Series, Parallel, and Series-Parallel Circuits

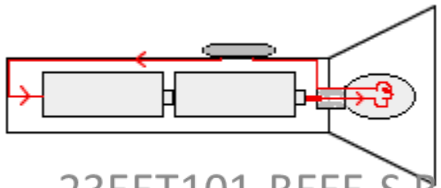
UNIT I

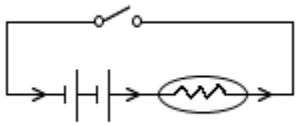
Review: Basic Elements of a Circuit

- **An electric circuit provides a complete path for current to flow**
- **A basic circuit must include:**
  - Power Source (battery)
  - Complete Path (wires)
  - Load (resistor, light, motor, etc.)
- **Many circuits also include:**
  - Control Devices (switch, etc.)
  - Protective Devices (fuse, circuit breaker, etc)

What components does the circuit below include?

Answer: Load, Path, Source, & Control





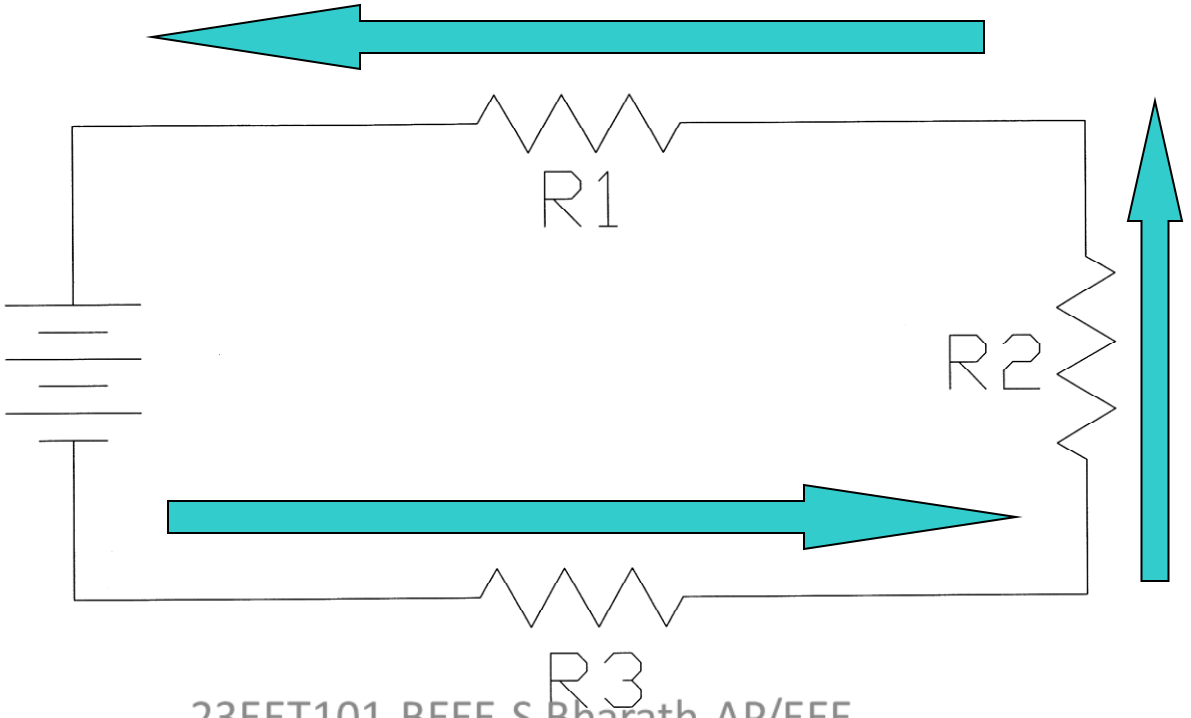
Types of Circuits

- Circuits with multiple loads can be placed into one of three categories: Series, Parallel, & Series-Parallel

