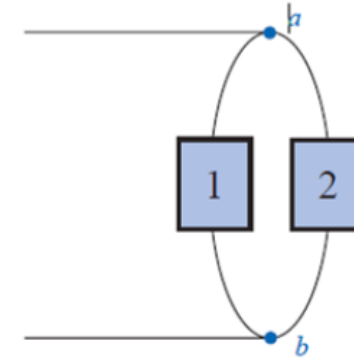
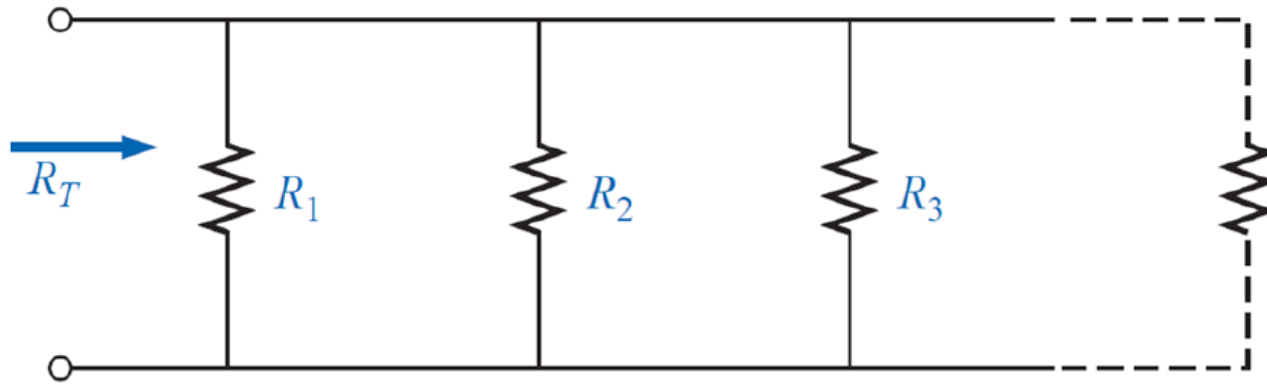


Parallel Circuits

PARALLEL ELEMENTS

Two elements, branches, or networks are in parallel if they have two points in common.



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

$$G_T = G_1 + G_2 + \dots + G_N$$

In parallel circuits

The voltage across parallel elements is the same.

