Electronics

Parallel Resistance

Lecture Contents

- Review of measuring voltage and current
- Understanding Parallel Resistors
  - Kirchhoff’s Current Law
  - Equivalent Resistance

Turning the Multimeter Off

- Turn the power off when you are finished using the multimeter.
- The meter will also first beep, then turn itself off if it hasn't been used for a time.

Measuring resistance

- When measuring **resistance** or **voltage**, insert:
  - the **black** lead into the “COM” (*common*) port, and
  - the **red** lead into the “ V Ω ⊣⊢ ” port.

By convention:

- **Black** is used for ***negative*** (or ***ground***)
- RED is used for ***positive*** voltage

Measuring resistance

- To measure resistance, set the dial to the appropriate value.
- The value on the dial should be slightly larger than the resistor value.

Measuring resistance

- If the dial setting is too low, the screen will read `OL` (*over limit*).

  Try a higher setting or, check the connections.

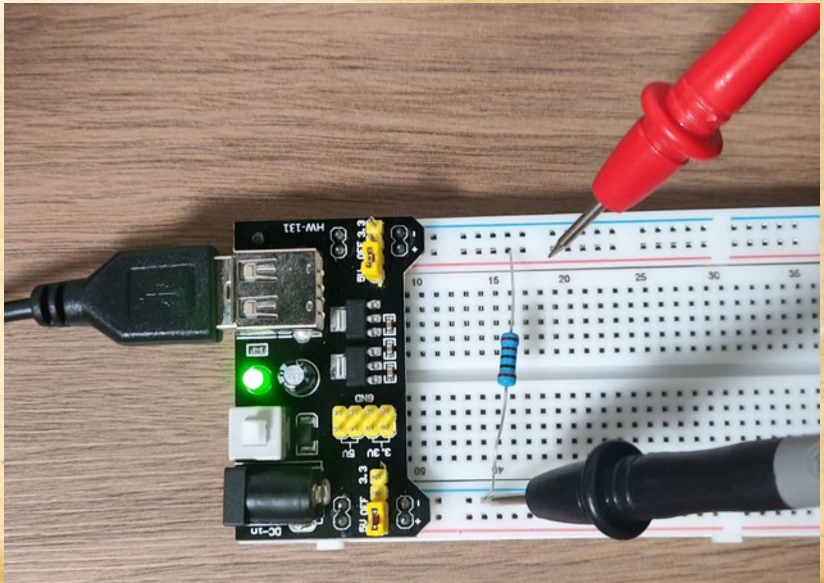
Measuring resistance

- If the dial setting is too high, the screen will measure zero or a small number.

  Try a lower setting to get a more accurate reading.

Warning

- Do **NOT** try to measure resistance when the resistor is in a circuit.
  - The value will be incorrect
  - If the power is on, it will likely damage the meter.

