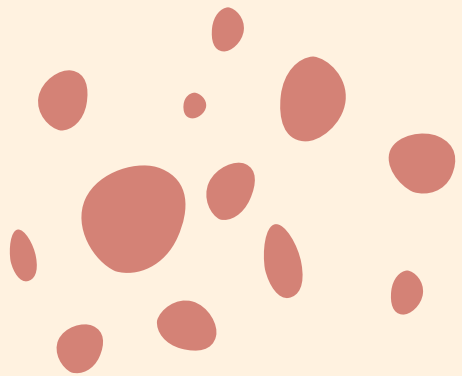




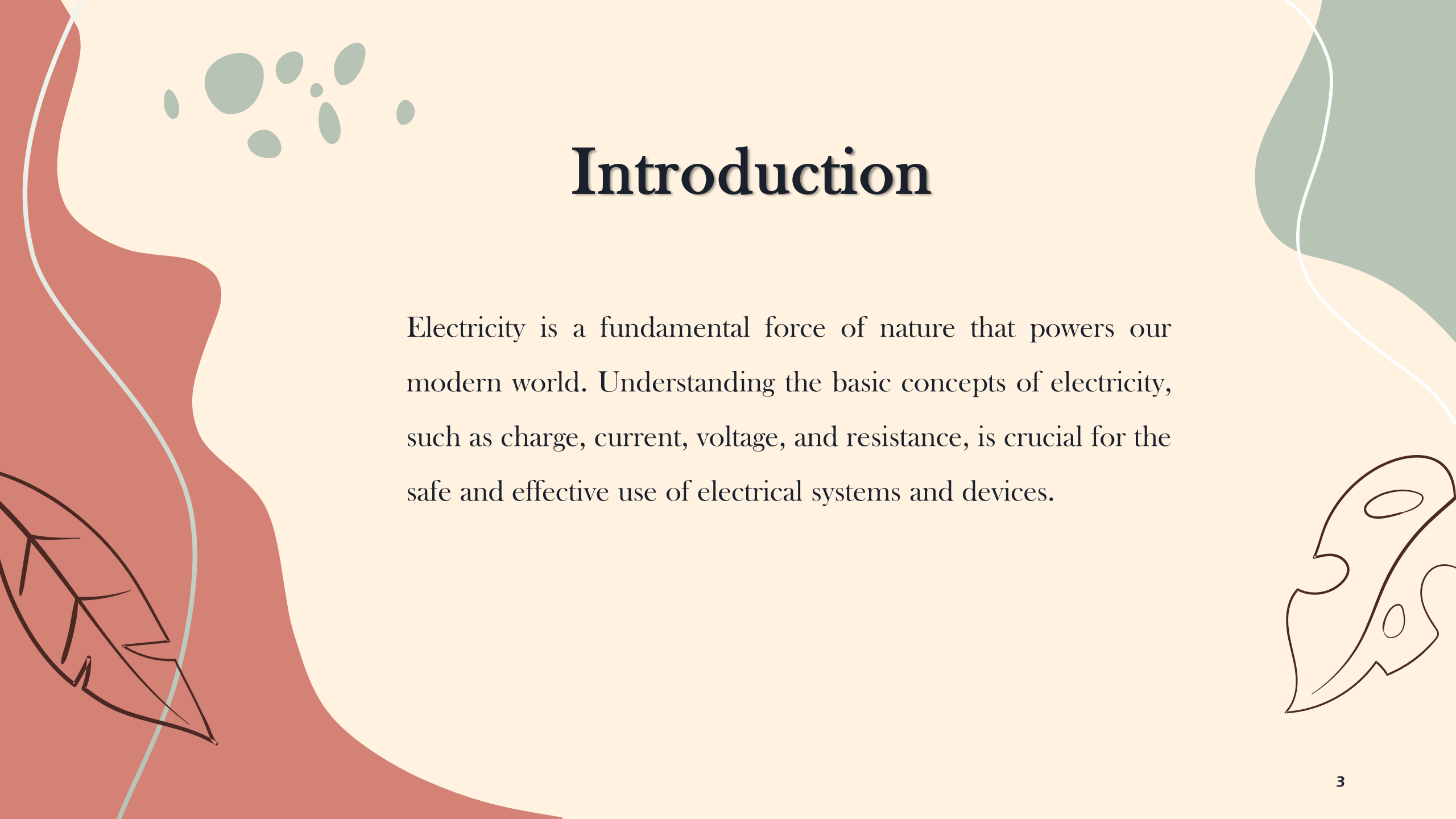
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Basic Electrical Concepts

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Introduction

Electricity is a fundamental force of nature that powers our modern world. Understanding the basic concepts of electricity, such as charge, current, voltage, and resistance, is crucial for the safe and effective use of electrical systems and devices.