Using this fact will result in

$$E = V_1 = V_2$$

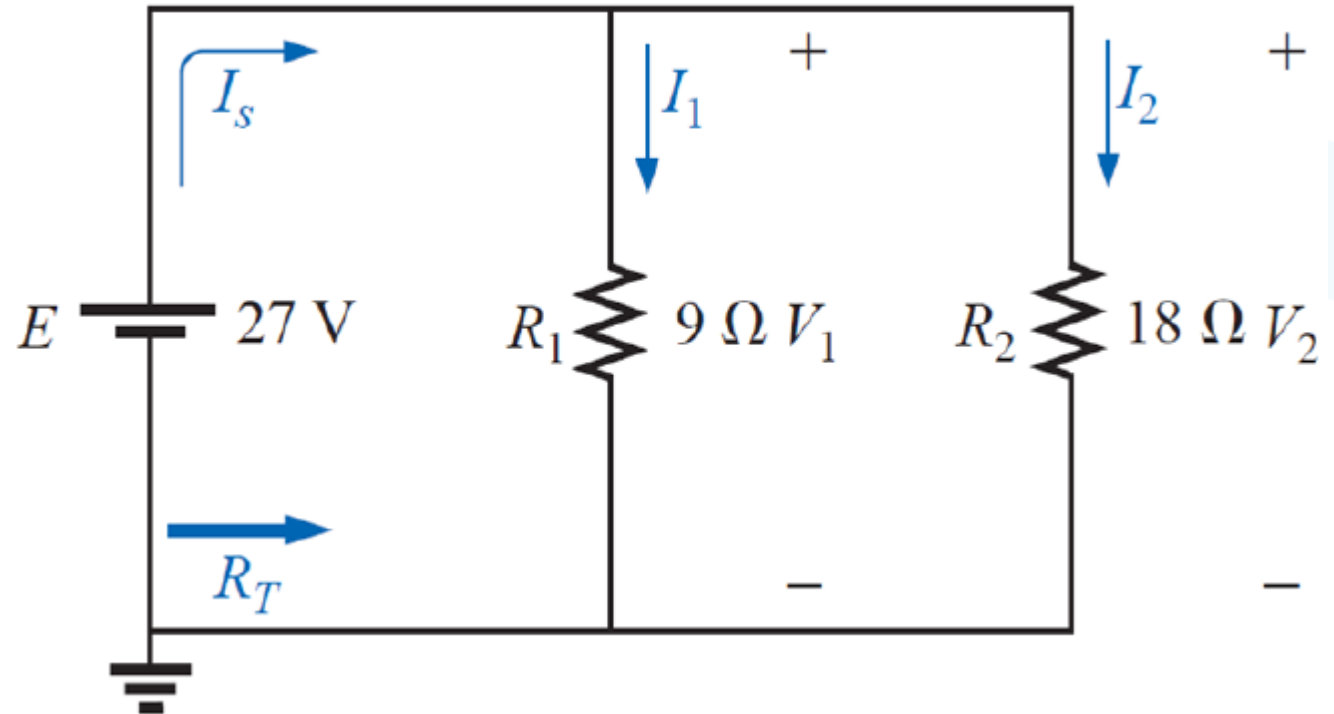
but

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

$$\frac{E}{R_T} = \frac{E}{R_1} + \frac{E}{R_2}$$

$$\frac{E}{R_T} = \frac{V_1}{R_1} + \frac{V_2}{R_2}$$

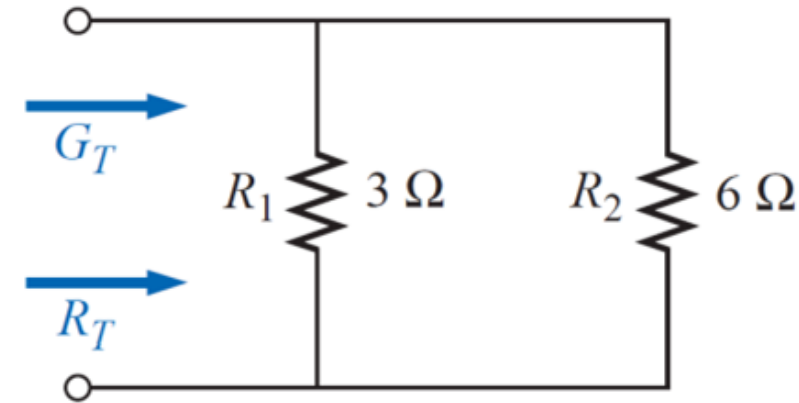
$$I_S = I_1 + I_2$$



Therefore, *The total current equal to algebraic sum of branches current*

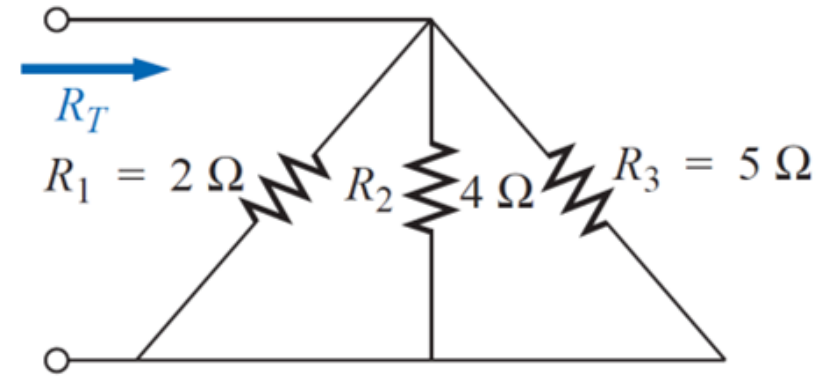
EXAMPLE 1

Determine the total conductance and resistance for the parallel network of Fig. shown below



EXAMPLE 2

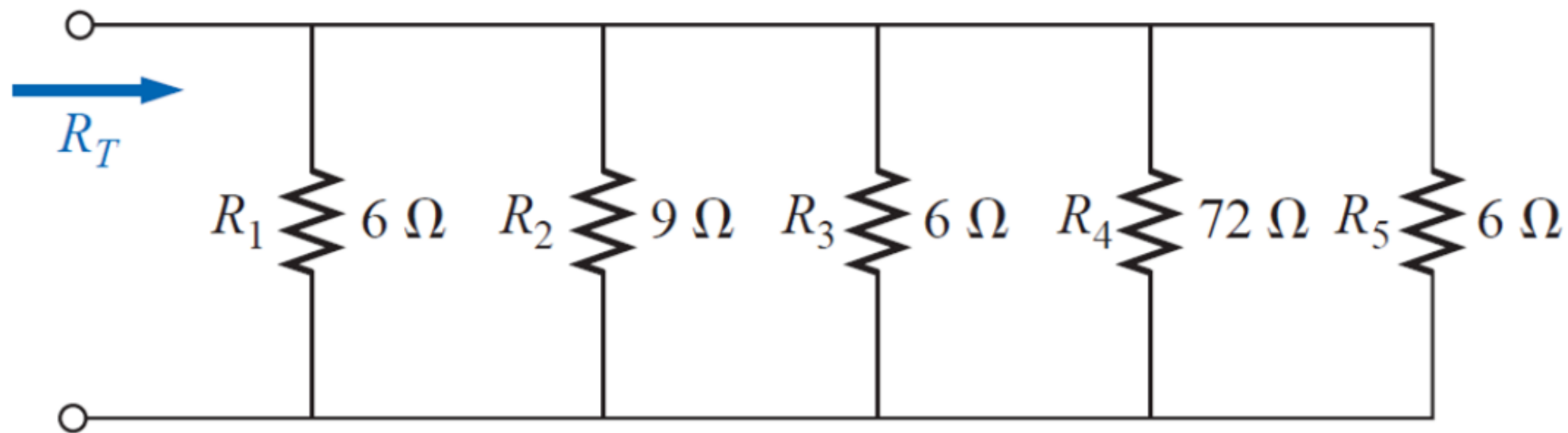
Determine the total conductance and resistance for the parallel network of Fig. shown below



The total resistance of parallel resistors is always less than the value of the smallest resistor.

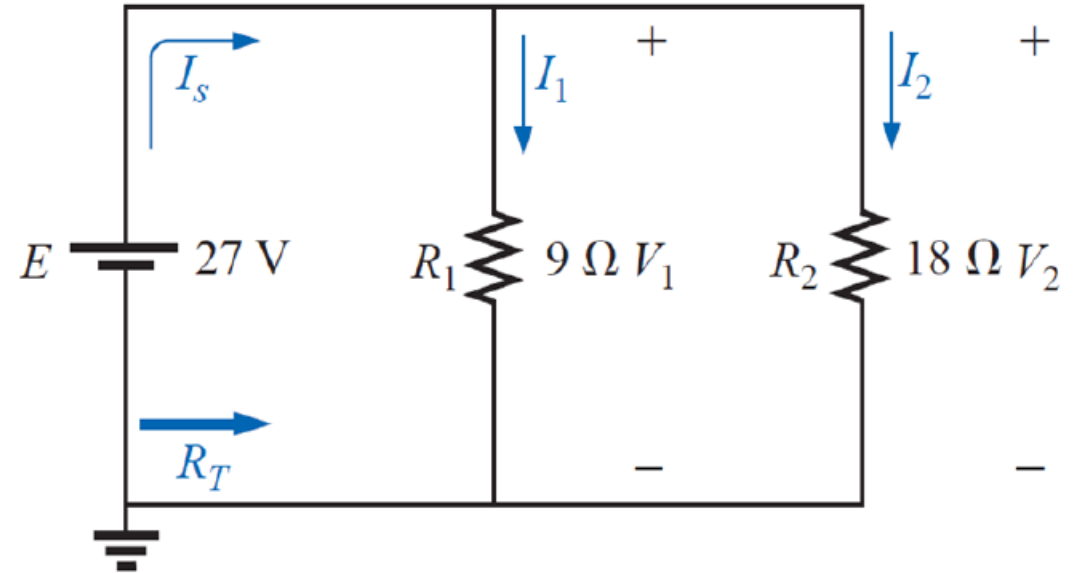
EXAMPLE 3

Determine the total conductance and resistance for the parallel network of Fig. shown below



EXAMPLE 4

For the following parallel network:



- Calculate R_T .
- Determine I_s .
- Calculate I_1 and I_2 , and demonstrate that $I_s = I_1 + I_2$.
- Determine the power to each resistive load.
- Determine the power delivered by the source, and compare it to the total power dissipated by the resistive elements.

