Lesson 4: Voltage and current divider rules

Circuit analysis toolbox

Ohm's law

Series resistance

KVL

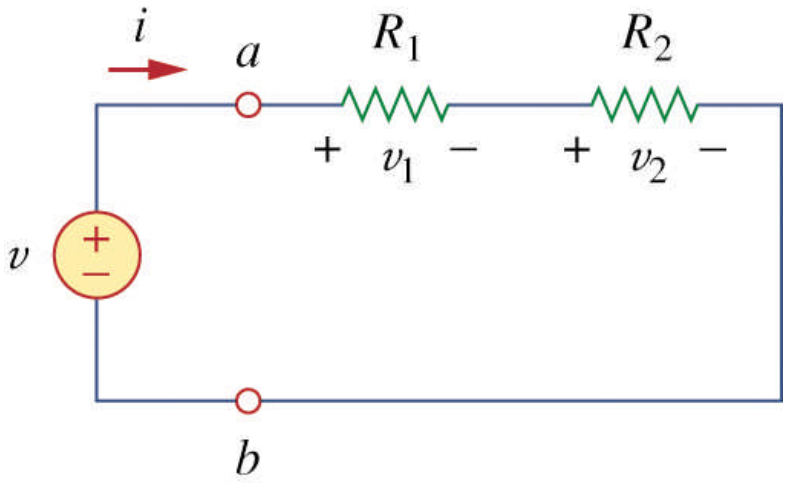
Parallel resistance

KCL

Circuit analysis toolbox

Voltage across resistors in series

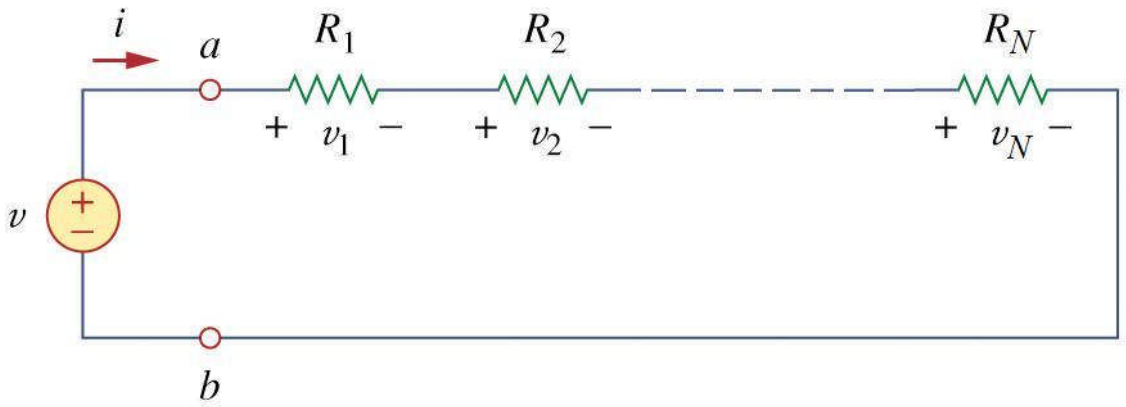
- Let us consider the voltages v_1 and v_2 across resistors in series.



Principle of voltage division

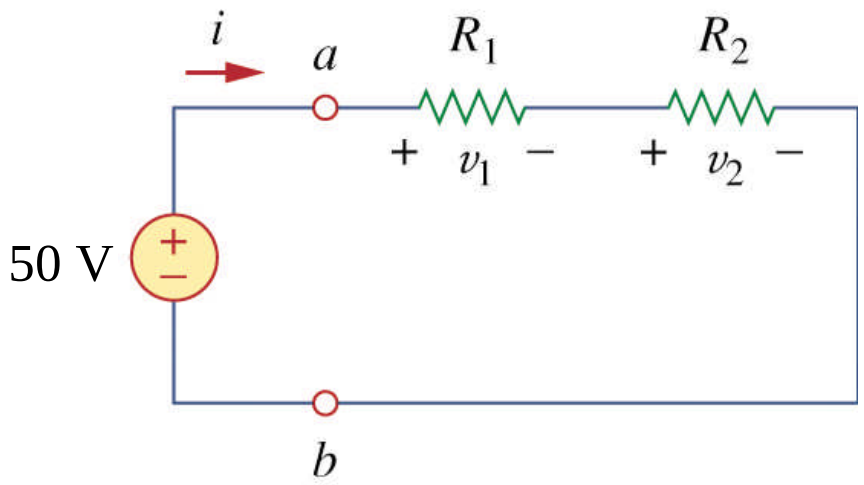
- The voltage drop across the nth resistor (R_n) is equal to the ratio of R_n to the total equivalent resistance R_{eq} times the total voltage across all N series resistors.

