KATHMANDU UNIVERSITY

DHULIKHEL, KAVRE

Subject: ENGG112
Assignment: 1

Submitted by:

Ashraya Kadel
UNG CE 1/2
Roll No. 25

Submitted to:

Santosh Shaha
Department of Electrical
and Electronics Engineering

DATE OF SUBMISSION: 15 / 09 / 2023

<Q-1>: Eight holiday light bulbs are connected in series as shown in figure.

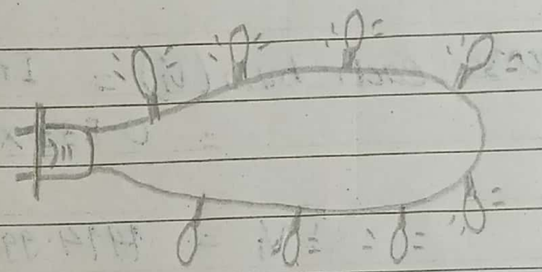
(a) If the set is connected to 120 V source, what is the current through the bulbs if each bulb has internal resistance of $28\,^1/_8\ \Omega$

(b) Determine the power delivered to each bulb.

(c): Calculate the voltage drop across each bulb.

(d): If one bulb burns out, what is effect on remaining bulbs?

Soln:



(a): Given,

Potential difference $(V) = 120\ V$

Internal resistance of each bulb $(r) = 28\,^1/_8\ \Omega = 225/8$

Current through each bulb $(I) = ?$

Since, the bulb are connected in series, the equivalent resistance $(r_{eq}) = 8 \times \left(\frac{225}{8}\right) = 225\ \Omega$

Since, same current flows through each bulb,

Current through each bulb $(I) = \frac{V}{r_{eq}} = \frac{120}{225}$

$\therefore I = 0.533\ A.$

Date
Page

(b) We know,

$r = 225/8\ \Omega$

$I = 0.533\ A$

Now, power delivered to each bulb $(P) = I^2 r$

$= (0.533)^2 \times 225/8$

$\therefore P = 7.99\ V$

(c) ~~E~~ Also,

$r = 225/8\ \Omega$

$I = 0.533\ A$

Now,

Voltage drop across each bulb $(V_i) = Ir$ {from ohm's law}

$= 0.533 \times \frac{225}{8}$

$\therefore V_i = \cancel{14}\ 14.99\ V$

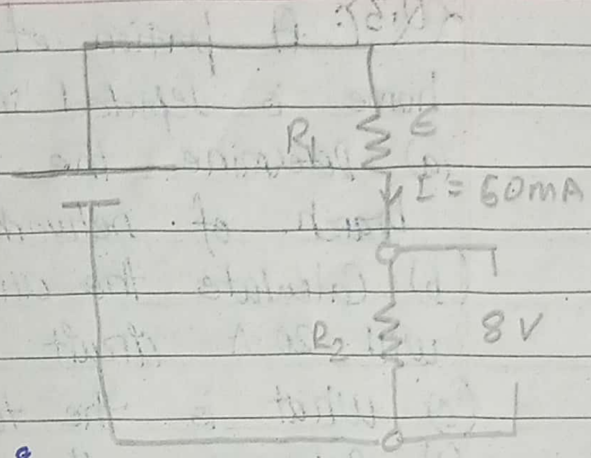
(d) Ans:

Since the bulbs are in series, if one of the filament burns/opens open, the circuit is incomplete ~~so~~ no current flows through the circuit.

<Q.2>: Design a voltage divider circuit that permits the use of an 8 V, 50 mA bulb in an automobile with 12 V electrical system. What is the minimum wattage rating of chosen resistor if 1/4 w, 1/2 w and 1 w resistors are available?

Date
Page

Ans:



Given,

supplied voltage $(V) = 12\,V$

required current $(I) = 50\,mA$

$= 50 \times 10^{-3}\,A$

voltage of bulb $(V_b) = 8\,V$

$\therefore$ Resistance of bulb $(R_2) = \dfrac{V_b}{I} = \dfrac{8}{50 \times 10^{-3}}$

$R_2 = 160\,\Omega$

Now, for the other resistor,

$E = 12 - 8$

$= 4\,V$

So, $R_1 = \dfrac{E}{I} = \dfrac{4}{50 \times 10^{-3}} = 80\,\Omega.$

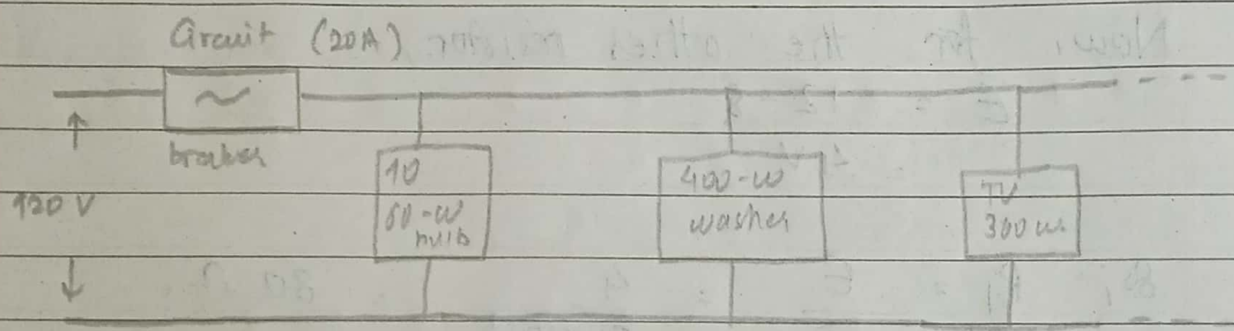
$\therefore$ The choosen resistor is $80\,\Omega$.

