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Electronics I

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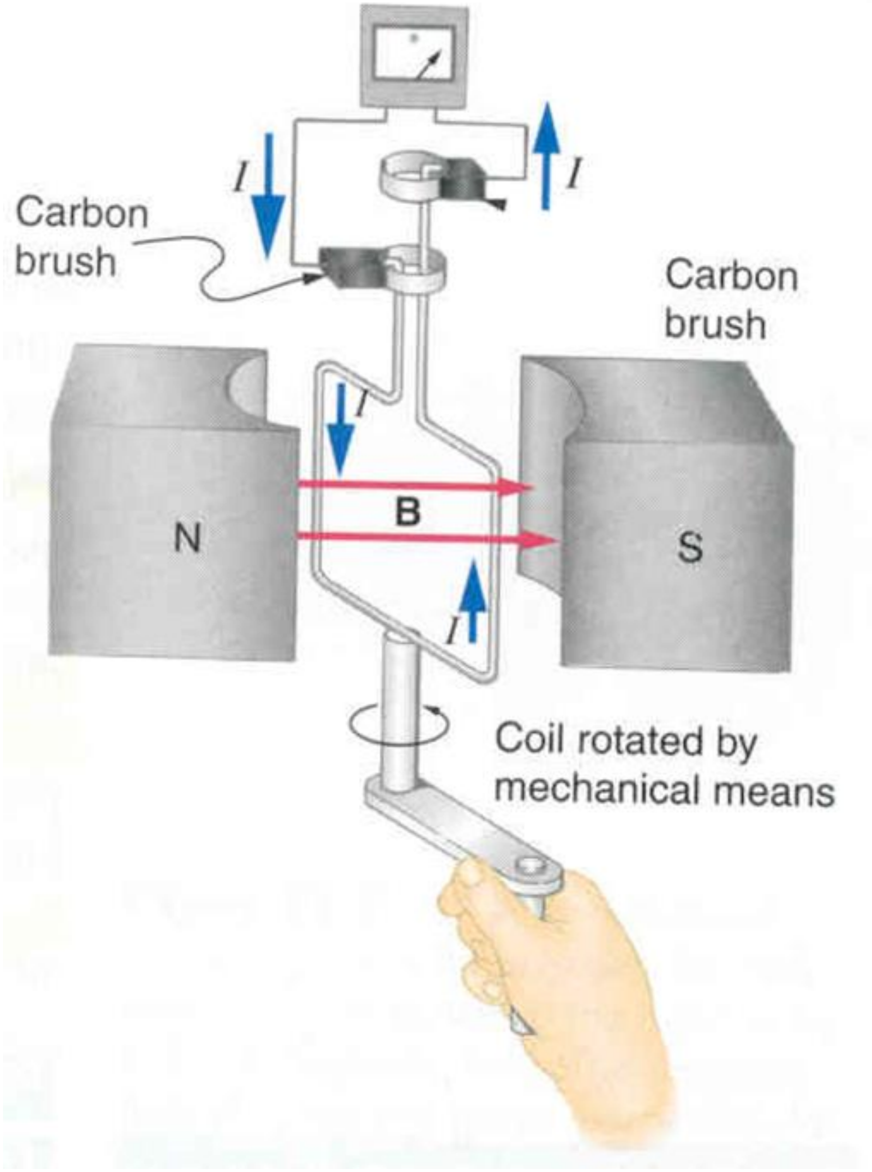
Introduction

Electricity has to be generated first…

- Why Electronics?
- The Diode



What energy can provide a force that sustainably turns the coil continuously?

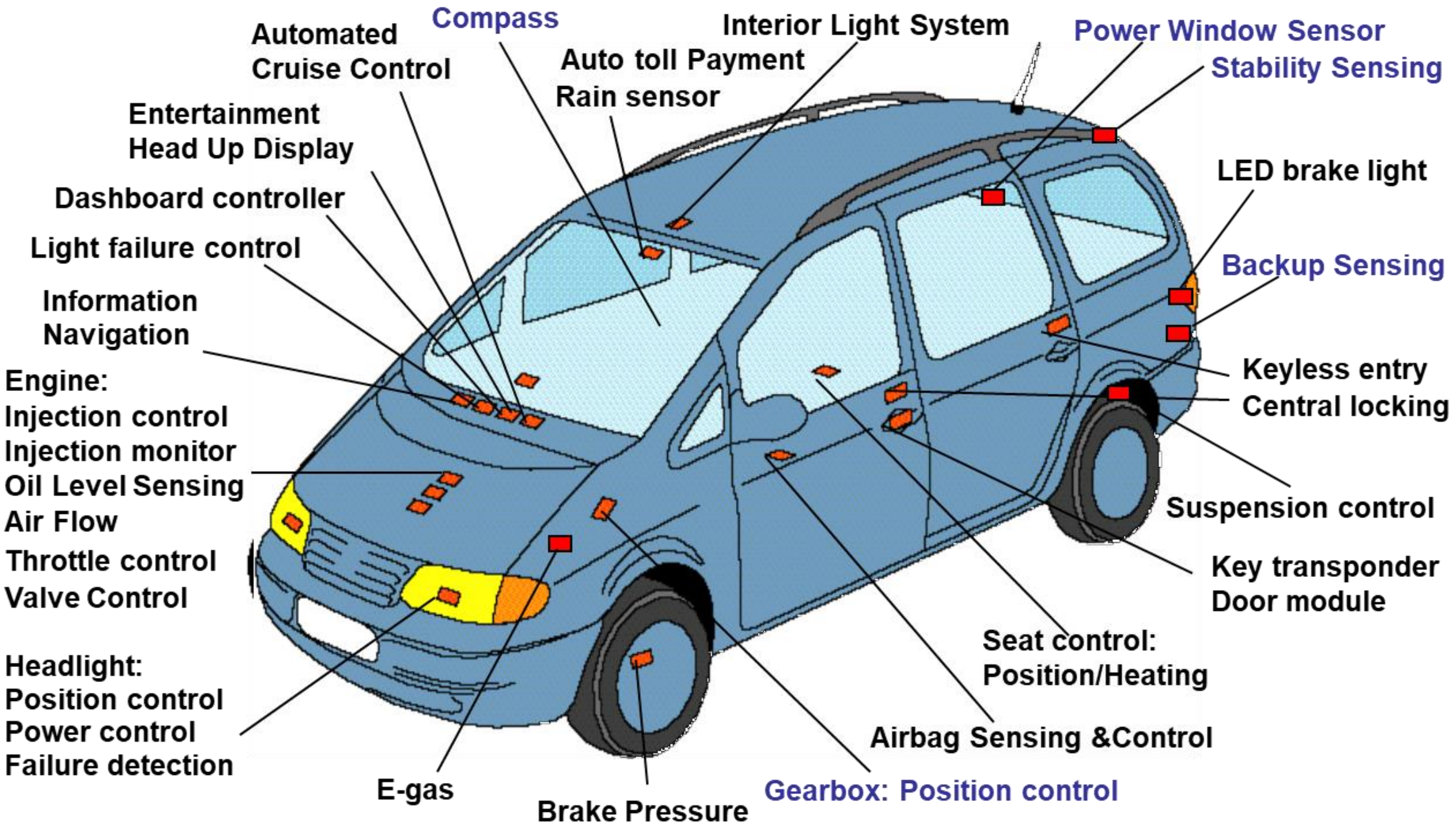
Electronics is part of everyday life

What energy can provide a force that sustainably turns the coil continuously?

Electronics is part of everyday life

Radio and Tele communications… information technology

Where do we find electronics in a car



Driving convenience and comfort?

Electronics is part of everyday life

Technology can provide a useful competitive advantage for business

Electronics can conveniently extend working hours

What is Electronics?

Electronics is the study of the flow of charge (electron) through various materials and devices such as semiconductors, resistors, inductors , capacitors , nanostructure etc.

All applications of electronics involve the transmission of power and possibly information.

A branch of engineering that deals with the design & practical applications of machinery & equipment for efficient communication.

- Examples

- Mobiles/TVs/DVDs
- computers/laptops
- Home Security Systems
- Intelligence systems

Electricity needs to be properly conditioned to meet the user's demand

What is Electronics?

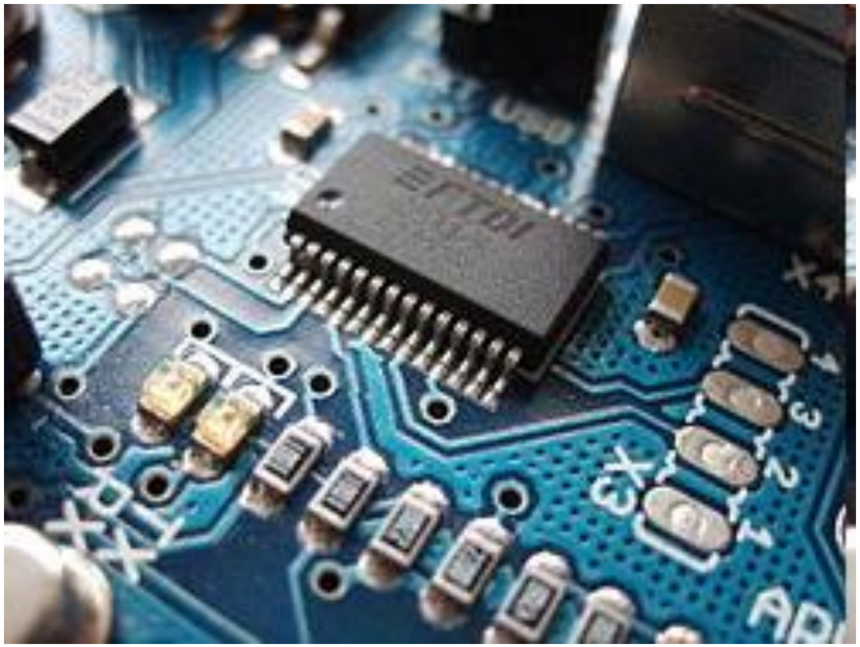
Electronics is distinct from electrical and electro-mechanical science and technology, which deals with the generation, distribution, switching, storage and conversion of electrical energy to and from other energy forms using wires, motors, generators, batteries, switches, relays, transformers, resistors and other passive components.

This distinction started around 1906 with the invention by Lee De Forest of the triode, which made electrical amplification of weak radio signals and audio signals possible with a non-mechanical device.

Until 1950 this field was called "radio technology" because its principal application was the design and theory of radio transmitters, receivers and vacuum tubes.

electrical amplification of weak radio and audio signals possible with a non-mechanical device

What is Electronics?



- Today, most electronic devices use semiconductor components to perform electron control.

- The study of semiconductor devices and related technology is considered a branch of solid state physics,
- whereas.,
- the design and construction of electronic circuits to solve practical problems come under electronics engineering.