$$v_n = \frac{R_n}{R_1 + R_2 + \cdots + R_N} \cdot v = \frac{R_n}{R_{eq}} \cdot v$$



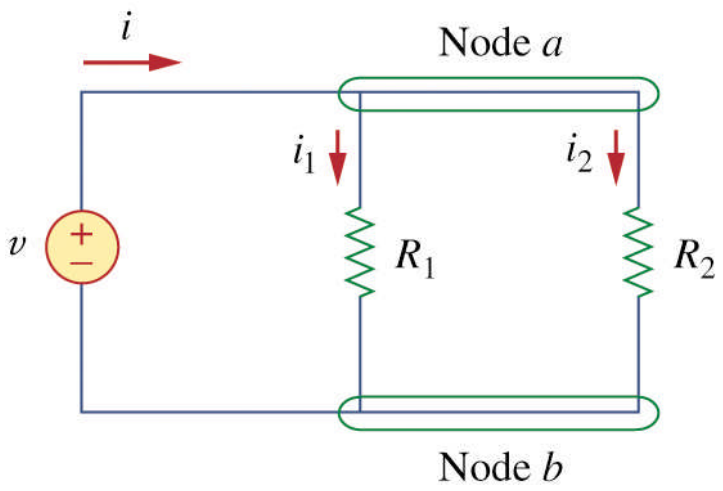
Example Problem 1

A 50-V source and two resistors, R_1 and R_2 are connected in series. If $R_2 = 3\,R_1$, find the voltages across the two resistors.



Current through resistors in parallel

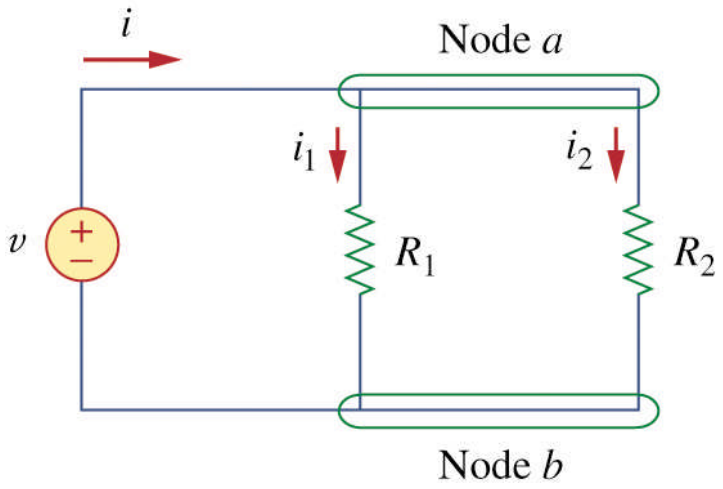
- Let us consider the current i_1 and i_2 through two resistors in parallel.