KIRCHHOFF'S CURRENT LAW

Kirchhoff's voltage law provides an important relationship among voltage levels around any closed loop of a network. We now consider

Kirchhoff's current law (KCL), which provides an equally important relationship among current levels at any junction.

Kirchhoff's current law (KCL) *states that the algebraic sum of the currents entering and leaving an area, system, or junction is zero.*

In other words,

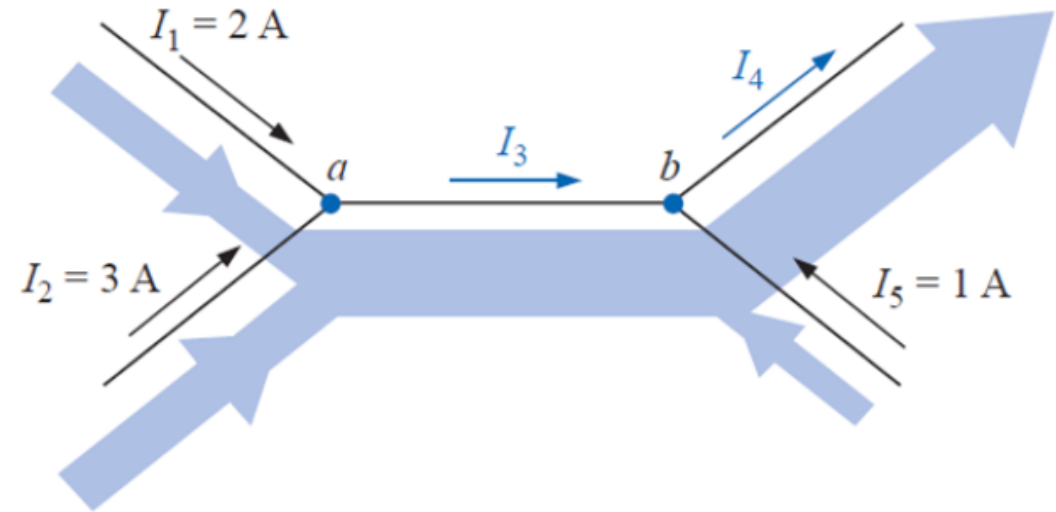
the sum of the currents entering an area, system, or junction must equal the sum of the currents leaving the area, system, or junction.

In equation form:

$$\sum I_{\text{entering}} = \sum I_{\text{leaving}}$$

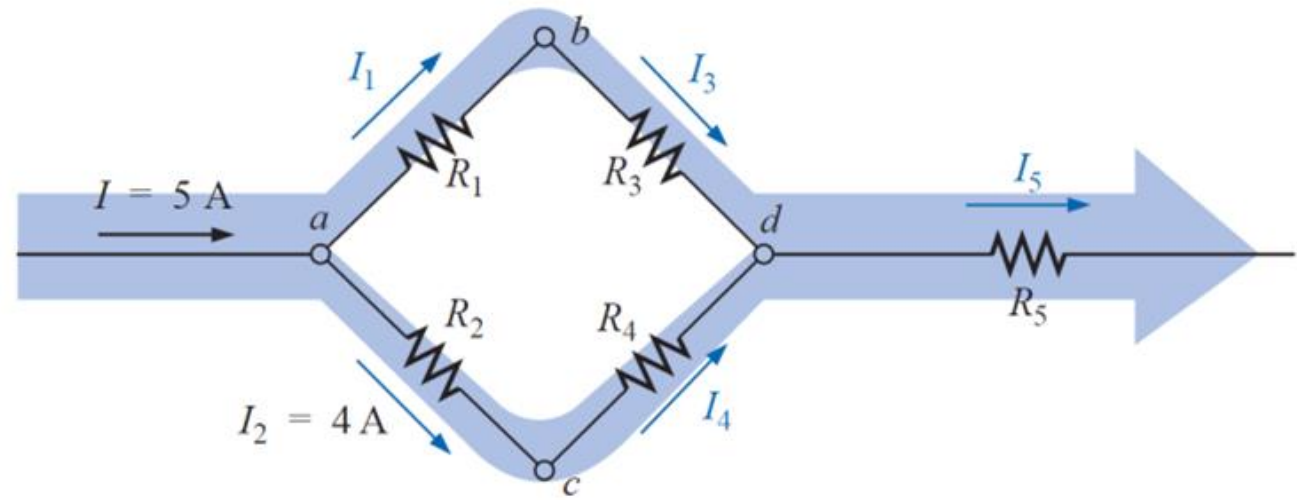
EXAMPLE 5

Determine the currents I_3 and I_4



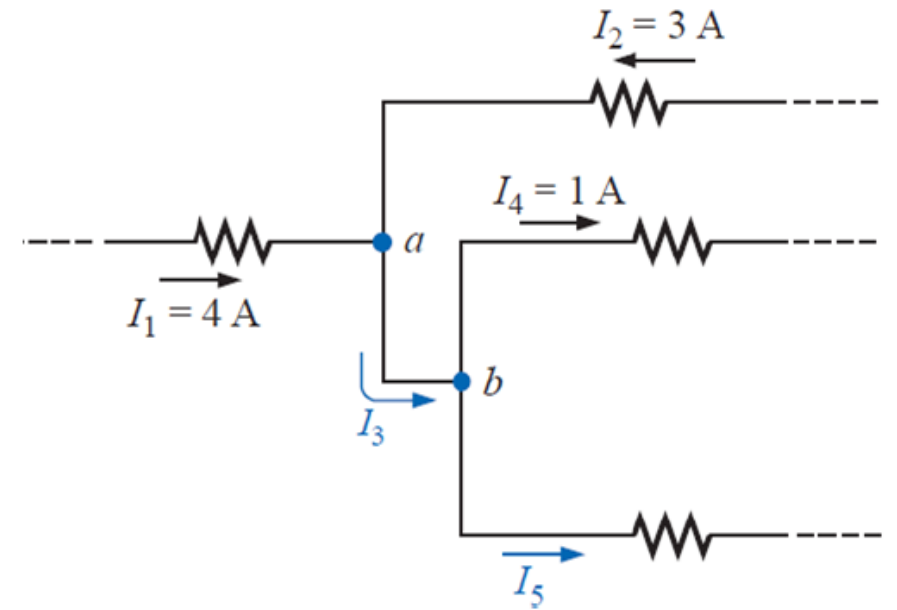
EXAMPLE 6

Determine I_1 , I_3 , I_4 , and I_5 for the network shown below



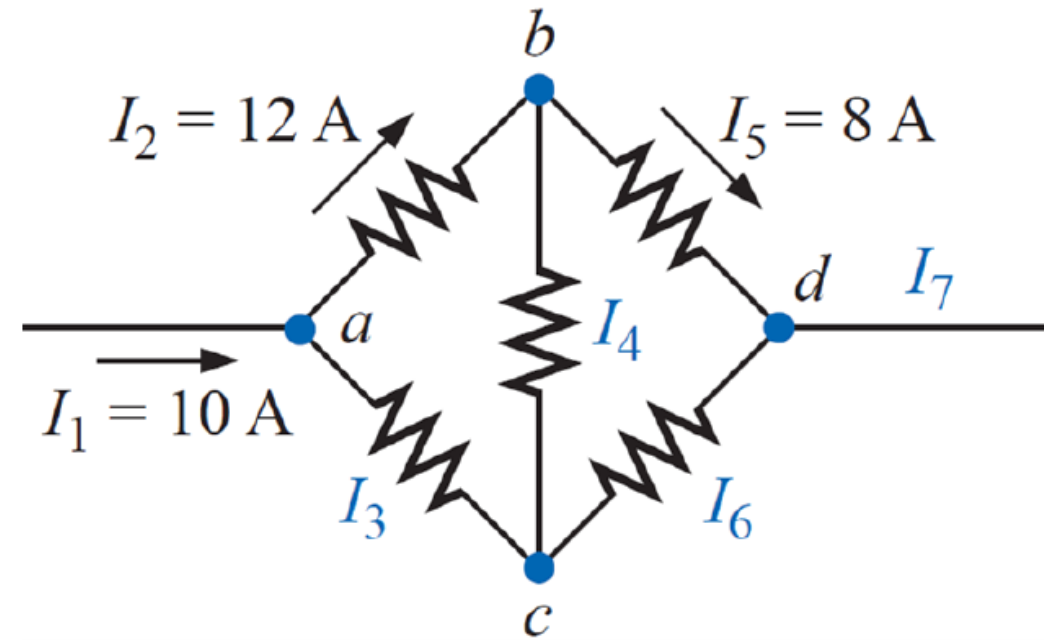
EXAMPLE 7

Determine the currents I_3 and I_5 of Fig. shown below through applications of Kirchhoff's current law.



EXAMPLE 8

Find the magnitude and direction of the currents I_3 , I_4 , I_6 , and I_7 for the network shown below. Even though the elements are not in series or parallel, Kirchhoff's current law can be applied to determine all the unknown currents.



CURRENT DIVIDER RULE

The **current divider rule (CDR)** will determine how the current entering a set of parallel branches will split between the elements.

For two parallel elements of equal value, the current will divide equally.

For parallel elements with different values,

The smaller resistance has greatest value of current.

The current will split with a ratio equal to the inverse of their resistor values.