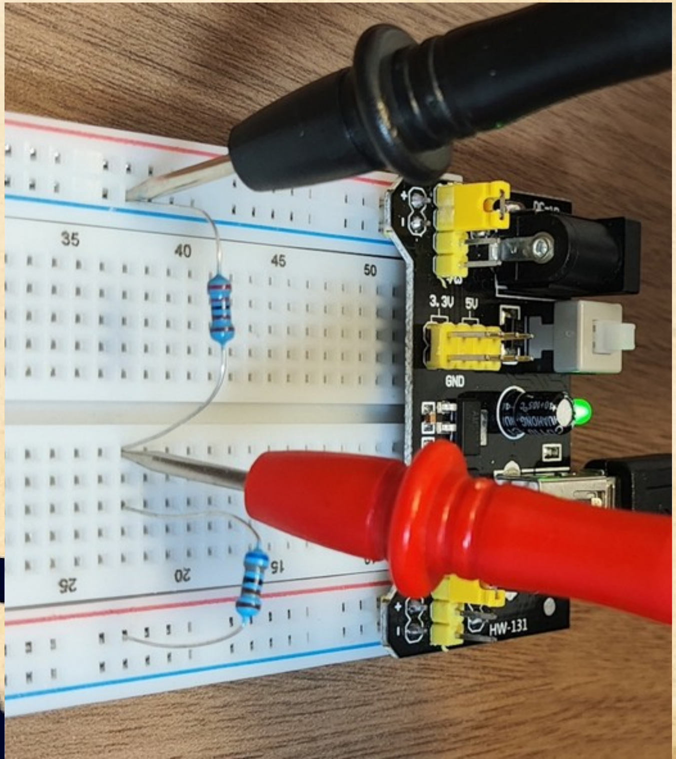


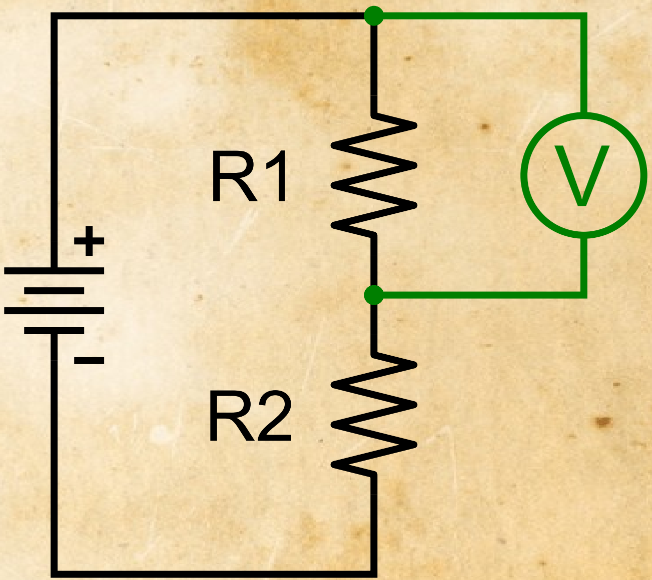
Measuring Voltage

- To measure voltage, set the dial to the appropriate value.
- Since we have a 5 volt power supply, in most cases, the 20V setting will be appropriate.

Measuring Voltage

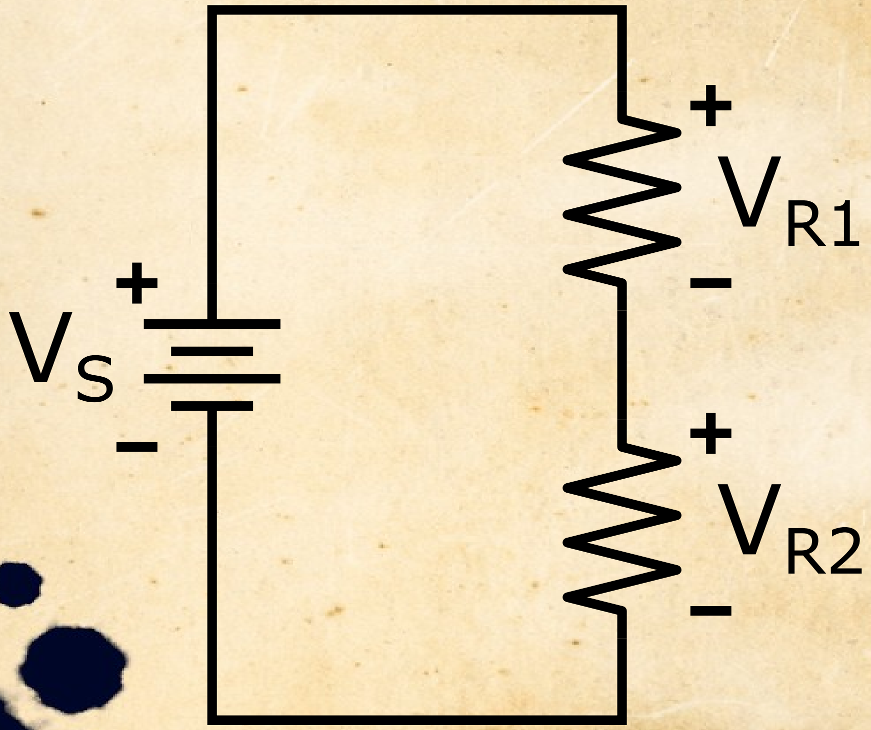
- Measure *voltage drop* across elements





