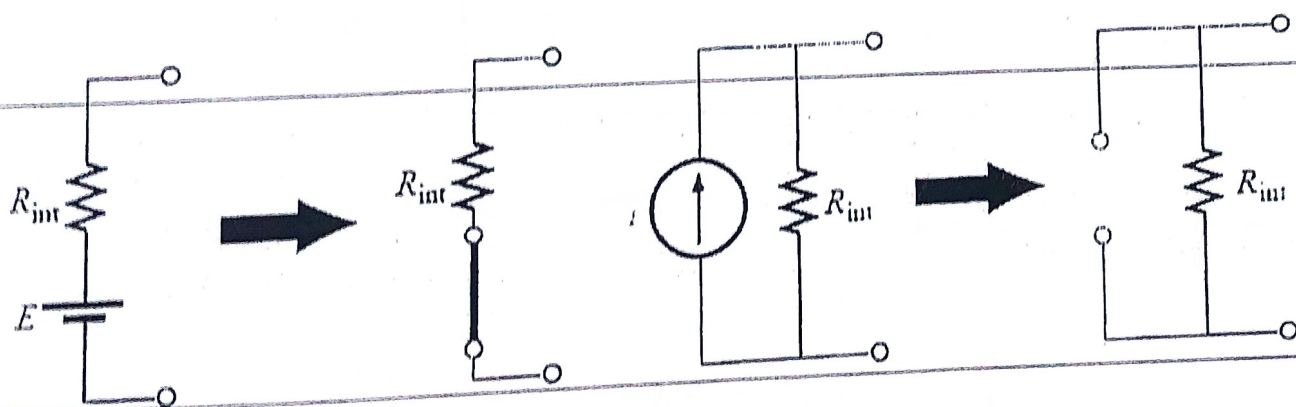
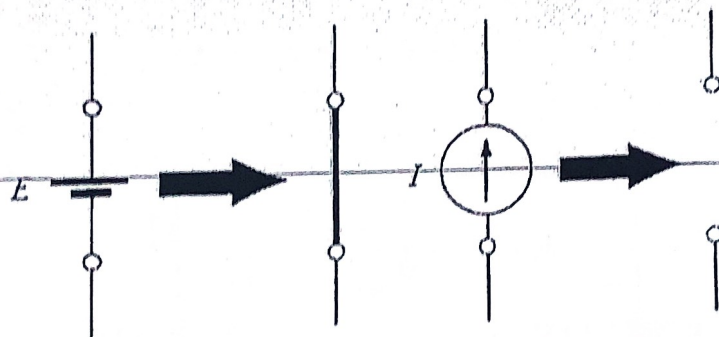


Superposition Theorem

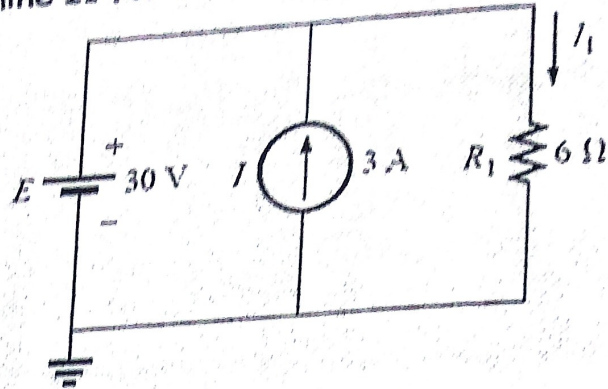
The current through, or voltage across, an element in a linear bilateral network is equal to the algebraic sum of the currents or voltages produced independently by each source.

