Current and Charge.

Simple description: Charge is a fundamental property of matter that causes it to experience a force when placed in an electric field.

Scientific definition: Electric charge is a fundamental quantity of nature that can be either positive or negative. It is measured in coulombs (C).

Unit of measurement: Coulomb (C)

How charges move through a material: Charges move through a material by interacting with the electric field created by the material's atoms. In metals, for example, the charges that move are electrons. The electrons are free to move around the metal atoms because they are not tightly bound to them.

Formula: None

Sample calculation: None

How to measure charge: There are a number of ways to measure charge, but the most common method is to use a capacitor. A capacitor is a device that stores charge. The amount of charge stored on a capacitor can be measured by measuring the voltage across the capacitor.

Voltage

Simple description: Voltage is the difference in electric potential between two points. It is a measure of the electrical energy per unit charge.

Scientific definition: Voltage is the electric potential difference between two points. It is measured in volts (V).
Unit of measurement: Volt (V)

How charges move through a material: Voltage causes charges to move from a region of higher electric potential to a region of lower electric potential.

Formula: $V = W/Q$, where V is voltage, W is work, and Q is charge.
Sample calculation: A 12V battery has a voltage of 12V. This means that it can do 12 joules of work per coulomb of charge.

How to measure voltage: Voltage can be measured using a voltmeter. A voltmeter is a device that measures the potential difference between two points. To use a voltmeter, connect the positive lead of the voltmeter to the point with the higher electric potential and the negative lead of the voltmeter to the point with the lower electric potential. The voltmeter will then display the voltage difference between the two points.

Current
Simple description: Current is the flow of electric charge. It is measured in amperes (A).

Scientific definition: Electric current is the rate of flow of electric charge through a conductor. It is measured in amperes (A).

Unit of measurement: Ampere (A)

How current move through a material: Current flows through a material due to the movement of charged particles. In metals, for example, the charged particles that move are electrons. The electrons are free to move around the metal atoms because they are not tightly bound to them.

Formula: I = Q/t, where I is current, Q is charge, and t is time.

Sample calculation: A current of 1A flows through a wire when 1C of charge flows through the wire in 1 second.

How to measure current: Current can be measured using an ammeter. An ammeter is a device that measures the current flowing through a circuit. To use an ammeter, connect the ammeter in series with the circuit. The ammeter will then display the current flowing through the circuit.

Conventional current vs. electron flow

Conventional current is defined as the flow of positive charge from a positive terminal to a negative terminal. Electron flow is the actual flow of electrons from a negative terminal to a positive terminal.

Why voltage is sometimes called Potential Difference
Voltage is sometimes called potential difference because it is the difference in electric potential between two points. Electric potential is the energy per unit charge at a point in space.

Resistance:

Resistance is the force that opposes the flow of charge.

Power	P	V		

Series Vs Parallel

Connection:

- Series circuit: Components are connected in a single loop, one after the other. Imagine Christmas lights strung together – if one bulb burns out, the entire string loses power.
- Parallel circuit: Components are connected across two common points, creating multiple paths for current to flow. Think of connecting two wires to a battery at separate points – both wires receive power independently.

Current:

- Series circuit: Same current flows through all components. Think of water flowing through a single pipe – the amount doesn't change as it passes through.
- Parallel circuit: Current splits and flows through each component individually. Picture water flowing through multiple pipes connected to a reservoir – each pipe receives a portion of the total flow.

Voltage:

- Series circuit: Voltage is divided across all components. The sum of the individual voltages across each component equals the total voltage supplied. Think of climbing stairs – each step represents a voltage drop.
- Parallel circuit: Same voltage is applied to all components. Imagine having identical water towers feeding multiple hoses – each hose receives the same pressure (voltage).

Behavior:

Series circuit: If one component fails, the entire circuit breaks. Like with the Christmas lights, a burnt bulb disrupts the whole set.

- Parallel circuit: Failure of one component doesn't necessarily affect the others. The remaining components continue to function independently, making parallel circuits more reliable.

Applications:

- Series circuits: Used for controlling current, like in dimmer switches or series-connected LEDs.
- Parallel circuits: Used for distributing power equally, like in household wiring or connecting multiple batteries for increased voltage.

A voltmeter is connected in a circuit in parallel with the component or section of the circuit where you want to measure the voltage.

- Parallel connection means that both the voltmeter and the component have the same potential difference across their terminals. This ensures you're measuring the actual voltage at that point.
- Voltmeters have a very high internal resistance. This minimizes the current flowing through the voltmeter itself and prevents it from significantly affecting the circuit's overall behavior.

