To determine the **current (amps) at different voltages with different resistors**, you can use **Ohm's Law** and the **Power Law**. Here's a step-by-step explanation:

Step 1: Understanding Ohm's Law

Ohm's Law is the fundamental equation that relates **Voltage (V), Current (I), and Resistance (R)**:

$$V = I * R$$

Rearranging for current:

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

where:

- V = voltage in **volts (V)**
- I = current in **amperes (A)**
- R = resistance in **ohms (Ω)**

Step 2: Calculate Current for a Given Voltage and Resistor

For a **specific voltage** and a **specific resistor**, you can find the current using:

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

Example 1: Single Resistor

If you apply **12V** to a **1kΩ (1000Ω) resistor**, the current is:

$$I = \frac{12V}{1000\Omega} = 0.012A = 12mA$$

If you increase the voltage to **24V**:

$$I = \frac{24V}{1000\Omega} = 0.024A = 24mA$$

Step 3: Working with Multiple Resistors

If you have **multiple resistors**, the calculation depends on how they are connected: **series or parallel**.

Case 1: Resistors in Series

In a **series circuit**, resistances **add up**:

$$R_{total} = R_1 + R_2 + R_3 + \ldots$$

The current is the same through all resistors:

$$I = \frac{V}{R_{total}}$$

Example: Two resistors in series

- R_1 = 1kΩ
- R_2= 2kΩ
- Voltage: V = 12V

Total resistance:

$$R_{total} = 1k\Omega + 2k\Omega = 3k\Omega$$

Current:

$$I = \frac{12V}{3000\Omega} = 0.004A = 4mA$$

Case 2: Resistors in Parallel

In a **parallel circuit**, the total resistance is found using:

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

The voltage across each resistor is the same, but the current is divided.

Example: Two resistors in parallel

- R_1 = 1kΩ
- R_2= 2kΩ
- Voltage: V = 12V

First, calculate total resistance:

$$\frac{1}{R_{total}} = \frac{1}{1000\Omega} + \frac{1}{2000\Omega}$$

$$\frac{1}{R_{total}} = 0.001 + 0.005 = 0.0015$$

$$R_{total} = \frac{1}{0.0015} = 666.7\Omega$$

Current:

$$I = \frac{12V}{666.7\Omega} = 0.018A = 18mA$$

Each resistor gets a different current:

$$I_1 = \frac{12V}{1000\Omega} = 12mA$$

$$I_1 = \frac{12V}{2000\Omega} = 6mA$$

Step 4: Power Dissipation

The power dissipated by a resistor is:

$$P = V * I$$

or using resistance:

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

or:

$$P = I^2 * R$$

Example: Power in a 1kΩ resistor at 12V

$$P = \frac{12^2}{1000} = \frac{144}{1000} = 0.144W$$

or using current:

$$P = (0.012A)^2 * 1000\Omega = 0.000144 * 1000 = 0.144W$$

Step 5: Generalized Formula for Any Voltage and Resistance

For **any resistor R at voltage V**:

1. **Current Calculation**:

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

2. **Power Calculation**:

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

Final Summary

- **To find current**: Use $I = V/R$
- **To find power**: Use $P = V^2/R$
- **For series resistors**: Add resistances $R_{total} = R_! + R_2 + \ldots$
- **For parallel resistors**: Use $1/R_{total} = 1/R_1 + 1/R_2 + \ldots$
- **Power dissipation** can be found using $P = V^2/R \; or \; P = I^2R$