What is Electronics?

Vacuum tubes were one of the earliest electronic components. They dominated electronics until the 1950s. Since that time, solid state devices have all but completely taken over. Vacuum tubes are still used in some specialist applications such as high power RF amplifiers, cathode ray tubes, and some microwave devices.

Silicon-Controlled Rectifier (SCR)

Ideal for many applications, e.g.:

- Power switching circuits (for both AC and DC)
- Zero-voltage switching circuits
- Over voltage protection circuits
- Controlled Rectifiers
- Inverters
- AC Power Control (including lights, motors, etc.)
- Pulse Circuits
- Battery Charging Regulator
- Latching Relays
- Computer Logic Circuits
- Remote Switching Units
- Phase Angle Triggered Controllers
- Timing Circuits
- IC Triggering Circuits
- Welding Machine Control
- Temperature Control Systems

The present & emerging technologies include:

- Wireless communication
- PLCC
- Satellite communication
- Internet Communication
- Nanotechnology
- Embedded Systems
- Display Techniques
- Robotics
- Radar
- Milk Fat Testing
- Remote Sensing
- Microwave Communication
- Advanced Processing

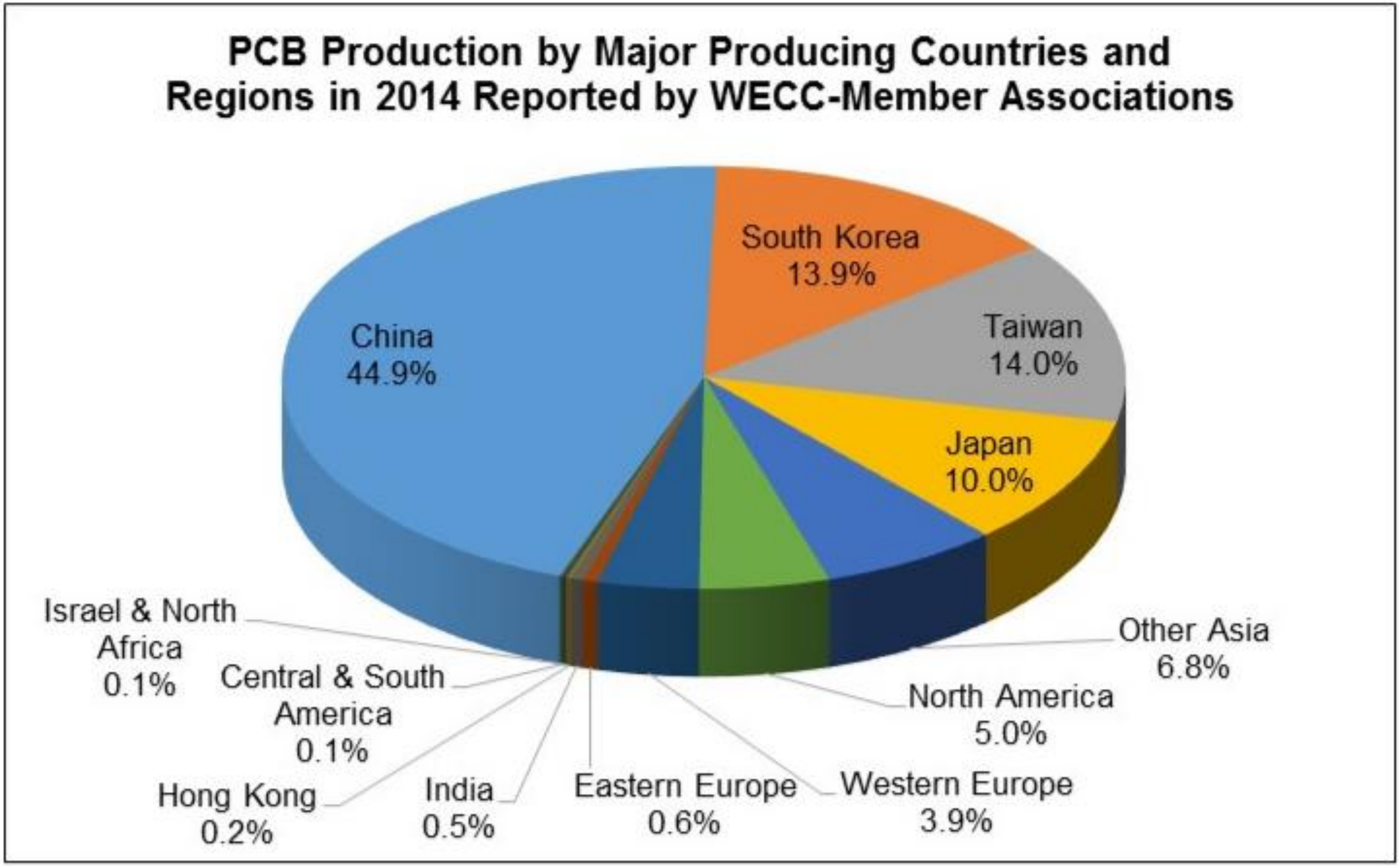
Some of Latest Electronic Gadgets

- LED , LCD . PLASMA & HD TV,S
- ANDROID MOBILES
- DVD PLAYERS
- LAPTOPS , E-BOOKS
- HOME SECURITY SYSTEM
- MP3 & MP 4 PLAYERS
- PROJECTORS
- SPEAKERS & WOOFERS
- SMART AIR –CONDITIONERS
- REMOTE SENSING

Specialised Electronic Fields

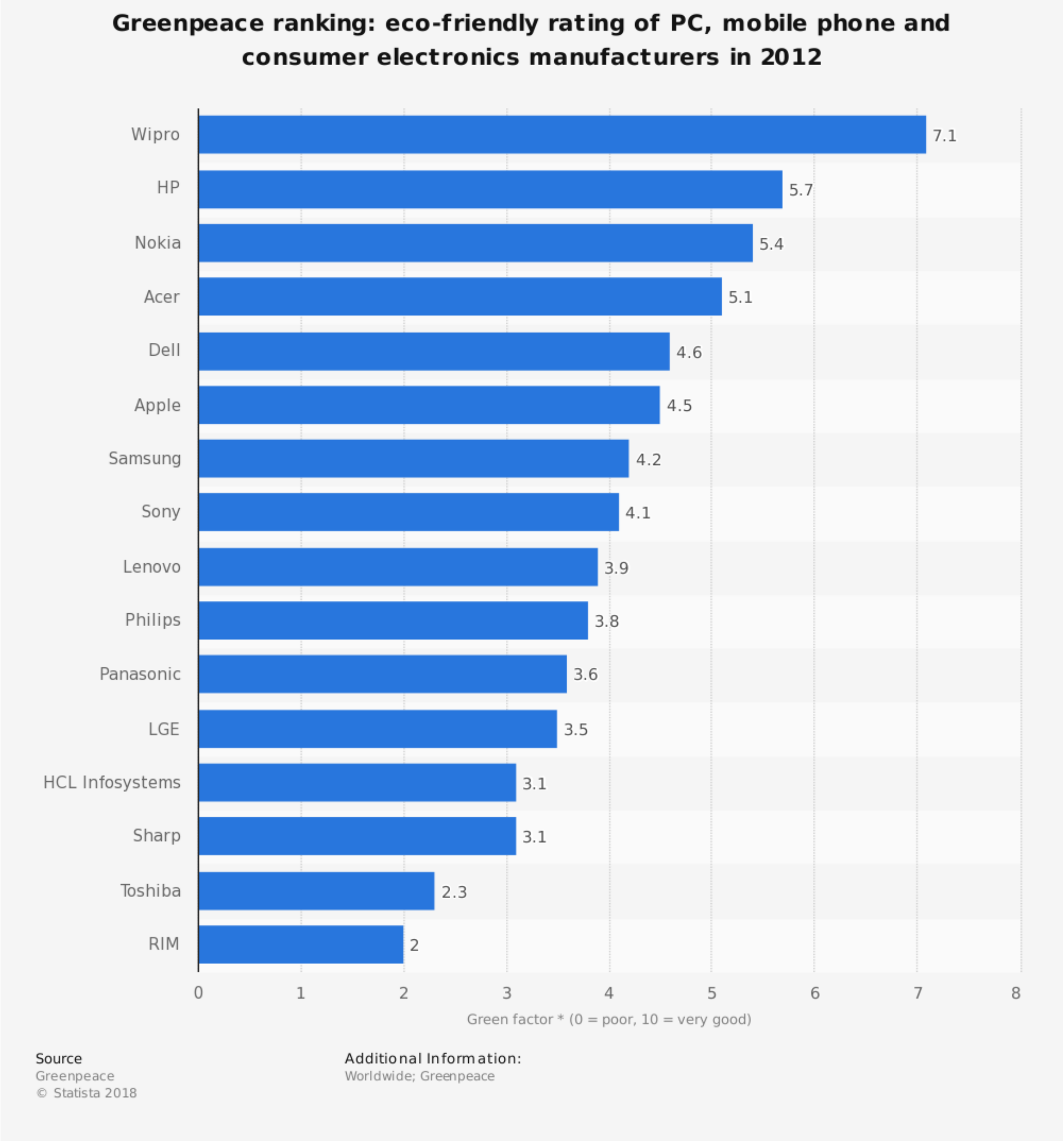
- Mechatronics
- Bio Medical Instrumentation
- Instruments Design
- PLC
- Electro Optics
- Propulsion Control Boards
- Scientific Instruments
- Electro Optics
- Weather Monitoring
- Metrology
- Coal Mineral Extraction
- Agronomics
- Development & Fabrication

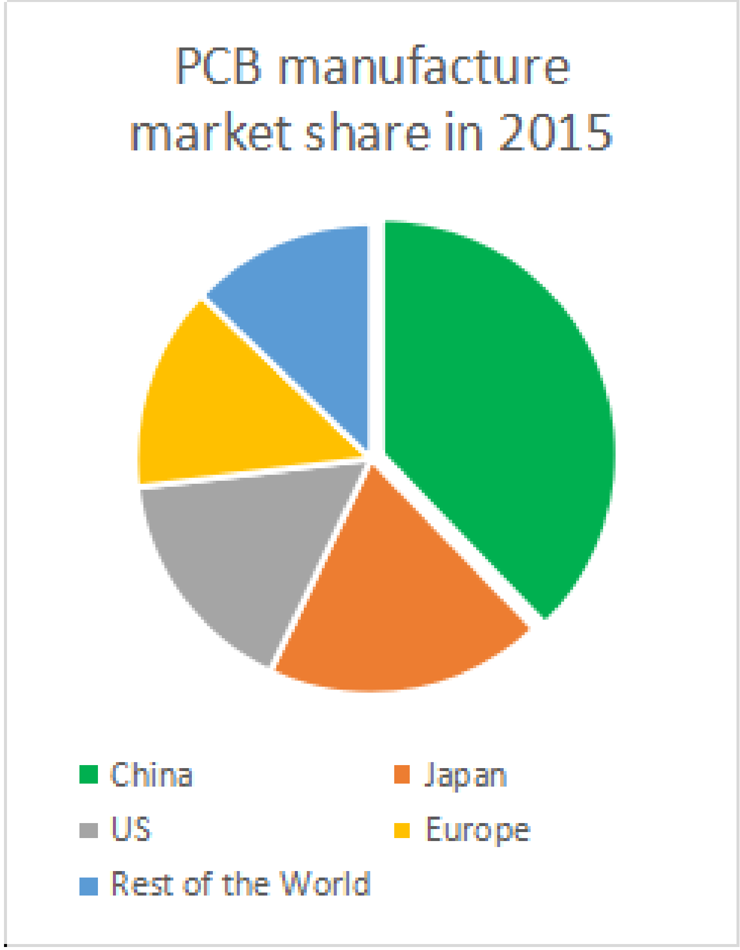
Printed Circuit Board Manufacture



Africa?