- These are based on paths of current flow through the circuit

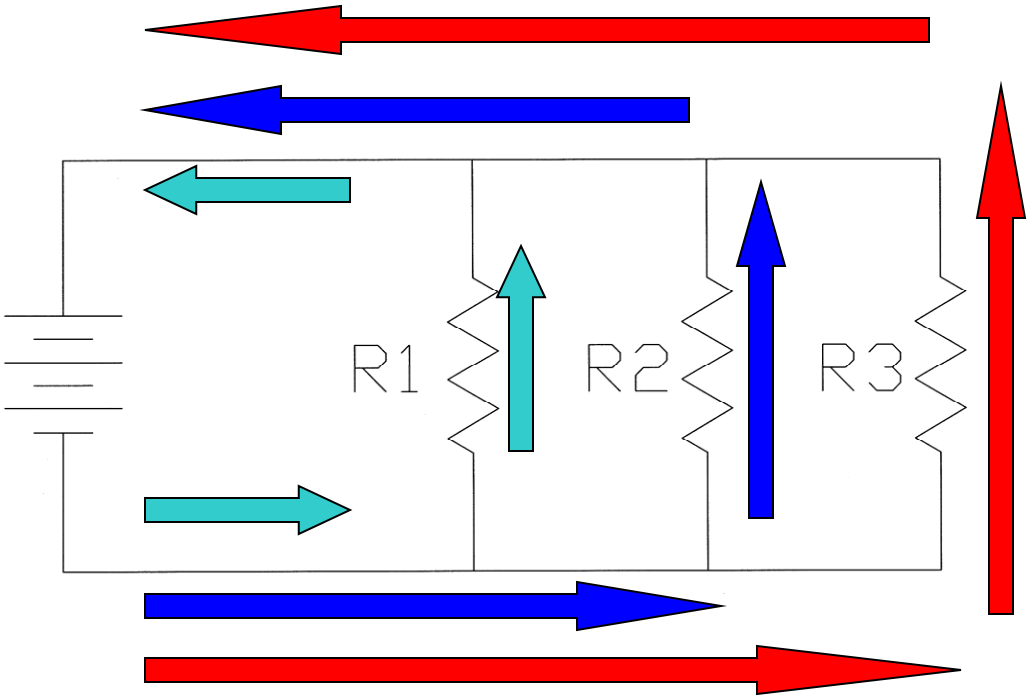
Series Circuits

- Only allow current to flow through one path from – to + through the loads
- Current only has one way to go from one side of the power source to the other



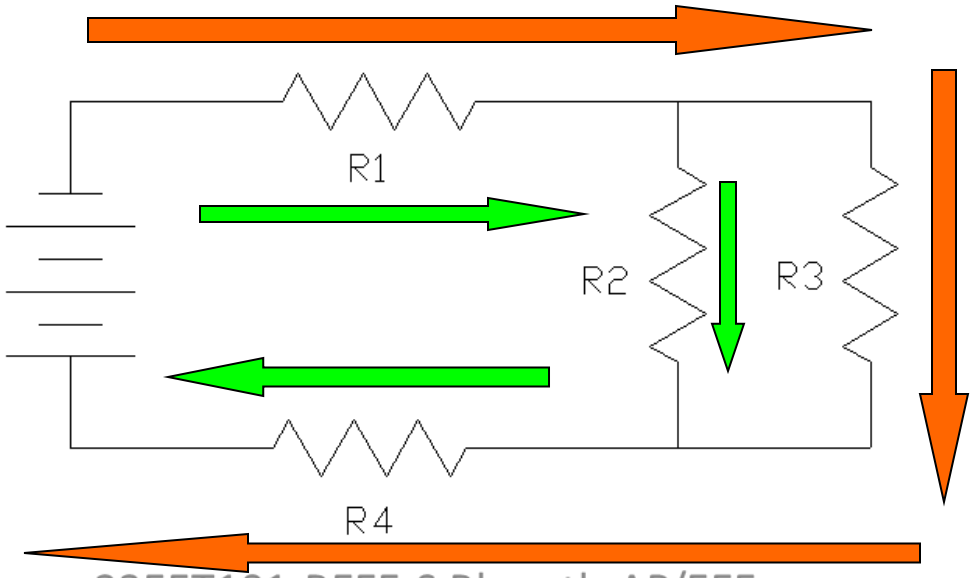
Parallel Circuits

- Allows current to take Multiple Paths from – to + through the loads.
- Current can follow different routes from the source, through the loads, and back to the source