$\therefore$ The wattage rating of the resistor $= \dfrac{V^2}{R_1}$

$= \dfrac{4^2}{80} = \dfrac{1}{5}\,W.$

<Q.3>: A portion of a residential service to a home is depicted in the figure.
(a) Determine the current through each parallel branch of network.
(b) Calculate the current drawn from 120 V source. Will 20-A circuit breaker trip?
(c) What is the total resistance of the network
(d) Determine the power supplied by 120-V source. How does it compare to the total power of load?

Ans:



(a) Given,
Power of a bulb (P_1) = 60 W
Power of washer (P_2) = 400 W
Power of TV (P_3) = 360 W

Now,
resistance of bulb (R_b) $= \frac{V^2}{P_1} = \frac{(120)^2}{60} = 240\,\Omega$

resistance of washer (R_2) $= \frac{V^2}{P_2} = \frac{(120)^2}{400} = 36\,\Omega$

resistance of TV (R_3) $= \frac{V^2}{P_3} = \frac{(120)^2}{360} = 40\,\Omega$

Date
Page

For 1st branch,

$R_1 = 10 \times 240\ \Omega$

$\therefore R_1 = 2400\ \Omega$

$\therefore$ Current $(I_1) = \dfrac{\cancel{1420}}{\cancel{2400}\ 20} = \cancel{0.05\ A}$ ~~(through whole)~~

$= \dfrac{120}{240} = 0.5\ A$

(current same through each bulb)

For 2nd branch,

$R_2 = 36\ \Omega$

$\therefore$ Current $(I_2) = \dfrac{120}{36} = 3.33\ A$

For 3rd branch,

$R_3 = 40\ \Omega$

$\therefore$ Current $(I_3) = \dfrac{120}{40} = 3\ A$

(c) ~~(b)~~: Given,

Since all the applicances are in parallel,

$$\frac{1}{R_T} = \frac{10}{R_b} + \frac{1}{R_2} + \frac{1}{R_3}$$

or, $$\frac{1}{R_T} = \frac{10}{240} + \frac{1}{36} + \frac{1}{40}$$

$\therefore R_T = 10.59\ \Omega$

(b): Given,

voltage $(V) = 120V$

equivalent resistance $(R_{eq}) = 10.59\,\Omega$

$\therefore$ Current $(I) = \frac{V}{R_{eq}} = \frac{120}{10.59}$

$\therefore I = 11.33\ A$

Since the current of circuit breaker is 20 A, the circuit won't trip.

(d): Given,

Total power of load $= P_1 + P_2 + P_3$

$= (10 \times 60) + \cancel{36}\ 400 + 360$

$= 1360\ W.$

The ~~d~~ power taken up from source $= IV$

$= 11.33 \times 120$

$= 1359.60\ W.$

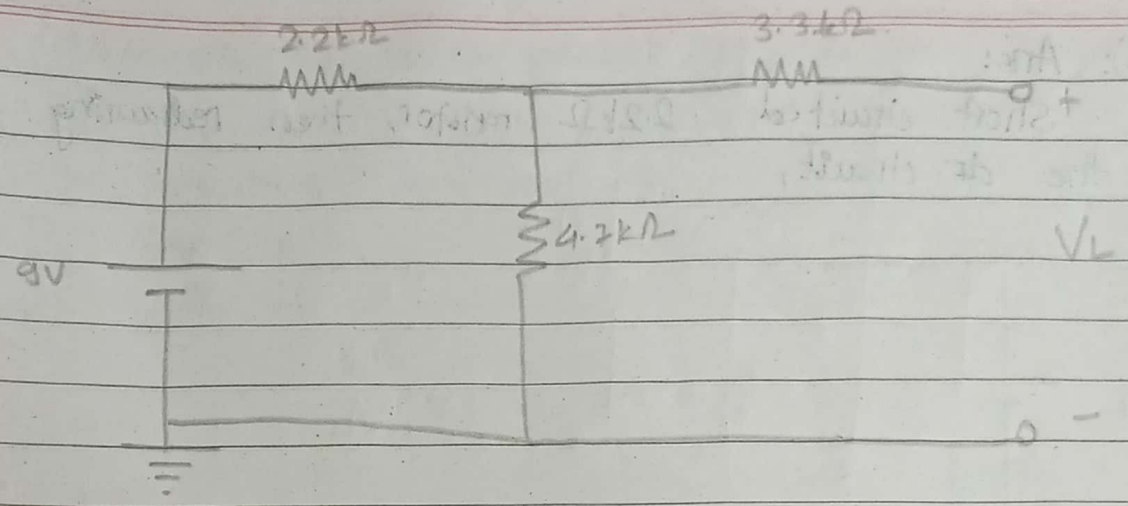
<Q.4>: For the network in figure,

(a) Determine the open-circuit voltage V_L.

(b) If the 2.2 kΩ resistor is short circuited, what is new value of V_L?

(c) Determine V_L if 4.7 kΩ resistor is replaced by open circuit.

Soln,



(a) We have,

$R_1 = 2.2\,k\Omega$ $\quad V = 9V$

$R_2 = 4.7\,k\Omega$ $\quad V_L = ?$

$R_3 = 3.3\,k\Omega$

The 3.3 kΩ resistor doesn't affect V_L as it is open circuit. ~~combination of R4~~

and the voltage along ~~along R2~~ R_2 = voltage (V_L)

$R_{eq} = (4.7 + 2.2) = 6.9\,k\Omega$.