Number of networks to be analyzed	=	Number of independent sources
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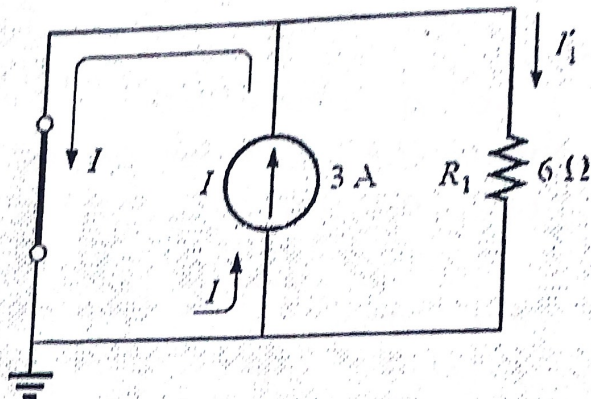
The total power delivered to a resistive element must be determined using the total current through or the total voltage across the element and cannot be determined by a simple sum of the power levels established by each source.

EXAMPLE: Determine I_1 for the network.



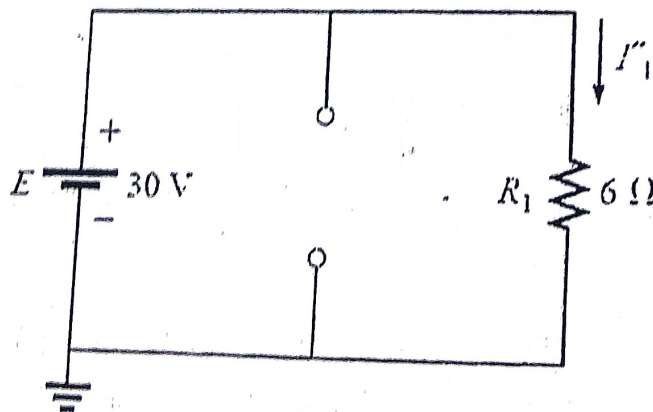
Solution:

1) Setting $E = 0$ V



$$I'_1 = \frac{R_{sc} I}{R_{sc} + R_1} = \frac{(0 \Omega) I}{0 \Omega + 6 \Omega} = 0 \text{ A}$$

2) Setting $I = \text{zero}$

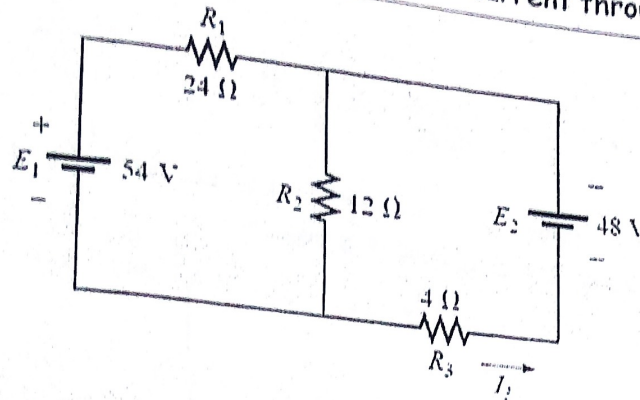


$$I''_1 = \frac{E}{R_1} = \frac{30 \text{ V}}{6 \Omega} = 5 \text{ A}$$

$$I_1 = I'_1 + I''_1 = 0 \text{ A} + 5 \text{ A} = 5 \text{ A}$$

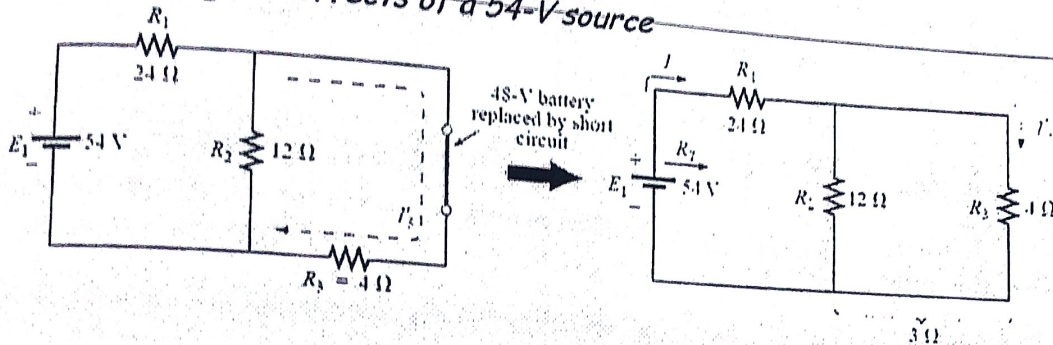
EXAMPLE: Using superposition, determine the current through the 4-
 Ω resistor