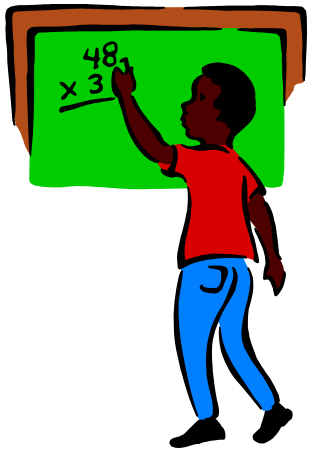
Series-Parallel Circuits

- Contains areas of both Series & Parallel circuits
- Some sections allow multiple paths for current flow
- Other areas only allow one path for current flow
- Must have at least three loads



Resistance Calculations

- Because some circuits allow current to follow multiple paths, current divides among these paths
- This reduces the total current of these sections
- Therefore, different resistance formulas must be used for different circuits



Series Circuit Calculations

- Only allow current to follow one path
- Total resistance is equal to the sum of all the individual resistances
- Formula Rt = R1 + R2 + R3…

R1 = 10Ω

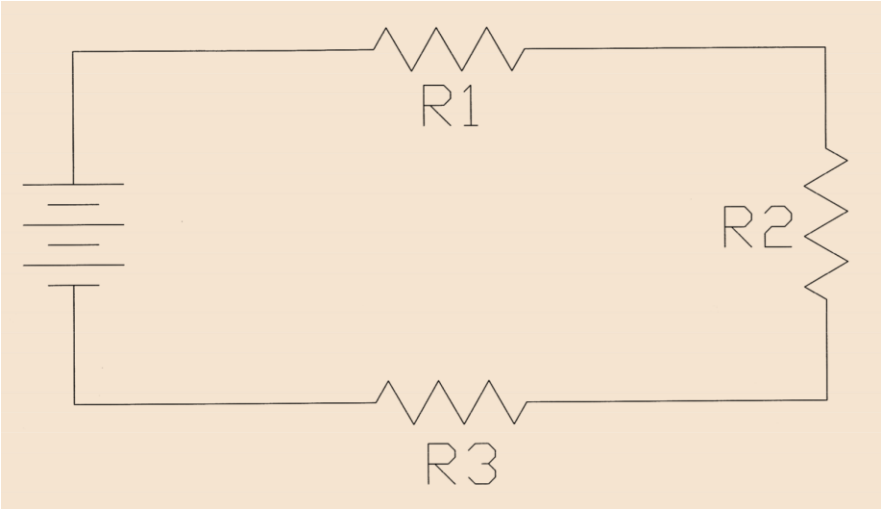
R2 = 20Ω

R3 = 30Ω

Rt = R1 + R2 + R3

Rt = 10Ω + 20Ω + 30Ω

Rt = 60Ω



Parallel Circuit Calculations

- Allow current to follow Multiple Paths
- Current divides among paths
- Total resistance is always less than smallest resistor
- Resistance Formula: Rt = 1/ [(1/R1)+(1/R2)+(1/R3)…]
  - This is Known as the Reciprocal Formula