$R_2 = 4.7\,k\Omega$.

By voltage divider rule,

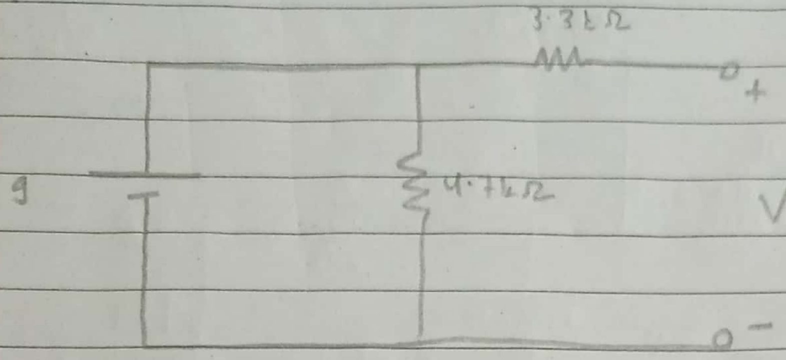
$$V_L = V \times \frac{R_2}{R_{eq}}$$

$$= 9 \times \frac{4.7}{6.9}$$

$\therefore V_L = 6.13\,V$

(b): Ans:

Short circuited 2.2kΩ resistor, then redrawing the ~~dr~~ circuit,

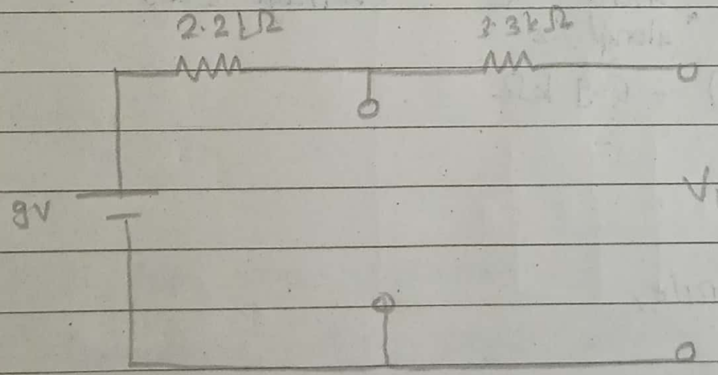


Here,

voltage (V) = voltage along R_2 = V_L

$\therefore V_L = 9V$.

(c): If the $R_2 = 4.7 k\Omega$ is replaced by open circuit,



Voltage (V) = V_L

$\therefore V_L = 9\ V$.

The series resistor doesn't affect voltage.

Date
Page

<Q·5>: for the series-parallel network

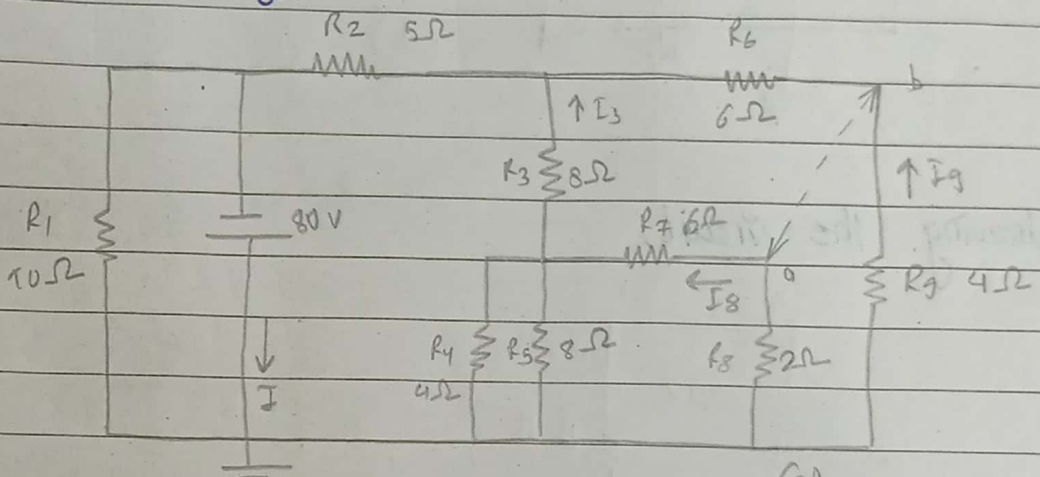
(a) find the current I

(b) Determine I_3 and I_9.

(c) find I_8.

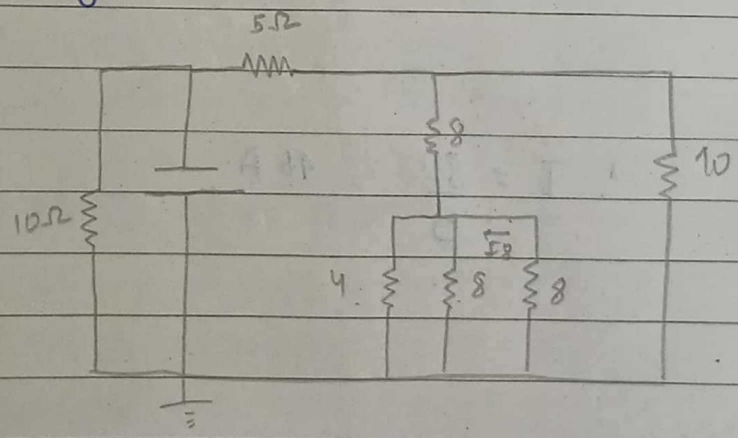
(d) find V_{ab}

Sol^n.



