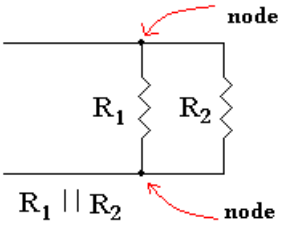
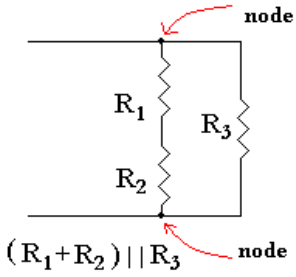
Enhanced Guided Notes: Set 6

Parallel Circuits

Topics:

A. Parallel Resistors and Circuits



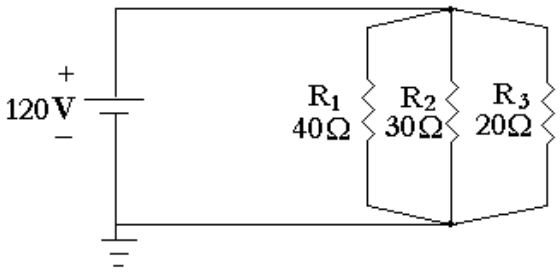


$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_N}$$

Conductance = _____

$\therefore G_T =$

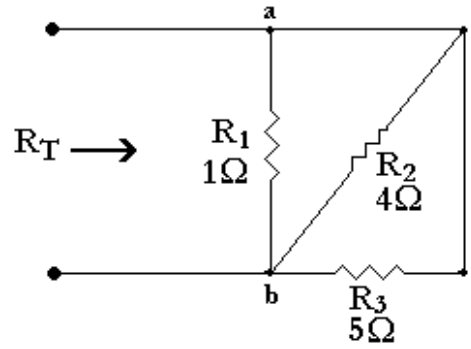
❋ Examples:



Calculate $R_{eq}(R_T)$

Are the resistors in parallel?

Which parallel element has the least conductance?

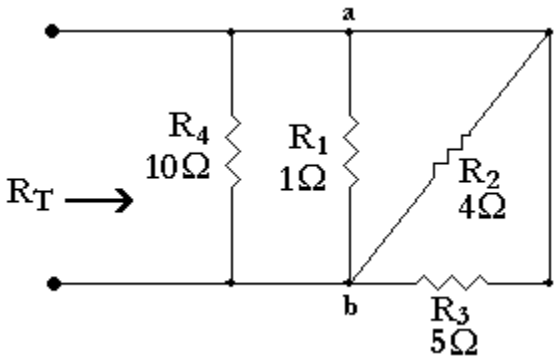


Calculate R_{eq} (R_T)

Are the resistors in parallel?

C

Now, what happens if one additional resistor is added to nodes a and b?



R_T =

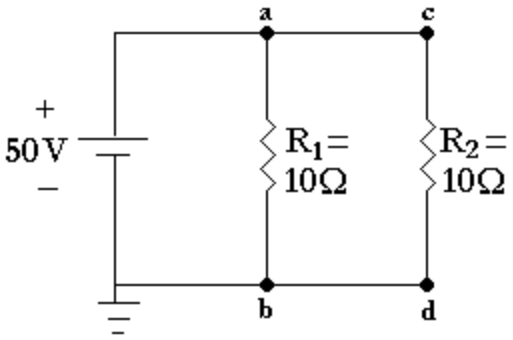
Conclusion:

If all four resistors (R1, R2, R3, R4) have the same resistance value (i.e. R):

RT = _____

SPECIAL CASE: If two resistors are in parallel, then

RT = _____

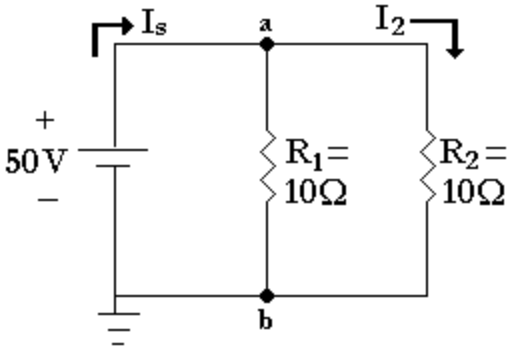


The voltage is always the same across parallel elements.