R1 = 10Ω **R2** = 20Ω **R3** = 30Ω

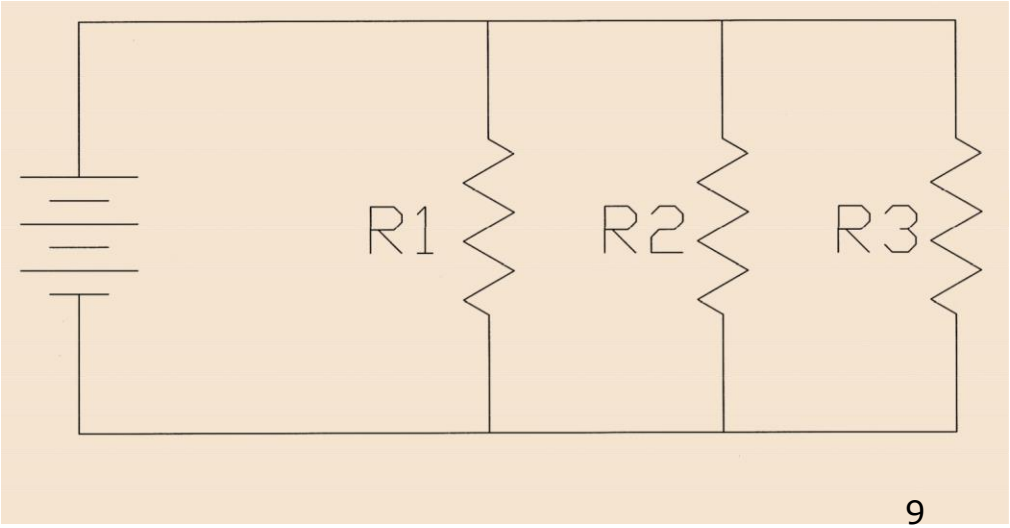
Rt = 1/ [(1/R1)+(1/R2)+(1/R3)]

Rt = 1/ [(1/10)+(1/20)+(1/30)]

Rt = 1/[.1+.05+.033]

Rt =1/.183

Rt =5.45 Ω



Parallel Circuit Calculations (Only Two Resistors)

- If only Two resistors are in parallel, then another formula can also be used to calculate total resistance
- This formula is: **Rt** = (R1 x R2) / (R1 + R2)
- Total resistance is always less than smallest resistor

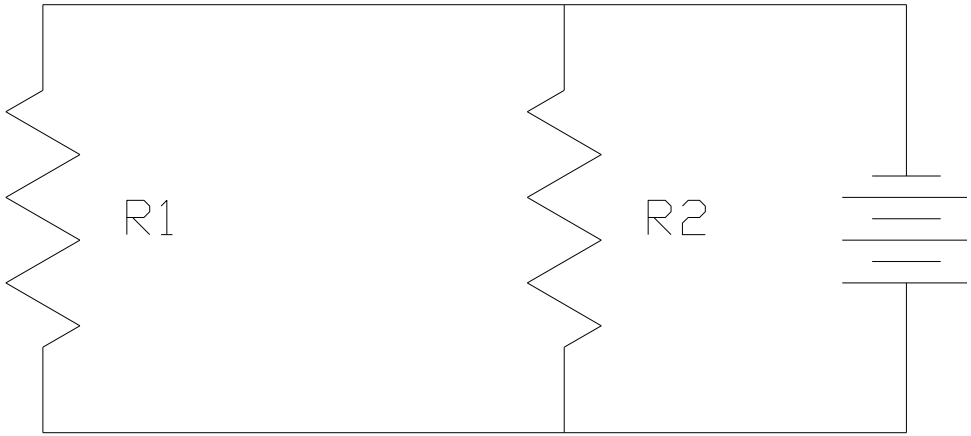
R1 = 20Ω **R2** = 20Ω

Rt = (R1 x R2) / (R1 + R2)

Rt = (20 x 20) / (20 + 20)

Rt = 400 / 40

Rt = 10Ω



Parallel Circuit Calculations (All Resistors Are the Same)

