Electrical circuits
Parallel dc Circuits

by

Hilal talib yaseen

الأفكار المركزية

1- connection and parallel CSC.

2 – voltage in parallel circuits

3 – current in parallel circuits

4 – Total Resistance =

5- Total Conductance

6 – Power

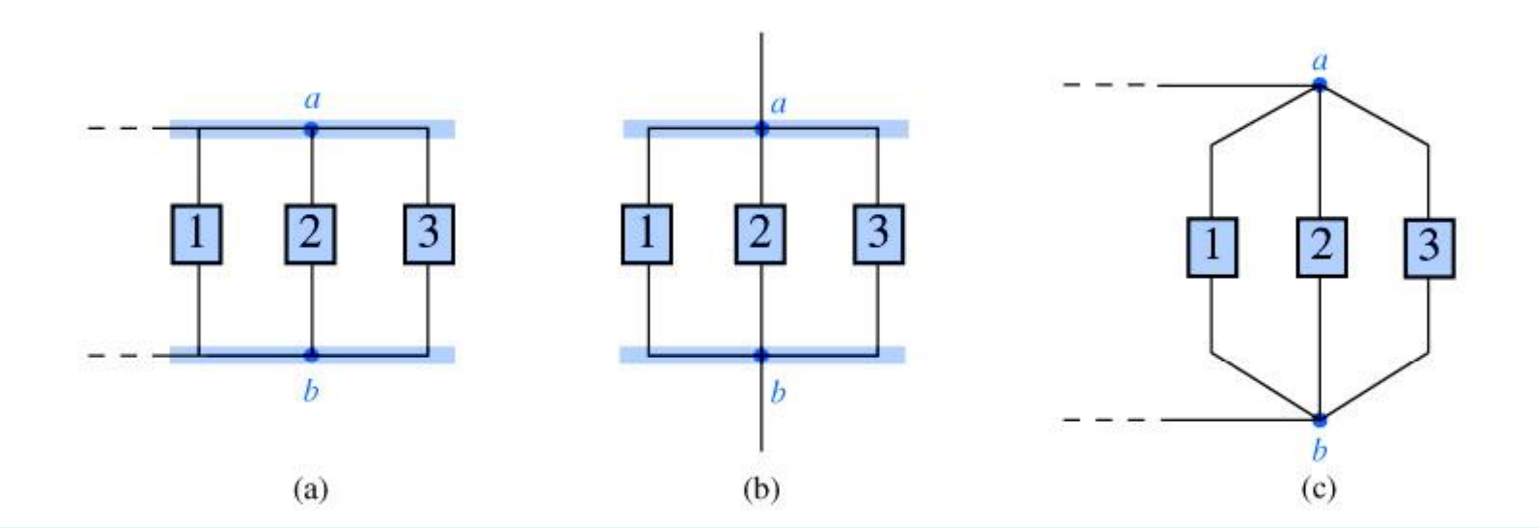
7 – CDR

8 – Example

9 - Homeworks

1- Parallel Resistors Conection

- Two elements, branches, or circuits are in parallel if they have two points in common as in the figure below