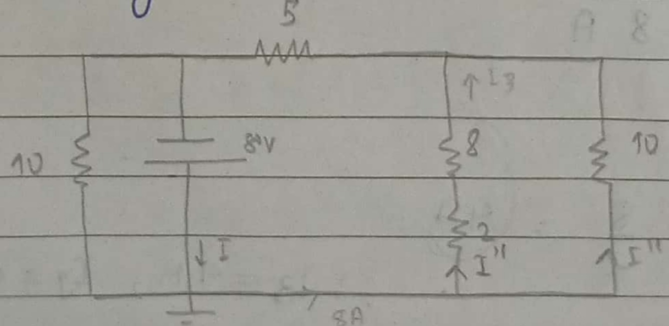
(a)

Redrawing the circuit.



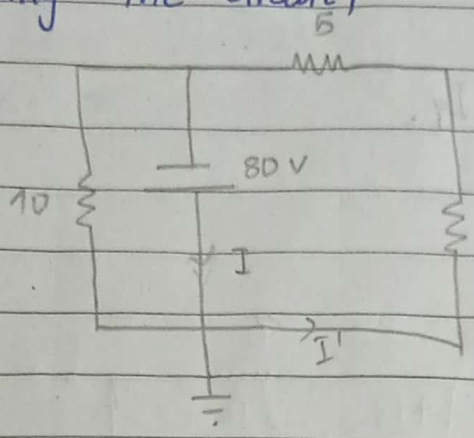
(b)

Redrawing the circuit,



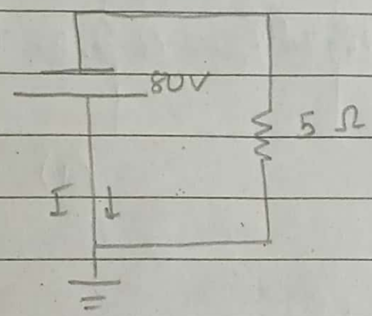
(c)

Redrawing the circuit,



(d)

Redrawing the circuit,



(e)

Now,

$$I = \frac{V}{R_{eq}} \qquad \therefore I = \frac{80}{5} = 16\ A.$$

(b): for figure (d).,

$$I' = I/2 = 8\ A$$

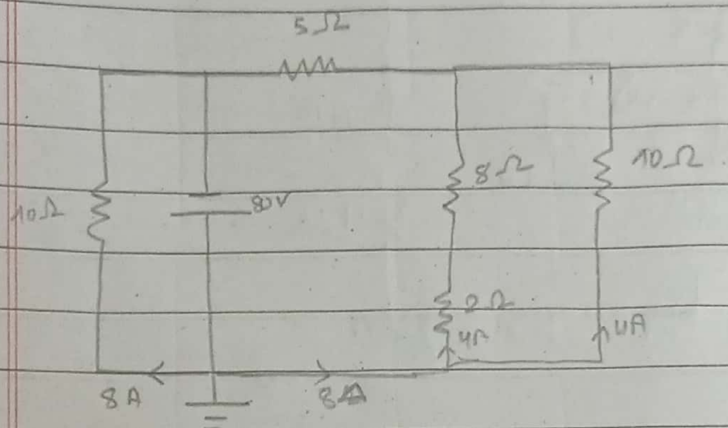
In figure (c),

$$I'' = \frac{I'}{2} = \frac{8}{2} = 4A$$

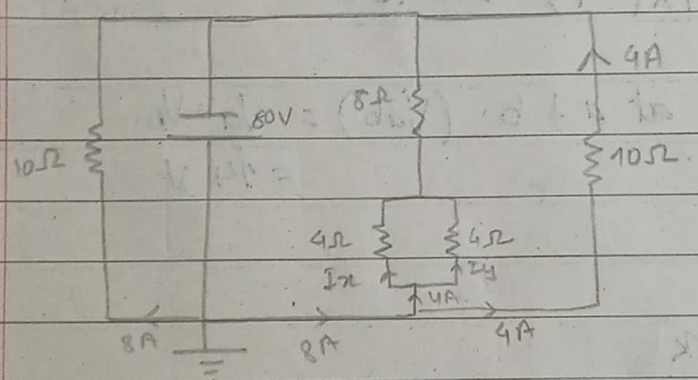
$\therefore I_3 = 4\ A,\ I_9 = 4\ A.$

Since $I_3 = I_9 = 4A$

(c): From figure (a):