What is electricity?

At its core, electricity is a form of energy that results from the movement of charged particles, primarily electrons. It's a fundamental force of nature that we have harnessed to power our modern world.

From lighting our homes and charging our devices to running massive industrial machinery, electricity is an indispensable part of daily life.



Electric charge and electric current



Analogy: Water Flow

If voltage is the water pressure, current is the actual flow rate of the water through the hose. A higher current means more electrons are flowing past a point each second

All matter is composed of atoms. Atoms contain a nucleus with positively charged protons and neutral neutrons. Negatively charged electrons orbit this nucleus. In many materials, especially metals, the outermost electrons are not tightly bound and are free to move between atoms. It is the flow of these 'free electrons' that constitutes an *electric current*.

Electrical charge is a fundamental property of matter, with positive and negative charges existing in all materials.

Current is the rate at which electric charge—specifically, electrons—flows past a point in a circuit. It is measured in amperes (A), and is a key factor in determining the power and energy consumption of electrical devices.

Voltage and potential difference

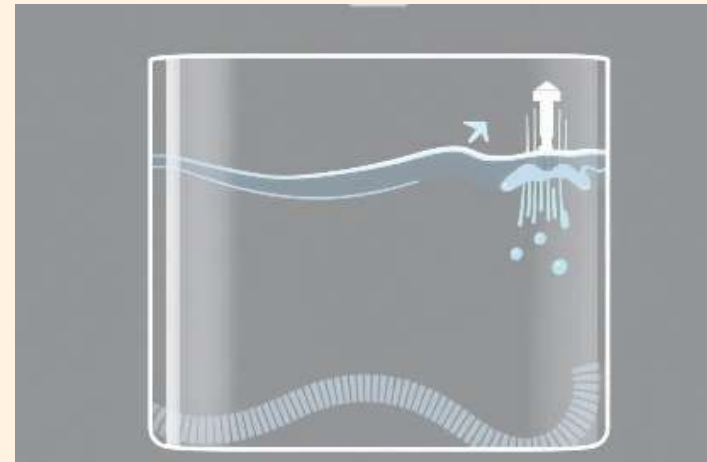
Voltage is the potential difference or 'pressure' that causes electrons to flow in a circuit. It's the push that sets the charges in motion.

Potential difference is the difference in electrical potential between two points in a circuit, which causes current to flow.

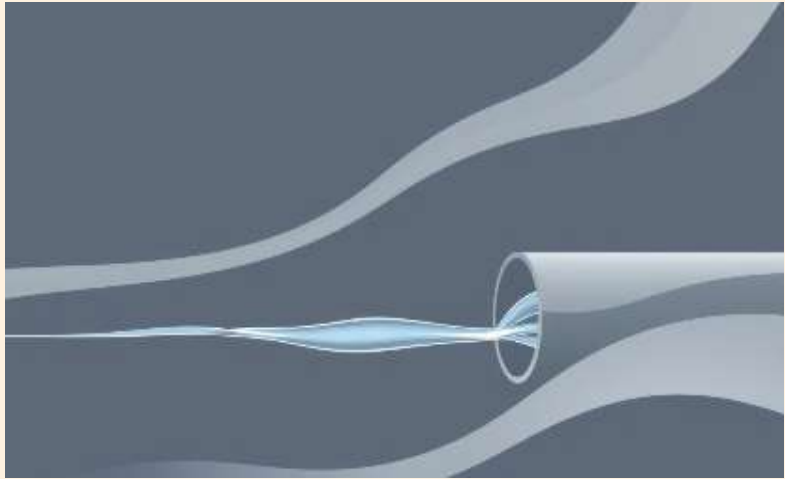
Voltage is measured in volts (V) and is a crucial factor in determining the power and energy consumption of electrical devices.