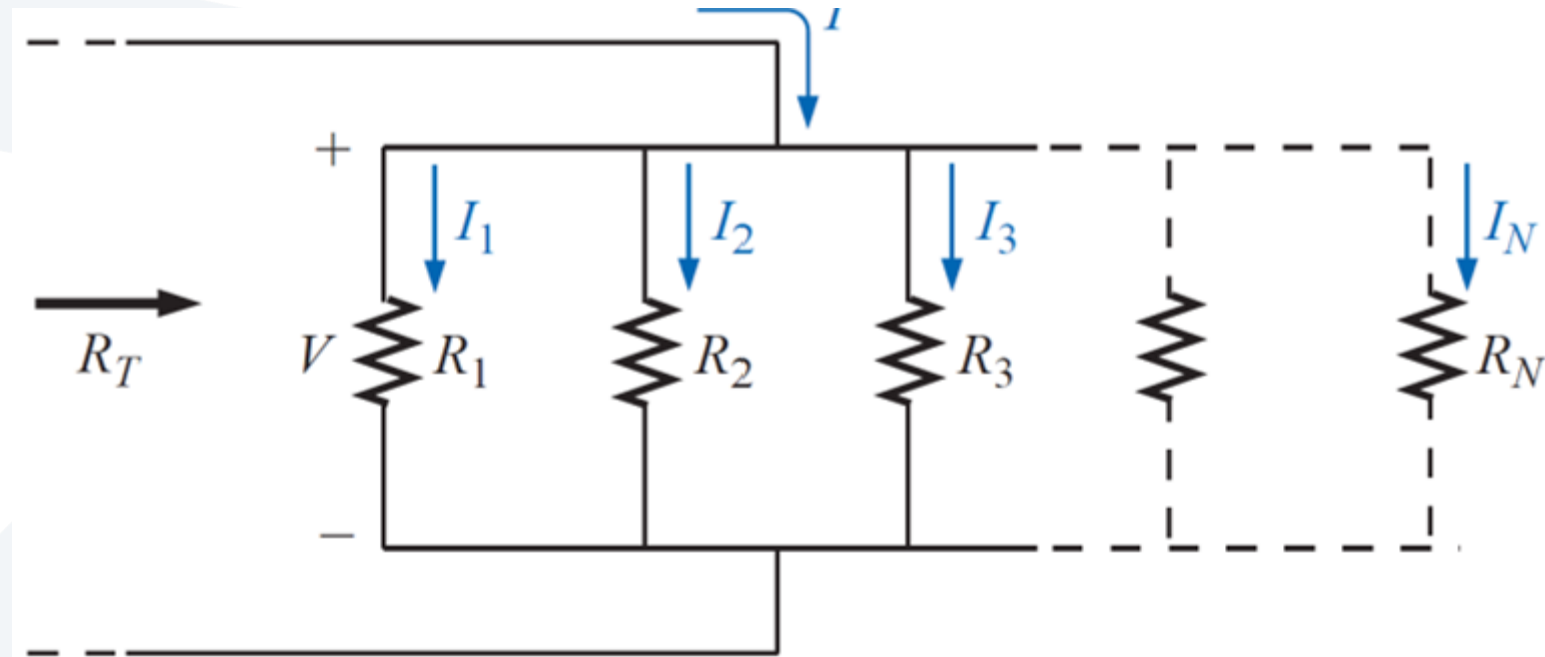
$$I_T = I_1 + I_2 + \dots + I_N$$

$$E = V_1 = V_2 = V_N$$

$$I_T = \frac{E}{R_T} = \frac{I_1 R_1}{R_T} = \frac{I_2 R_2}{R_T} = \frac{I_N R_N}{R_T}$$

$$I_T = \frac{I_x R_x}{R_T}$$

$$I_x = I_T \frac{\frac{1}{R_x}}{\frac{1}{R_T}} = I_T \frac{R_T}{R_x}$$



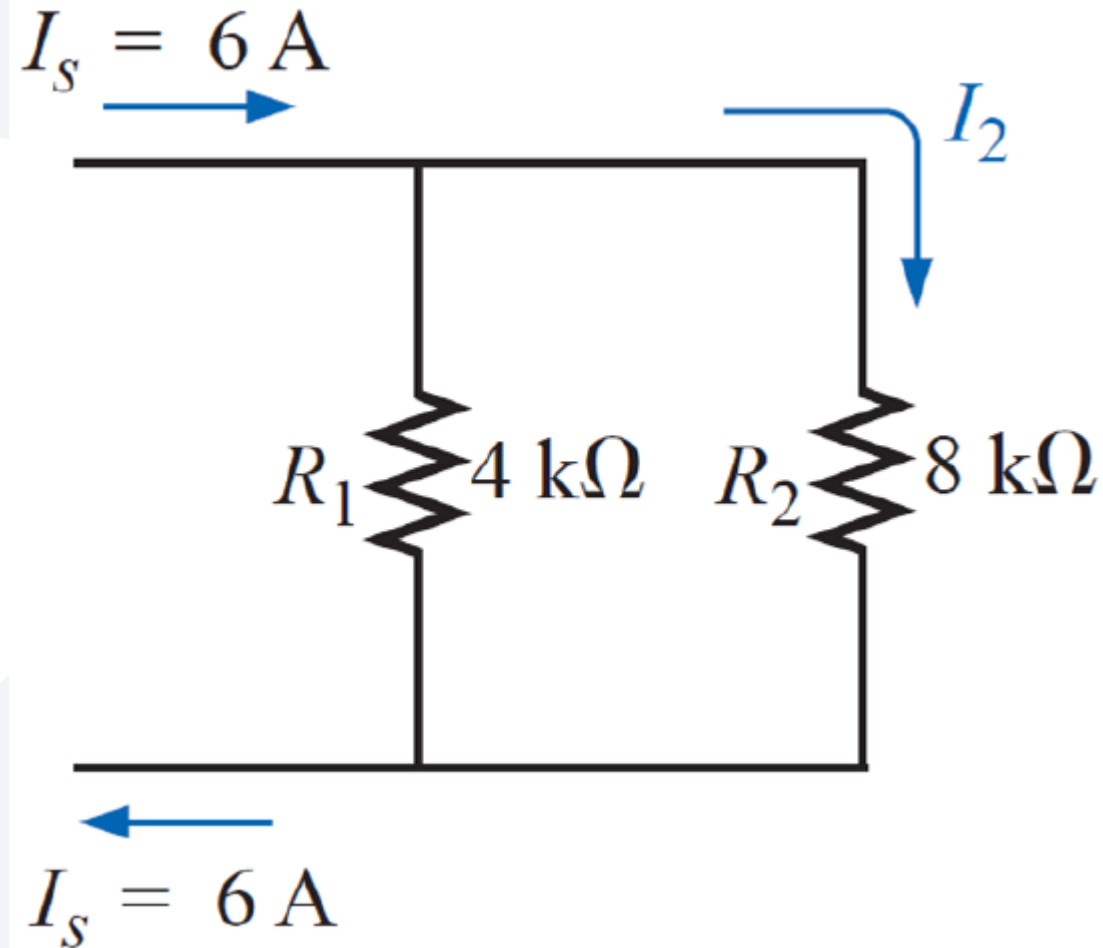
For the particular case of *two parallel resistors*,

$$I_1 = I_T \frac{\frac{1}{R_1}}{\frac{1}{R_T}} = I_T \frac{\frac{1}{R_1}}{\frac{1}{R_1} + \frac{1}{R_2}} = I_T \frac{\frac{1}{R_1}}{\frac{R_1 + R_2}{R_1 R_2}} = I_T \frac{R_2}{R_1 + R_2}$$

$$I_2 = I_T \frac{\frac{1}{R_2}}{\frac{1}{R_T}} = I_T \frac{\frac{1}{R_2}}{\frac{1}{R_1} + \frac{1}{R_2}} = I_T \frac{\frac{1}{R_2}}{\frac{R_1 + R_2}{R_1 R_2}} = I_T \frac{R_1}{R_1 + R_2}$$