Consumer Electronics Manufacturers



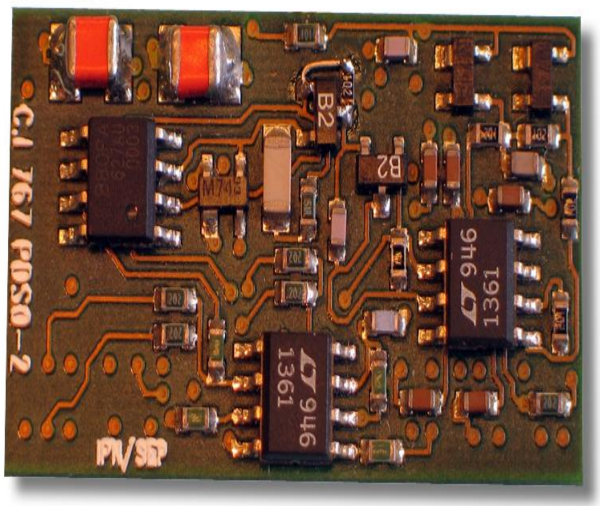


Africa?

Some Private Sector Electronics Companies

- PANASONIC
- SAMSUNG
- SONY
- PHILIPS
- TOSHIBA
- VIDEOCON
- ONIDA
- LG ELECTRONIC
- HITACHI
- WIPRO
- SOLAR ENERGY
- SANYO

Electronic devices and components



- An electronic component is any physical entity in an electronic system used to affect the electrons or their associated fields in a desired manner consistent with the intended function of the electronic system.
- Components are generally intended to be connected together, usually by being soldered to a printed circuit board (PCB), to create an electronic circuit with a particular function (for example an amplifier, radio receiver, or oscillator).
- Components may be packaged singly or in more complex groups as integrated circuits.
- Some common electronic components are capacitors, inductors, resistors, diodes, transistors, etc.
- Components are often categorized as active (e.g. transistors and thyristors) or passive (e.g. resistors and capacitors).

Diodes act like one way valves for electric current and are significant in Electronics

Basic concepts of analogue electronics

- *Electronics* is the study of flow of electrons in various materials or space subjected to various conditions.
- The main focus of electronics remains the controlled flow of electrons through a medium. By controlling the flow of electrons, we can make them perform special tasks, such as power an induction motor or heat a resistive coil.

Basic concepts of analogue electronics

- Electricity is the flow of electrons due to a difference in electrical charge between two points.

- Matter can either be electrically neutral, or carry a positive or negative charge.

- On a microscopic level, a negative charge corresponds to an excess of electrons in the material, and a positive charge a shortage.

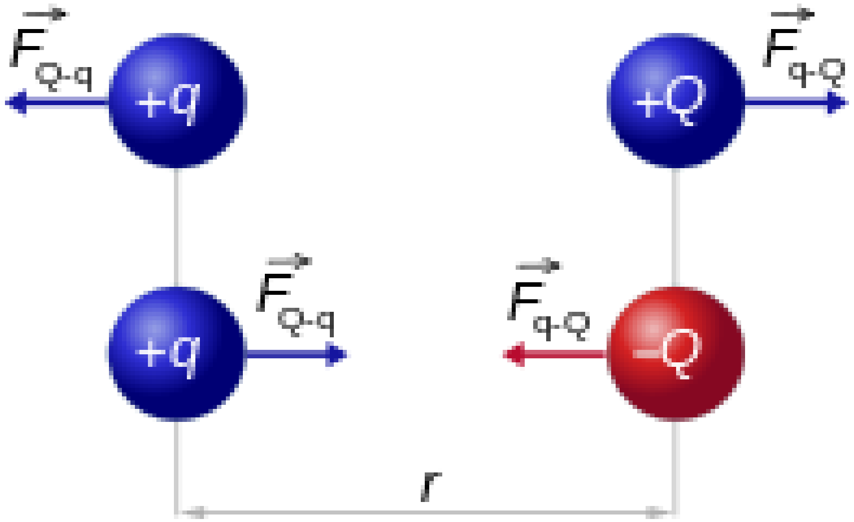
- We denote the charge of an object by Q, which is measured in Coulombs.

Coulomb's Law

- Two objects that have the same type of charge are known to repel, whereas objects with opposite charges attract.

- The force between charged objects is given by Coulomb's Law

- Where r is the distance between two objects carrying charges *q* and *Q*, and k is a constant.



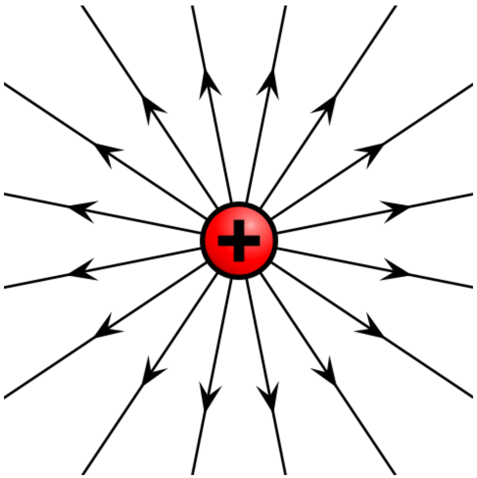
$$|\vec{F}_{Q\text{-}q}| = |\vec{F}_{q\text{-}Q}| = k\frac{|q \times Q|}{r^2}$$

Electric field

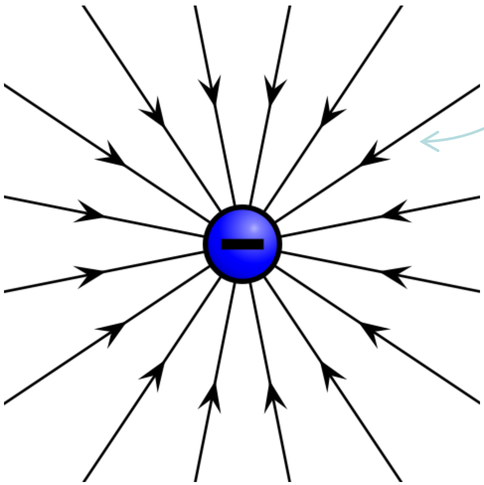
Electric field: $E=F/Q$

- An *electric field* is a vector *field* that associates to each point in space the Coulomb force that would be experienced per unit of *electric* charge, by an infinitesimal test charge at that point.

Electric field lines



Electric field of an isolated positive charge



Electric field of an isolated negative charge

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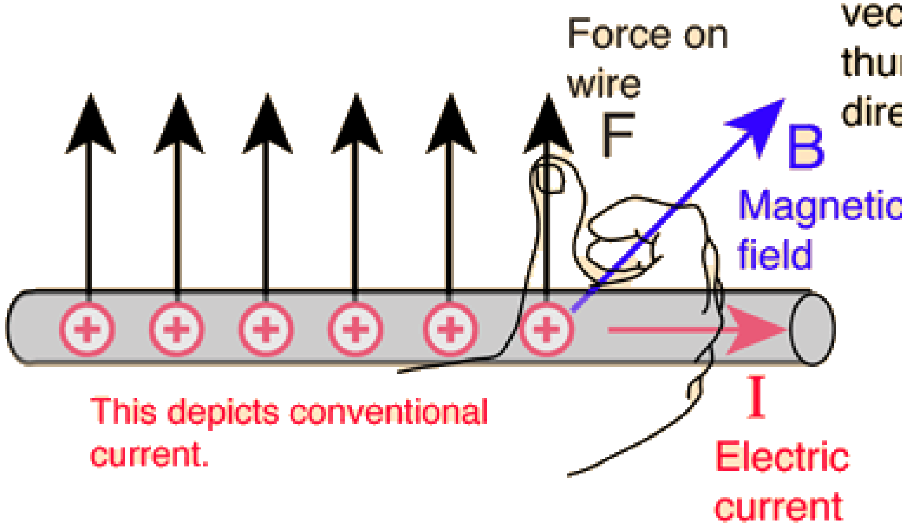
Lorentz force law

Lorentz force law: $\vec{F} = q\vec{E} + q\vec{v} \times \vec{B}$

Electric force *Magnetic force*

- the **force** exerted on a particle of charge *q* moving with velocity *v* through an electric E and magnetic field B.

