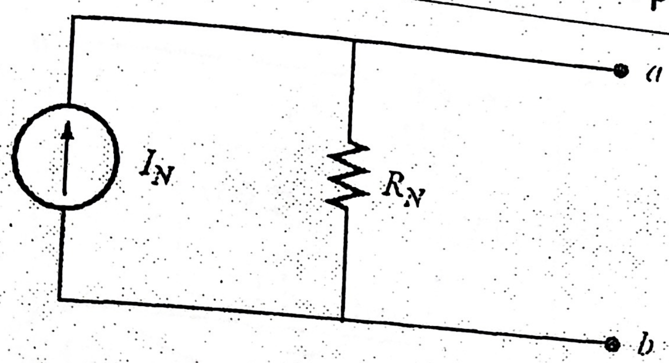
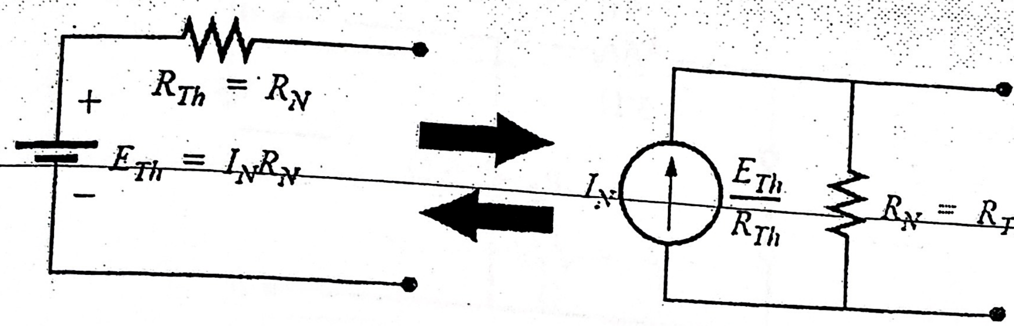
Norton's Theorem

Any two-terminal linear bilateral dc network can be replaced by an equivalent circuit consisting of a current source and a parallel resistor,





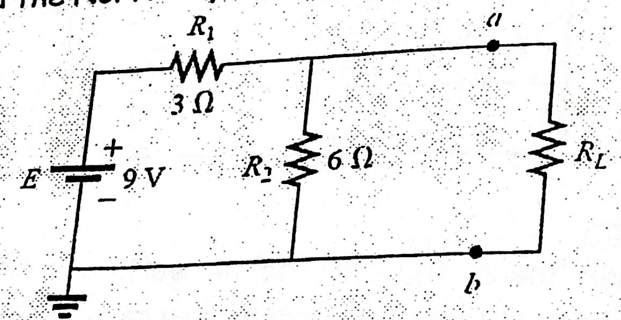
The steps leading to the proper values of I_N and R_N are now listed.

1) Remove that portion of the network across which the Norton equivalent circuit is found.
2) Mark the terminals of the remaining two-terminal network.
3) Calculate RN by first setting all sources to zero (voltage sources are replaced with short circuits and current sources with open circuits) and then finding the resultant resistance between the two marked terminals.
4) Calculate IN by first returning all sources to their original position and then finding the short-circuit current between the marked terminals.
5) Draw the Norton equivalent circuit with the portion of the circuit previously removed replaced between the terminals of the equivalent circuit.