Q- Write the CSC of parallel Resistors

1- Same voltage is on all Resistances E = V1 = V2

2- Current is shared between the Resistances

3 – Current in each Resistor is given by ohm ,s Law

4- Total Current is equal to the sum of branche Currents

I = I1 + I2

5- Total Resistance is given by

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots + \frac{1}{R_N}$$

6- Total Conductance is the sum of parallel conductance

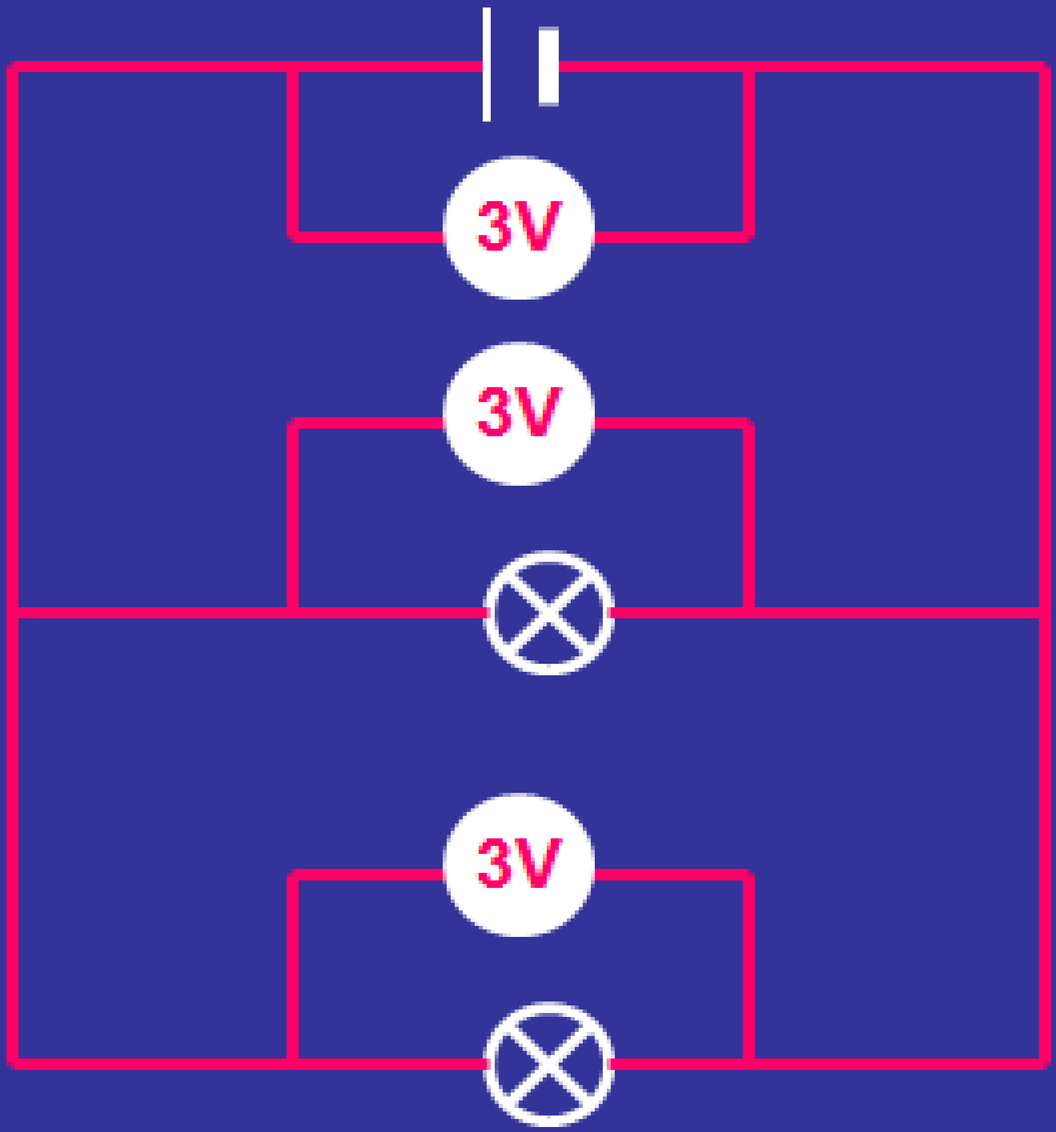
Gt = G1 + G2 G = 1/R

7- For equal Resistors

$$R_T = \frac{R}{N}$$

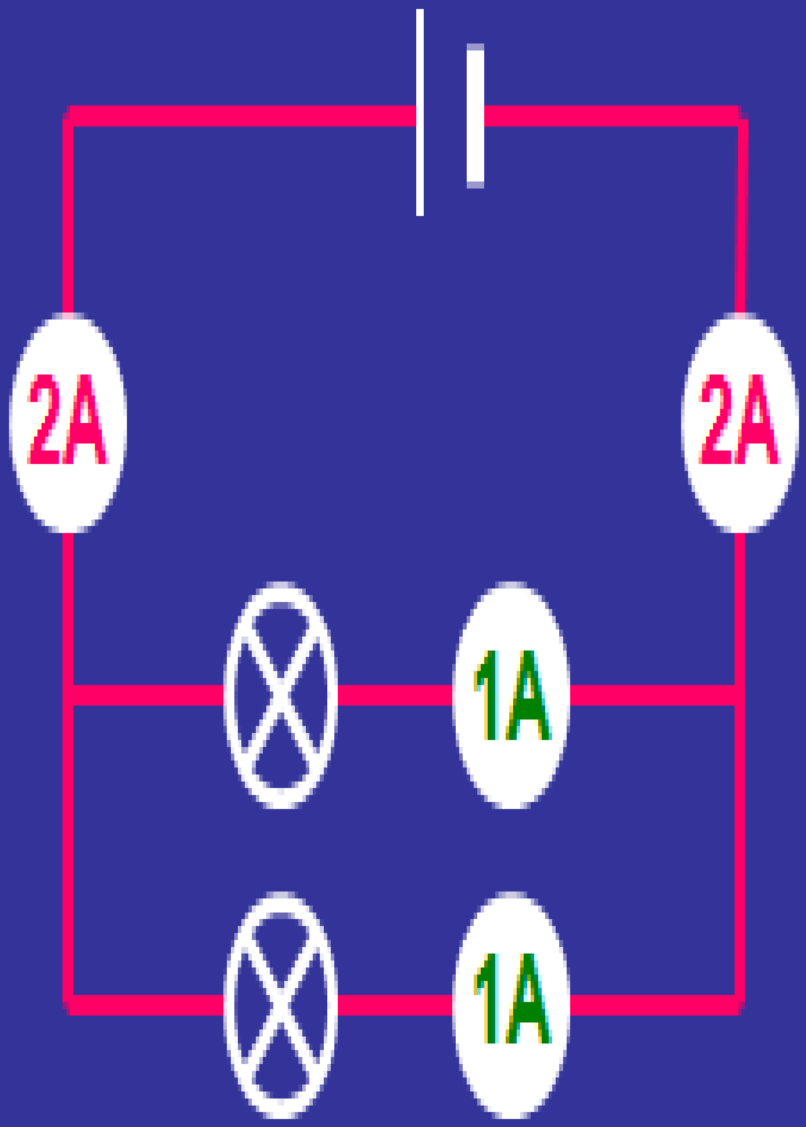
8- The smaller the Resistance , the greater the current

9- Total power is the sum of powers in each Resistor voltage is the **same** in all parts of the circuit.



PARALLEL CIRCUIT

- current is **shared** between the components



3- Total current

- For single-source parallel networks, the source current (I_s) is equal to the sum of the individual branch currents.

$$I_s = I_1 + I_2$$

- For a parallel circuit, source current equals the sum of the branch currents. For a series circuit, the applied voltage equals the sum of the voltage drops.

4 – Branch Currents

- For parallel circuits, the greatest current will exist in the branch with the lowest resistance.

$$I_s = I_1 + I_2 = \frac{E}{R_1} + \frac{E}{R_2}$$

5- Total Parallel Resistors

- For resistors in parallel, the total resistance is determined from

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots + \frac{1}{R_N}$$

6 – Total Parallel Resistors Formula

- The total resistance of two resistors is the product of the two divided by their sum.

If $R1 \parallel R2$

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

If $R1 \parallel R2 \parallel R3$

$$Rt = \frac{R1\ R2\ R3}{R1\ R2 + R2\ R3 + R3\ R1}$$

7 - Parallel Resistors

- For equal resistors in parallel:

$$R_T = \frac{R}{N}$$

Where N = the number of parallel resistors.

8 – Total conductance

- For parallel elements, the total conductance is the sum of the individual conductance values.

$$G_T = G_1 + G_2 + G_3 + \ldots + G_N$$

- As the number of resistors in parallel increases, the input current level will increase for the same applied voltage.
- This is the opposite effect of increasing the number of resistors in a series circuit.

9- Power Distribution in a Parallel Circuit

- For any resistive circuit, the power applied by the battery will equal that dissipated by the resistive elements.

$$P_E = P_{R_1} + P_{R_2} + P_{R_3} + \ldots + P_{R_N}$$

- The power relationship for parallel resistive circuits is identical to that for series resistive circuits.

10 - Current Divider Rule

- The **current divider rule (CDR)** is used to find the current through a resistor in a parallel circuit.

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

- General points:
  - For two parallel elements of equal value, the current will divide equally.
  - For parallel elements with different values, the smaller the resistance, the greater the share of input current.
  - For parallel elements of different values, the current will split with a ratio equal to the inverse of their resistor values.

Example : 12 Two Resistances 3 Ω , 6 Ω are connected in parallel to 12 V supply , calculate :

1- Total Resistance 2 – Total current 3 – branch current 4- total power consumed

Solution :

1 - $Rt = R1 // R2 = \frac{R1*R2}{R1+R2} = \frac{3*6}{3+6} = 2\ \Omega$

2- $I1 = \frac{v}{R1} = \frac{12}{3} = 4A$

$I2 = \frac{V}{R2} = \frac{12}{6} = 2\ A$

3 - $It = I1 + I2 = 4 + 2 = 6\ A$

OR $It = \frac{V}{Rt} = \frac{12}{2} = 6\ A$

4- $P1 = I1^2\ R1 = 4^2 * 3 = 16 * 3 = 48\ W$

$P2 = I2^2\ R2 = 2^2 * 6 = 4 * 6 = 24\ W$

$Pt = p1 + p2 = 48 + 24 = 72\ w$

Or $Pt = It^2\ Rt = 6^2 * 2 = 36 * 2 = 72\ w$

Example :13

Two Resistances 5Ω , 20 Ω are connected in parallel , use (CDR) find the current through each resistor if the total current is (10 A)

Solution :

$$I1 = \frac{R2}{R1+R2} I = \frac{20}{5+20} * 10 = \frac{20}{25} * 10 = 8 \text{ A}$$

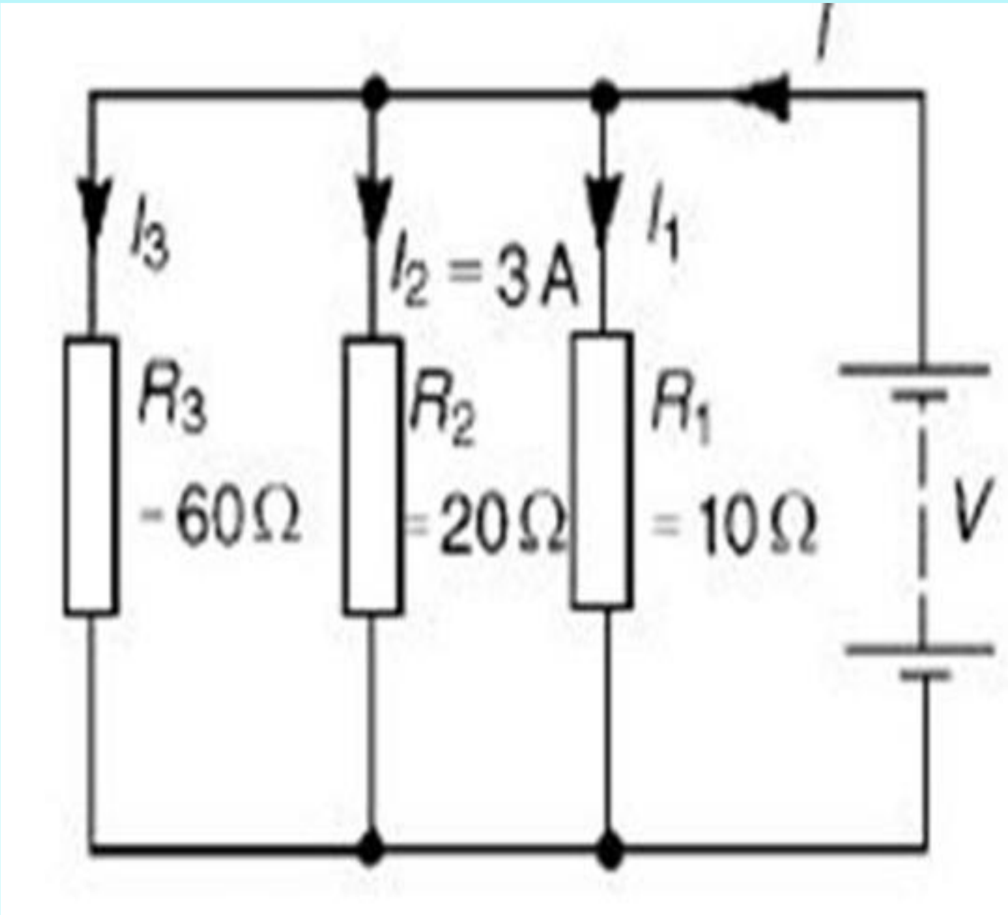
$$I2 = \frac{R1}{R1+R2} I = \frac{5}{5+20} * 10 = \frac{5}{25} * 10 = 2 \text{ A}$$