Curl fingers as if rotating vector I into vector B. The thumb is then in the direction of the force F



$$\vec{F} = \vec{I}L \times \vec{B}$$

Force on straight wire of length L

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Lorentz force

Lorentz force:

$$\vec{F} = q\vec{E} + q\vec{v} \times \vec{B}$$

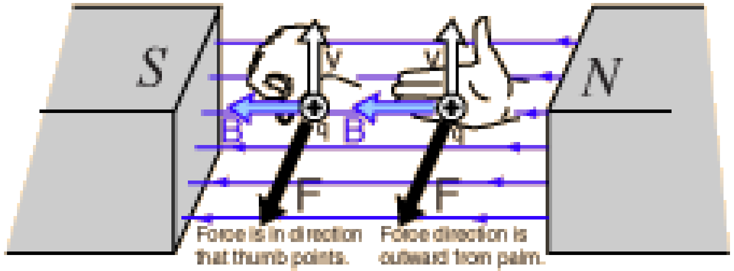
Electric force *Magnetic force*

- **the Electromagnetic force**

Electric

$$F = \frac{kq_1q_2}{r^2}$$

Magnetic



$$\vec{F} = q\vec{v} \times \vec{B}$$

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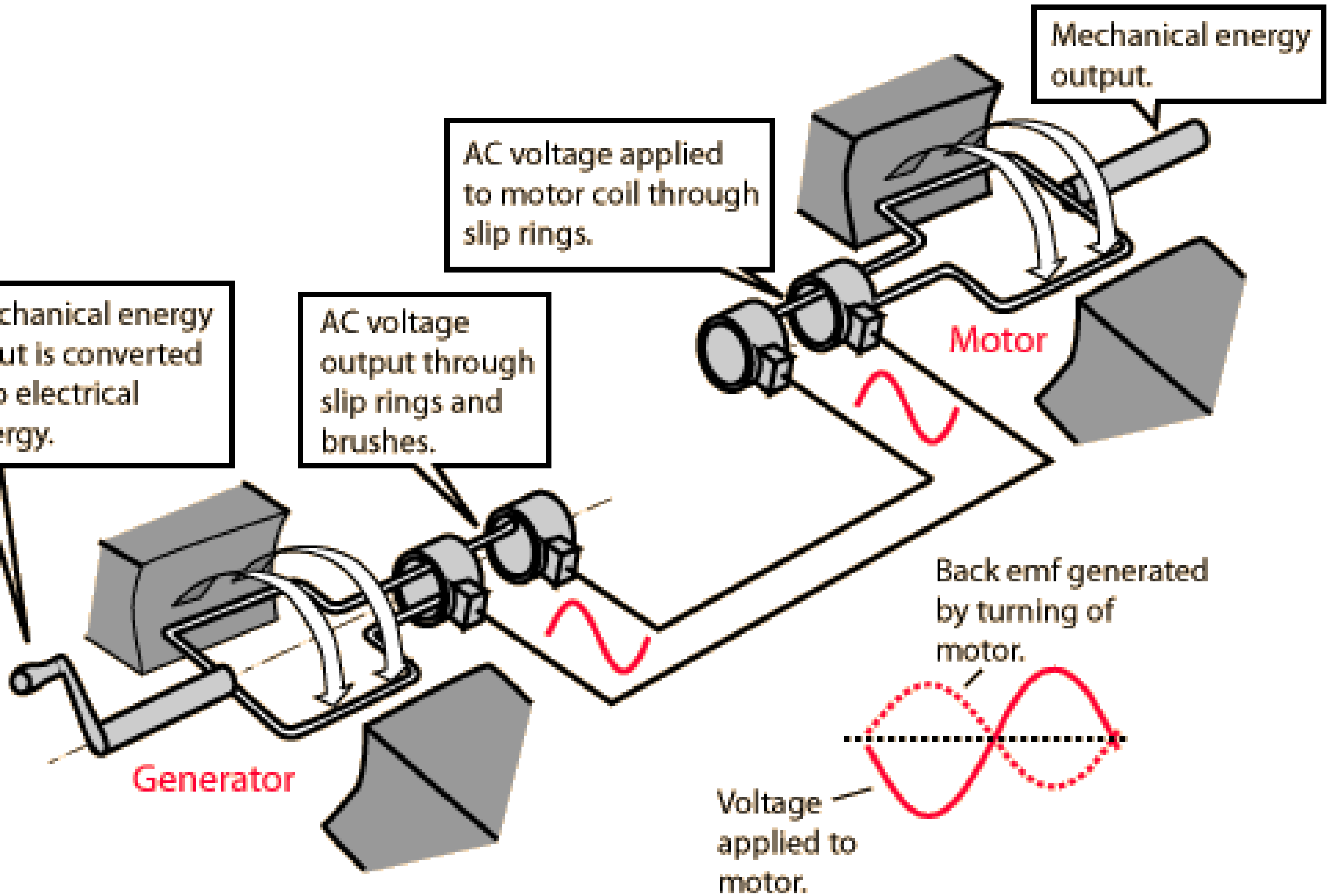
Electronics



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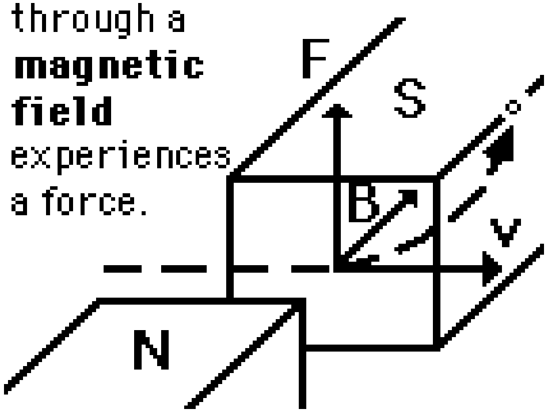
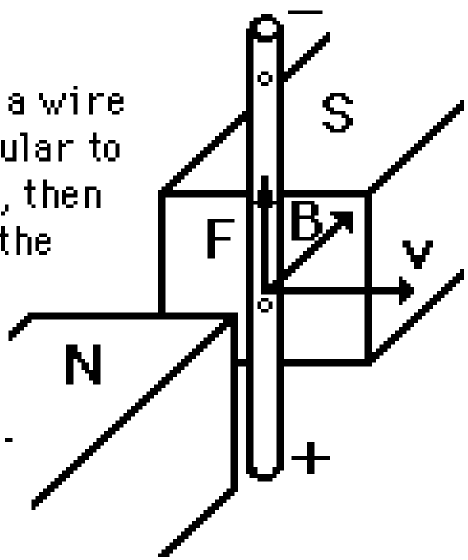
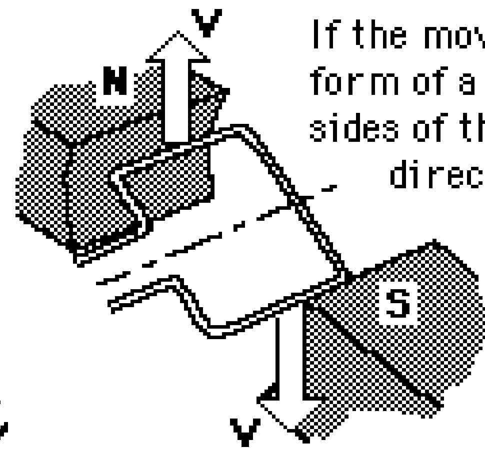
Electronics

Any charge moving through a **magnetic field** experiences a force.



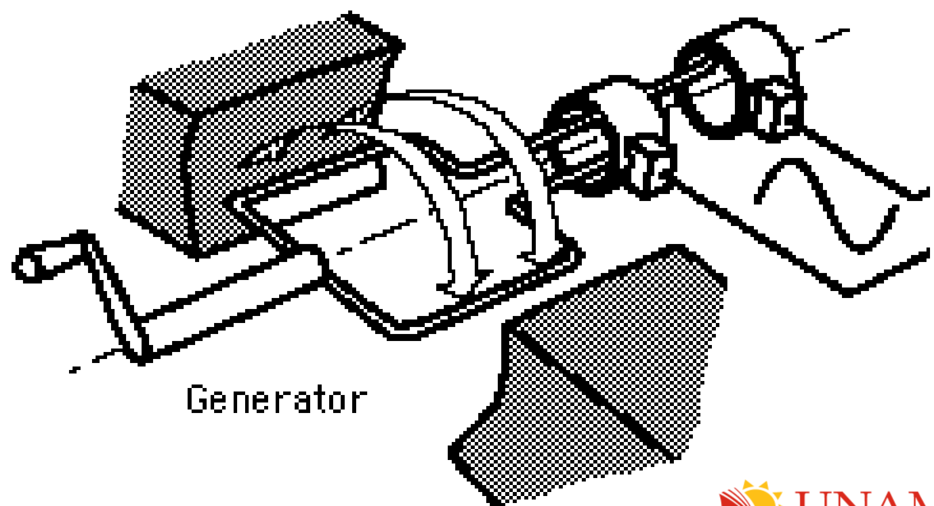
If the charge is in a wire moving perpendicular to the magnetic field, then the force is along the wire. This force does work, and work per unit charge is **voltage**.





If the movement of the wire is in the form of a rotating coil, then the two sides of the coil move in opposite directions and the generated voltages add.

Since the rotation produces different directions of motion at different points on the circle, the voltage generated is sinusoidal (AC).



Generator

Electricity and Matter

- All matter interacts with Electricity, and is divided into three categories: Conductors, Semi Conductors, and Non Conductors.

Conductor

- Matter that conducts Electricity easily. Metals like Zinc (Zn) and Copper (Cu) conduct electricity very easily. Therefore, they are used to make Conductors.

Non-Conductor

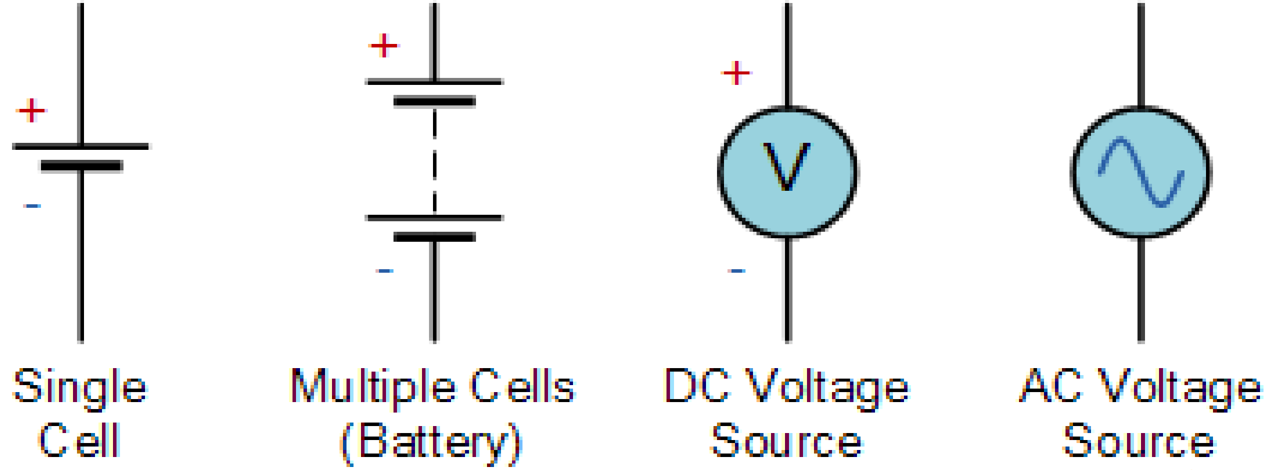
- Matter that does not conduct Electricity at all. Non-Metals like Wood and Rubber do not conduct electricity so easily. Therefore, they are used to make Non-Conductors.

Semi Conductor

- Matter that conducts electricity in a manner between that of Conductors and Non-Conductors. For example, Silicon (Si) and Germanium (Ge) conduct electricity better than non-conductors but worse than conductors. Therefore, they are used to make Semi Conductors.

