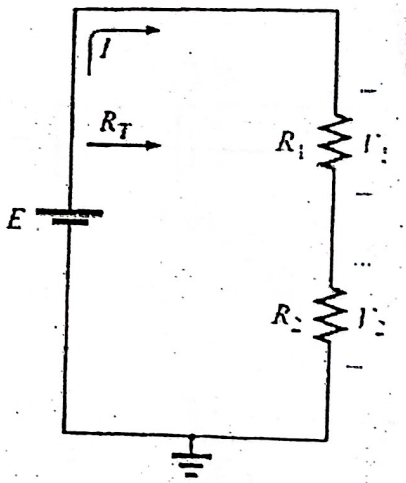
VOLTAGE DIVIDER RULE:

In a series circuit,
the voltage across a resistor in a series circuit is equal to the value of that resistor times the total impressed voltage across the series elements divided by the total resistance of the series elements.

$$V_x = \frac{R_x E}{R_T}$$

Where *Vx* is the voltage across *Rx*.

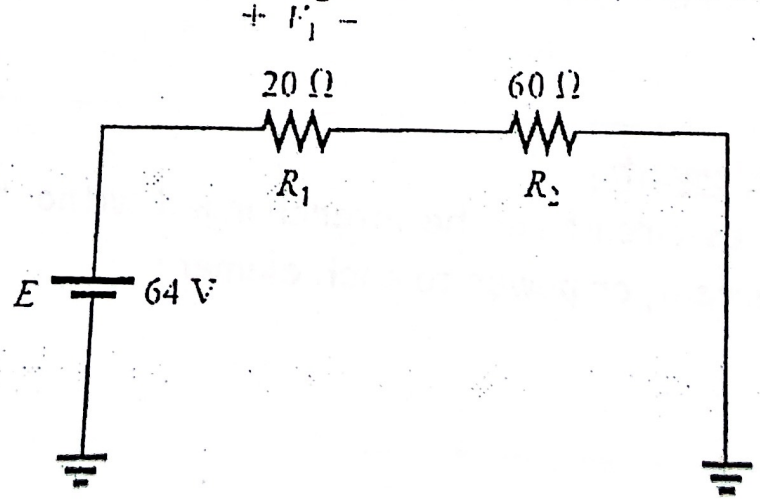
For example:



$$V_1 = IR_1 = \left(\frac{E}{R_T}\right)R_1 = \frac{R_1 E}{R_T}$$

$$V_2 = IR_2 = \left(\frac{E}{R_T}\right)R_2 = \frac{R_2 E}{R_T}$$

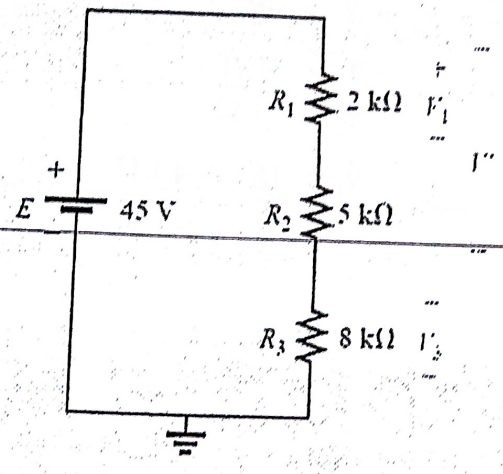
EXAMPLE: Determine the voltage *V1* for the network of Figure below.



Solution:

$$V_1 = \frac{R_1 E}{R_T} = \frac{R_1 E}{R_1 + R_2} = \frac{(20\ \Omega)(64\ \text{V})}{20\ \Omega + 60\ \Omega} = \frac{1280\ \text{V}}{80} = 16\ \text{V}$$

EXAMPLE: Using the voltage divider rule, determine the voltages V1 and V3 for the series circuit of Figure below.