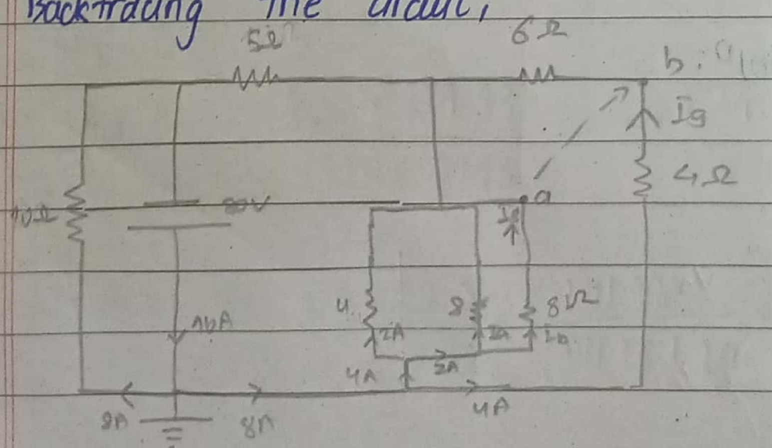


Backtracing the circuit,

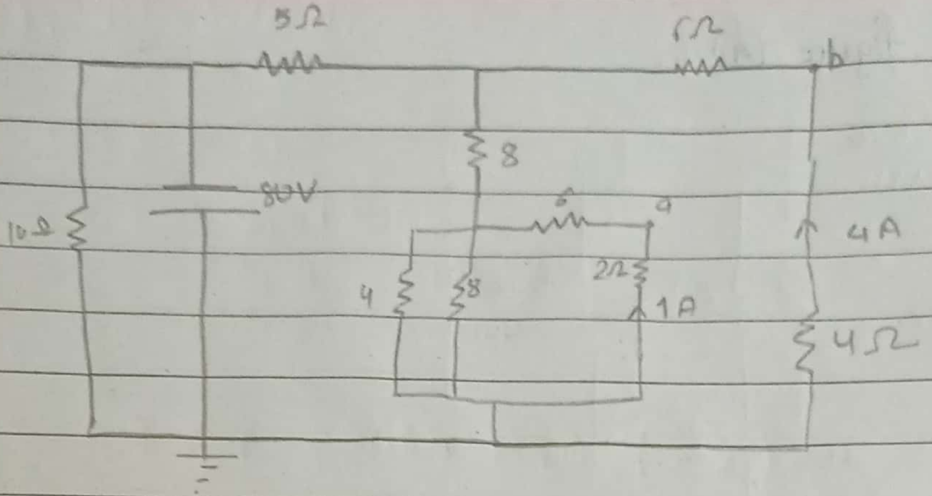


Here, $I_x = I_y = \frac{4}{2} = 2$ A.

Backtracing the circuit,



Here, $I_a = I_b = I_8$ $\therefore$ $I_8 = \frac{2}{2} = 1$ A.



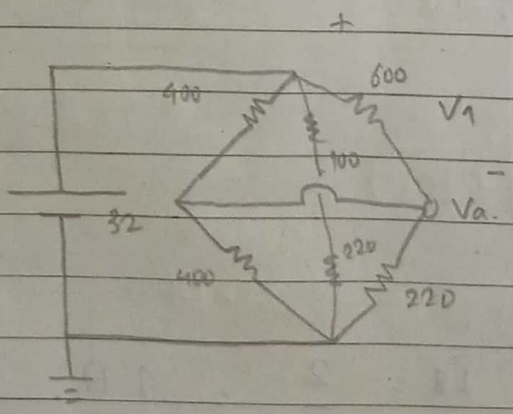
Voltage at a (V_a) = $2 \times (-1)$ = $-2V$
Voltage at b (V_b) = $4 \times (-4)$ = $-16V$.

∴ Voltage difference at a & b (V_{ab}) = $V_a - V_b$
= 14 V

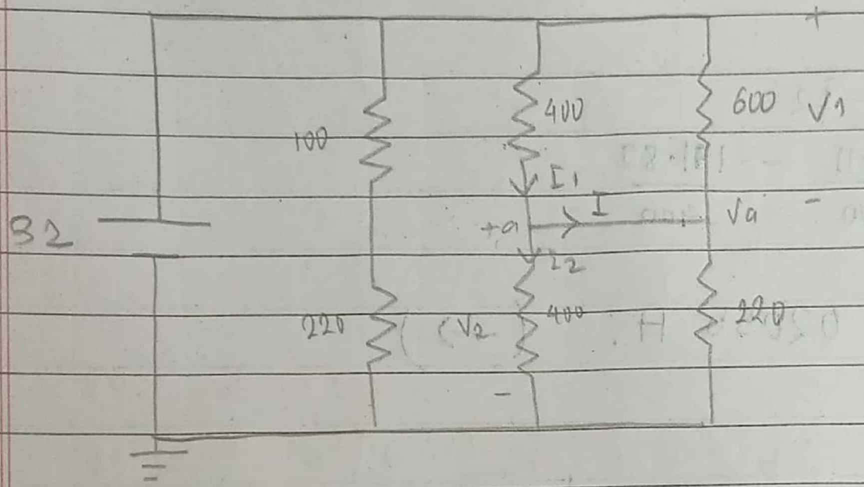
<Q.67>: For the network

a) Determine R_T
b) Calculate V_a
c) Find V_1
d) Calculate V_2.
e) Determine I.

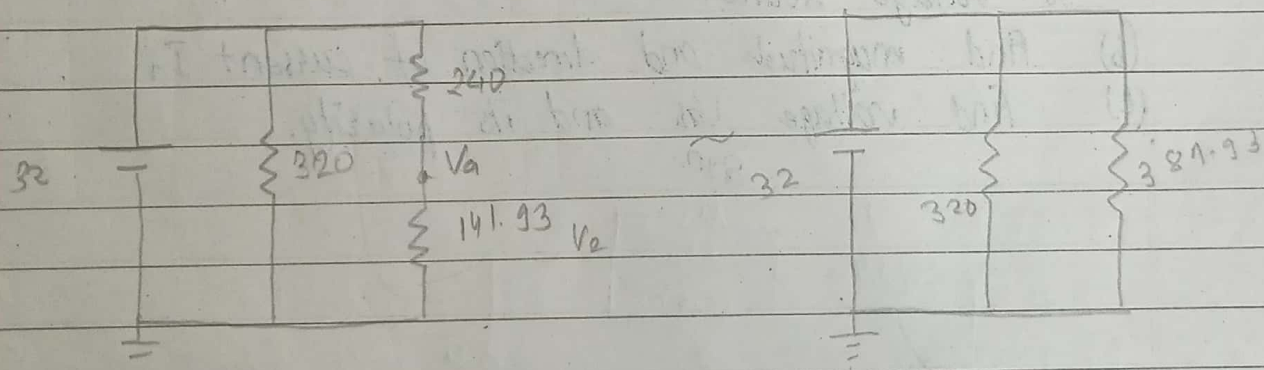
Sol^n:



Redrawing the circuit,



Redrawing the circuit,



Now,

(a): $R_{eq} = \dfrac{320 \times 381.93}{320 + 381.93} = 174.11\ \Omega$

(b)/(d) $V_2 = V_a = 32 \times \dfrac{141.93}{(141.93 + 240)} = 11.89\ V$

(c) $V_1 = 32 - V_2 = 32 - 11.89 = 20.11.$

(e): At node a,

$$I_2 + I = I_1$$

or, $I = I_1 - I_2$

$= \frac{20.11}{400} - \frac{191.89}{400}$

$\therefore I = 0.02055\ A.\ (\rightarrow)$

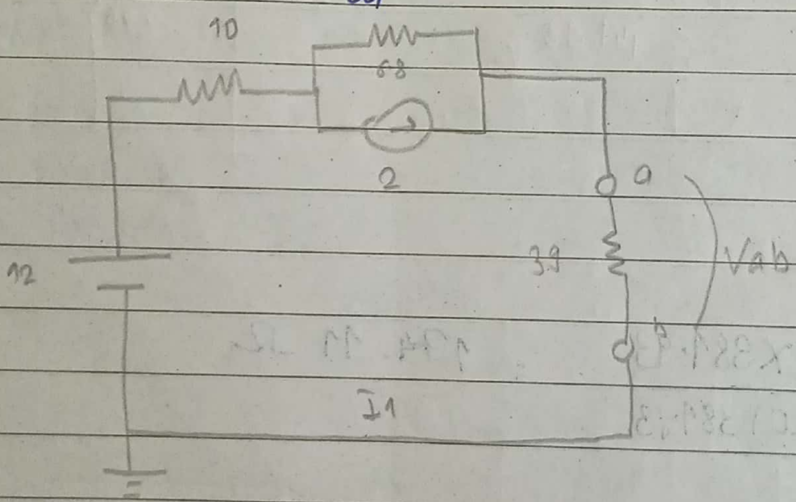
<Q.7>: For the given configuration,

(a): Convert the current source and $6.8\ \Omega$ resistor to voltage source.

(b) Find magnitude and direction of current I_1

(c) Find voltage V_{ab} and its polarity.

Sol.



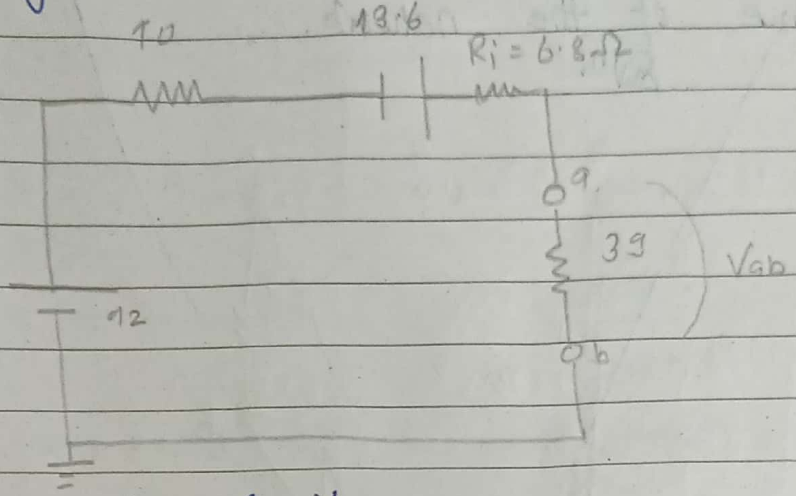
(a): Now,

$I = 2A\ (\rightarrow)$

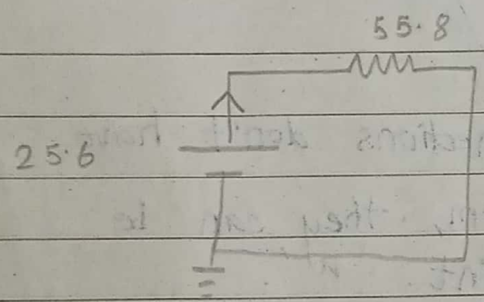
$R = 6.8\ \Omega$

$\therefore V = IR = 13.6\ V$

Redrawing the circuit,



Redrawing the circuit,



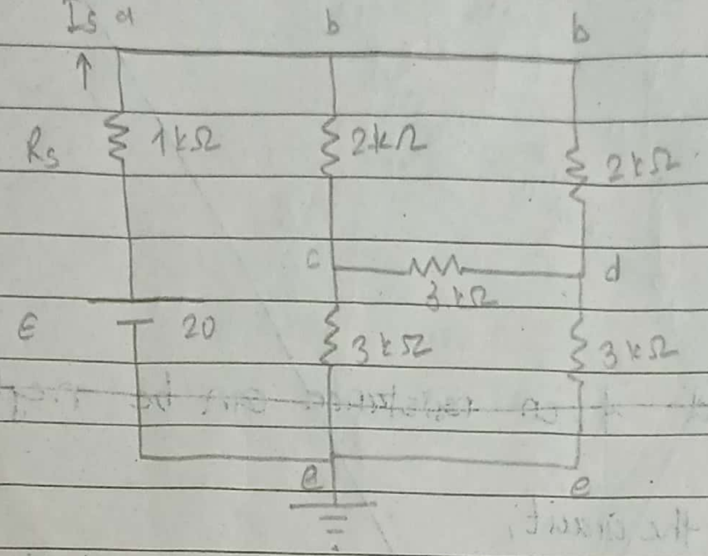
<b>: $I = \frac{V}{R} = \frac{25.6}{55.8} = 0.45875$ A