Electronics

- **Voltage** is electric potential energy per unit charge, measured in joules per coulomb (=volts).
- It is often referred to as "electric potential", which then must be distinguished from electric potential energy by noting that the "potential" is a "per-unit-charge" quantity.
- **Symbols**



Electronics

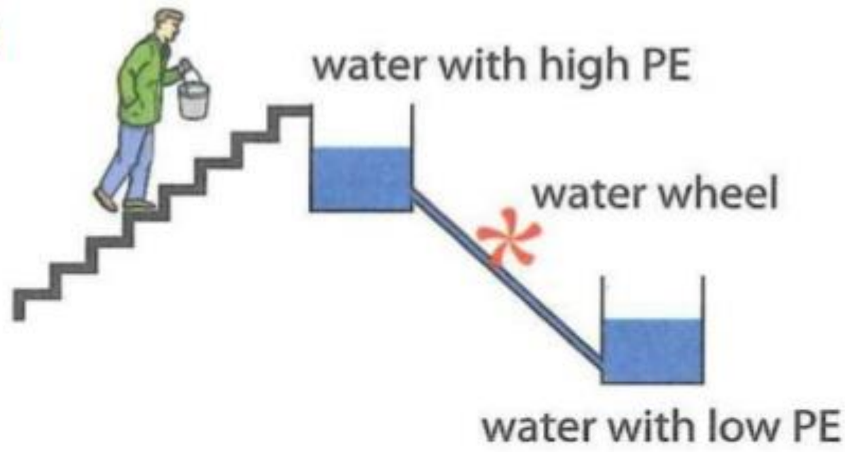
- **Potential Difference**

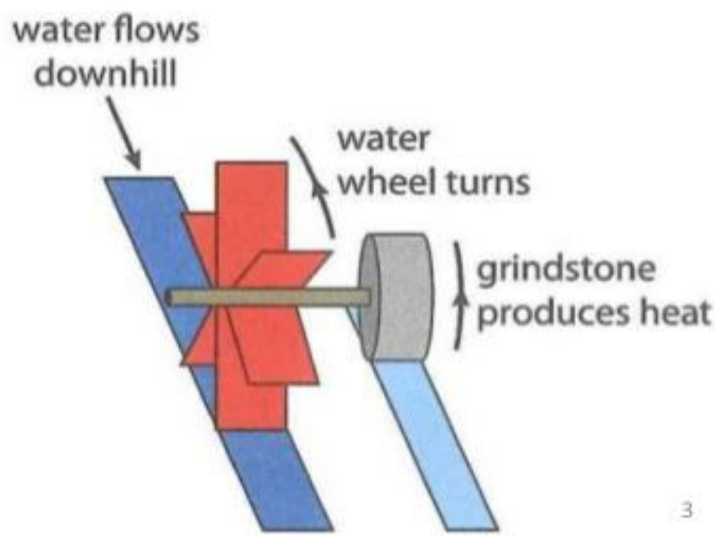
  The easiest way to think about what batteries do is to use a water analogy.

- Batteries 'lift' **charges (Q)** to a higher **Potential (V)**.

  There is a **Potential Difference (V)** between one end of the battery and the other.

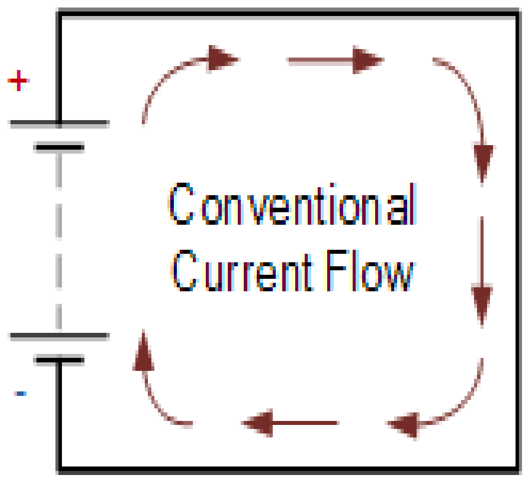
  Batteries store **Potential Energy** as **Chemical Energy**.

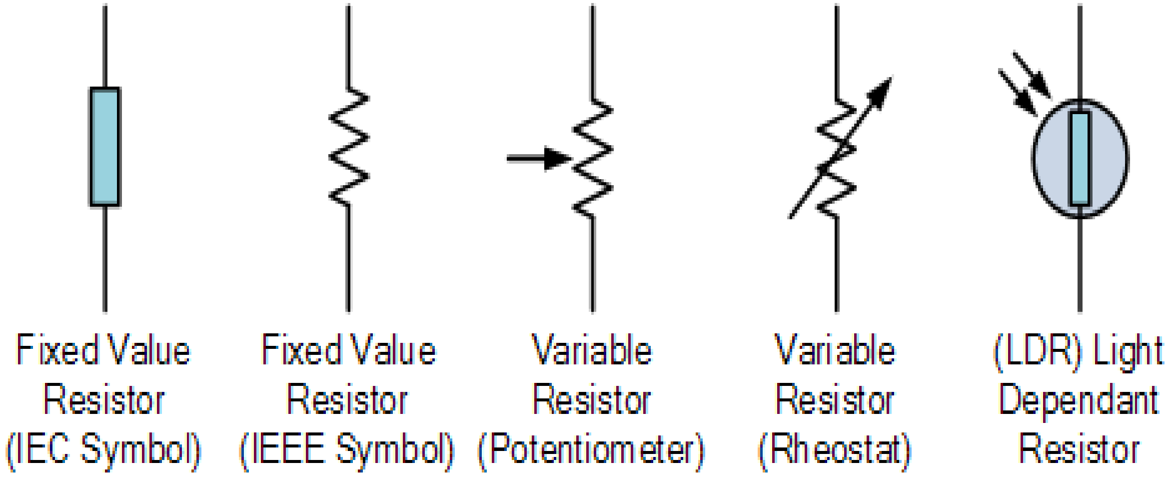




Electronic circuit quantities

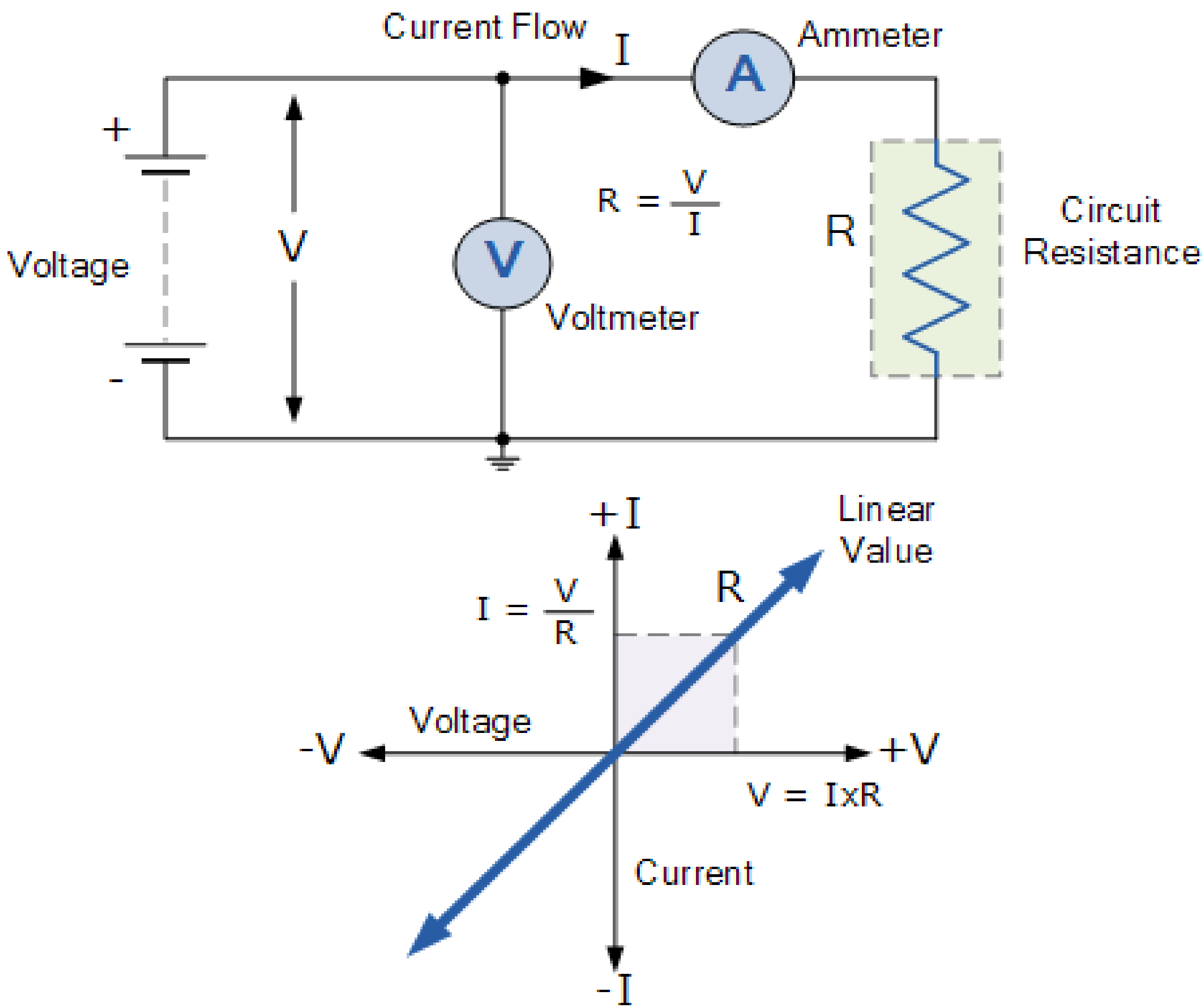
- all basic electrical or electronic circuits consist of three separate but very much related electrical quantities called: Voltage, (V), Current, (I) and Resistance, (R)





Symbols

Ohm’s law: I = V/R



- All basic electrical or electronic circuits consist of three separate but very much related electrical quantities called: Voltage, (V), Current, (I) and Resistance, (R)

Electronics

Current: I = Q/t

- **Current** is the rate at which electric charge flows past a point in a circuit, i.e., *Charge flow through an area in a unit of time.* It is measured in Ampere (A)

Conductance: Y = I/V

- Conductance is defined as *the ratio of current over voltage* denoted as Y measured in mho