Example : 14

For the circuit shown find :

1- supply voltage

2 – ammeter reading



(a) Voltage across 20 Ω resistor $= I_2R_2 = 3 \times 20 = 60$ V; hence, supply voltage $V = \mathbf{60\,V}$ since the circuit is connected in parallel.

(b) Current $I_1 = \dfrac{V}{R_1} = \dfrac{60}{10} = 6\text{ A}; I_2 = 3\text{ A}$

$$I_3 = \frac{V}{R_3} = \frac{60}{60} = 1\text{ A}$$

Current $I = I_1 + I_2 + I_3$ and hence, $I = 6 + 3 + 1 = \mathbf{10\,A}$

Alternatively, $\dfrac{1}{R} = \dfrac{1}{60} + \dfrac{1}{20} + \dfrac{1}{10} = \dfrac{1+3+6}{60} = \dfrac{10}{60}$

Hence, total resistance $R = \dfrac{60}{10} = 6\,\Omega$

Current $I = \dfrac{V}{R} = \dfrac{60}{6} = \mathbf{10\,A}$

Example : 15

For the circuit shown find :

1- supply voltage

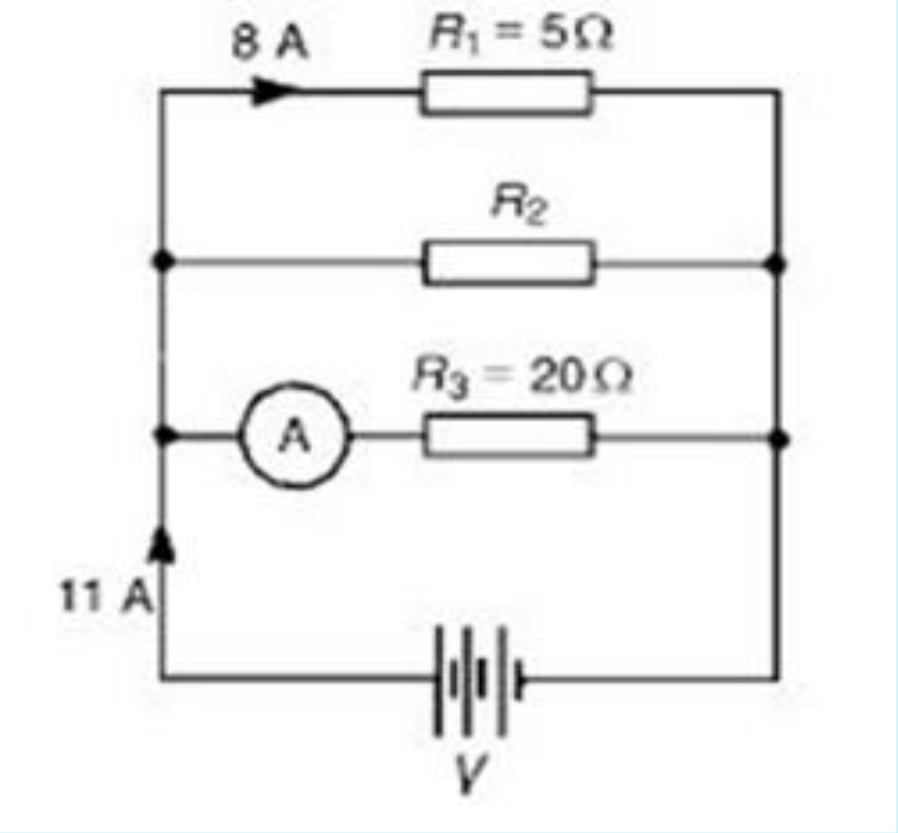
2- Total current

3 – Branch currents

4 – Total Resistance

5 – Total power deliverd

6 – Total power consumed



Solution

Voltage across R_1 is the same as the supply voltage V. Hence, supply voltage $V = 8 \times 5 = 40\text{V}$.

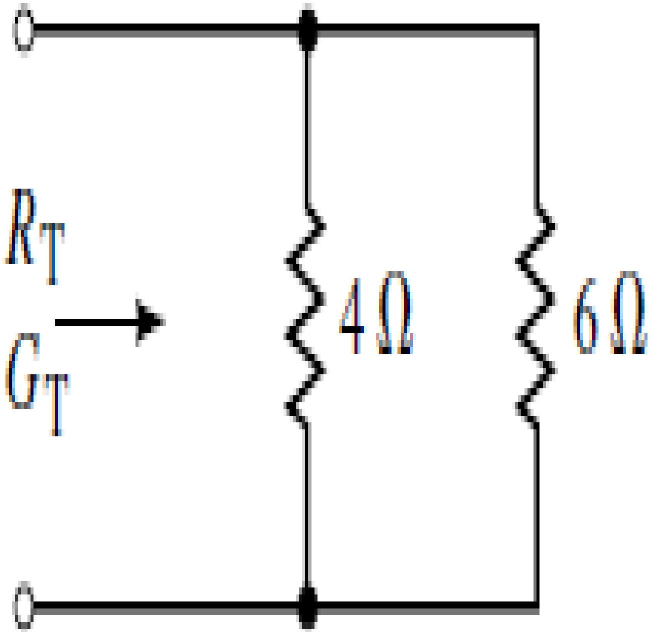
(a) Reading on ammeter, $I = \dfrac{V}{R_3} = \dfrac{40}{20} = 2\text{ A}$