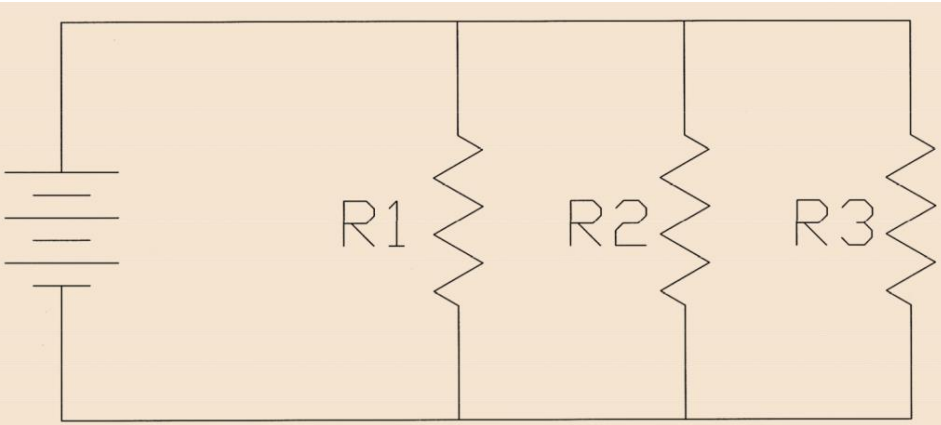
- If all of the resistors in the circuit are equal, then this formula may be used:
  - **Rt** = R / N (N = Number of resistors/ loads)
- Total resistance is always less than smallest resistor

R1 = 30Ω **R2** = 30Ω **R2** = 30Ω

Rt = R / N

Rt = 30 / 3

Rt = 10Ω



Series-Parallel Circuit Calculations

- Contain series & parallel elements
- Must use series & parallel formulas
- First determine Parallel R-value, then add to series sections

R1 = 10Ω **R2** = 10Ω **R3** = 10Ω **R4** = 10Ω

Rt = (R1 x R2) / (R1 + R2)

Rt = (10 x 10) / (10 + 10)