Analogy: Water Tank

Think of a water tank. The height of the water in the tank creates pressure. Higher water level means higher pressure. Similarly, a higher voltage provides a stronger 'push' for the electrons.



Resistance and Ohm's law

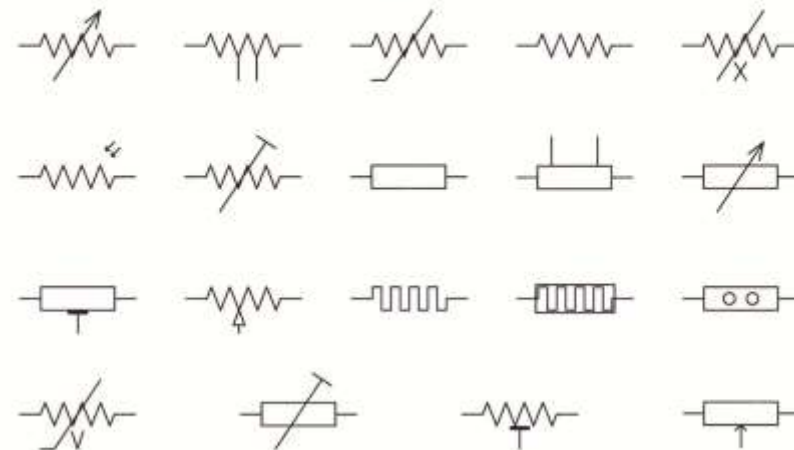


Analogy: Narrow Pipe

Imagine the water hose being squeezed or filled with gravel. This restriction makes it harder for water to flow. In an electrical circuit, resistance similarly limits the flow of electrons.

Resistance is a measure of how much a material opposes the flow of electric current. Conductors have low resistance, while insulators have very high resistance. It is measured in ohms (Ω).

Electrical / Resistors



Resistance and Ohm's law

Ohm's Law defines the fundamental relationship between voltage, current, and resistance. It states that the current flowing through a circuit is directly proportional to the voltage and inversely proportional to the resistance.

- Voltage (V) = Current I $\times$ Resistance R
- If you increase voltage, current will increase.
- If you increase resistance, current will decrease.

