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Some Common Formulae

For Electrical Science & Principles

Electric Current and Quantity of

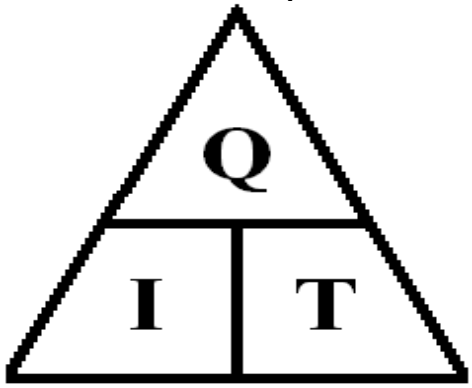
The movement of free electrons in a conductor depends on the law of electric charge. Electricity is the flow of free moving very small electrons along a conductive material. These electrons are so very tiny we group a number of electrons together and measure the number of grouped electrons moving. The unit used for this is the COULOMB (symbol C)

If the drift of these very tiny electrons in a conductor takes place at the rate of one coulomb per second, the resulting current is said to be that of one AMPERE (symbol A).

Q = charge transferred in coulombs
I = current in amperes
T = time during which the current flows **(always in seconds)**

$$Q = I \times T$$

Memory Aid! By putting this formula in the form of a triangle it can be easier to transpose.



$$I = \frac{Q}{T} \qquad T = \frac{Q}{I}$$

Ohms Law

States: If the temperature of a conductor remains constant the current in a circuit is directly proportional to the voltage and inversely proportional to the resistance.

So, we can show ohms law by means of the following formula:

$$I = \frac{V}{R}$$

Also transposed as

$$R = \frac{V}{I}$$

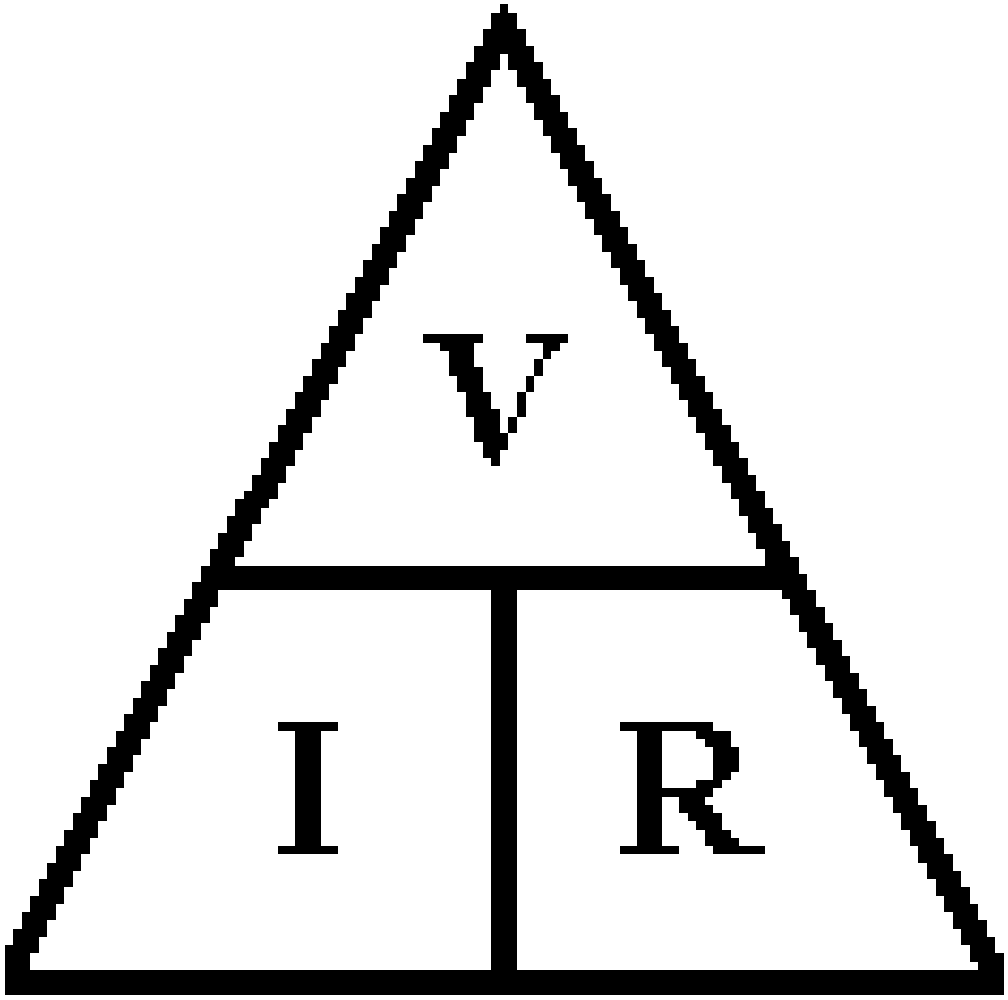
Also transposed as

$$V = I \times R$$

If you double the voltage you double the current **I x V**

If you double the resistance you half the current **I x $\frac{1}{R}$**

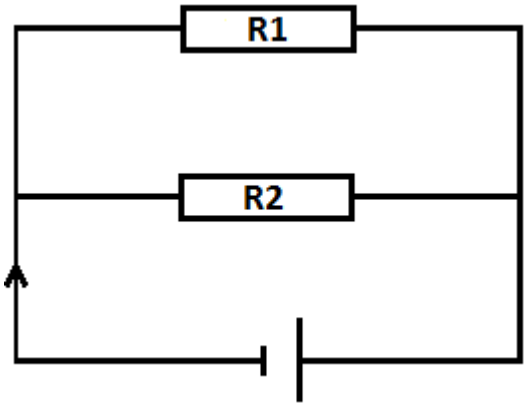
By putting this formula in the form of a triangle it can be easier to transpose



$$V = I \times R \qquad I = \frac{V}{R} \qquad R = \frac{V}{I}$$

Finding Total Resistance of 2 Resistors Connected in Parallel

If you are required to find the total resistance of any two resistors in parallel you can use the following calculation product over sum.



$$R_T = \frac{\text{Product}}{\text{Sum}}$$

$$R_T = \frac{R_1 \times R_2}{R_1 + R_2}$$

Resistance

Resistance opposing the flow of **current** in a circuit is measured in **ohms** and has the unit symbol Ω. Resistance changes with conductor **length** and **cross sectional area** and **temperature** change.

Resistivity

Resistivity tells how **resistive** a material is. The Greek name for resistivity is RHO and is represented by this symbol ρ a bit like the letter p and its units are ohm metres. In effect, the resistivity represents the **resistance** across two opposite faces of a cubic metre of material (in the same way that density is the mass of a cubic metre).

The formula for calculating resistance is:

$$\text{Resistance} = \frac{\text{Resistivity x Length}}{\text{Cross-sectional area}}$$

OR

$$R = \frac{\rho \times L}{A}$$

The formula for calculating resistivity is:

$$\textbf{Resistivity} = \frac{\textbf{Resistance x Cross-sectional area}}{\textbf{Length}}$$

OR

$$\rho = \frac{R \times A}{L}$$

The formula for calculating length is:

$$\textbf{Length} = \frac{\textbf{Resistance x Cross-sectional area}}{\textbf{Resistivity}}$$

OR

$$L = \frac{R \times A}{\rho}$$

The formula for calculating cross-sectional area is:

$$\text{Cross-sectional area} = \frac{\text{Resistivity x Length}}{\text{Resistance}}$$

OR

$$A = \frac{\rho \times L}{R}$$

Power Formula

Power in a circuit is measured in Watts (W), Kilowatts (kW) and Megawatts (MW). Power can be found for a DC circuit or purely resistive AC circuits from the following.