(b) Current flowing through $R_2 = 11 - 8 - 2 = 1\text{ A}$

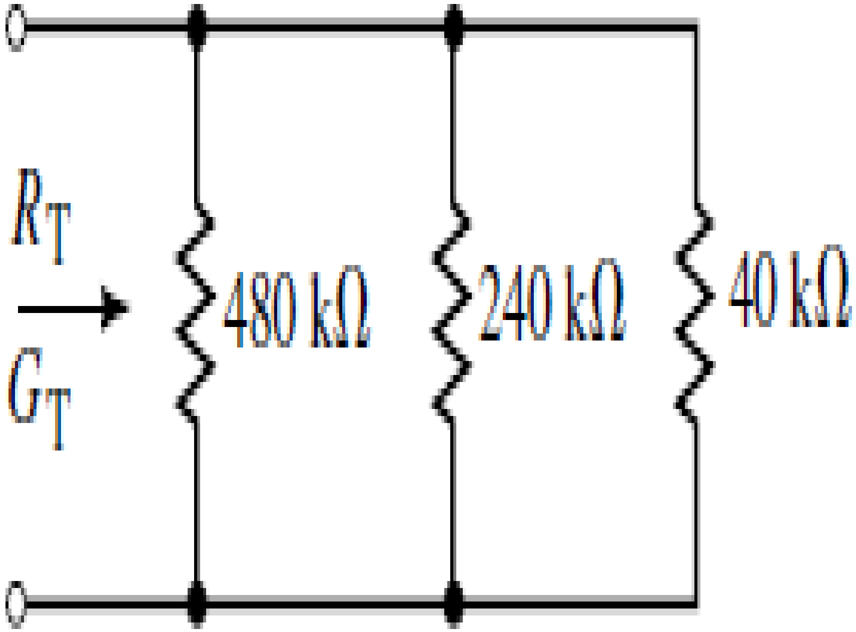
Hence, $R_2 = \dfrac{V}{I_2} = \dfrac{40}{1} = 40\,\Omega$

Example; 16 - find Rt & Gt

H.W



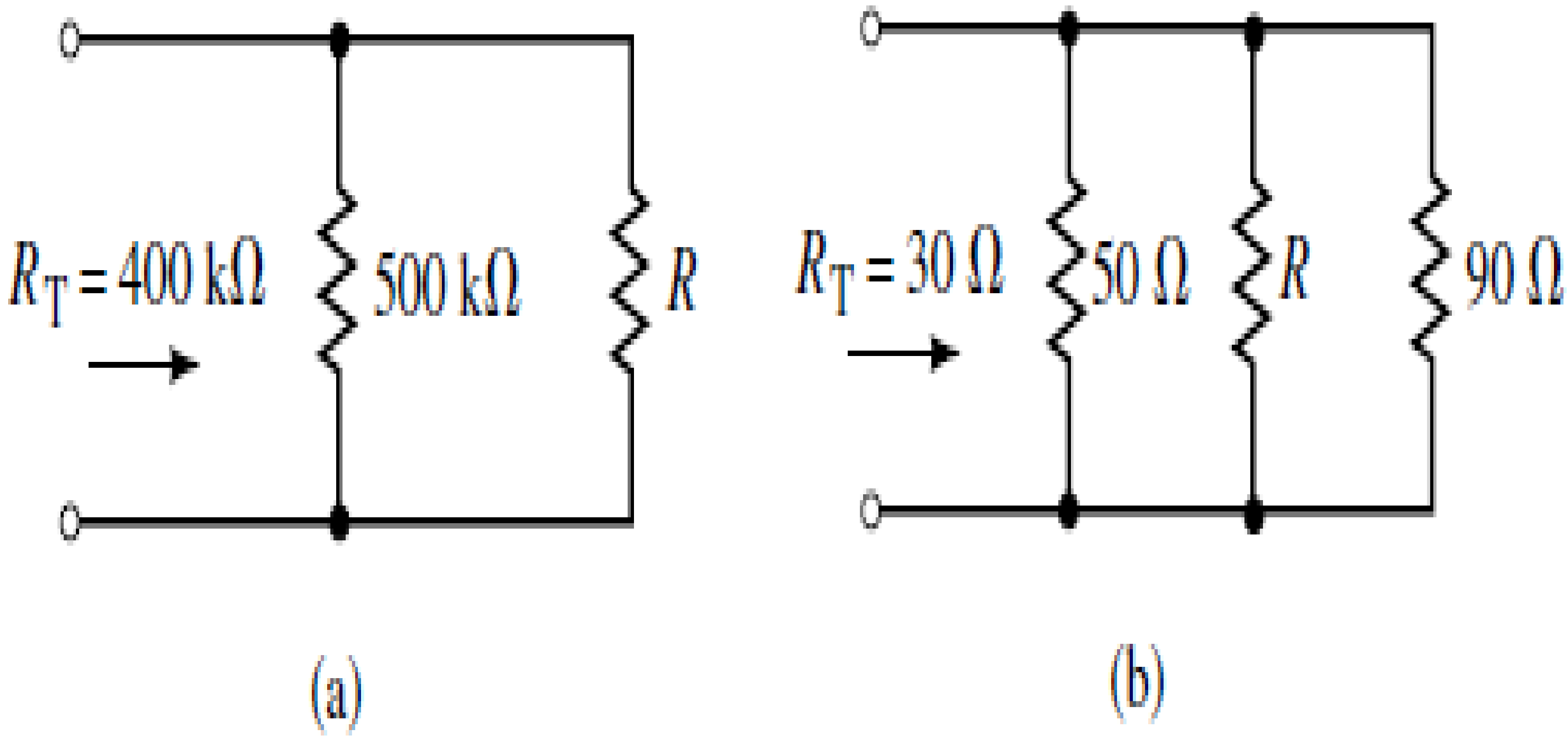
(a)



(b)