Energy

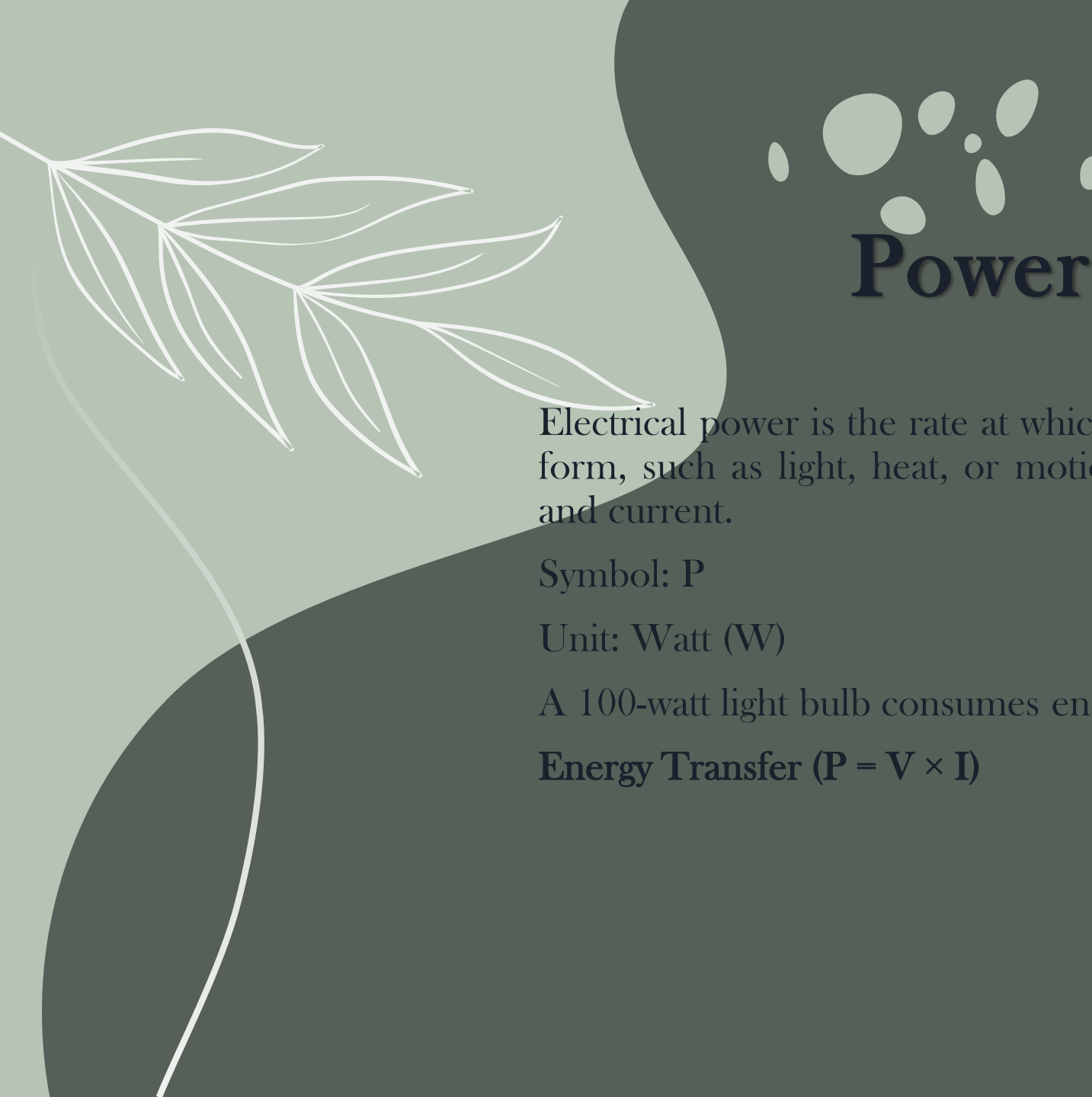
Electrical energy is the capacity to do work, measured in joules (J) or kilowatt-hours (kWh).

the heat produced (or energy dissipated) is given by the equation:

$$W = I^2 R t$$

And applying Ohm's law, we obtain

$$W = \frac{V^2 t}{R} \text{ or } W = V I t$$



Power

Electrical power is the rate at which electrical energy is converted into another form, such as light, heat, or motion. It's calculated as the product of voltage and current.

Symbol: P

Unit: Watt (W)

A 100-watt light bulb consumes energy at a higher rate than a 60-watt bulb.

Energy Transfer ($P = V \times I$)

Circuits

An electric circuit is an interconnection of electrical elements. Electric circuits are used in numerous electrical systems to accomplish different tasks.



Components are connected end-to-end.

There is only one path for the current.

If one bulb burns out, the entire circuit breaks.

$$V = V_1 + V_2 + V_3 + \dots = \sum_{i=1}^n V$$
$$I = I_1 = I_2 = I_3 = \dots$$



Components are connected on separate branches.

The current splits to flow through multiple paths.

If one bulb burns out, the other can stay lit.

$$I = I_1 + I_2 + I_3 + \dots = \sum_{i=1}^n I$$
$$V = V_1 = V_2 = V_3 = \dots$$

Circuits

Common Electrical Components



Resistor

Controls or
limits current.



Capacitor

Stores
electrical
energy.



LED

Emits light
when current
flows.



Switch

Opens or
closes a
circuit.

Circuits

Alternative circuit vs Direct circuit

Direct Current
(DC)

Direct current (DC) is a unidirectional flow of electric charge, where the electrons move in a single direction.