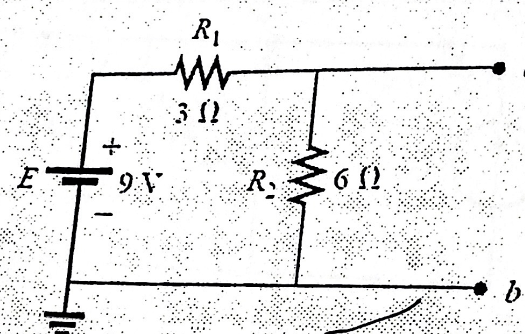
Then

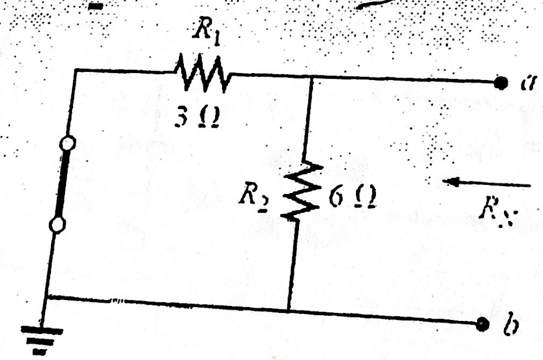
$$I_L = I_N \frac{R_N}{R_N + R_L}$$

EXAMPLE: Find the Norton equivalent circuit for the network.

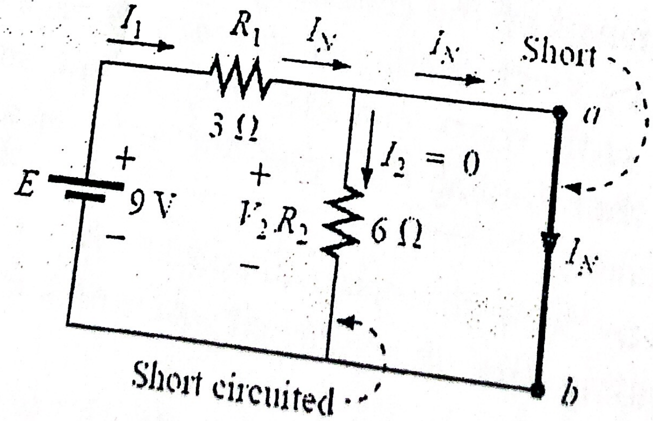


Solution:



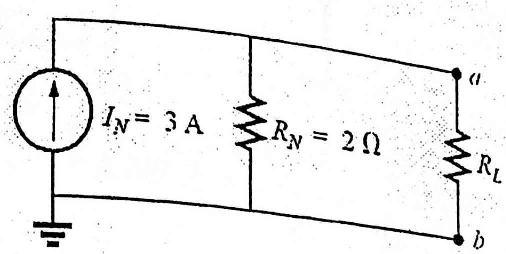


$$R_N = R_1 \parallel R_2 = 3\,\Omega \parallel 6\,\Omega = \frac{(3\,\Omega)(6\,\Omega)}{3\,\Omega + 6\,\Omega} = \frac{18\,\Omega}{9} = 2\,\Omega$$

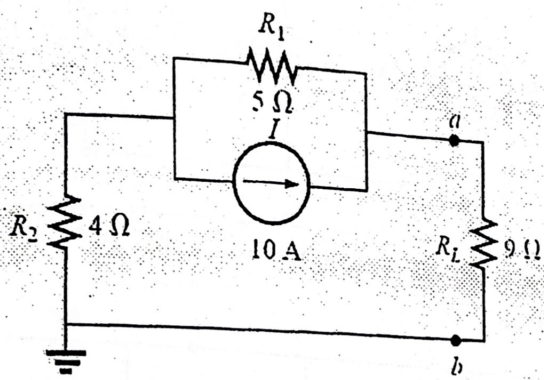


$V_2 = I_2 R_2 = (0)6\ \Omega = 0\ V$

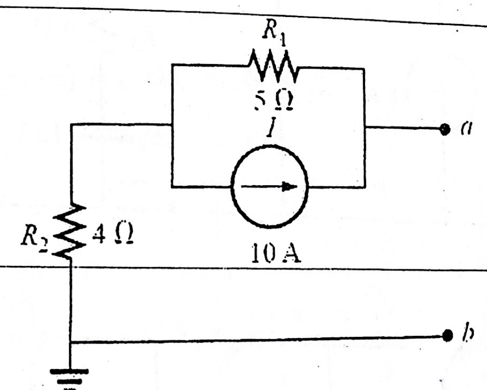
$$I_N = \frac{E}{R_1} = \frac{9\ V}{3\ \Omega} = 3\ A$$