Resistance: R = V/I

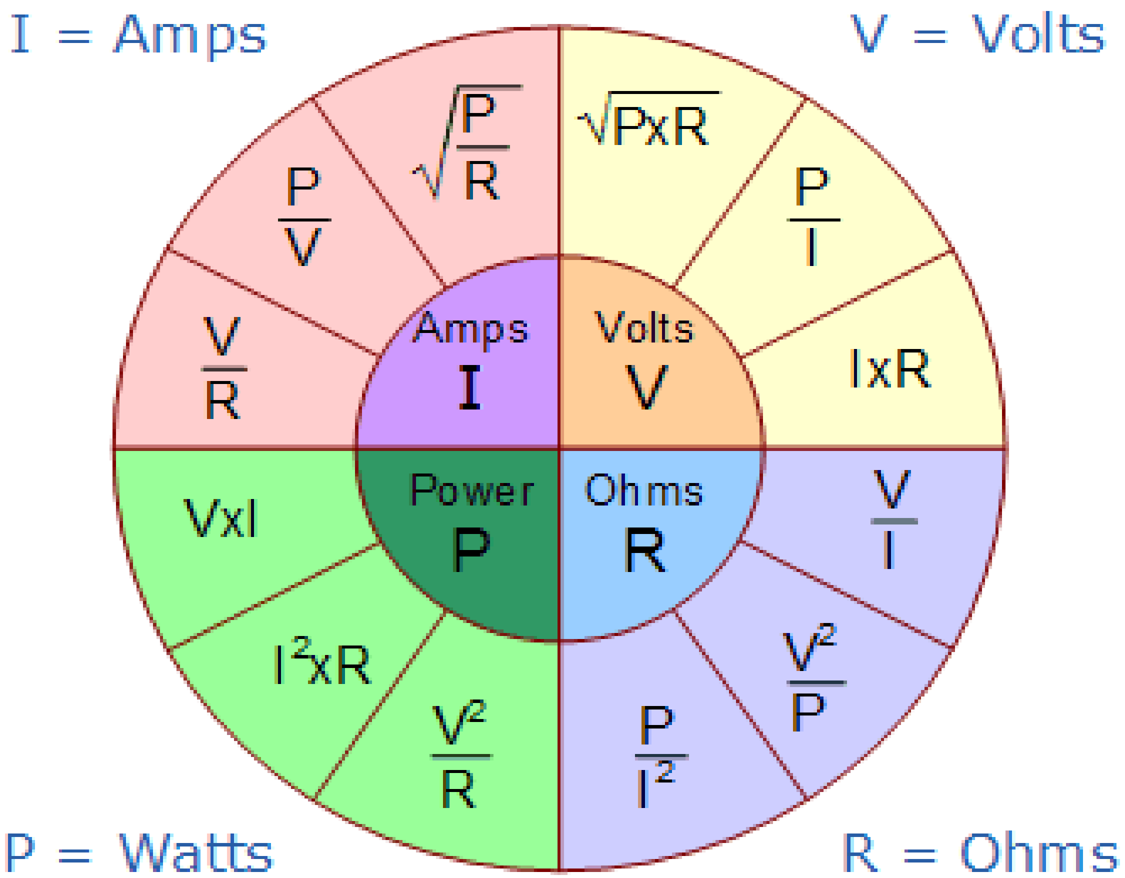
- Resistance is defined as *the ratio of voltage over current* denoted as R measured in Ohm (Ω)

Power: P = VI

- Electrical power is defined as *the product of voltage and current* denoted as P measured in Watt (W)

Ohm's law pie chart

The fundamental relationship between voltage, current and resistance in an electrical or electronic circuit is called **Ohm's Law**



Ohm's law matrix table

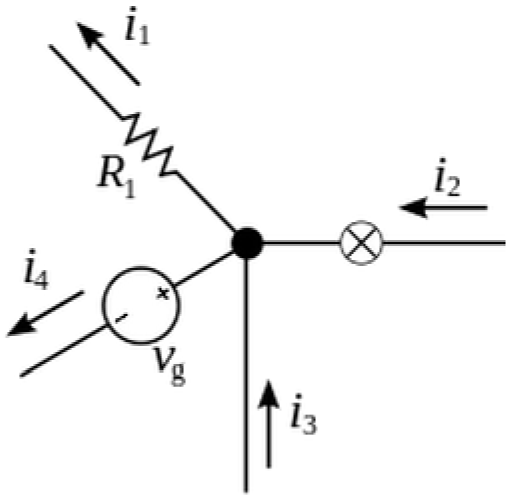
Ohms Law Formulas				
Known Values	Resistance (R)	Current (I)	Voltage (V)	Power (P)
Current & Resistance	---	---	$V = I \times R$	$P = I^2 \times R$
Voltage & Current	$R = \frac{V}{I}$	---	---	$P = V \times I$
Power & Current	$R = \frac{P}{I^2}$	---	$V = \frac{P}{I}$	---
Voltage & Resistance	---	$I = \frac{V}{R}$	---	$P = \frac{V^2}{R}$
Power & Resistance	---	$I = \sqrt{\frac{P}{R}}$	$V = \sqrt{P \times R}$	---
Voltage & Power	$R = \frac{V^2}{P}$	$I = \frac{P}{V}$	---	---

Kirchhoff's current law (KCL)

- Kirchoff’s first law: Point rule or Kirchhoff's junction rule (or nodal rule).

The current entering any junction is equal to the current leaving that junction:

i1 + i4 = i2 + i3

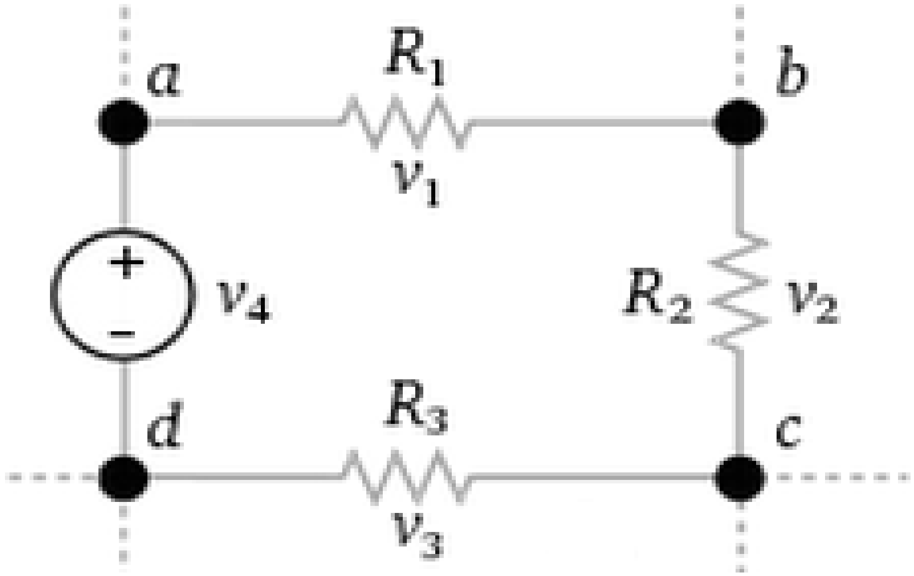


The algebraic sum of current at a junction is zero

Kirchhoff's voltage law (KVL)

- Kirchhoff's second law or Kirchhoff's loop (or mesh) rule.

The sum of all the voltages around the loop is equal to zero :



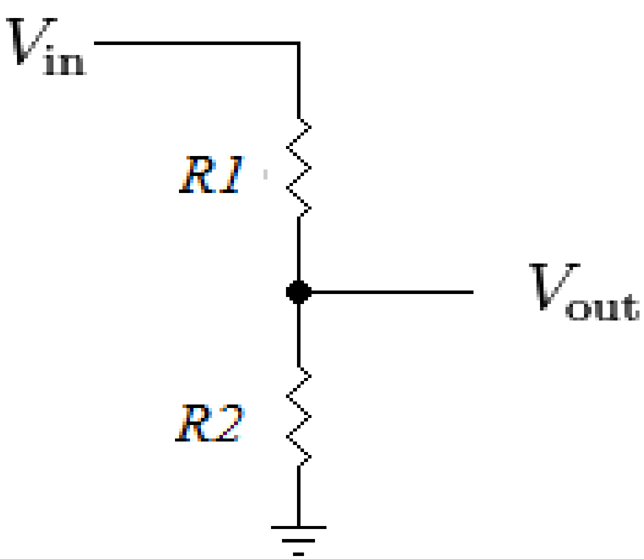
v4 = v1 + v2 + v3

The sum of the emf's in a closed circuit is equal to the sum of potential drops

KVL and KCL Examples

- **VOLTAGE DIVIDER**
- is a linear circuit that produces an output voltage (Vout) that is a fraction of its input voltage (Vin). Voltage division refers to the partitioning of a voltage among the components of the divider.

Applying **KCL**, it can be observed by inspection, that the current i flowing through the resistors R1 and R2 must be equal.



Applying **KVL**

Vin = i R1 + i R2,   then   i = Vin/(R1 + R2)

The voltage across R2 is given by

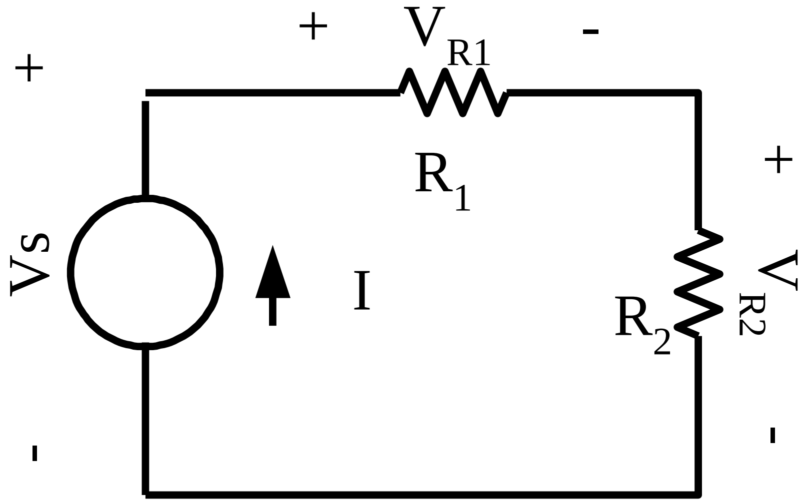
Vout =[i / (R1 + R2)] x Vin

This formula is called the voltage divider rule.