V_{ab} = 50V

V_{cd} = Why?

$\therefore V_{ab} = V$ $= V$ $= 50V$



$\therefore R_2 = 10\ \Omega$

How do we find I_S?

Why?

How do we find I_1 and I_2?

We need to use _____ law.

We know that $V_{ab} = V_{R1} = V_{R2} = 50V$

$\therefore$ I_1 = _____ =

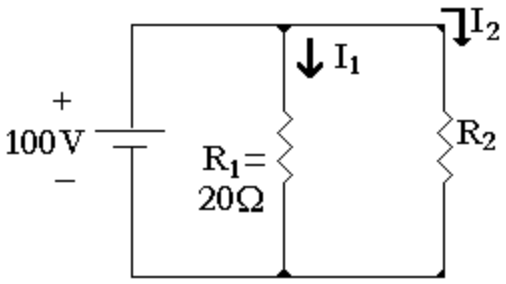
I_2 = _____ =

From I_S, I_1 and I_2, we can conclude that

I_S = =

❋ Example:

Find the current in the R_2 branch of the circuit below. Let's assume $R_T = 10\,\Omega$

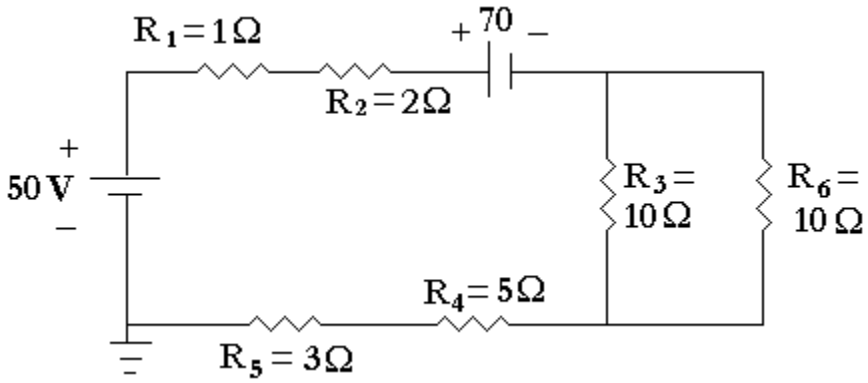


How do we find I_2?

d

❋ Example:

What is the voltage across the $10\,\Omega$ resistor in the circuit below?



What is the first step to solve this problem?

$R_{eq1} = R_3 \,||$ ~> R_{eq1} = _____ = _____ Ω

Redraw the circuit

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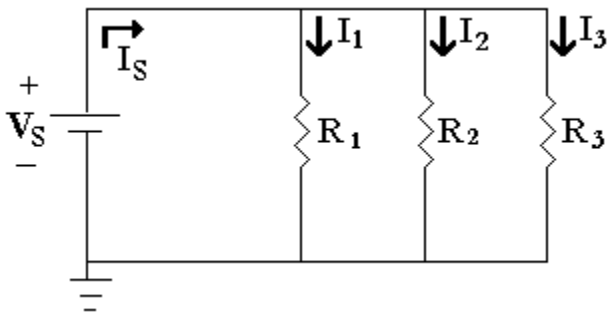
B. Power Distribution in a Parallel Circuit