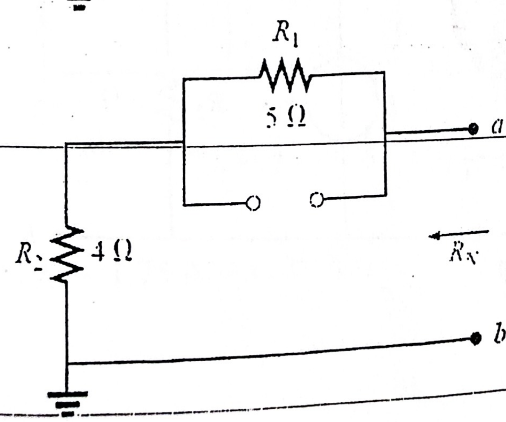


- **EXAMPLE:** Find the Norton equivalent circuit for the network external to the 9-Ω resistor.

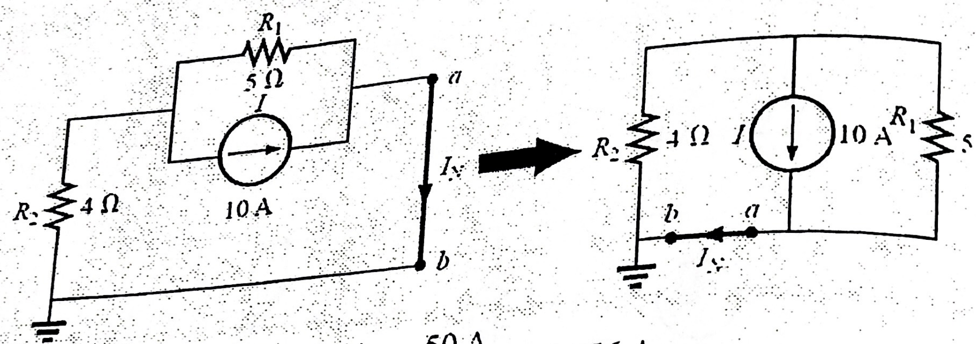


Solution:

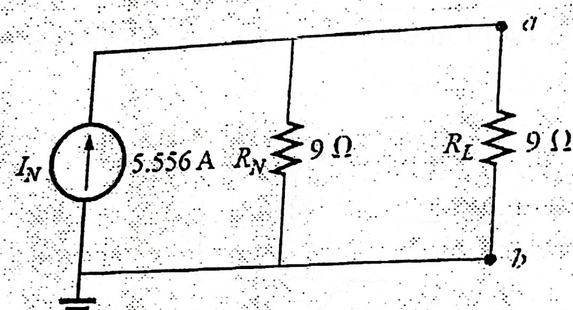




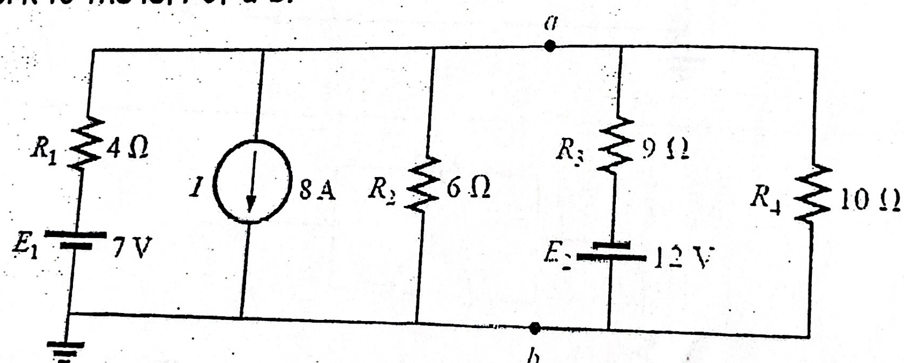
$$R_N = R_1 + R_2 = 5\ \Omega + 4\ \Omega = 9\ \Omega$$