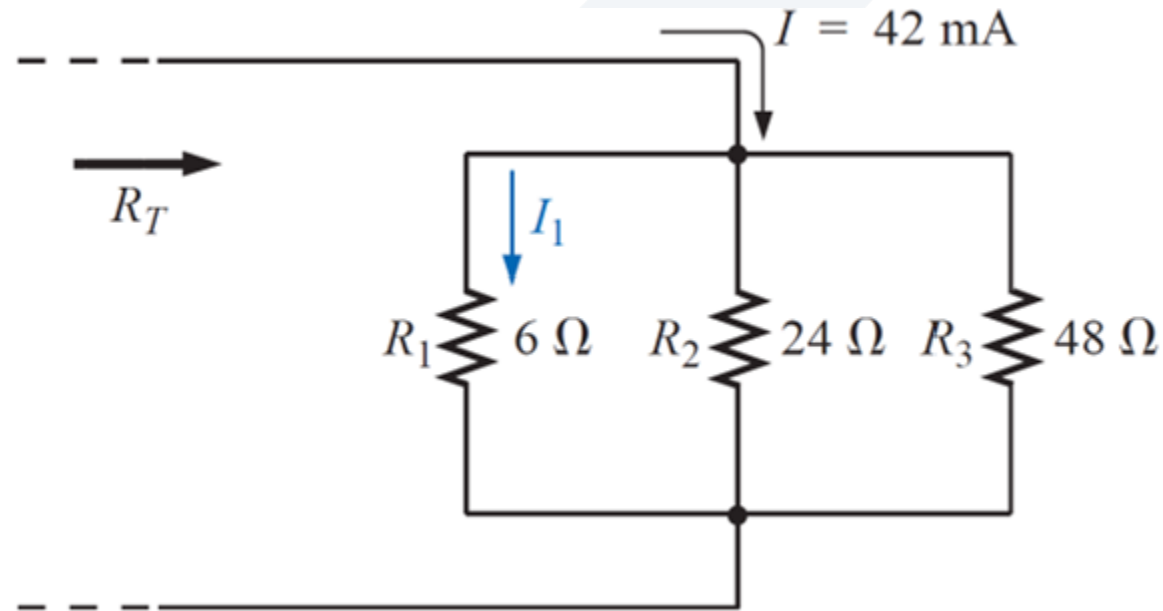
EXAMPLE 9

Determine the current I_2 for the network shown below using the current divider rule.



EXAMPLE 10

Determine the current I_1 for the network shown below using the current divider rule.

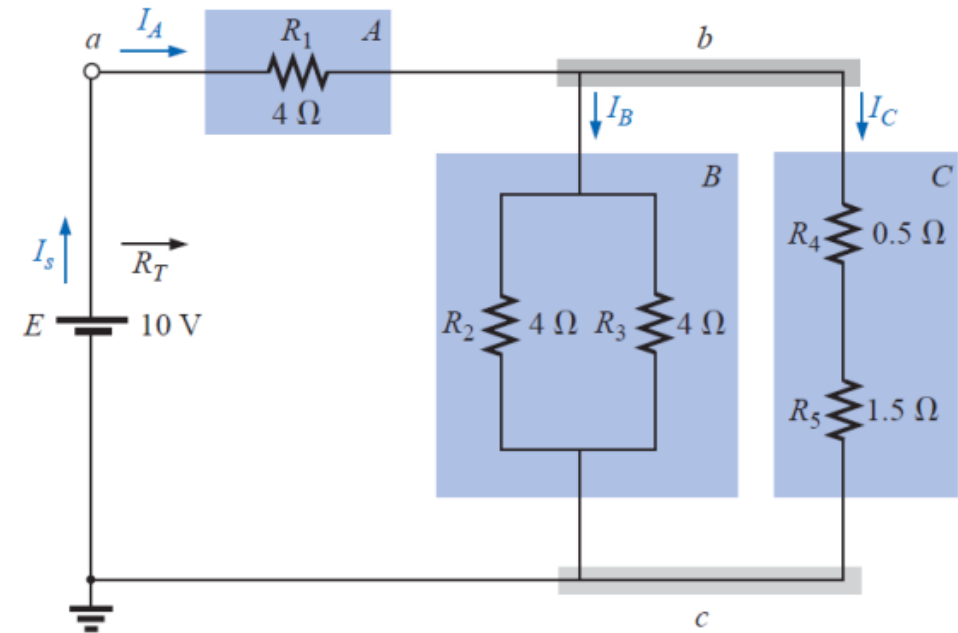


Series-Parallel Networks

series-parallel networks *are networks that contain both series and parallel circuit configurations.*

