Resistor

Resistors are essential components in circuits, useful for simple projects like LEDs and more complex tasks.
Directly connecting an LED to the battery results in immediate failure due to excess voltage.
Ohm's Law is used to calculate the necessary resistance value (approximately 524 Ohms), with a commercial option of 680 Ohms being suitable.
Standard resistors (1/4 Watt) cannot handle high power applications; thus, "power resistors" are required, albeit less efficient due to energy loss as heat.
Using two or more resistors in series creates a voltage divider, allowing different output voltages without exceeding the supply voltage.
This technique can convert Arduino data signals from 5V to 3.3V for devices like the ESP8266 Wi-Fi module.
Potentiometers serve as adjustable resistances; they can stabilize input voltages for microcontrollers or operational amplifiers.
An Arduino Nano example illustrates how pressing a button sends a HIGH signal (+5V), but releasing it causes erratic behavior.
A pull-down resistor (10 KOhms) stabilizes the input by grounding it when not pressed, creating stable logic levels (0 and 1).
A pull-up resistor connects the input pin to +5V, ensuring stable readings when switches are involved; commonly used with MOSFET gates.
Small-value resistors ("shunts") measure current by amplifying voltage drop across them; useful in multimeters and current meters.
Resistors can act as fuses by exceeding their power rating deliberately or be utilized in sensors like photoresistors or temperature sensors (PT100). Unlike inductors or capacitors, resistors do not cause phase shifts; they behave similarly under DC conditions but consume more current at higher frequencies.
Parasitic inductance and capacitance affect real-world resistor performance, leading to unexpected behaviors if not accounted for during circuit design.