Kirchhoff's Voltage Law

- ***the algebraic sum of all voltages around any closed loop is zero.***

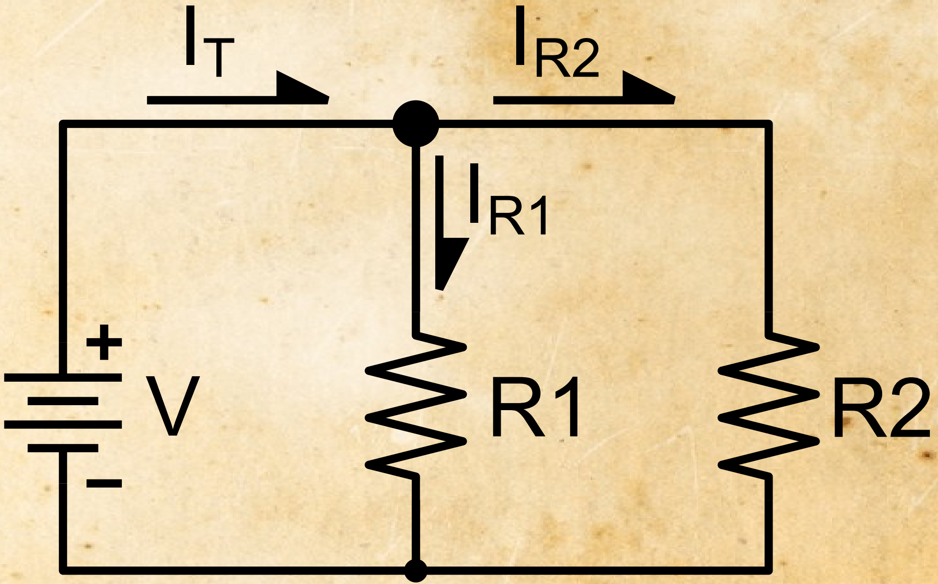


$$V_S + (-V_{R1}) + (-V_{R2}) = 0$$

$$V_S = V_{R1} + V_{R2}$$

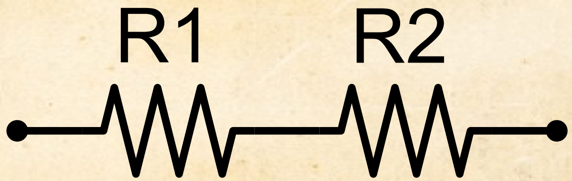
Kirchhoff's Current Law

- *The sum of all currents into a node equals the sum of all currents out of the node.*

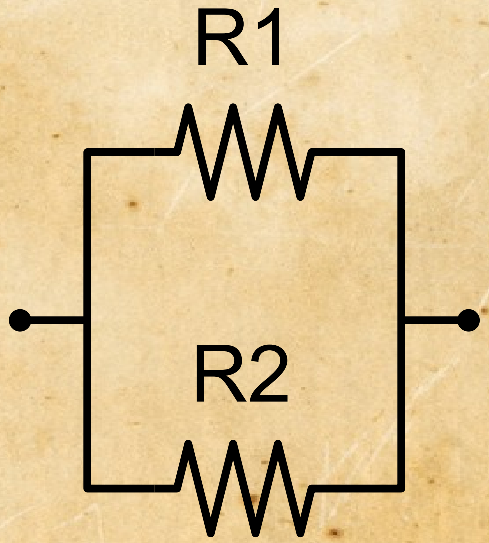


Series Versus Parallel Resistors

- The current splits between two or more paths in a parallel circuit.