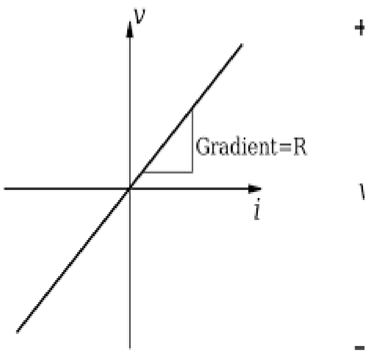
There are two main reasons why voltmeters are connected in parallel with the component whose voltage they are measuring:

- Measure Potential Difference: Voltmeters are designed to measure the potential difference (voltage) between two points in a circuit. Since components in parallel experience the same potential difference, the voltmeter is placed across those two points to accurately reflect the voltage.
- High Resistance: An ideal voltmeter has a very high internal resistance. This minimizes the current drawn by the meter itself, ensuring it doesn't significantly affect the overall current flow in the circuit. If a voltmeter with high resistance were connected in series, it would act like a large obstacle for the current, leading to inaccurate readings

V-I Graphs

1. Resistor:

V-I Graph: A straight line passing through the origin, with a constant slope equal to the reciprocal of the resistance (1/R).

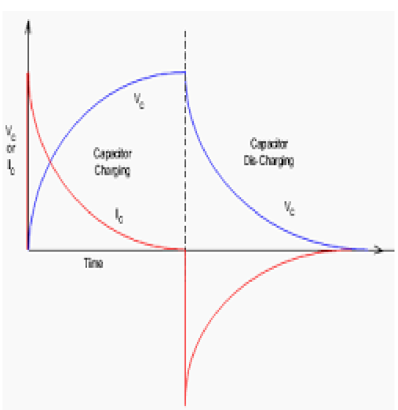


VI graph for Resistor

Justification: Ohm's Law dictates that V = IR, where V is voltage, I is current, and R is resistance. For a constant resistor, the ratio of V to I remains constant, resulting in a straight line.

2. Capacitor:

V-I Graph: A semicircle centered at the origin, with the slope increasing gradually towards the positive and negative voltage axes.

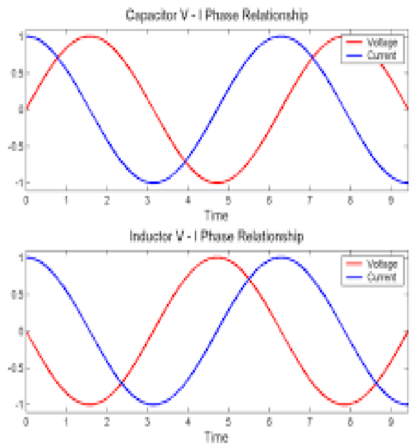


VI graph for Capacitor

Justification: Capacitors oppose changes in voltage by storing and releasing electrical energy. As the voltage applied to a capacitor increases, its current initially shoots up but then gradually tapers off as the capacitor charges and reaches its steady state. The reverse happens when the voltage decreases.

3. Inductor:

V-I Graph: A straight line with a positive slope, intersecting the y-axis at a point proportional to the inductance (L).



VI graph for Inductor

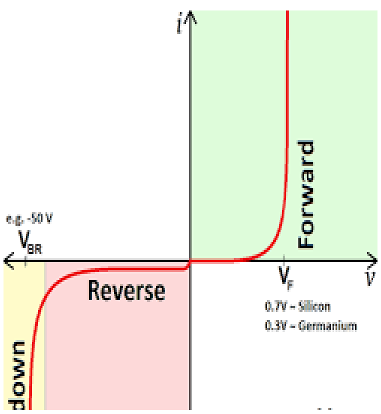
Justification: Inductors resist changes in current by inducing a voltage opposite to the change. When the voltage applied to an inductor increases, the induced voltage opposes the change, causing the current to rise gradually. Once the voltage reaches a steady state, the induced voltage disappears, and the current remains constant.

4. Diode:

V-I Graph: A curve with two distinct regions:

Forward Bias: A sharp rise in current at a specific voltage threshold (forward voltage), followed by a relatively linear increase with further voltage increase.

Reverse Bias: Almost negligible current flow until a breakdown voltage is reached, at which point current increases dramatically.



VI graph for Diode

Justification: Diodes allow current to flow in one direction (forward bias) with minimal resistance after the forward voltage is overcome. In reverse bias, they act as insulators, blocking current flow until the breakdown voltage is reached.

What is static electricity?

Static electricity is a buildup of electrical charges on an object. It can be caused by friction, contact with another object with a different charge, or even by walking across a carpet. Static electricity is often associated with a shock or spark when you touch something with a different charge. However, it can also cause other problems, such as damaging electronic devices or interfering with manufacturing processes.

causes your bad hair day?

How does static electricity work?

Static electricity is caused by an imbalance of electrons between two objects. Electrons are negatively charged particles, so when they move from one object to another, they create a charge imbalance. The object with more electrons becomes negatively charged, while the object with fewer electrons becomes positively charged.

Static electricity can be generated in a number of ways, but the most common is through friction. When two objects rub against each other, electrons can be transferred from one object to the other. This creates a charge imbalance, and the two objects become oppositely charged.

Static Induction:

Electrostatic induction, also known as "electrostatic influence" or simply "influence" in Europe and Latin America, is a redistribution of electric charge in an object caused by the influence of nearby charges.