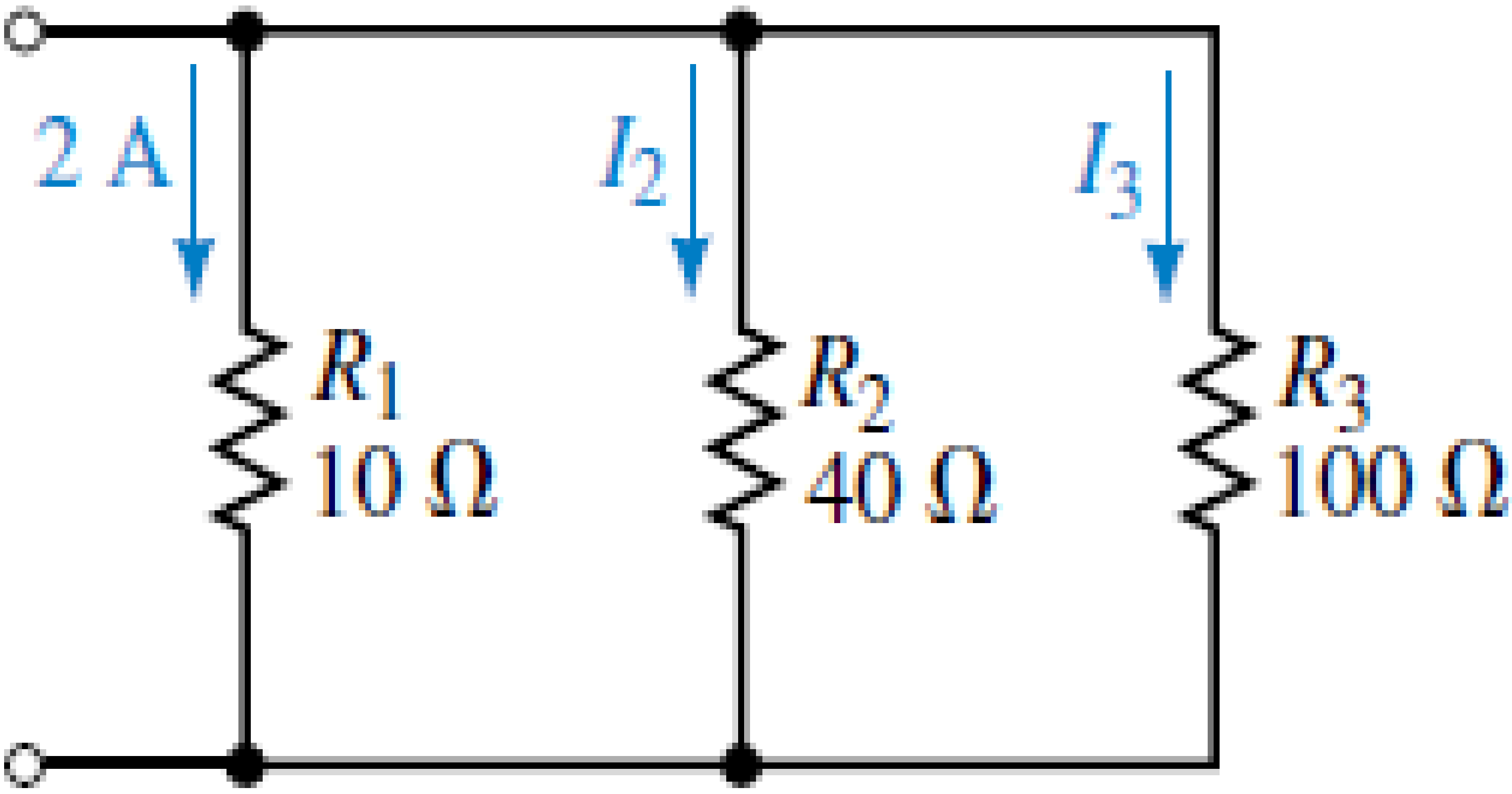
Example; 17 - find the value of R

H.W

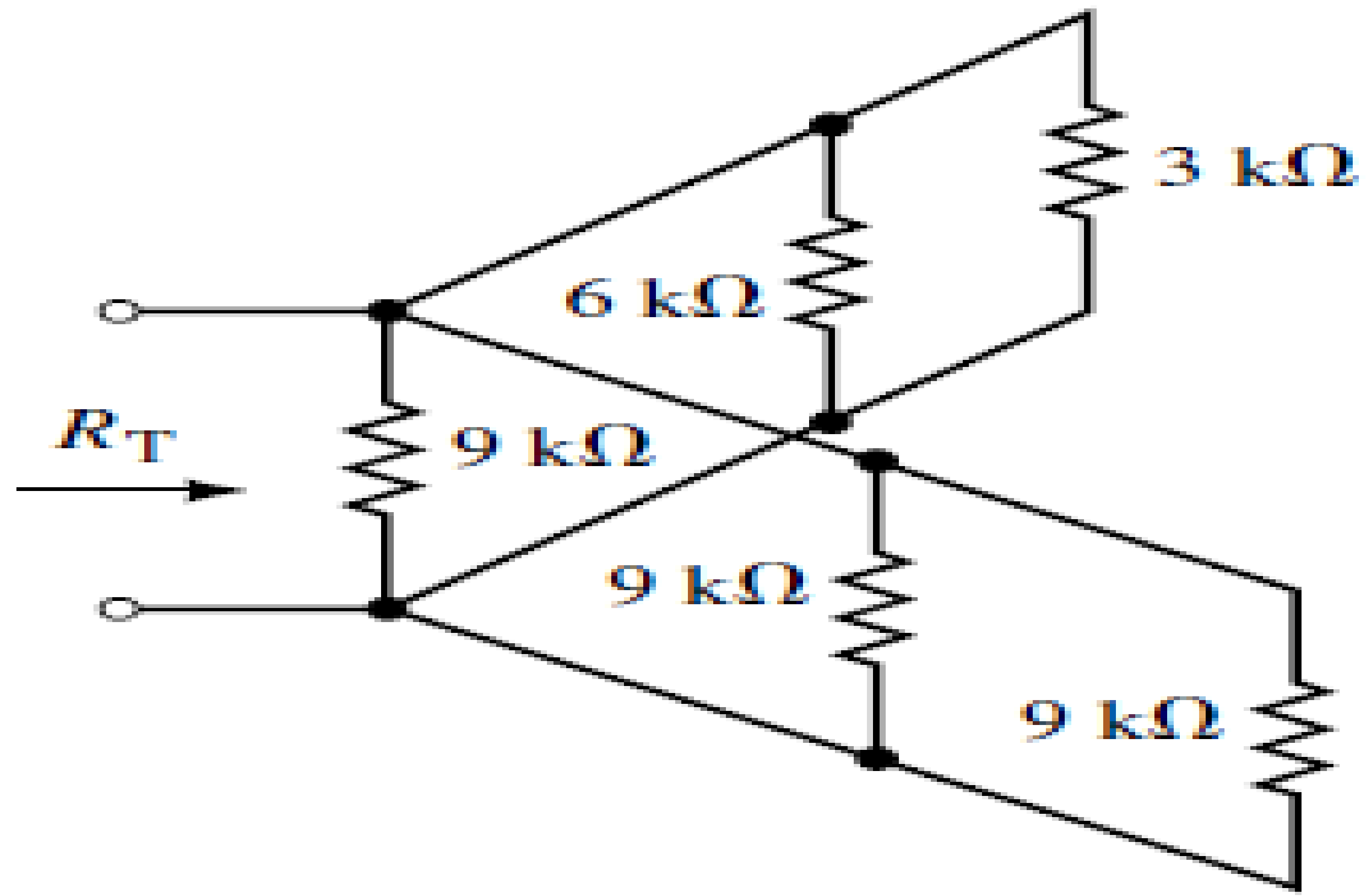


Example : 18- Find the indicated current

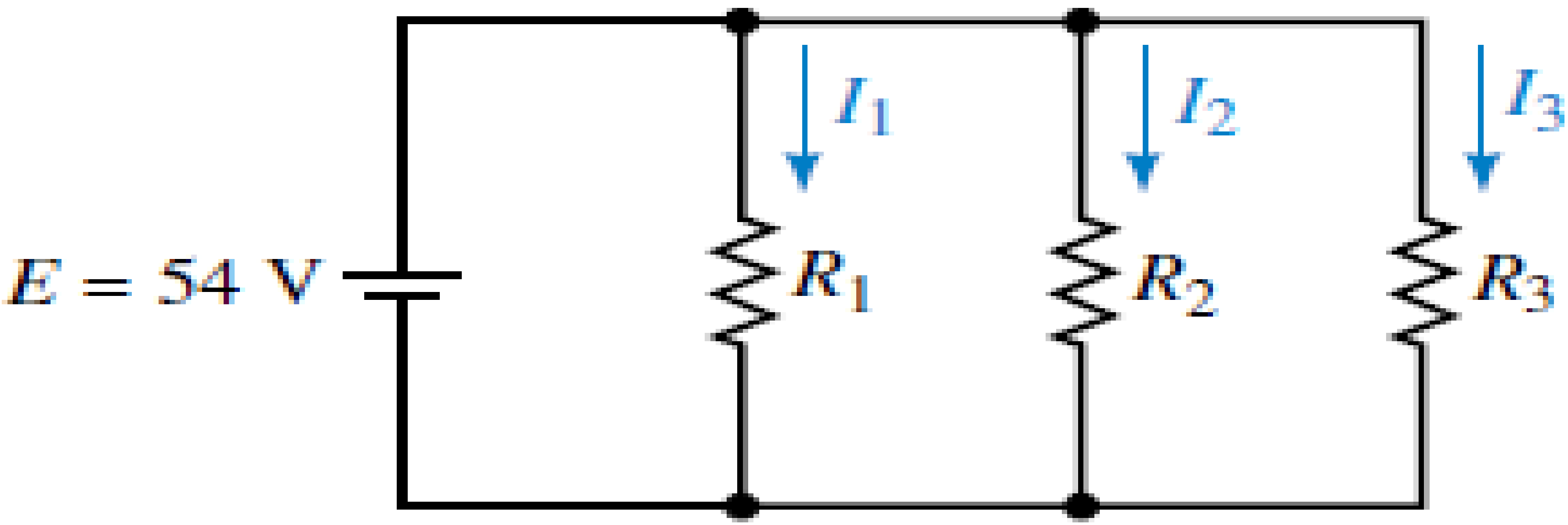