Solution:

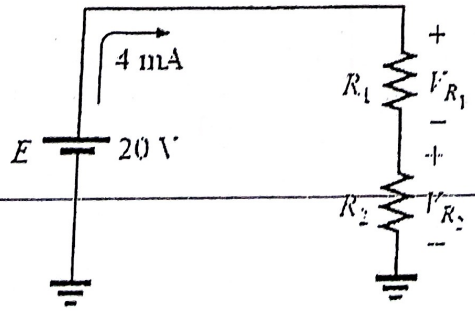
$$V_1 = \frac{R_1 E}{R_T} = \frac{(2\ \text{k}\Omega)(45\ \text{V})}{2\ \text{k}\Omega + 5\ \text{k}\Omega + 8\ \text{k}\Omega} = \frac{(2\ \text{k}\Omega)(45\ \text{V})}{15\ \text{k}\Omega}$$

$$= \frac{(2 \times 10^3\ \Omega)(45\ \text{V})}{15 \times 10^3\ \Omega} = \frac{90\ \text{V}}{15} = 6\ \text{V}$$

$$V_3 = \frac{R_3 E}{R_T} = \frac{(8\ \text{k}\Omega)(45\ \text{V})}{15\ \text{k}\Omega} = \frac{(8 \times 10^3\ \Omega)(45\ \text{V})}{15 \times 10^3\ \Omega}$$

$$= \frac{360\ \text{V}}{15} = 24\ \text{V}$$

EXAMPLE: Design the voltage divider of Figure below such that VR1 = 4 VR2.



Solution: The total resistance is defined by

$$R_T = \frac{E}{I} = \frac{20\ \text{V}}{4\ \text{mA}} = 5\ \text{k}\Omega$$

Since $V_{R_1} = 4V_{R_2}$,

$$R_1 = 4R_2$$

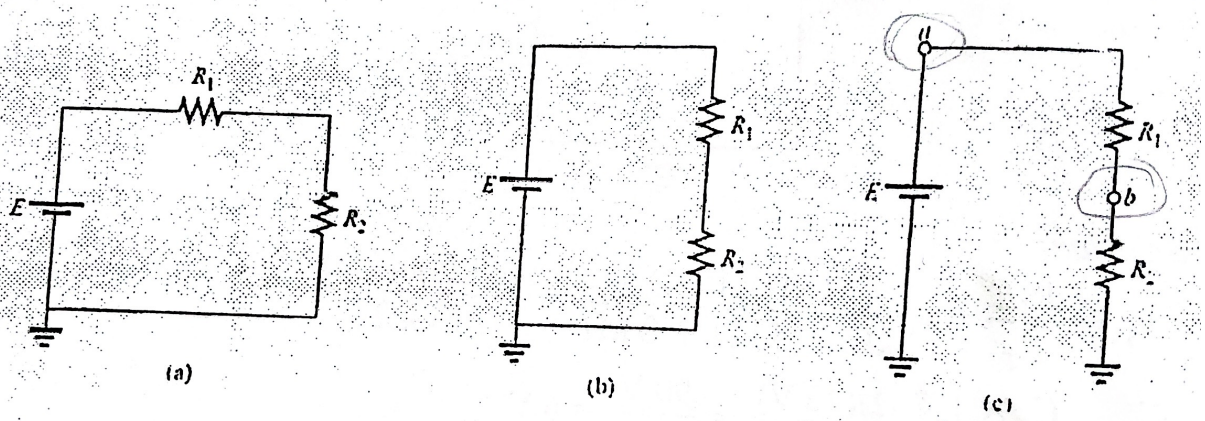
Thus $$R_T = R_1 + R_2 = 4R_2 + R_2 = 5R_2$$