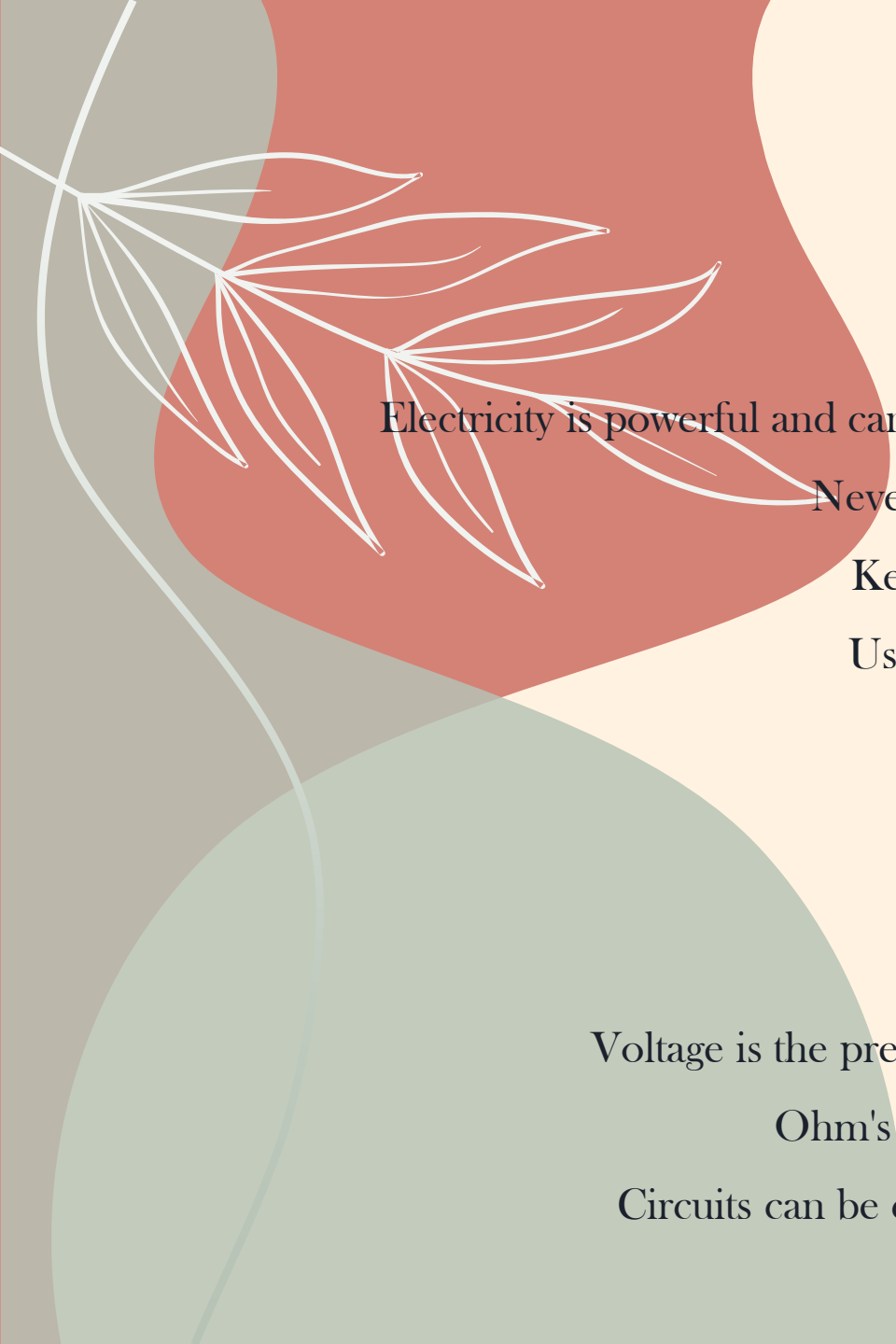
Alternating Current
(AC)

Alternating current (AC) is a type of electric current where the flow of electric charge periodically reverses direction.

Applications

DC is commonly used in batteries and electronic devices, while AC is the standard for power grids and household outlets.





Conclusion

Electricity is powerful and can be dangerous. Always treat it with respect and follow safety guidelines.

Never work on live circuits. Disconnect power first.

Keep water away from all electrical equipment.

Use tools with insulated handles for protection.

Do not overload electrical outlets.

Be aware of warning signs.

Key Takeaways

Electricity is the flow of electrons.

Voltage is the pressure, Current is the flow, and Resistance is the opposition.

Ohm's Law ($V=IR$) is the key formula connecting them.

Circuits can be connected in series (one path) or parallel (multiple paths).

Always prioritize safety!