HV Chart

- HV charts are just meant to help understanding vector maths
- It allows you to easily split Horizontal and Vertical components of a vector to understand it and find a total resultant vector

	H (Cos)	V (Sin)
$V_1 = v\ @\ \theta$	= cos(θ)*v	= sin(θ)*v
$V_2 = v\ @\ \theta$	= cos(θ)*v	= sin(θ)*v
$V_T = v\ @\ \theta$		

Solving an example

	H	V
$V_1 = 16_v\ @\ 10^o$	= cos(10)*16 = 15.76	= sin(10)*16 = 2.78
$V_2 = 8_v\ @\ 45^o$	= cos(45)*8 = 5.66	= sin(45)*8 = 5.66
$V_T =$	= 15.76 + 5.66 = 21.42	= 2.78 + 5.66 = 8.44

$$\tan(\theta) = \frac{opp}{adj} = \frac{8.44}{21.42} = 0.39 \qquad \theta = \tan^{-1} 0.39 = 21.31^o$$

$$a^2 + b^2 = c^2 \quad 21.42^2 + 8.44^2 = c^2 \quad \sqrt{21.42^2 + 8.44^2} = c \quad 23.02_v = c$$

$$V_T = 23.02_v\ @\ 21.31^o$$

What is the complex plane

- The complex plane is a 2D plane where each point represents a complex number, with the x-axis as the real part and the y-axis as the imaginary part.

- Any complex number z=a+bi is a point on the plane, where a is the real component and b is the imaginary component.

- Addition, subtraction, multiplication, and division of complex numbers can be visualised geometrically as translations, rotations, and scaling on the plane.

Example of plotting on the complex plane

- Take the complex number z=3+4i.

- On the complex plane:
  - Plot the real part (3) on the x-axis. Plot the imaginary part (4) on the y-axis.

- Mark the point (3,4) on the plane.

- This point represents the complex number z=3+4i, and the distance from the origin to this point is its **magnitude** (calculated as $\sqrt{3^2+4^2} = 5$).