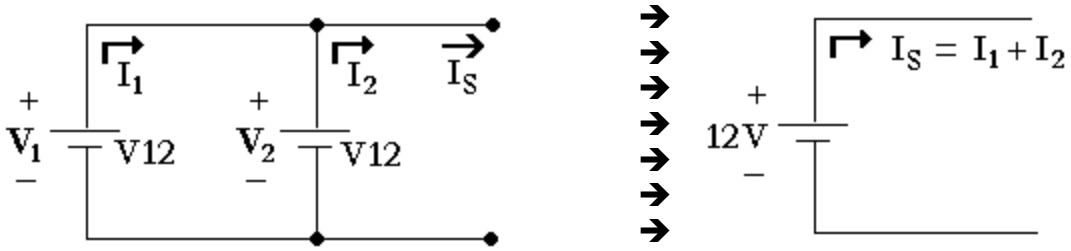
Power applied by the voltage source will equal that dissipated by the resistive element.



$P_S = P_{R1} + P_{R2} + P_{R3}$

$V_S I_S$ = _____ + _____ + _____

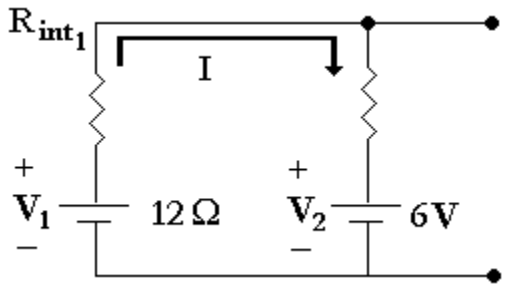
C. Voltage Sources in Parallel



The primary reason for placing two or more batteries or supplies in parallel is to _____

What about the total power?

What will happen if two batteries of different voltages are placed in parallel?

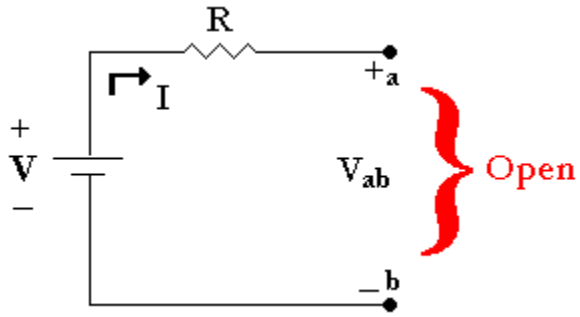


$$I = \frac{V_1 - V_2}{R_{int_1} - R_{int_2}}$$

Conclusions:

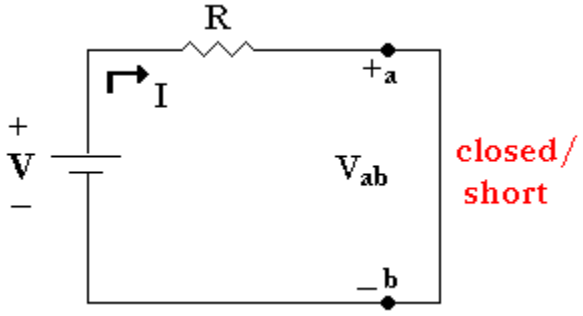
D. Open and Short Circuits

What is an open circuit?