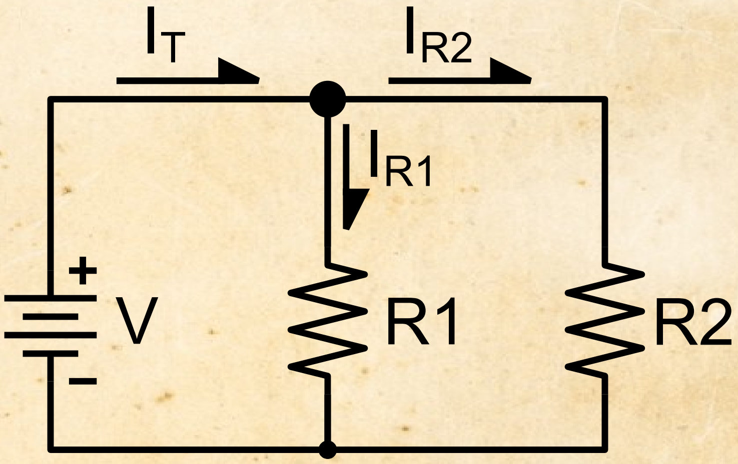
Series Resistors

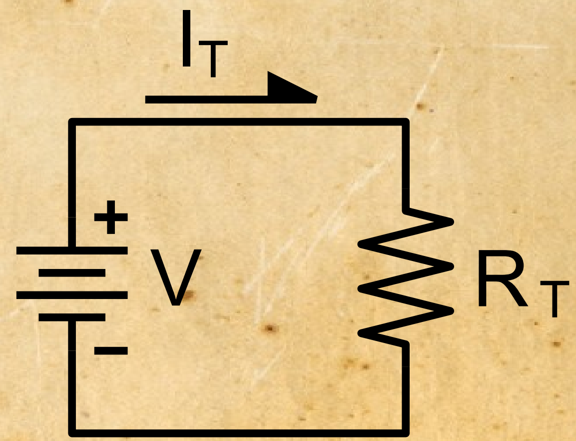


Parallel Resistors

Equivalent Resistance

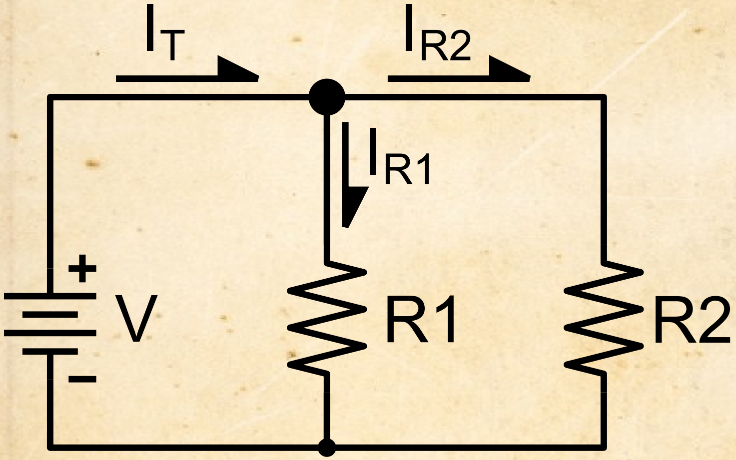
- To the voltage source, is no difference between the two resistors and a single resistor with an *equivalent resistance*.
  - The equivalent resistor value can be calculated.





Equivalent Resistance

- To calculate the *equivalent resistance*, we will first calculate the currents.



$$I_{R1} =$$

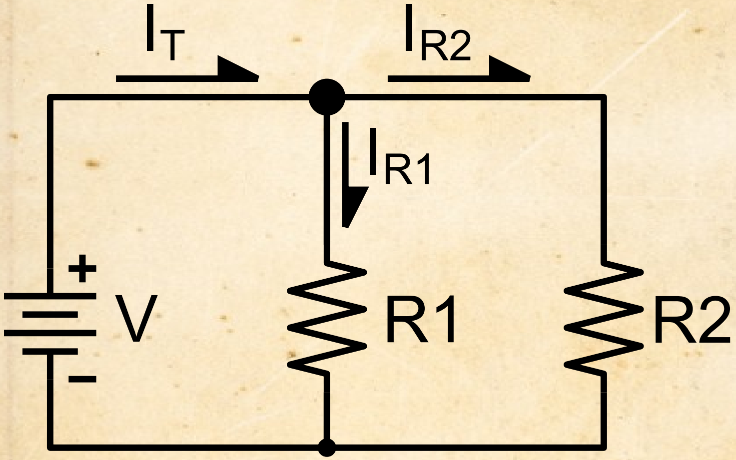
$$I_{R2} =$$

And, using *Kirchhoff's Current Law* :

$$I_T =$$

Equivalent Resistance

- To calculate the *equivalent resistance*, we will first calculate the currents.