First class



Solution:

1) Considering the effects of a 54-V source

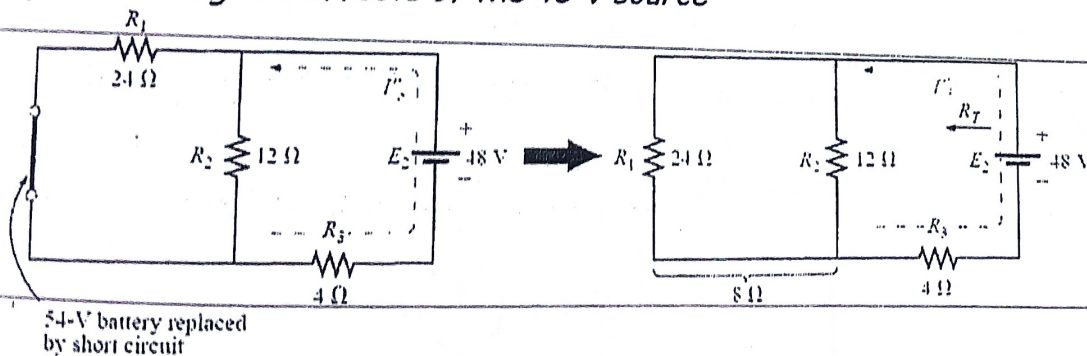


$$R_T = R_1 + R_2 \parallel R_3 = 24 \Omega + 12 \Omega \parallel 4 \Omega = 24 \Omega + 3 \Omega = 27 \Omega$$

$$I = \frac{E_1}{R_T} = \frac{54 \text{ V}}{27 \Omega} = 2 \text{ A}$$

$$I'_3 = \frac{R_2 I}{R_2 + R_3} = \frac{(12 \Omega)(2 \text{ A})}{12 \Omega + 4 \Omega} = \frac{24 \text{ A}}{16} = 1.5 \text{ A}$$

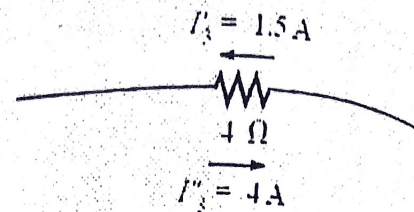
2) Considering the effects of the 48-V source



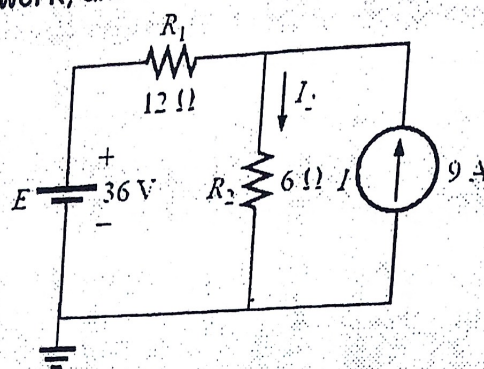
$$R_T = R_3 + R_1 \parallel R_2 = 4 \Omega + 24 \Omega \parallel 12 \Omega = 4 \Omega + 8 \Omega = 12 \Omega$$

$$I''_3 = \frac{E_2}{R_T} = \frac{48 \text{ V}}{12 \Omega} = 4 \text{ A}$$

$$I_3 = I''_3 - I'_3 = 4 \text{ A} - 1.5 \text{ A} = 2.5 \text{ A}$$

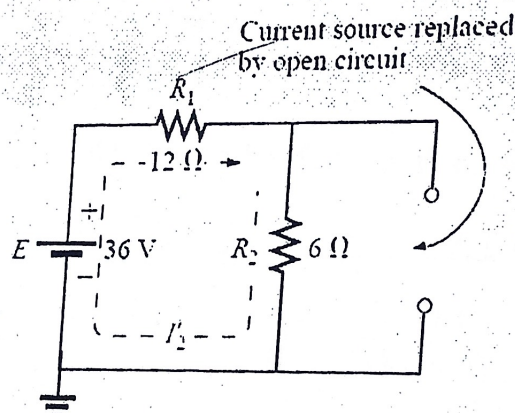


EXAMPLE: Using superposition, find the current through the $6\text{-}\Omega$ resistor of the network, and find its power.