Law of Voltage division

$$V_{R_1} = \frac{R_1}{R_1 + R_2} V_s$$

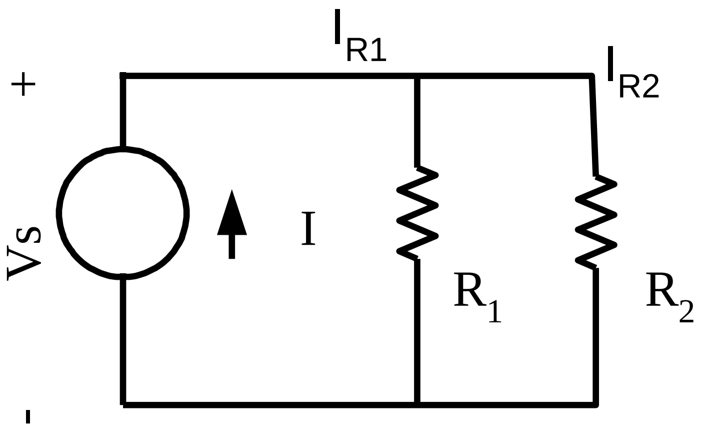
$$V_{R_2} = \frac{R_2}{R_1 + R_2} V_s$$



Law of Current division

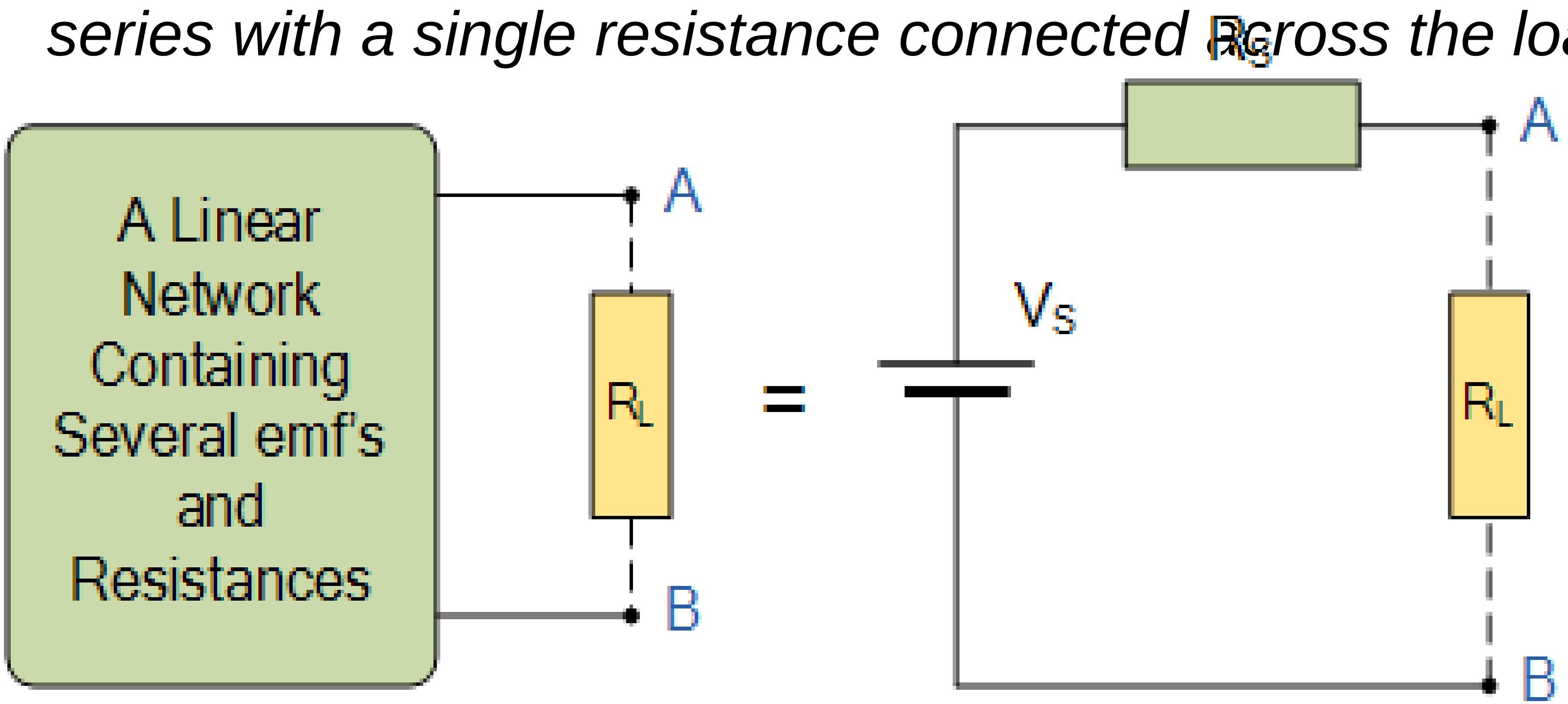
$$I_{R_1} = \frac{R_2}{R_1 + R_2} I$$

$$I_{R_2} = \frac{R_1}{R_1 + R_2} I$$



Thevenin's Theorem

- *Any linear circuit containing several voltages and resistances can be replaced by just one single voltage in series with a single resistance connected across the load*

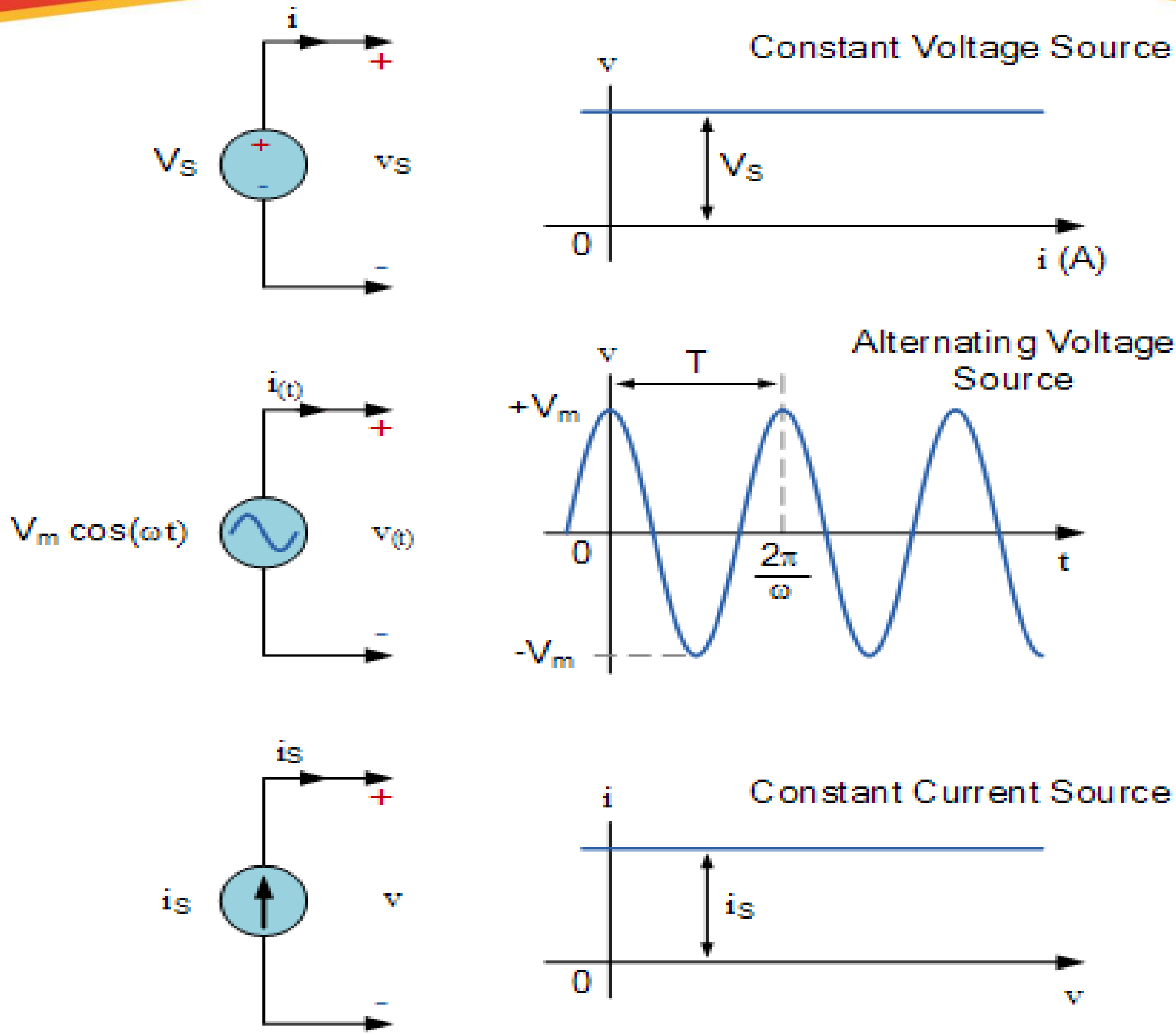


Any complex "one-port" network consisting of multiple resistive circuit elements and energy sources can be replaced by one single equivalent resistance Rs and one single equivalent voltage Vs.

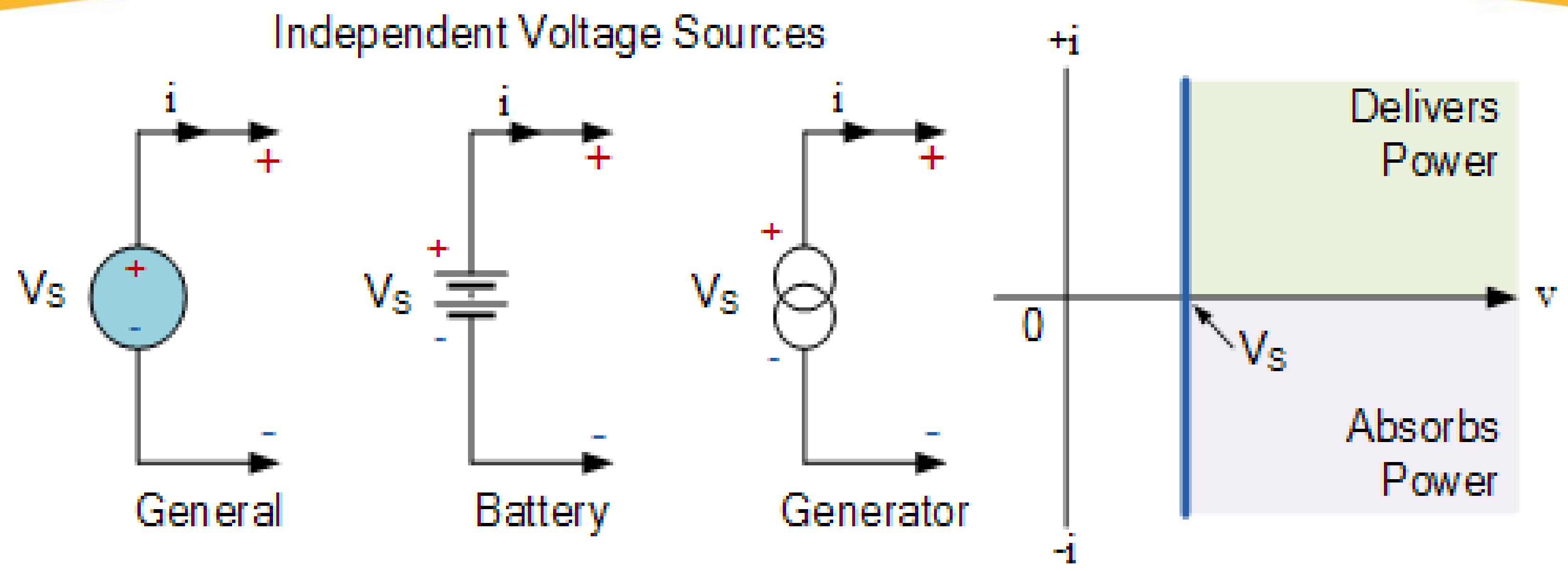
Electrical Sources

- There are two types of elements within an electrical or electronics circuit: *passive elements* and *active elements*
- An **active element** is one that is capable of continuously supplying energy to a circuit, such as a battery, a generator, an operational amplifier, etc.
- A **passive element** on the other hand are physical elements such as resistors, capacitors, inductors, etc, which cannot generate electrical energy by themselves but only consume it.
- a "s**ource**", is a device that supplies electrical power to a circuit in the form of a voltage source or a current source. can be classed as a direct (DC) or alternating (AC) source