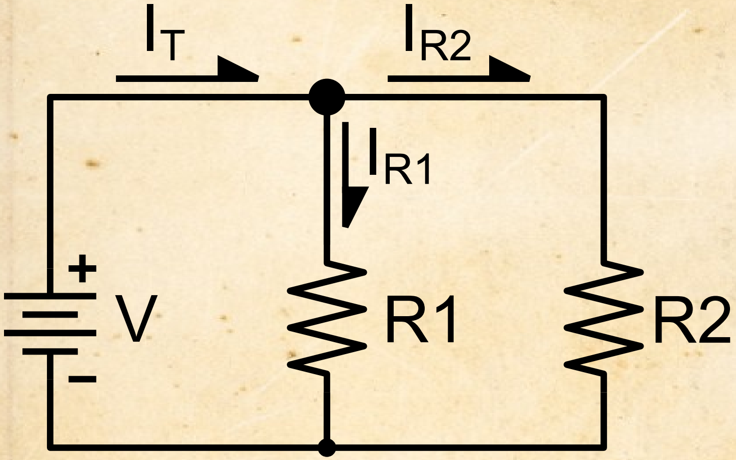
$I_{R1} =$ $I_{R2} =$

And, using *Kirchhoff's Current Law* :

$I_T =$

Equivalent Resistance

- To calculate the *equivalent resistance*, we will first calculate the currents.



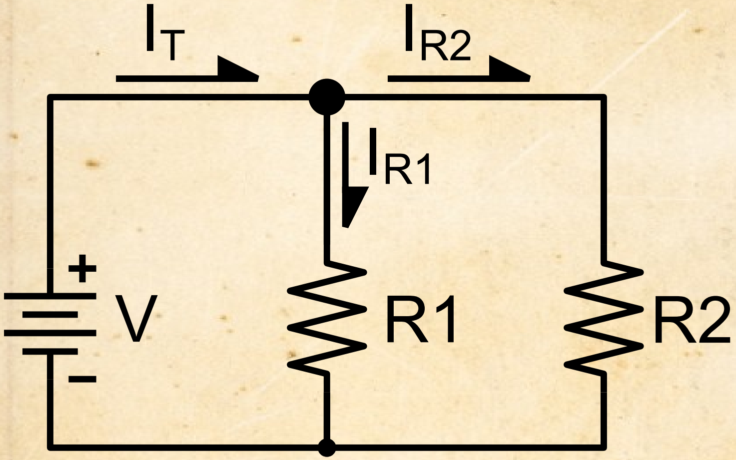
$$I_{R1} = \frac{V}{R1} \qquad I_{R2} = \frac{V}{R2}$$

And, using *Kirchhoff's Current Law* :

$$I_T = I_{R1} + I_{R2}$$

Equivalent Resistance

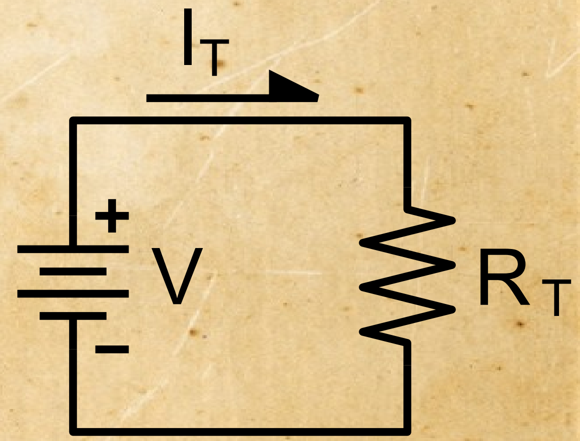
- To calculate the *equivalent resistance*, we will first calculate the currents.