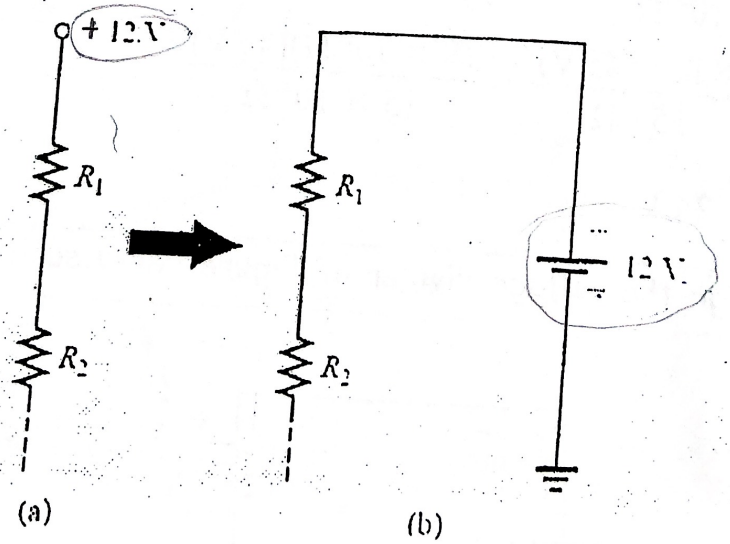
and $$5R_2 = 5\ \text{k}\Omega$$

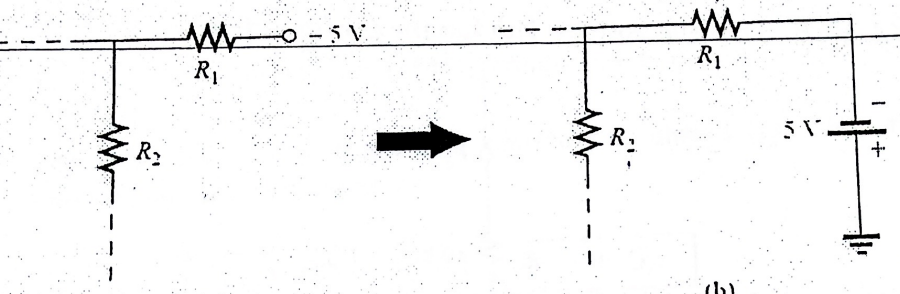
$$R_2 = 1\ \text{k}\Omega$$

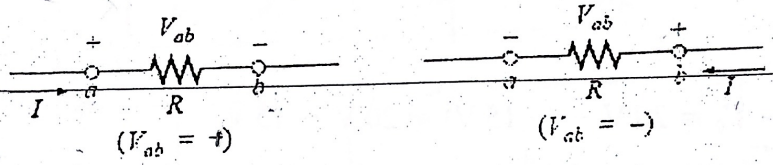
and $$R_1 = 4R_2 = 4\ \text{k}\Omega$$

NOTATION:



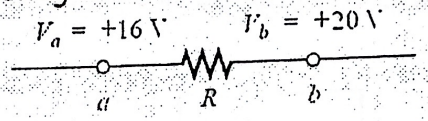






(a) (b)

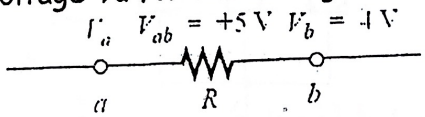
EXAMPLE: Find the voltage *Vab* for the conditions.



Solution:

$$V_{ab} = V_a - V_b = 16\text{ V} - 20\text{ V}$$
$$= -4\text{ V}$$

EXAMPLE: Find the voltage *Va* for the configuration.

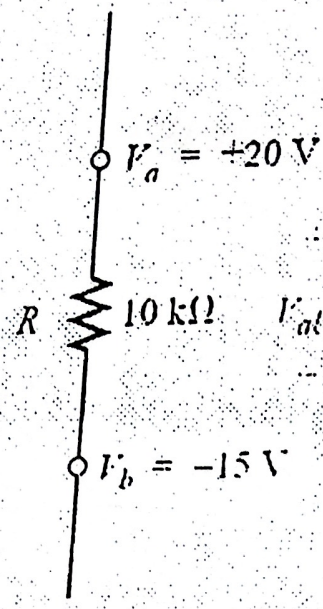


Solution:

$$V_{ab} = V_a - V_b$$

$$V_a = V_{ab} + V_b = 5\text{ V} + 4\text{ V}$$
$$= 9\text{ V}$$

EXAMPLE: Find the voltage *Vab* for the configuration.



Solution:

$$V_{ab} = V_a - V_b = 20\text{ V} - (-15\text{ V}) = 20\text{ V} + 15\text{ V}$$
$$= 35\text{ V}$$