Electrical Sources



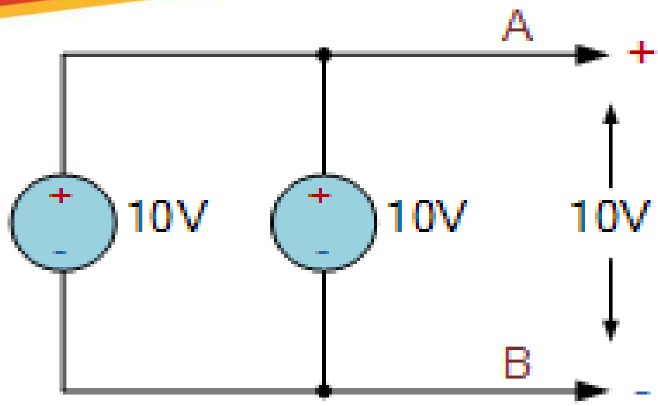
Voltage Sources



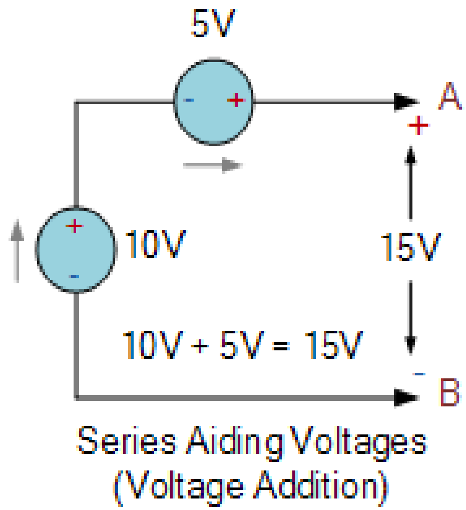
•An **ideal voltage source** will supply a constant voltage at all times regardless of the value of the current being supplied producing an I-V characteristic represented by a straight line.

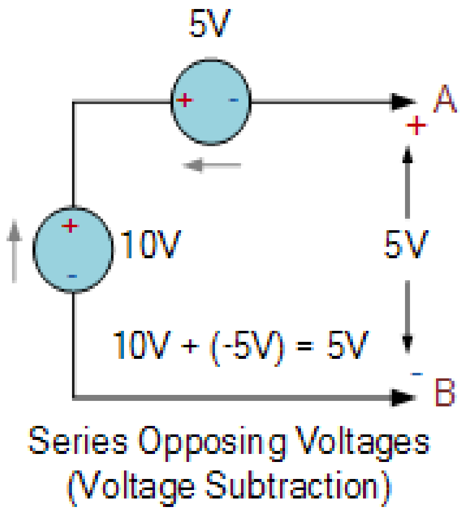
•a **Dependent Voltage Source** or controlled voltage source, provides a voltage supply whose magnitude depends on either the voltage across or current flowing through some other circuit element

Connecting Voltage Sources together



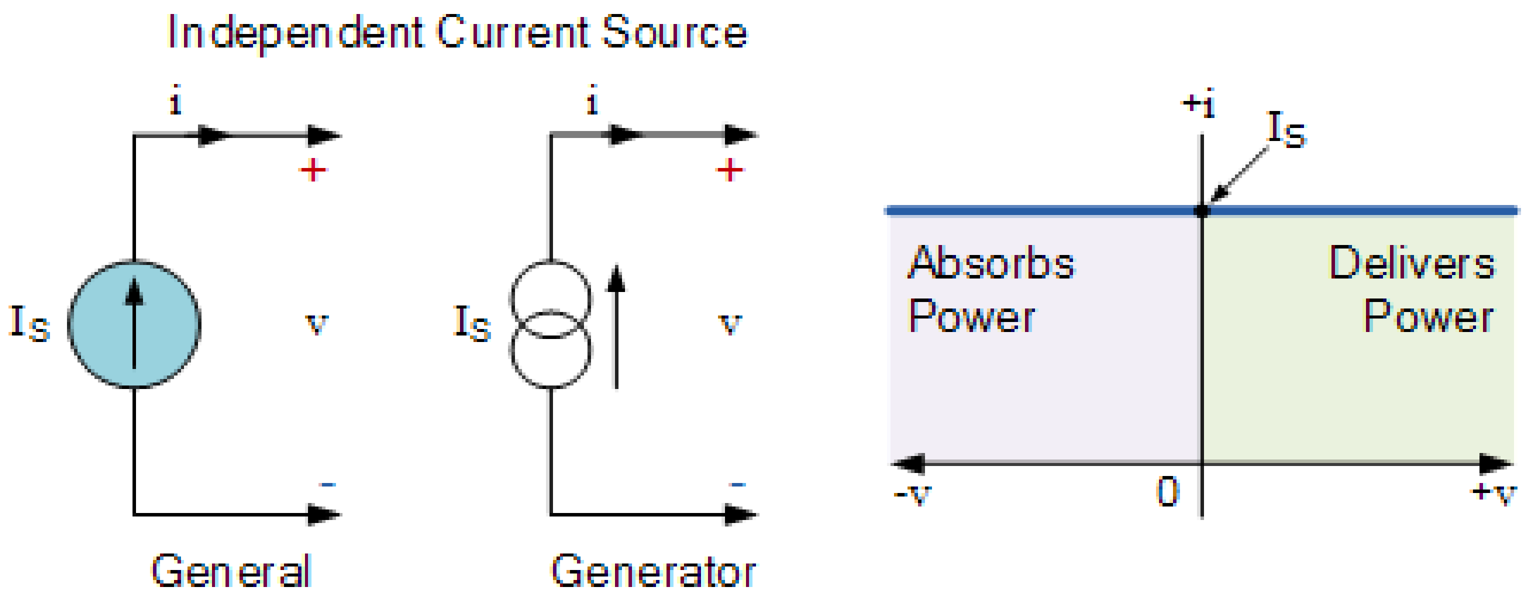
Voltage Sources in Parallel





Voltage Sources in Series

Current Sources



•an **ideal current source** is called a “constant current source” as it provides a constant steady state current independent of the load connected to it producing an I-V characteristic represented by a straight line..

•The current source can be either independent (ideal) or dependent i.e. controlled by a voltage or current elsewhere in the circuit, which itself can be constant or time-varying.

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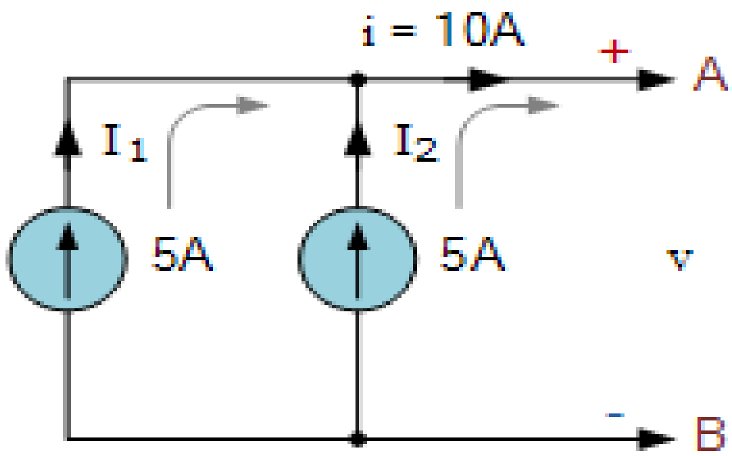
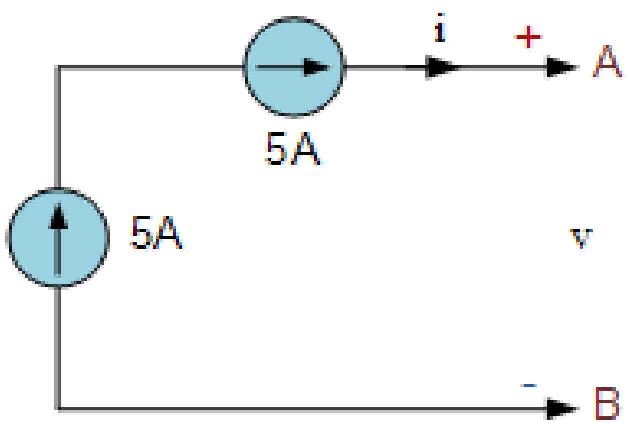
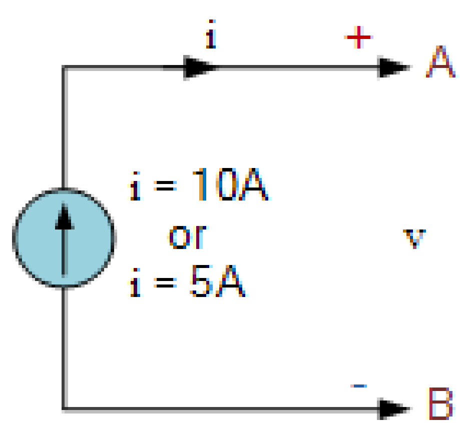
Connecting Current Sources together



Current Sources in Parallel





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Current Sources in Series

It is **not allowed** to connect current sources together in series, either of the same value or ones with different values.

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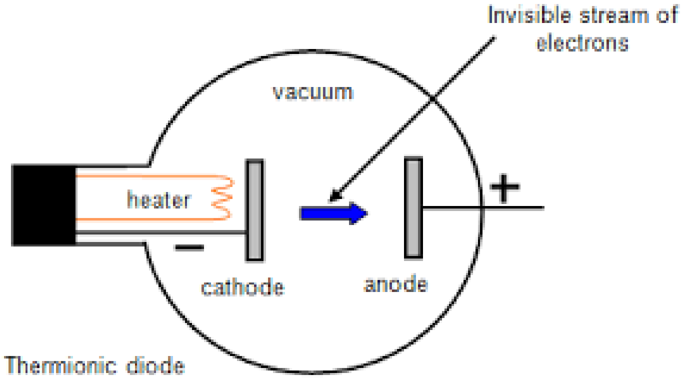

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THANK YOU