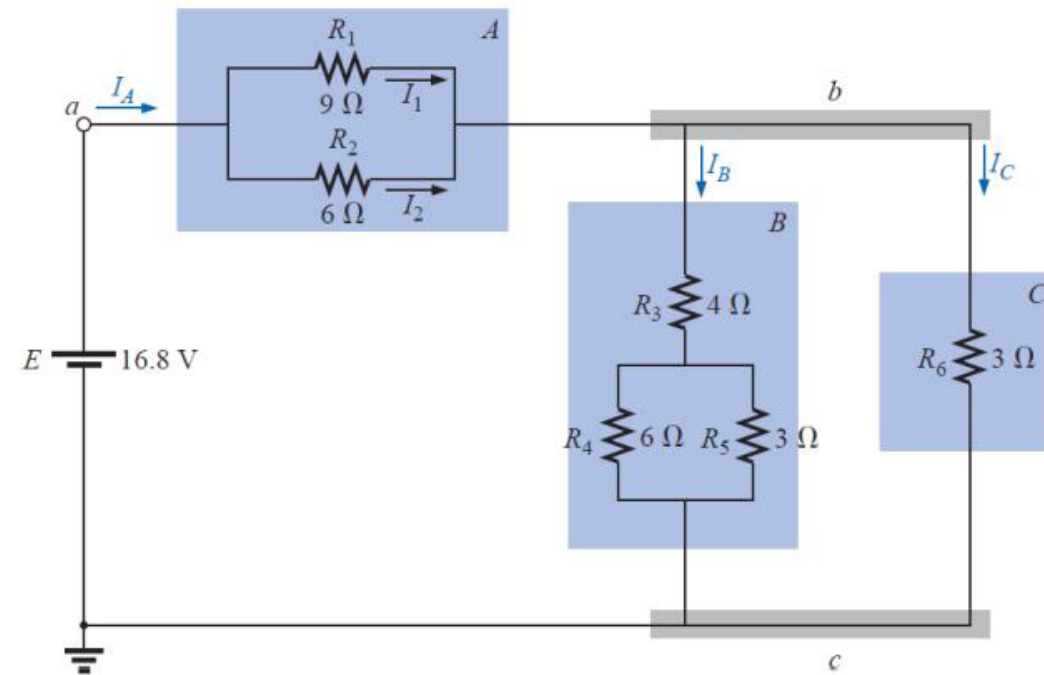
Example 1

Find the indicated currents of the figure shown below



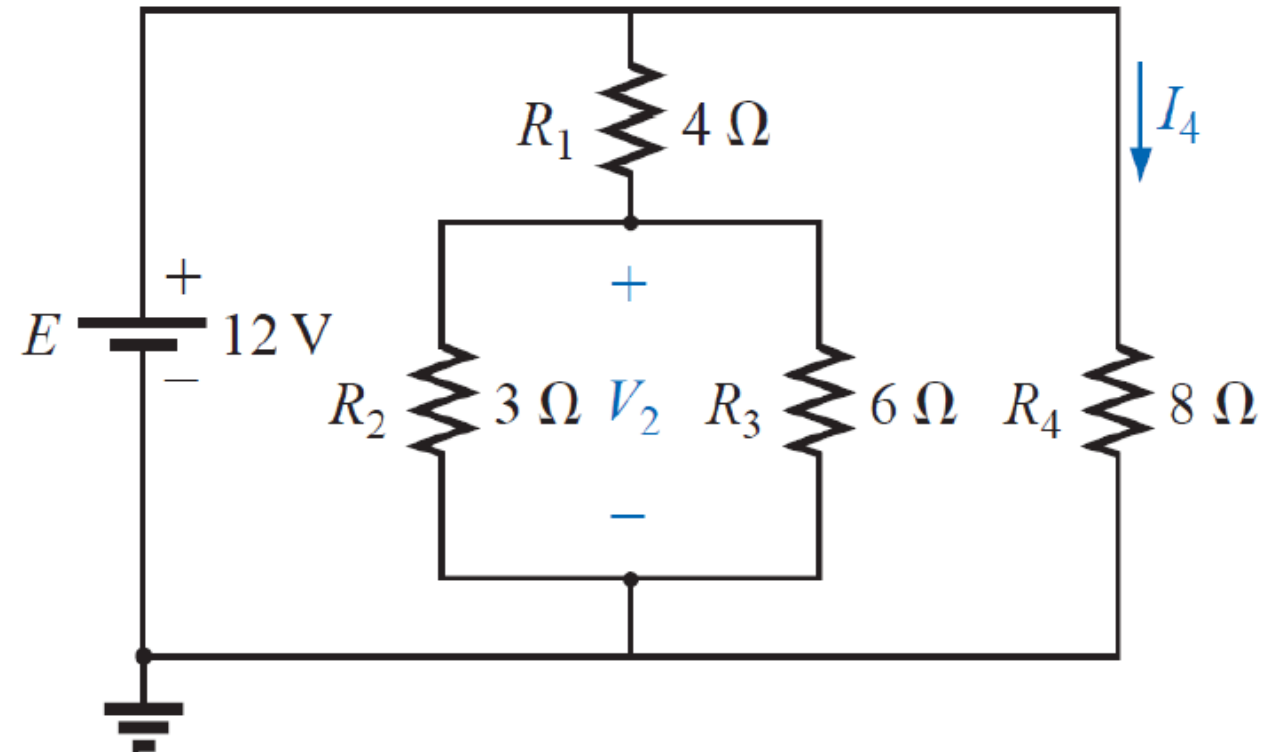
Example 2

Find the indicated currents of the figure shown below



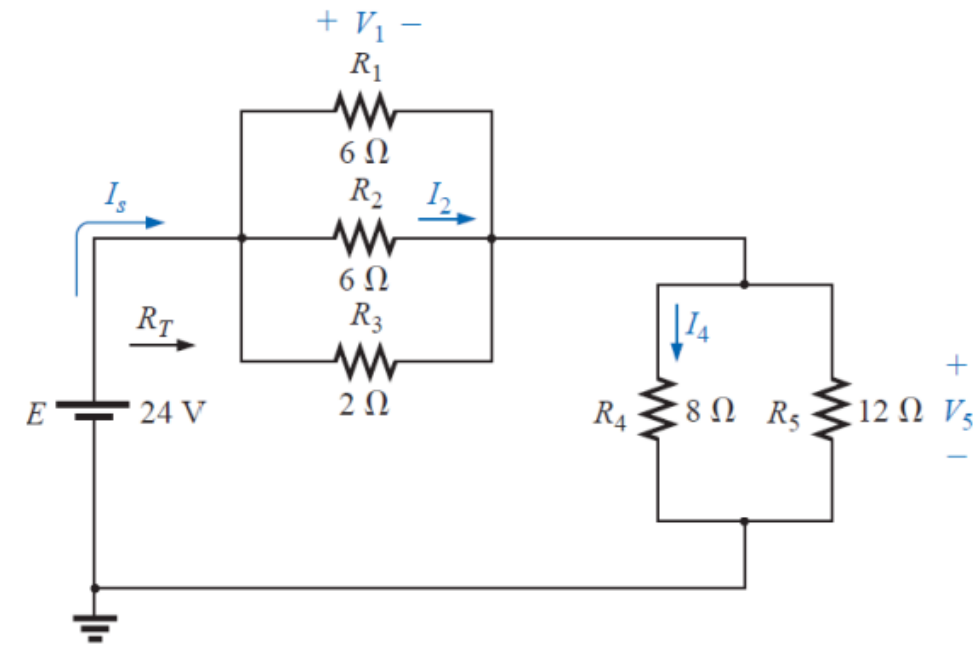
EXAMPLE 3

Find the current I_4 and the voltage V_2 for the network shown below



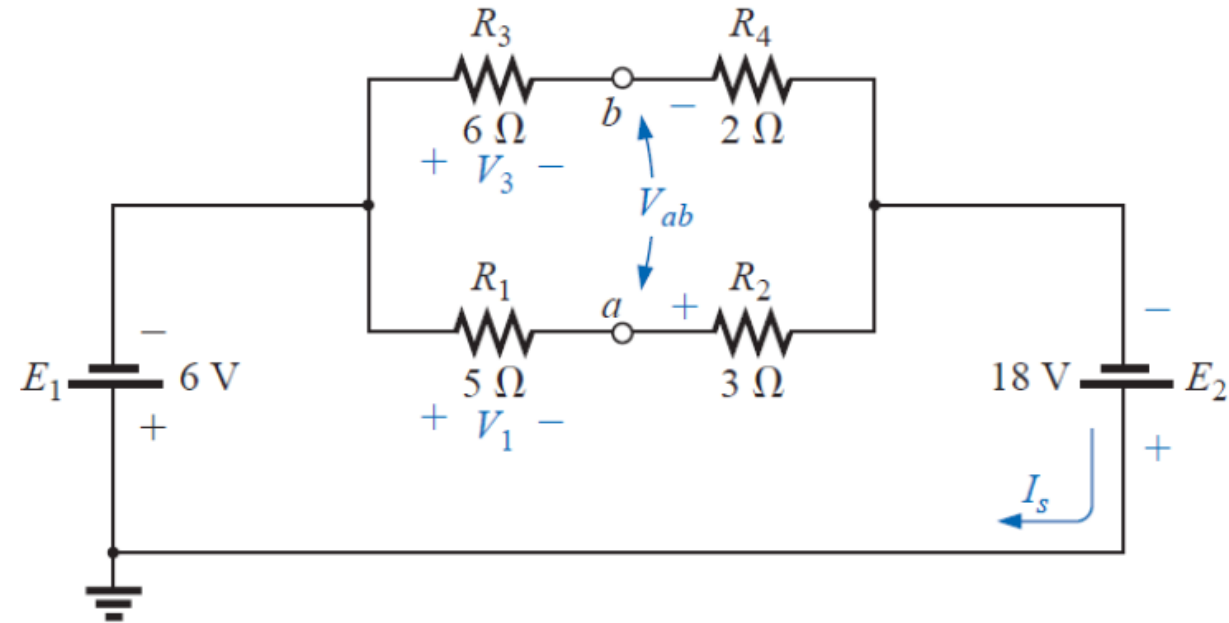
Example 4

Find the indicated currents and voltages for the network shown below



EXAMPLE 5

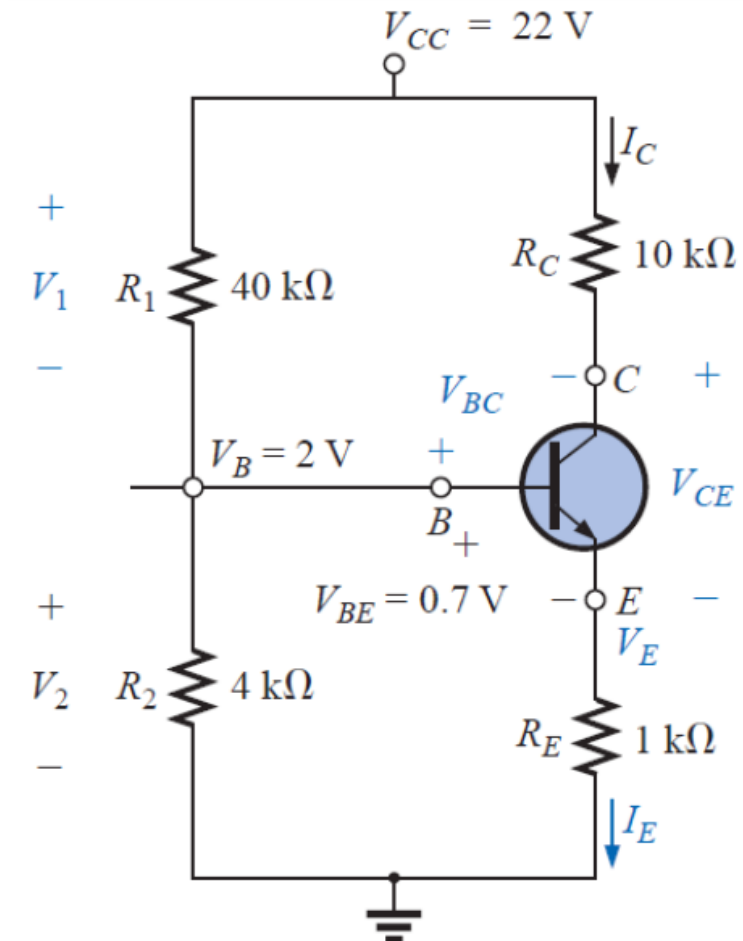
- Find the voltages V_1 , V_3 , and V_{ab} for the network shown below.
- Calculate the source current I_s .



EXAMPLE 6

For the transistor configuration shown below, in which V_B and V_{BE} have been provided:

- Determine the voltage V_E and the current I_E .
- Calculate V_1 .
- Determine V_{BC} using the fact that the approximation $I_C = I_E$ is often applied to transistor networks.
- Calculate V_{CE} using the information obtained in parts (a) through (c).



Example 7

Find the indicated currents of the figure shown below