Power = Current x Voltage

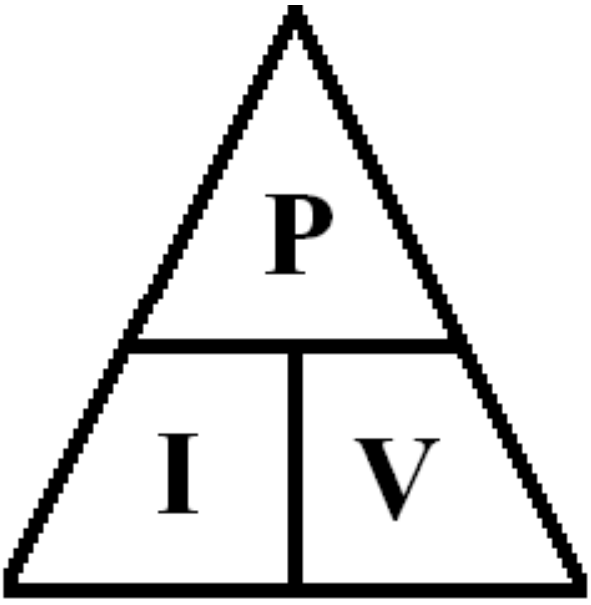
$$P = I \times V$$

Once again the use of a triangle can aid the transposition of the formula.

Transposed for I and V

$$I = \frac{P}{V}$$

$$V = \frac{P}{I}$$



The Three Power Formulae

Power can be found using the following three formulae

$$P = I \times V$$

Or

$$P = I^2 \times R$$

Or

$$P = \frac{V^2}{R}$$

Using Ohms Law to Find Power

We now know power can be calculated by…

$$P = I \times V$$

Using Ohms Law voltage (V) can be found by

$V = I \times R$

$P = I \times (I \times R)$ we have replaced the voltage with $I \times R$

This is expressed as

$$P = I^2 \times R$$

Once again we now know power can be calculated by

$$P = I \times V$$

Using Ohms Law current (I) can be found by

$$I = \frac{V}{R}$$

$P = \frac{V \times V}{R}$ we have replaced the current with $\frac{V^2}{R}$

This is expressed as

$$P = \frac{V^2}{R}$$

Electromagnetic Induction

If a conductor is passed through a magnetic field an above an e.m.f. will be induced into the conductor this is known as electromagnetic induction. The amount of induced e.m.f. (e) depends upon 3 factors.

1. The flux density in Tesla (B)

2. The length (L) of the conductor in the magnetic field in metres

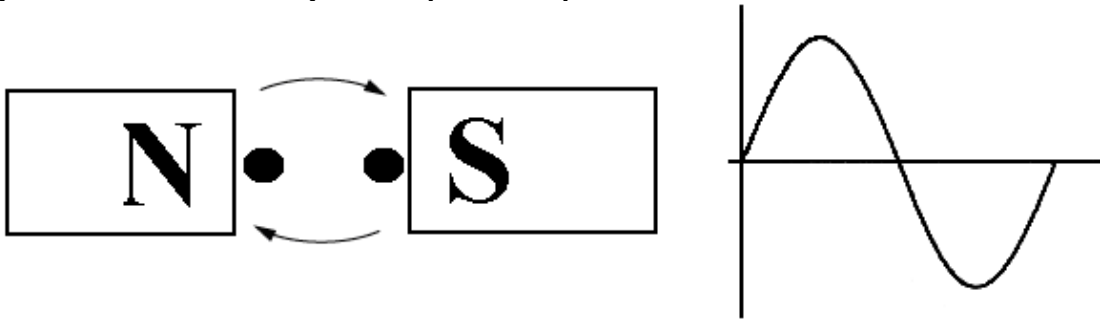
3. The velocity (v) (speed) of the conductor