$$I_{R1} = \frac{V}{R1}$$

$$I_{R2} = \frac{V}{R2}$$

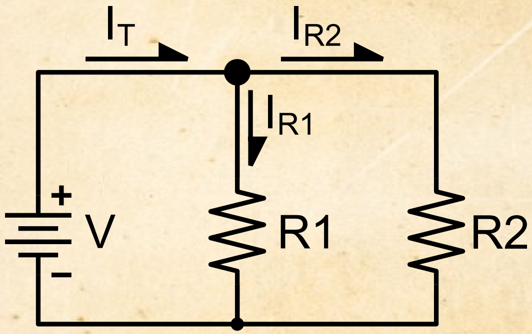
$$I_T = I_{R1} + I_{R2}$$



$$I_T = \frac{V}{R_T}$$

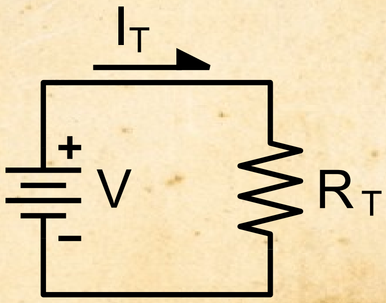
Equivalent Resistance

- To calculate the *equivalent resistance*, we will first calculate the currents.



$$I_{R1} = \frac{V}{R1} \qquad I_T = \frac{V}{R_T}$$

$$I_{R1} = \frac{V}{R1} \qquad I_T = I_{R1} + I_{R2}$$

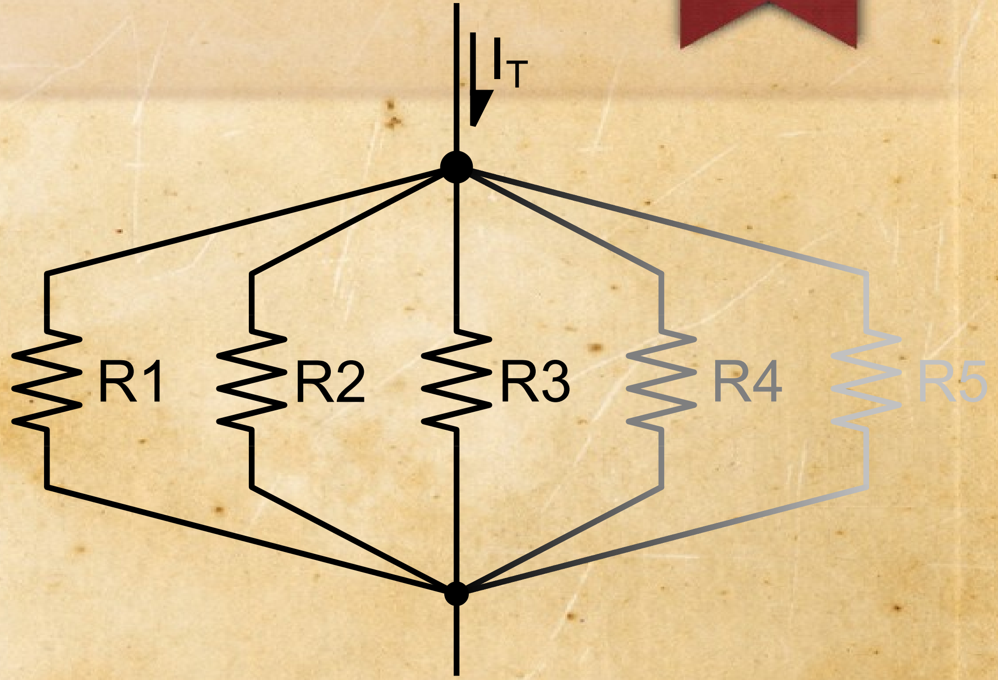


$$\frac{V}{R_T} = \frac{V}{R_1} + \frac{V}{R_2}$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

Equivalent Resistance

- We can extend this to any number of parallel resistors



$$I_T = I_{R1} + I_{R2} + I_{R3} + \ldots$$

$$\frac{V}{R_T} = \frac{V}{R1} + \frac{V}{R2} + \frac{V}{R3} + \ldots$$

$$\frac{1}{R_T} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \frac{1}{R4} + \ldots$$

Electronics

Measuring Voltage