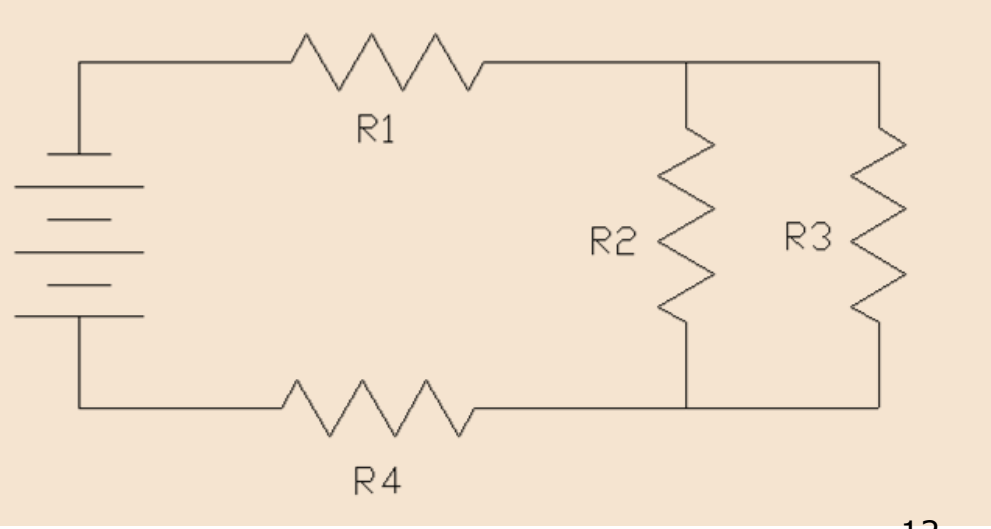
Rt = 100 / 20

Rt = 5Ω

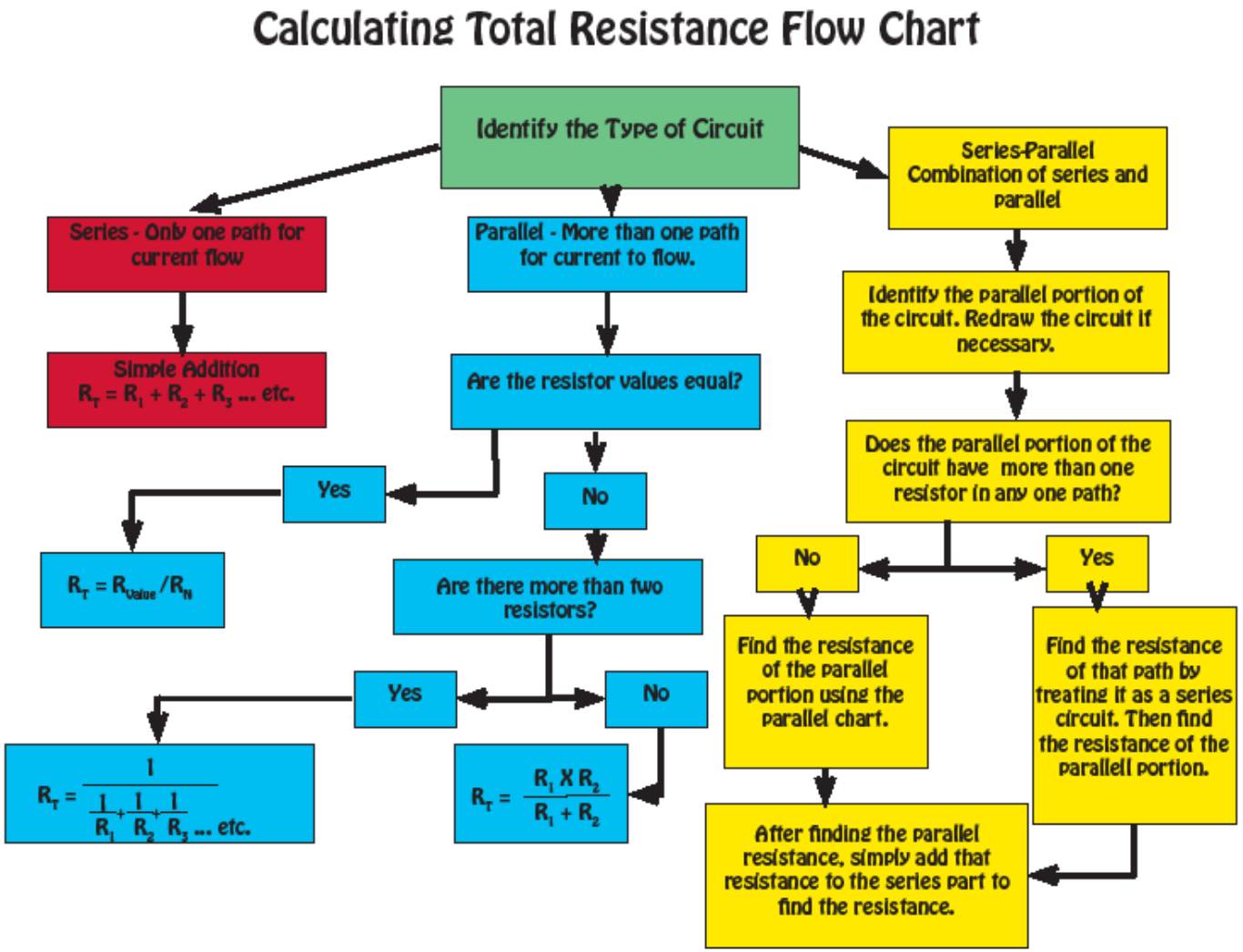
Rt = R1 + R2 + R3

Rt = 10Ω + 5Ω + 10Ω

Rt = 25Ω



Resistance Formula Flow Chart



Guided Practice #1

- **What kind of circuit is it?**

  Series Circuit

- **What Formula can be used?**

  $Rt = R_1 + R_2 + R_3$

- **What is the total resistance?**

R1 = 30Ω

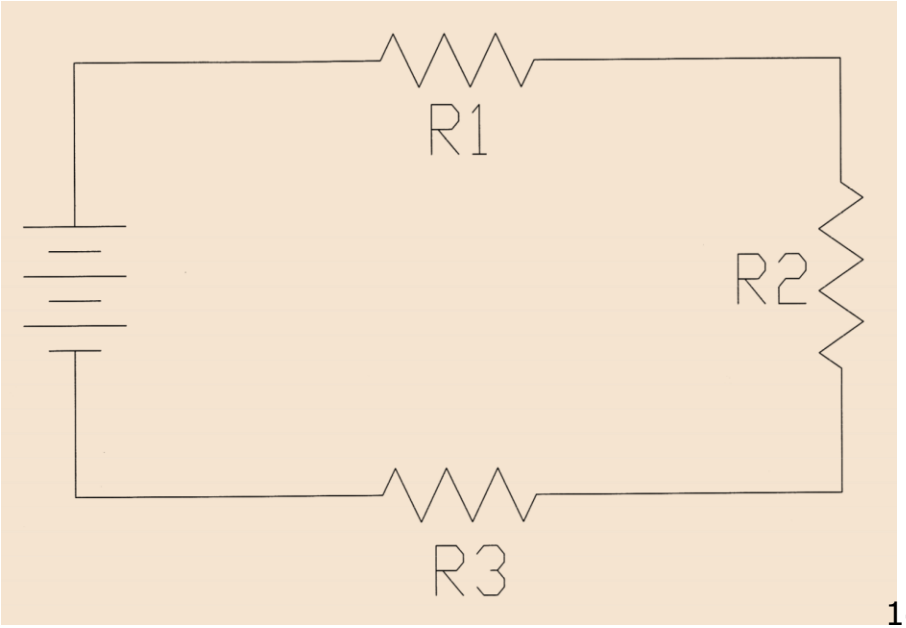
R2 = 50Ω

R3 = 70Ω

Rt = R1 + R2 + R3

Rt = 30Ω + 50Ω + 70Ω

Rt = 150Ω



Guided Practice #2

- **What kind of circuit is it?**

  Parallel Circuit

- **What Formula can be used?**