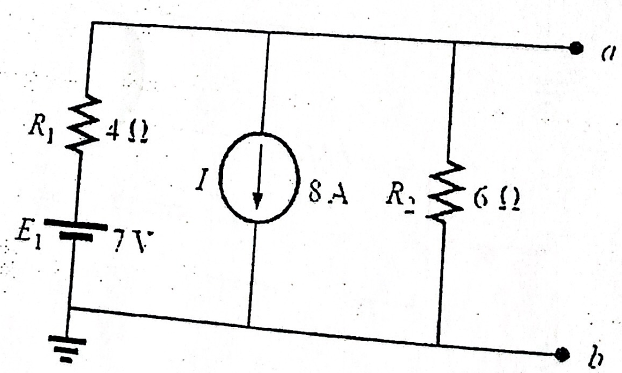
$$I_N = \frac{R_1 I}{R_1 + R_2} = \frac{(5\,\Omega)(10\,\text{A})}{5\,\Omega + 4\,\Omega} = \frac{50\,\text{A}}{9} = 5.556\,\text{A}$$

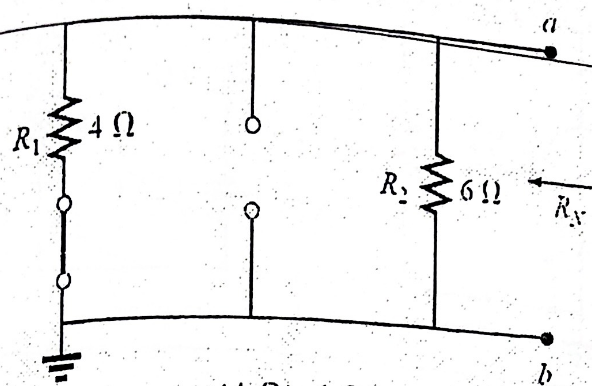


EXAMPLE: Find the Norton equivalent circuit for the portion of the network to the left of *a-b*.



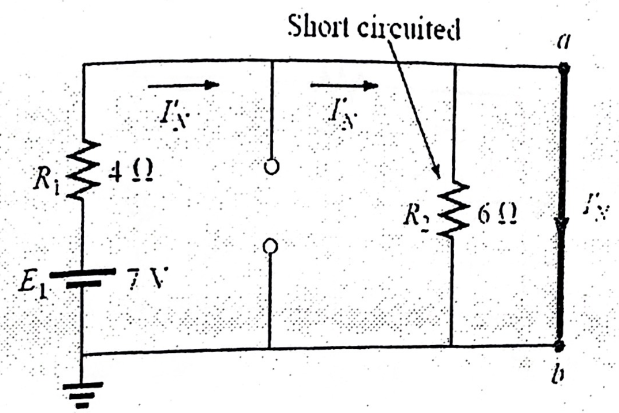
Solution:





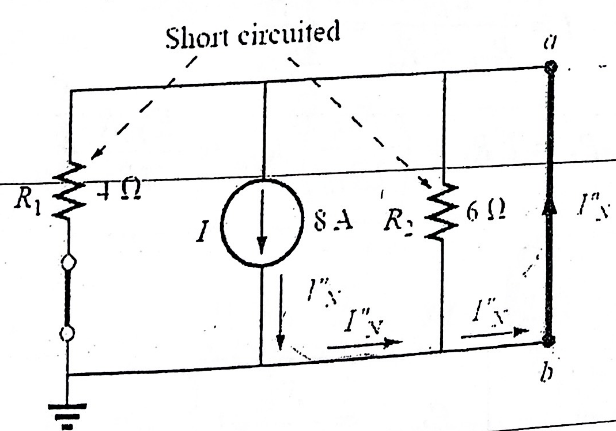
$$R_N = R_1 \parallel R_2 = 4\ \Omega \parallel 6\ \Omega = \frac{(4\ \Omega)(6\ \Omega)}{4\ \Omega + 6\ \Omega} = \frac{24\ \Omega}{10} = 2.4\ \Omega$$

1) (Using superposition) for the 7-V battery



$$I'_N = \frac{E_1}{R_1} = \frac{7\text{V}}{4\ \Omega} = 1.75\text{ A}$$

2) (Using superposition) for the 8-A source



$$I''_N = I = 8\text{ A}$$

$$I_N = I''_N - I'_N = 8\text{ A} - 1.75\text{ A} = 6.25\text{ A}$$

, November 12, 2012