H.W



Example: 19- find the total Resistance (Rt) H.W



Example: 20 – find indicated currents and unknown Resistances H.W

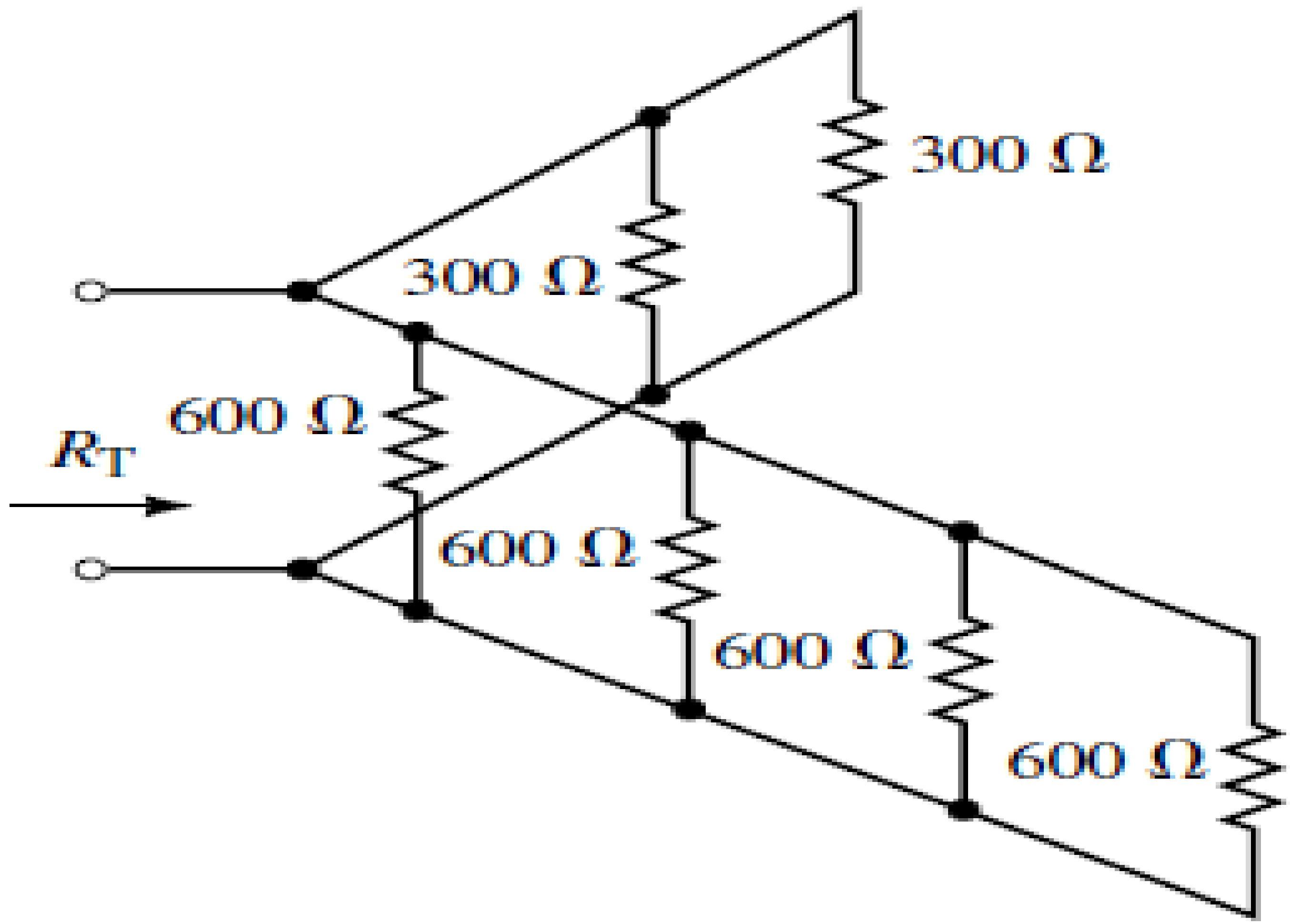


$R_1 = 36\ \Omega$

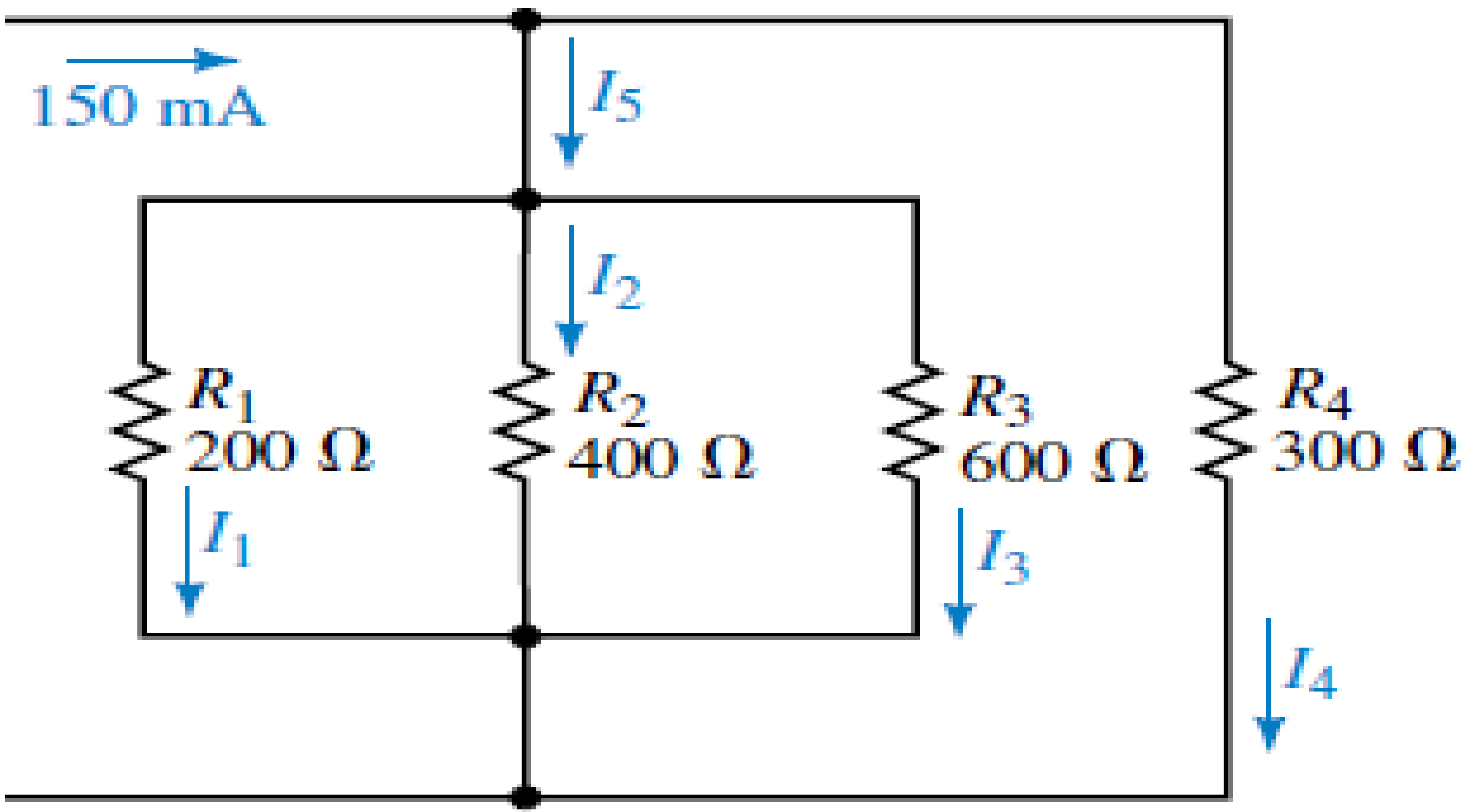