  Rt = 1/ [(1/R1)+(1/R2)+(1/R3)…]
  or … Rt = (R1 x R2) / (R1 + R2)

- **What is the total resistance?**

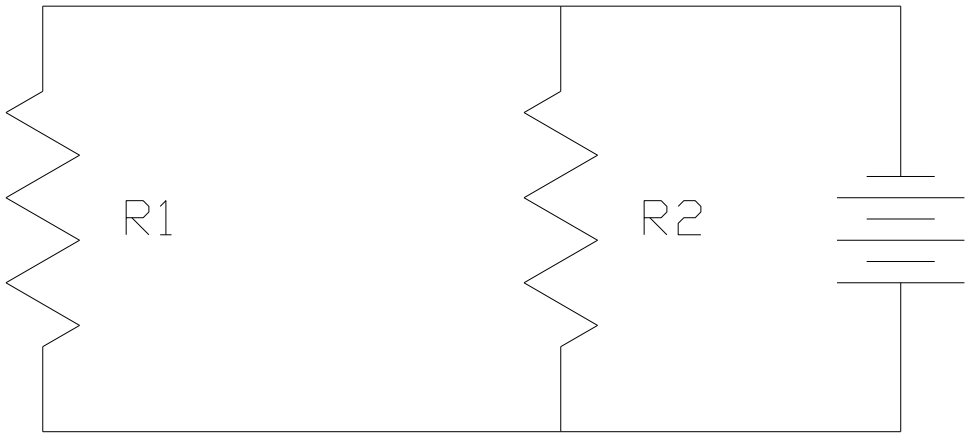
R1 = 10Ω R2 = 20Ω

Rt = (R1 x R2) / (R1 + R2)

Rt = (10 x 20) / (10 + 20)

Rt = 200 / 30

Rt = 6.67Ω



Guided Practice #3

- **What kind of circuit is it?**

  Series-parallel

- **What Formula can be used?**

  Rt = (R1 x R2) / (R1 + R2) & Rt = R1 + R2 + R3

- **What is the total resistance?**

R1 = 5Ω **R2** = 4Ω **R3** = 6Ω **R4** = 5Ω

Rt = (R1 x R2) / (R1 + R2)

Rt = (4 x 6) / (4 + 6)

Rt = 24 / 10

Rt = 2.4Ω

Rt = R1 + R2 + R3

Rt = 5Ω + 2.4Ω + 5Ω

Rt = 12.4Ω