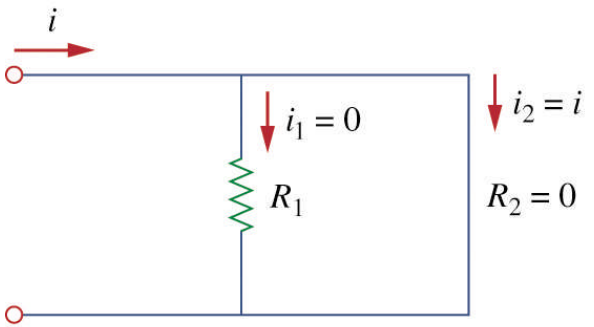
Principle of current division

- The total current i is shared by the resistors in **inverse** proportion to their resistances.
- “Current follows the path of least resistance.”

$$i_1 = \frac{R_2 i}{R_1 + R_2} \qquad i_2 = \frac{R_1 i}{R_1 + R_2}$$

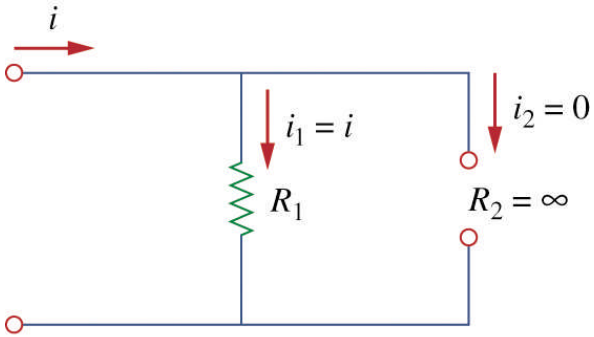


Extreme cases for current division



(a)

short circuit

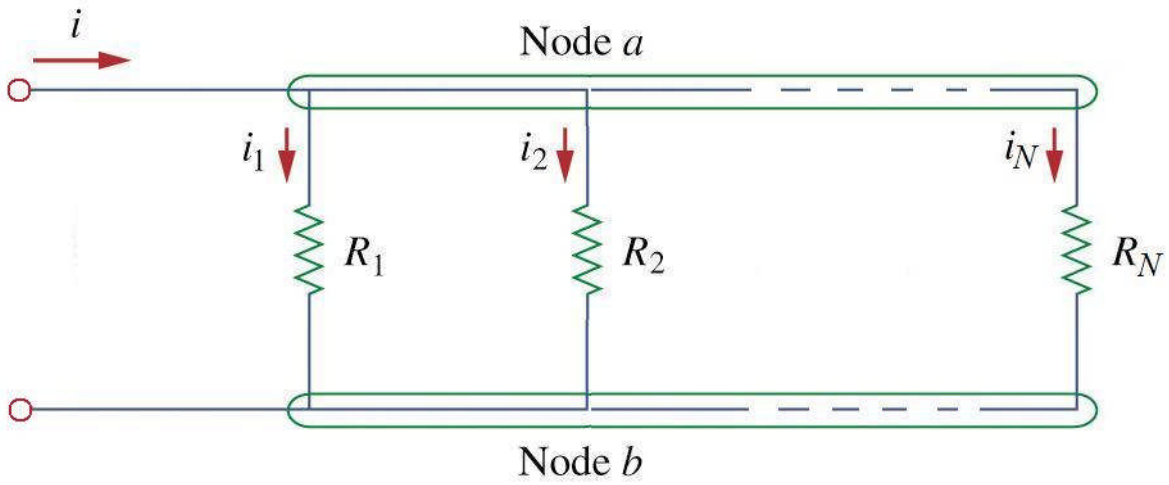


(b)

open circuit

N resistors in parallel

- What is the current i_n for N resistors in parallel?



Principle of current division

- The current through the nth resistor (R_n) is equal to the **inverse** ratio of R_n to the total equivalent resistance R_{eq} times the total current through N parallel resistors.