$I_3 = 500\ mA$

$R_2 = 4R_1$

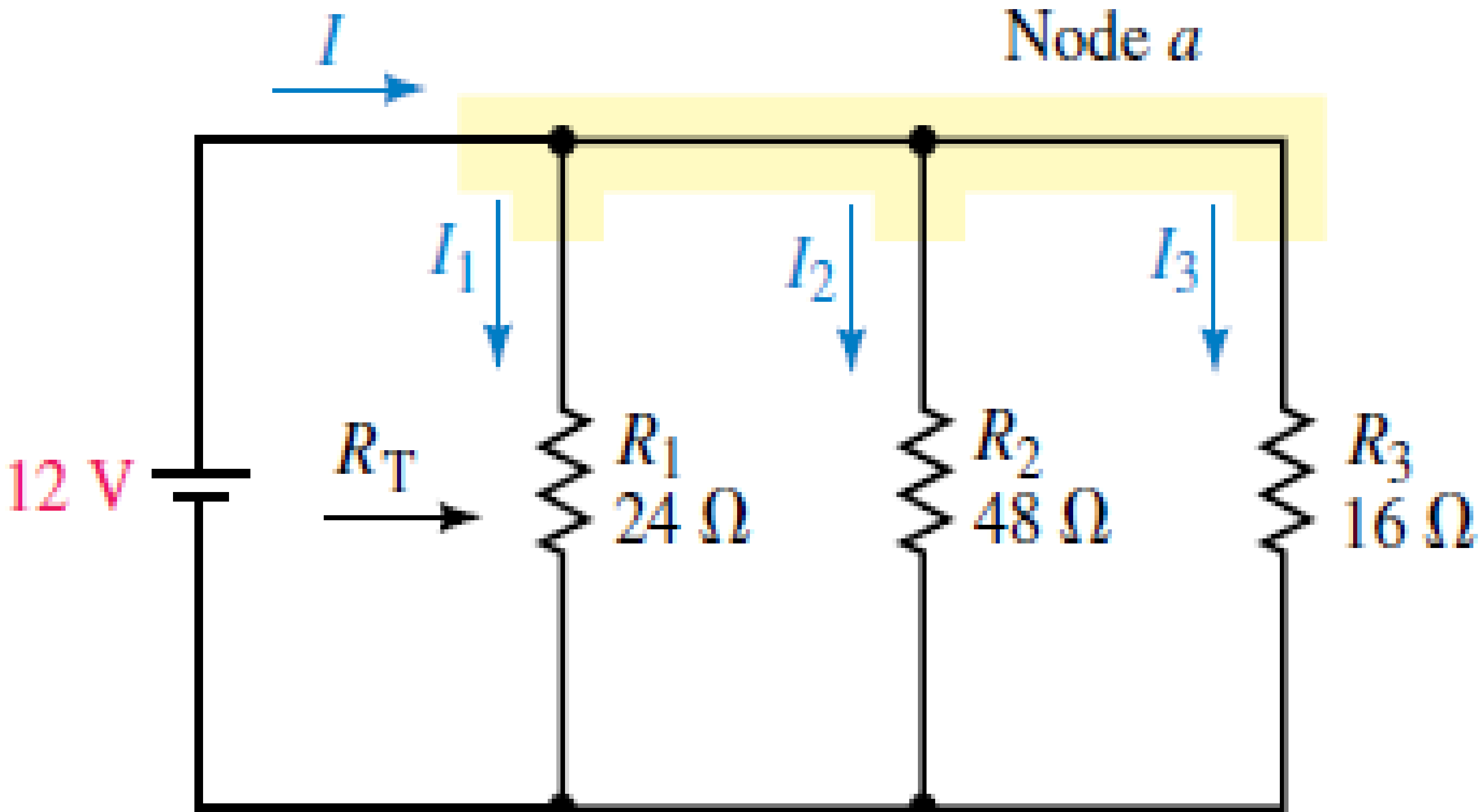
Example: 21 – find Rt H.W



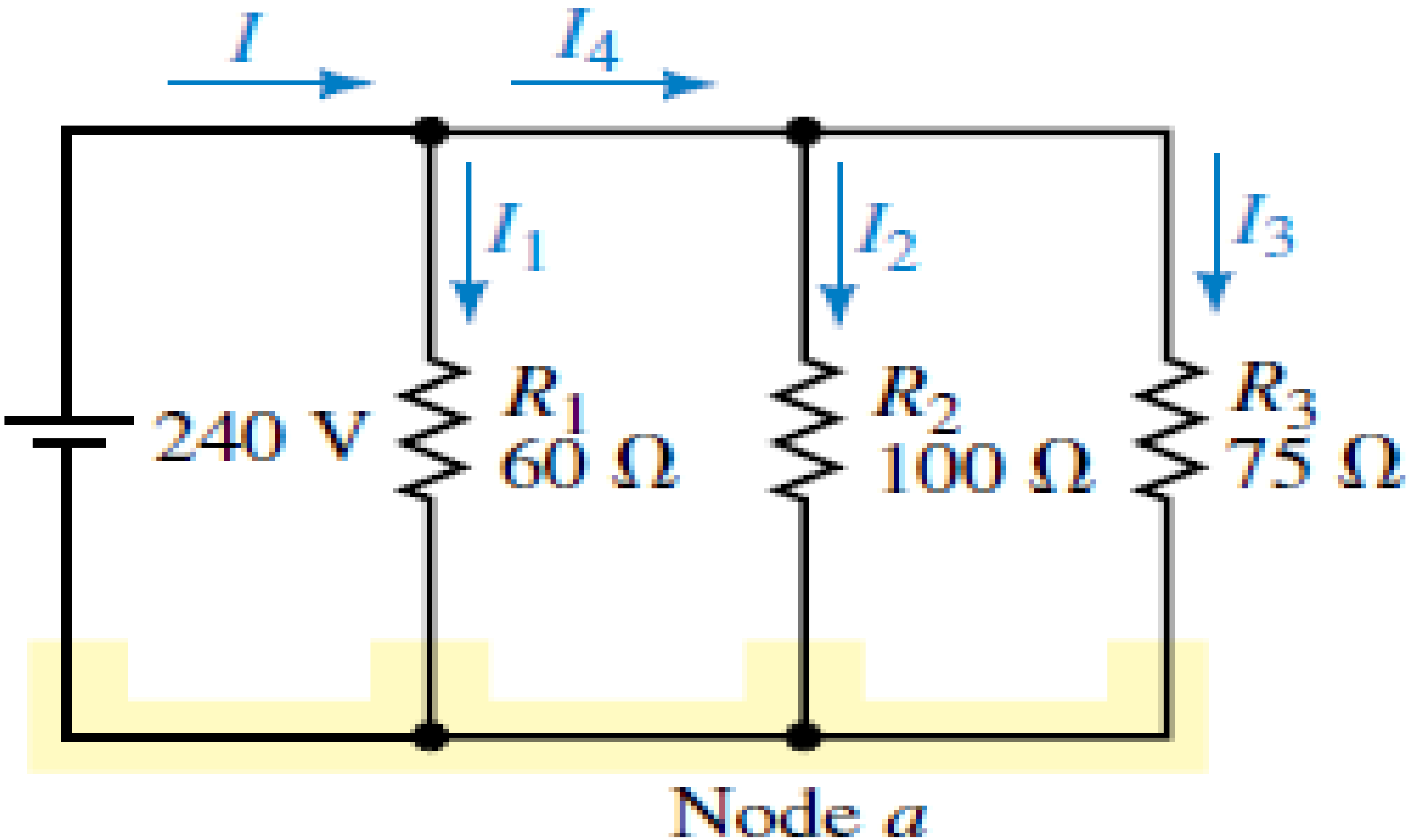
Example: 22- find the indicated currents H.W



