Three numbers are used to specify a sinusoidal waveform:—

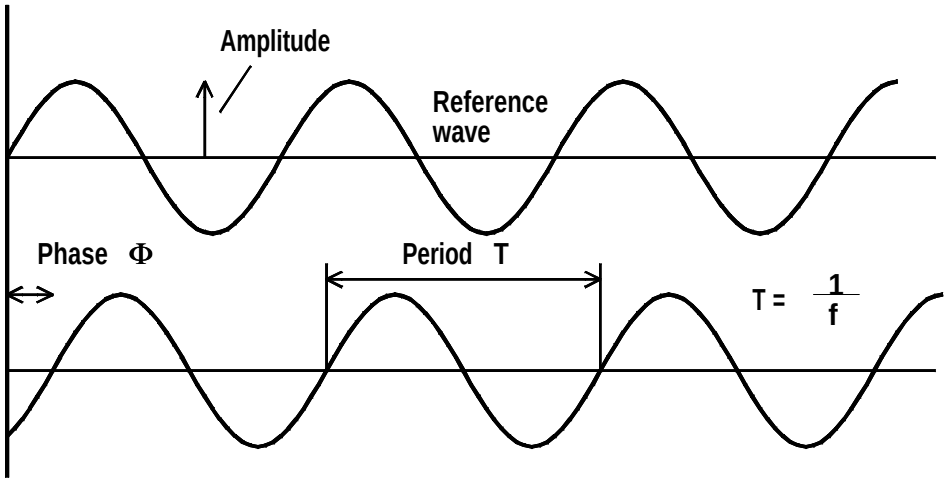
- Amplitude
- Frequency OR
  Period, T given by $T = \frac{1}{f}$
- Phase, ϕ

$$\begin{aligned} \omega &= 2\pi f \\ T &= \frac{1}{f} \\ V &= V_0 \sin(2\pi f t + \phi) \text{ For voltage waveforms} \\ I &= I_0 \sin(2\pi f t + \phi) \text{ For current waveforms} \end{aligned}$$

$$V = V_0 \sin(2\pi f t + \phi)$$

Use radian mode in calculations.

The sign of the phase shift is the same as the sign of the output waveform measured at the time of a positive going zero crossing of the reference sine wave. ϕ is negative in the figure.



A generator depends on Lenz's Law
When the magnetic flux through a conducting loop changes, a voltage is generated or induced in the conductor proportional to
the rate of change of the magnetic field, B,
the area of the loop, A,
the number of turns of conductor, N.

The induced emf, $\mathcal{E}$, is then given by

$$\mathcal{E} = -NA\frac{dB}{dt}$$

Note the sign of the induced emf

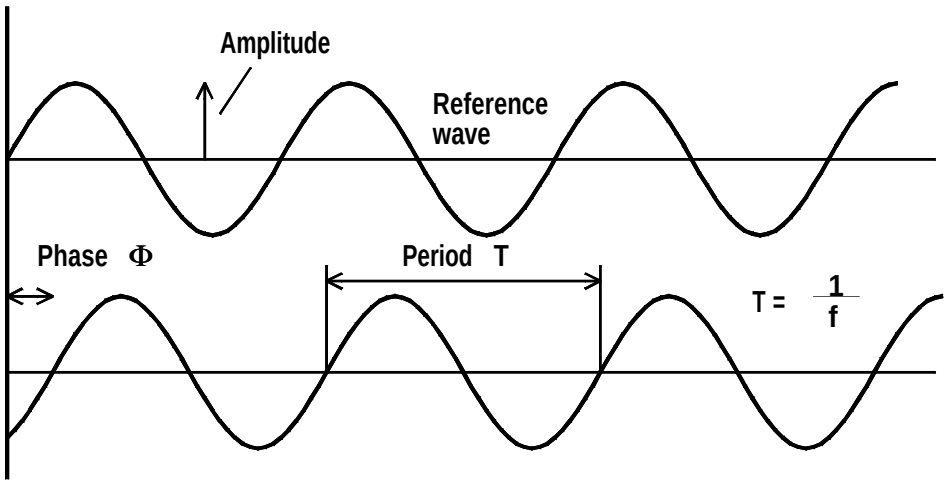
The work done by the motor is converted into electrical power at the output of the generator.

The rotary motion gives an alternating voltage waveform

In electronics we will use alternating voltages which do not always originate from rotation of coils in magnetic fields but the description of the waveforms is the same.

To specify the phase, ϕ, a wave of the same frequency is used as a reference.
If the second wave has a positive value of phase, it is said to **lead** the reference;
If the second wave has a negative value of phase, it is said to **lag** the reference wave .
Therefore, if the magnitude of the phase shift is 60^o or 1.05 radians, the equation which describes the second wave is:—

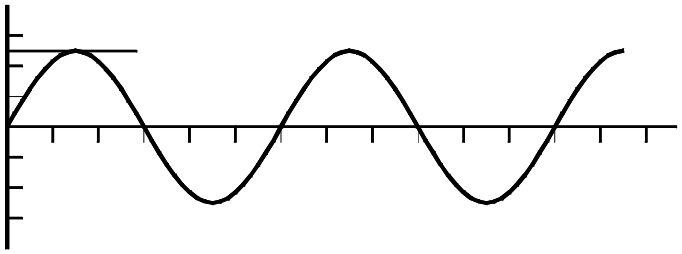
$$Y = Y_0 \sin(2\pi ft - 1.05)$$



Example 1

The oscilloscope has a Y axis setting of 2V/division and a time axis setting of 5msec/division.

Calculate the amplitude, frequency, angular frequency and period of the waveform and write down the equation for the voltage waveform.



The maximum of the waveform is at 2.5 division and therefore the amplitude of the waveform is $2.5 \times 2V = 5.0V$.

The period of the waveform is 6 divisions and therefore
$T = 6 \times 5 \times 10^{-3}$seconds $= 30ms$.

The frequency is $f = \frac{1}{T} = \frac{1}{30 \times 10^{-3}}$Hz $= 33.3Hz$.

The angular frequency is $\omega = 2\pi f = 209.3$ radians per

There is no reference waveform so the phase $\phi = 0$.

The equation which describes the waveform is therefore:-

$V = 5.0 \sin(209.3t + 0) = 5.0 \sin(209.3t)$ Volts

Not all waveforms are sinusoidal.

Not all waveforms can be described with a simple equation.