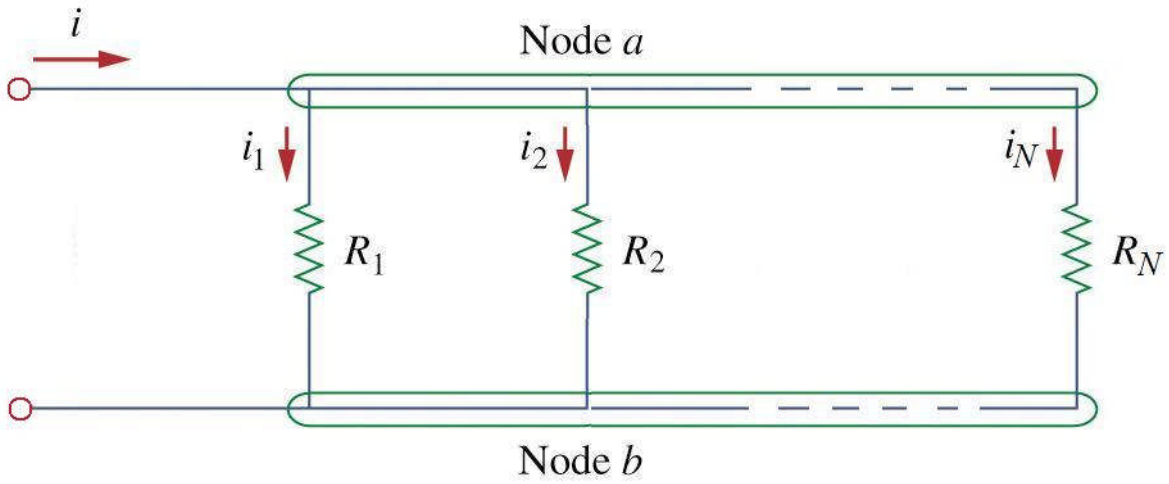
$$i_n = \frac{\frac{1}{R_n}}{\frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_N}} \cdot i = \frac{R_{eq}}{R_n} \cdot i$$

Current division with conductances

- Using conductances (G), the nth conductor will have current

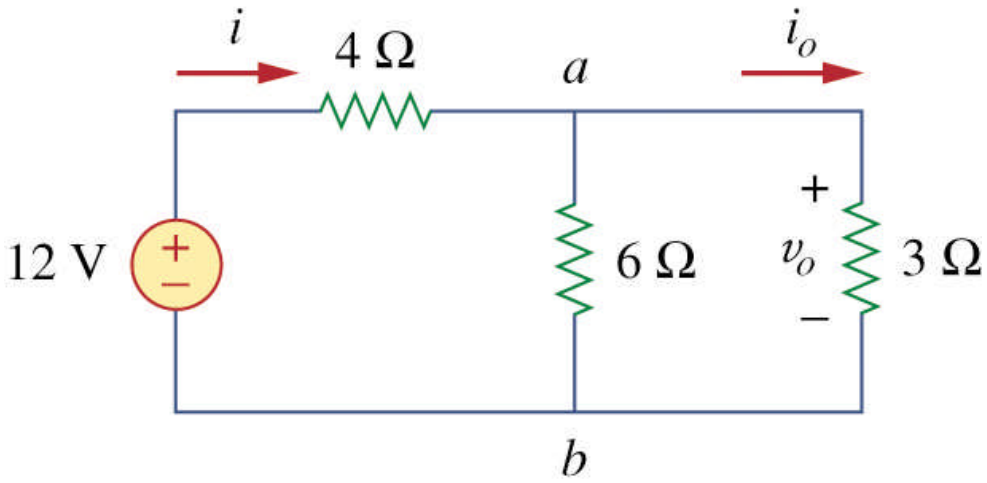
$$i_n = \frac{G_n}{G_1 + G_2 + \cdots + G_N} \cdot i$$