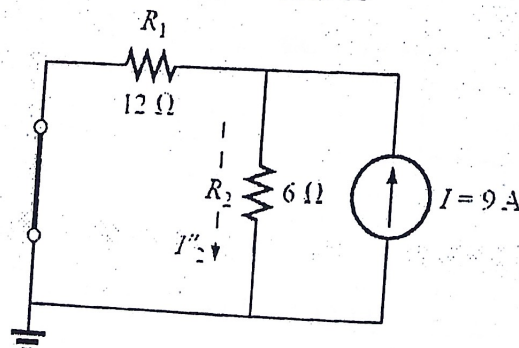
Solution:

1) Considering the effect of the 36-V source



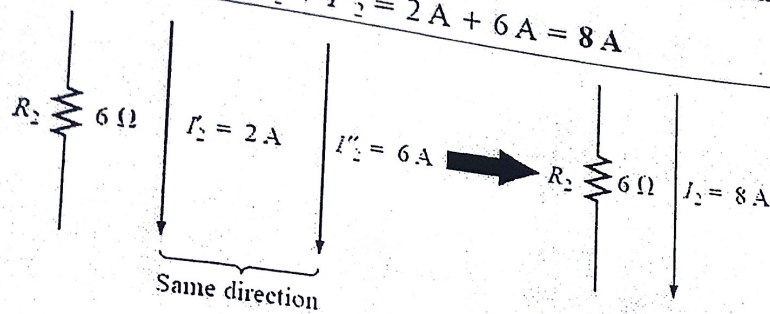
$$I'_2 = \frac{E}{R_T} = \frac{E}{R_1 + R_2} = \frac{36 \text{ V}}{12 \Omega + 6 \Omega} = 2 \text{ A}$$

2) Considering the effect of the 9-A source



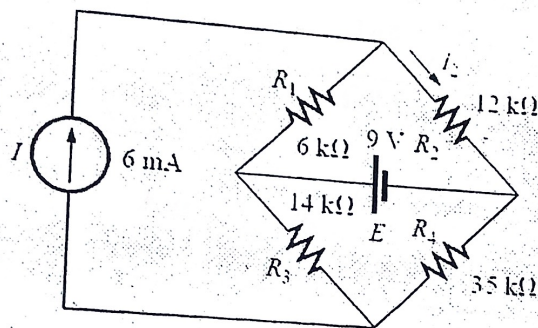
$$I''_2 = \frac{R_1 I}{R_1 + R_2} = \frac{(12 \Omega)(9 \text{ A})}{12 \Omega + 6 \Omega} = \frac{108 \text{ A}}{18} = 6 \text{ A}$$