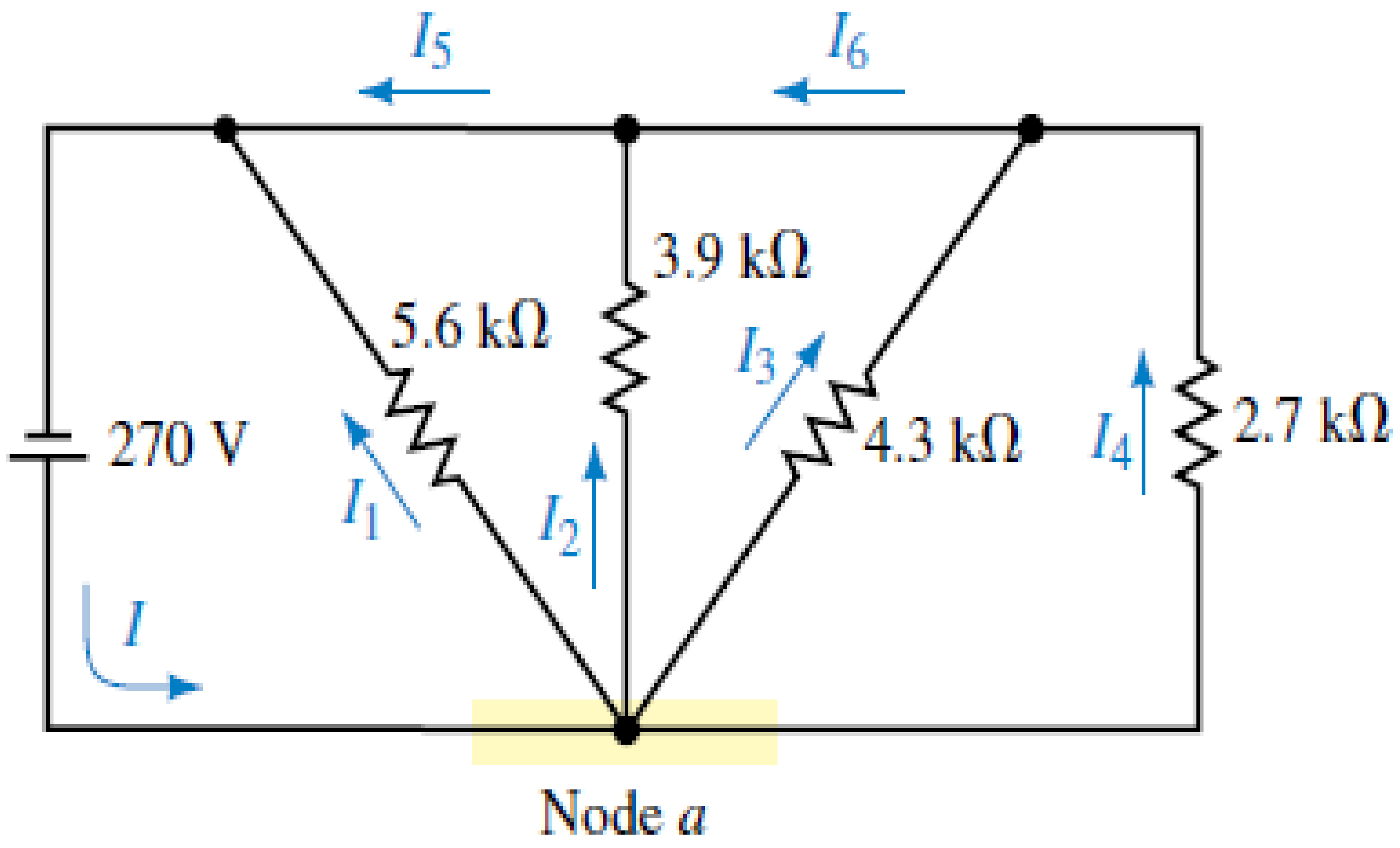
Example: 23- find the indicated currents H.W



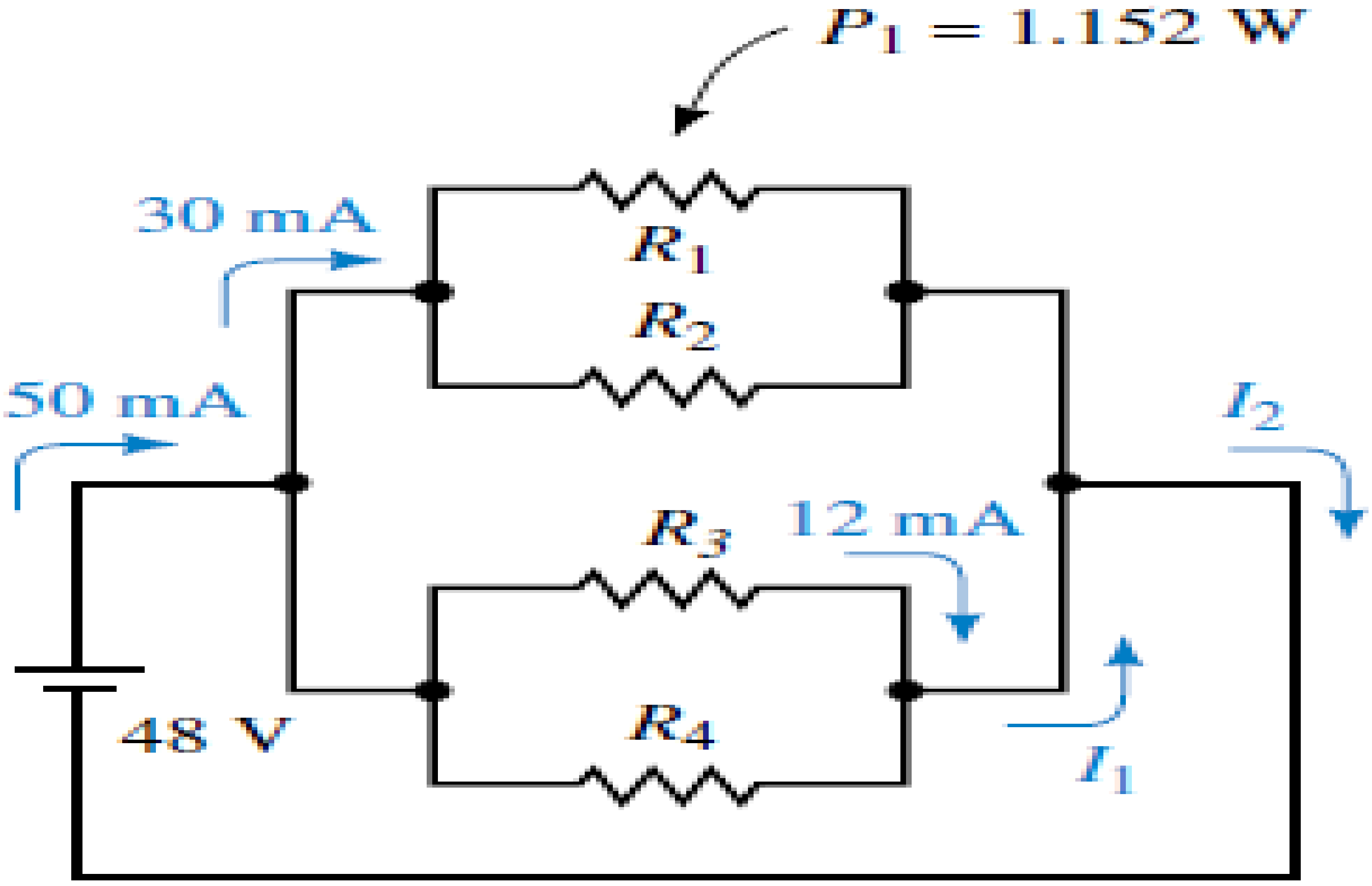
exampl:e: 24- find the indicated currents (H.W)



Example ;25 – find the indicated currents (H.W)



Example: 26 - find the unknown current and Resistances (H.W)



Example: 27- find the unknown Resistance H.W