where $G_n = 1/R_n$ for $n = 1, 2, \ldots, N$



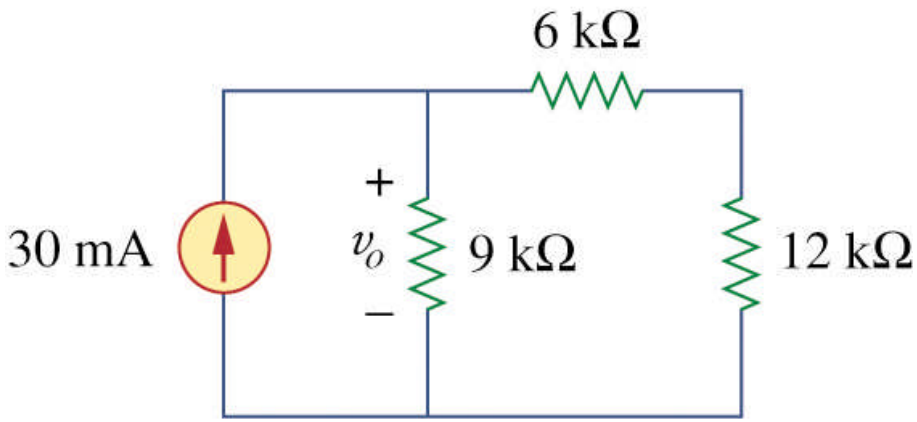
Example Problem 2

Calculate i_o and v_o and find the power dissipated in the 3-Ω resistor.



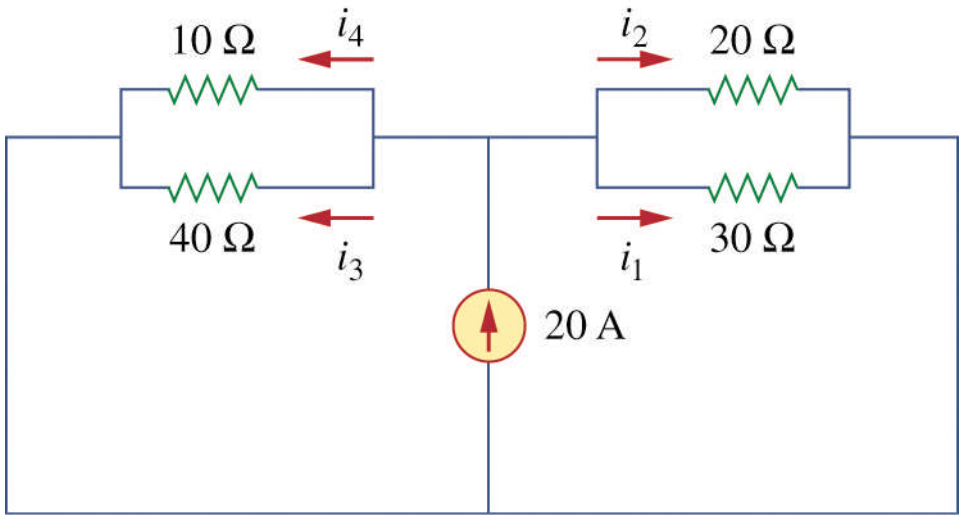
Example Problem 3

Determine v_o, the power supplied by the current source, and the power absorbed by each resistor.



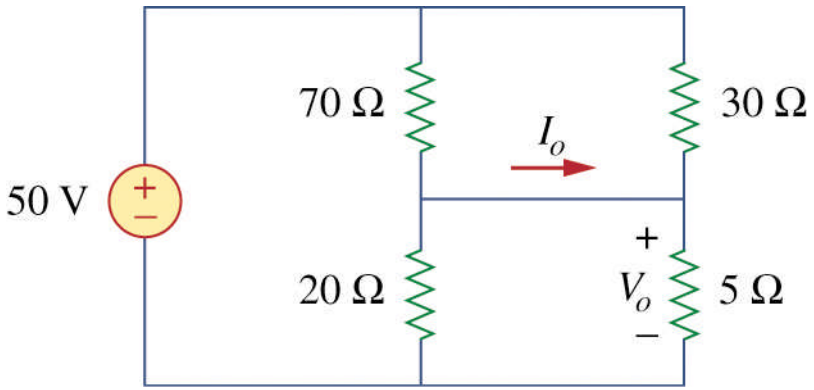
Example Problem 4

Find i_1 through i_4.



Example Problem 5

Find V_o and I_o.



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Voltage divider rule

Current divider

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