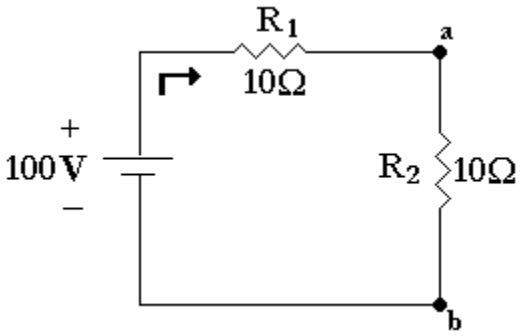
I =

V_{ab} =



I =

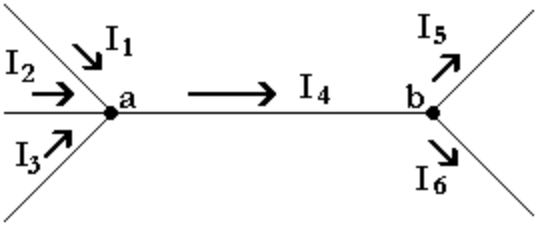
V_{ab} =



E. Kirchhoff's Current Law (KCL)

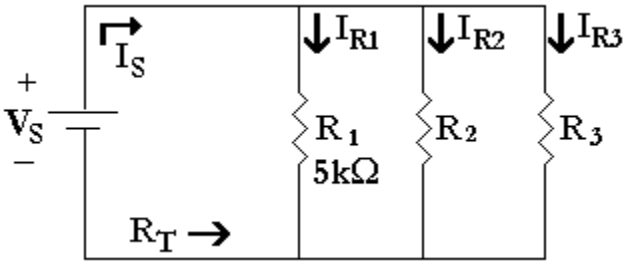
"The algebraic sum of the currents entering and leaving a junction of a network is zero."

$$\therefore \Sigma_i + \Sigma_\sigma = 0 \quad \rightarrow \quad \Sigma I_i = \Sigma I_\sigma$$



$$\Sigma I_i = \Sigma I_\sigma$$

❋ Example:



Let's say

I_{R1} = 2 mA
I_{R2} = 5 mA
I_{R3} = 10 mA

Find:

a. I_5

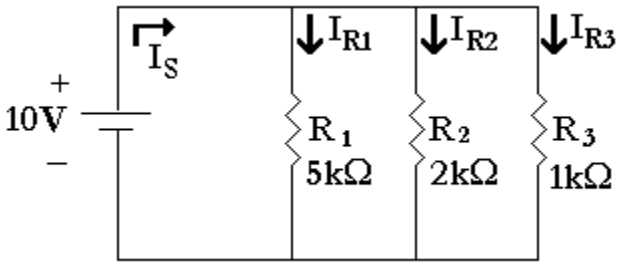
b. V

c. R_2

d. R_T

F. Current Divider Rule

(From Previous Example)



Applying KCL

$I_S = I_1 + I_2 + I_3$

17mA = 2mA + 5mA + 10mA

$I_2 = 2.5\ I_1$

$I_2 = R_1 / R_2 * I_1$

Similarly, $I_3 = 5I_1$

$I_3 =$ _____ I_1

Now, what do we know about the connection between I_S and I_1, I_2, and I_3?

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

Since $V_1 = V_2 = V_3 = V$

$\therefore$ $V = I_1R_1 = I_2R_2 = I_3R_3$

Now, if we substitute V with I_1R_1 or I_2R_2 or I_3R_3

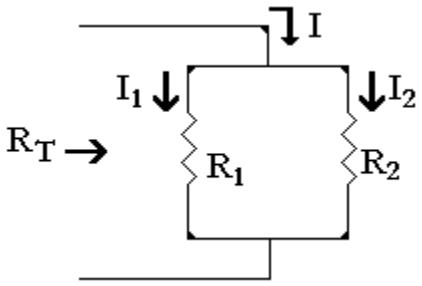
$\therefore$ I_S = _____ = _____ = _____

$\therefore$ I_1 =

$\therefore$ I_2 =

$\therefore$ I_3 =

Special Case: 2-Parallel Resistors



How do we find I_1 and I_2?

R_T = _____

$I_1 = R_T/R_1 * I$ = _____

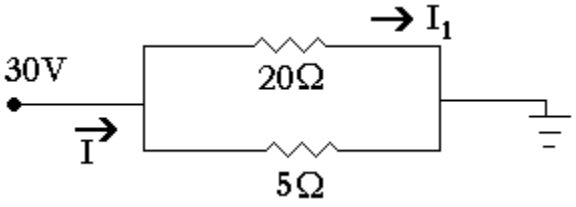
$\therefore \quad I_1 = \_\_\_\_\_$

$I_2 = \_\_\_\_\_$

Conclusions:

❋ Example:

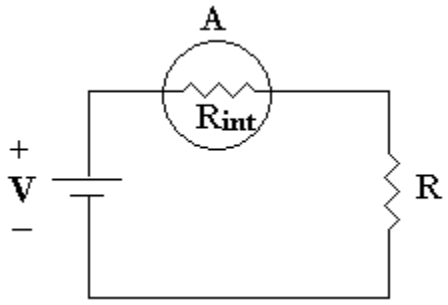
Find the currents I_1 and I for the following circuit:



How do we solve this problem?