The induced e.m.f. can be found by

$$e = B \times L \times v$$

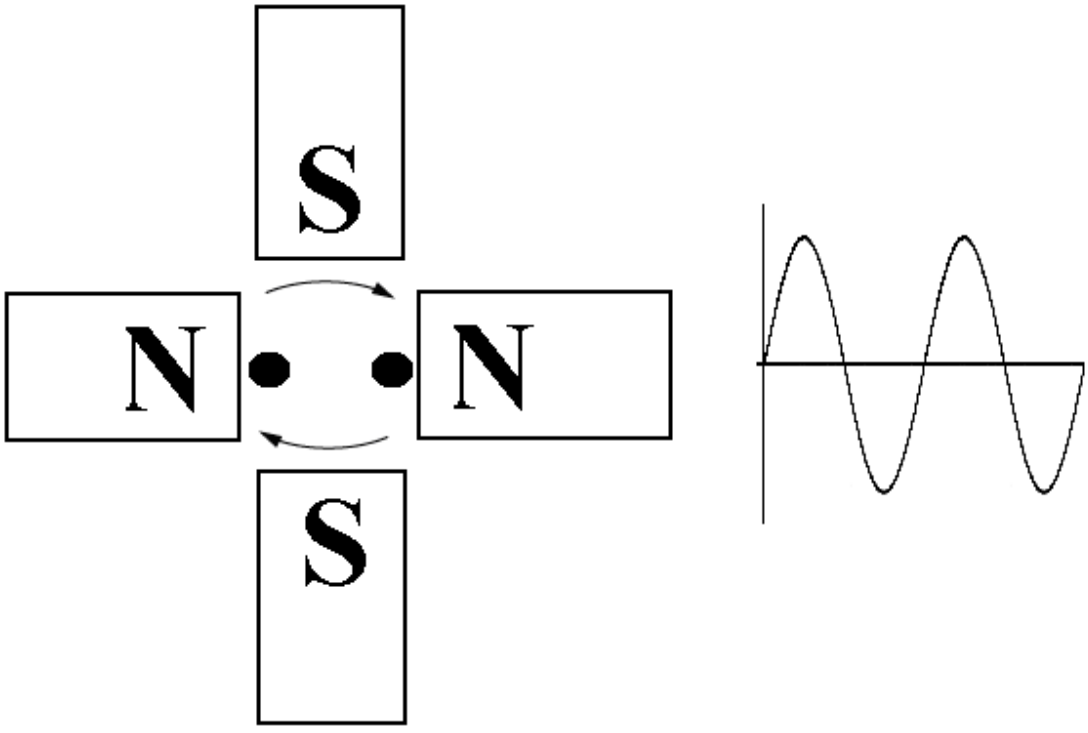
Frequency

A single loop alternator produces a single waveform or **cycle** for each **revolution** when rotated between 2 poles (north and south) or 1 pair of poles.



1 Pair of Poles

With a four pole machine (2 pairs) 2 cycles per revolution are produced.



2 Pairs of Poles

The frequency can be found by...

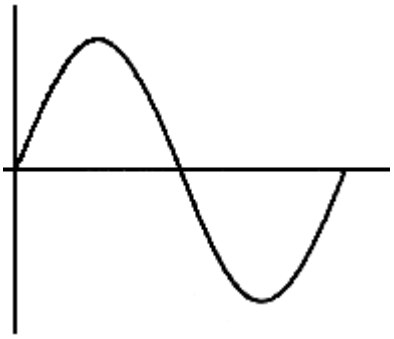
$$f = n \times p$$

Where f is frequency in H_Z
Where n is speed in revolutions per second (rps)
Where p is the number of pairs of poles

$$n = \frac{f}{p} \qquad p = \frac{f}{n}$$

Periodic Time

The time taken for a sine wave to complete one cycle is known as the periodic time (T).



The frequency of the sine wave is the number of cycles that occur every **second**. The periodic time of one cycle can be found by dividing the frequency by one second.

$$T = \frac{1}{f}$$

Where T is periodic time in seconds (s)
Where f is frequency in H_z

Efficiency

Efficiency η of a machine or system is the ratio of the output power or energy compared to input power or energy

The formula for Efficiency η is:

$$\% \text{ Efficiency } \eta = \frac{\text{Work Output (Po)}}{\text{Work Input (Pi)}} \times 100$$