$$I_2 = I'_2 + I''_2 = 2 \text{ A} + 6 \text{ A} = 8 \text{ A}$$



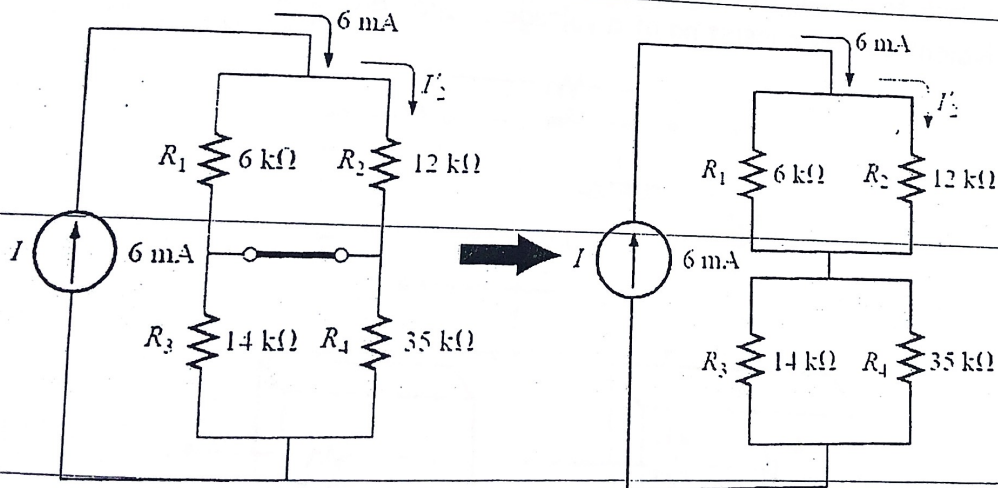
$$\text{Power} = I^2 R = (8 \text{ A})^2 (6 \Omega) = 384 \text{ W}$$

EXAMPLE: Using the principle of superposition, find the current I_2 through the 12-k Ω resistor.



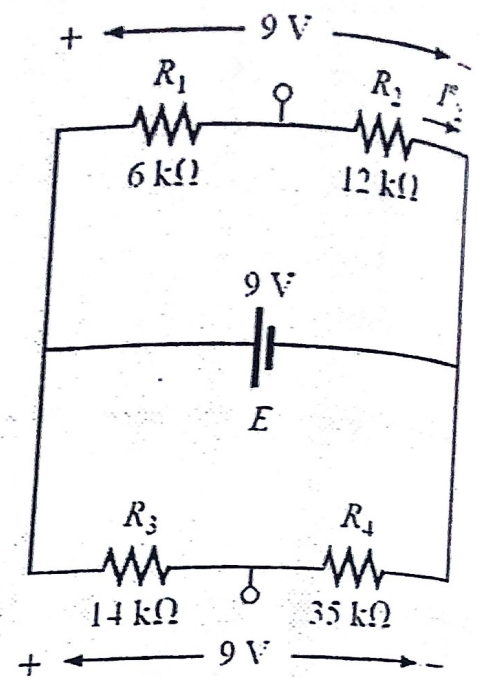
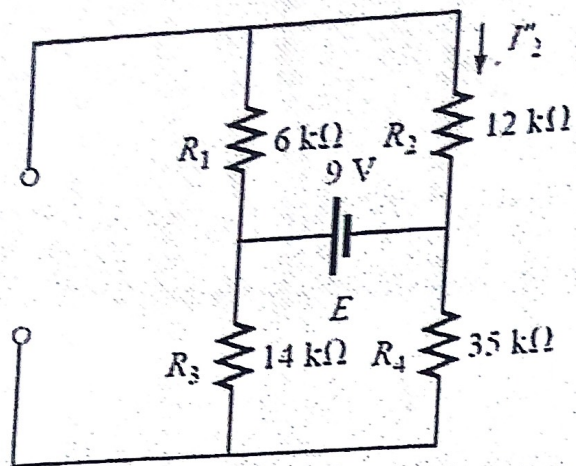
Solution:

1) Considering the effect of the 6-mA



$$I'_2 = \frac{R_1 I}{R_1 + R_2} = \frac{(6 \text{ k}\Omega)(6 \text{ mA})}{6 \text{ k}\Omega + 12 \text{ k}\Omega} = 2 \text{ mA}$$

2) Considering the effect of the 9-V voltage source



$$I''_2 = \frac{E}{R_1 + R_2} = \frac{9 \text{ V}}{6 \text{ k}\Omega + 12 \text{ k}\Omega} = 0.5 \text{ mA}$$

$$\begin{aligned} I_2 &= I'_2 + I''_2 \\ &= 2 \text{ mA} + 0.5 \text{ mA} \\ &= 2.5 \text{ mA} \end{aligned}$$