G. Loading Effects of Instruments

Ammeter

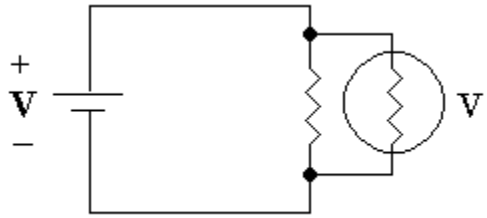


R_{int} is in _____ with the branch in which we are measuring the current.

$\therefore$ ideal R_{in} is _____

Why?

Voltmeter



R_{int} is in _____ with the branch in which we are measuring the voltage.

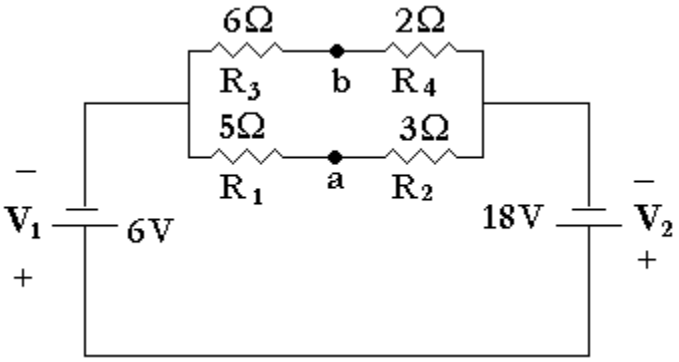
$\therefore$ ideal R_{in} is _____

Why?

H. Series-Parallel Circuits

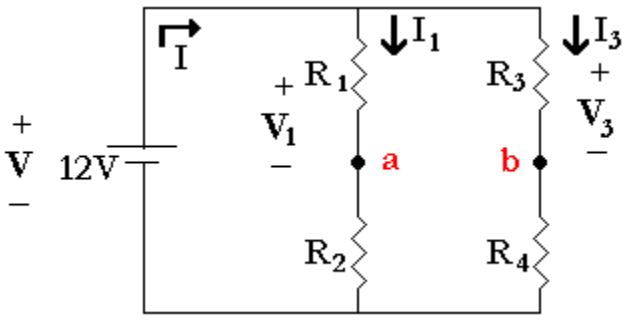
It is formed by a combination of series and parallel elements

❋ Examples:



Find:
V_1 V_3 V_{ab} and I

Redraw the circuit



V_1 =

V_3 =

V_{ab} =

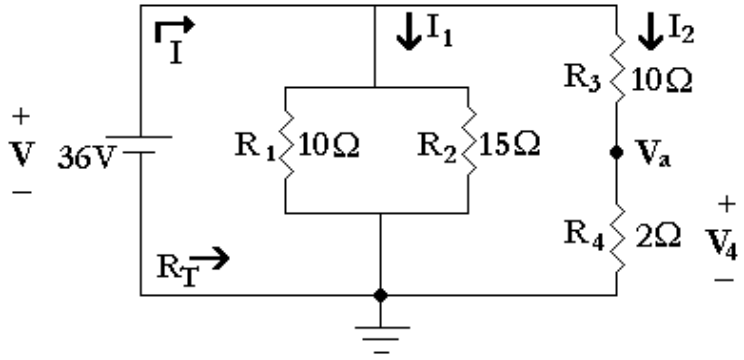
Applying Ohm's Law

I_1 =

I_3 =

Applying KCL ~> I =

❋ Example:



Find:

a. R_T

b. I, I_1 and I_2

c. V_4