(c): $V_{ab} = \frac{I \times R_{ab}}{\cancel{R_{ab}}} = 0.45875 \times 39$

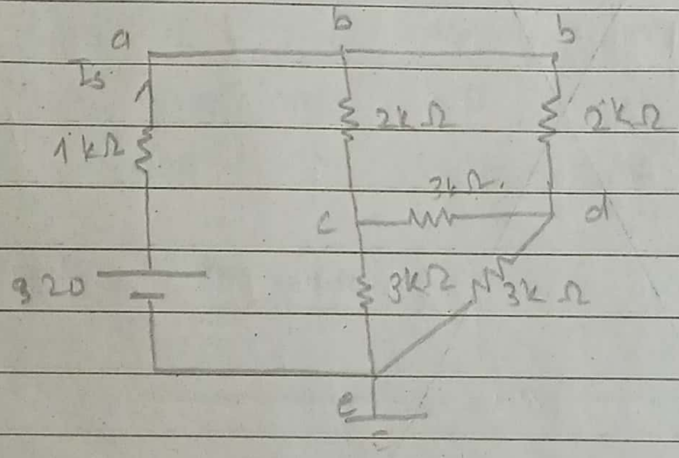
$\therefore V_{ab} = 17.89$ V

<Q.9>: Find the current Is for the network.

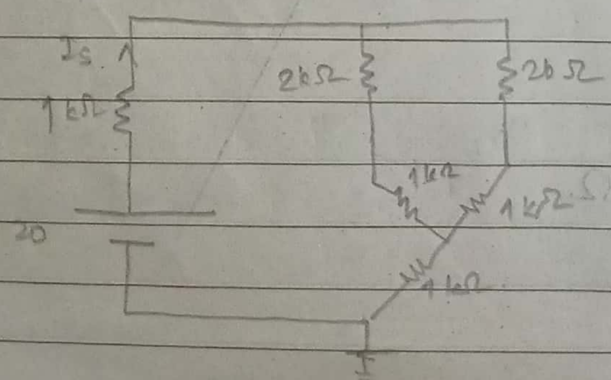
Sol^n:



The circuit can also be drawn as:

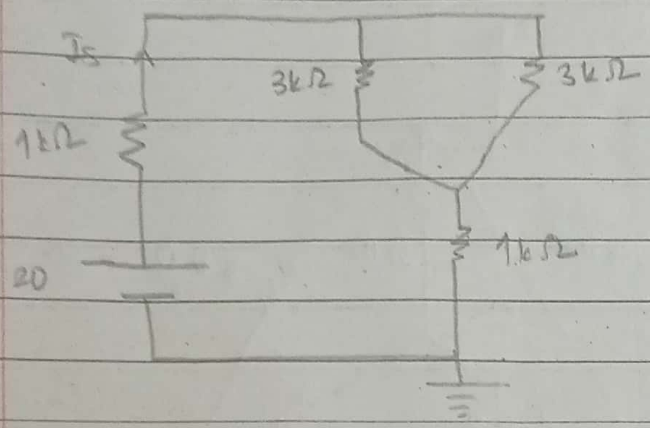


Applying Δ→Y conversion on Δcde,

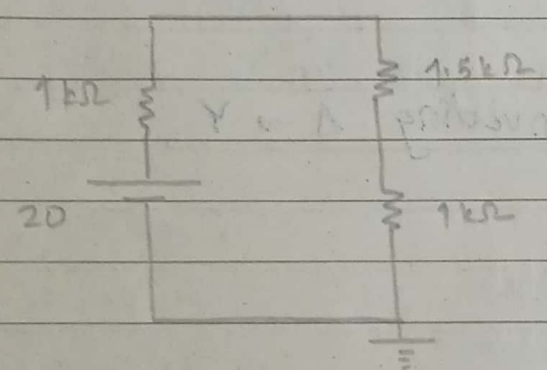


Date
Page

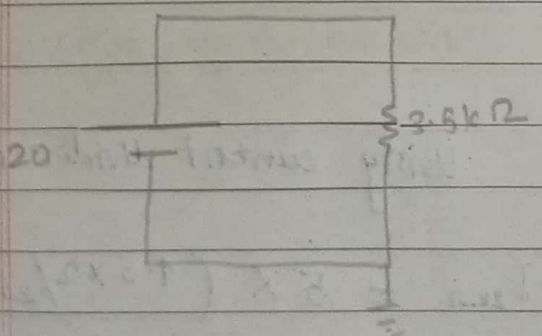
Redrawing the circuit,



Redrawing the circuit,



Redrawing the circuit,



Now,

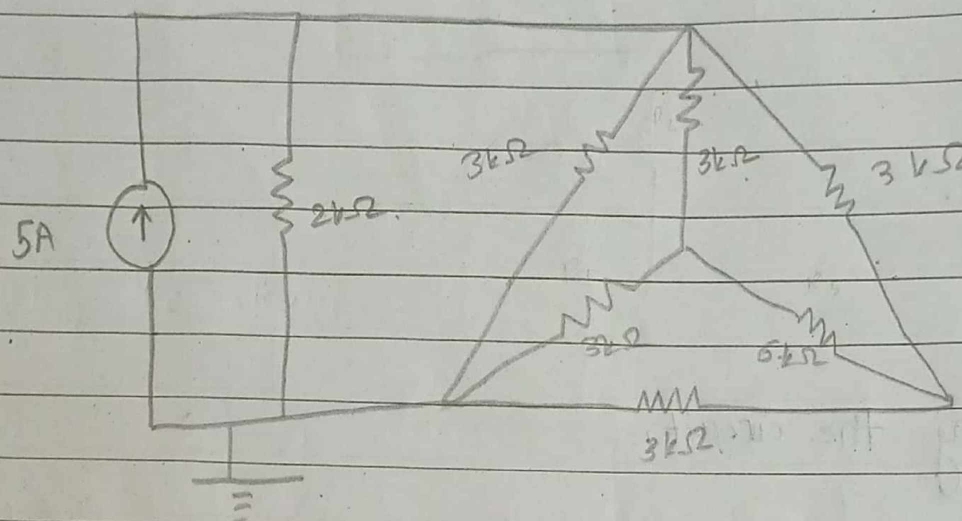
$$I_s = \frac{20}{3500} = 5.714 \times 10^{-3}\ A$$

$$= 5.714\ mA.$$

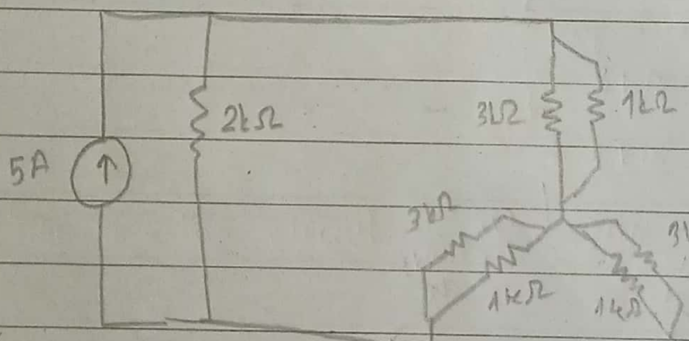
Date
Page

<Q.10>: Determine the current Is through the network.

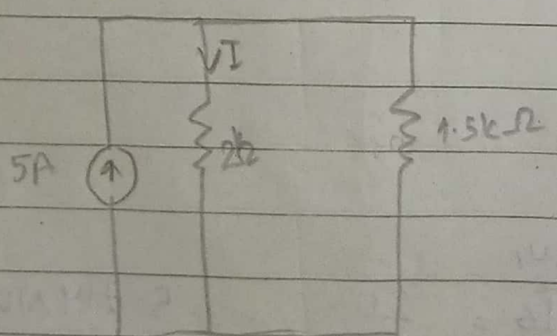
Sol^n:



Redrawing the circuit, converting $\Delta \rightarrow Y$,



Redrawing the circuit,



Using current dividor rule.

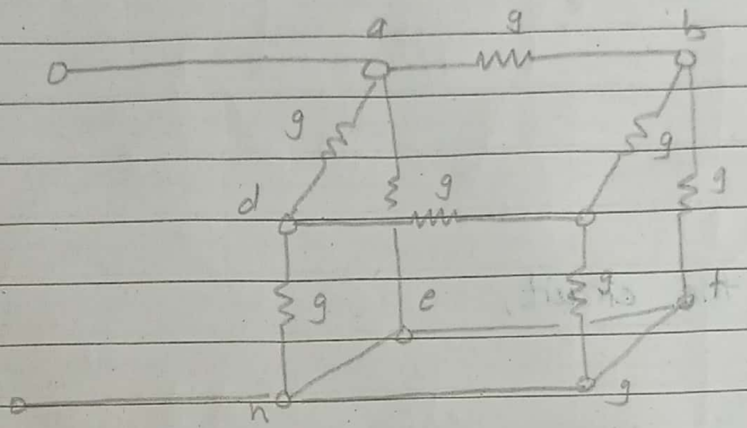
$$I_{2k\Omega} = 5 \times \frac{\left(1.5 \times 2 / 2 + 1.5\right)}{2}$$

$\therefore I_{2k} = 2.142$ A.

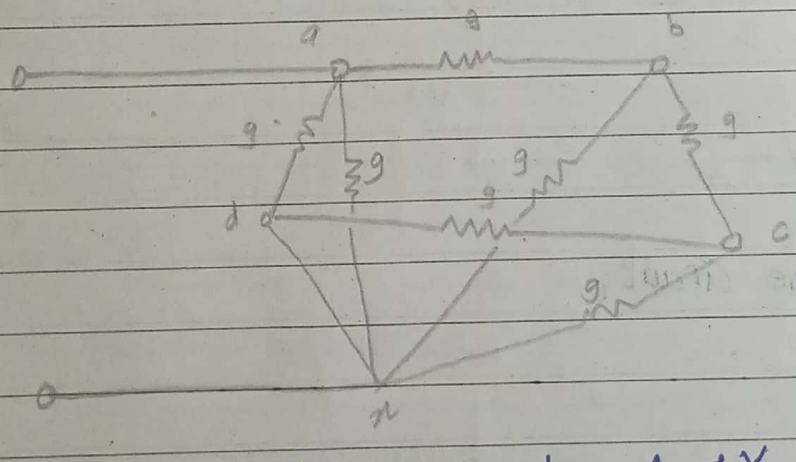
Date
Page

<Q.8>: Using the Y-Δ conversion or Δ-Y conversions, determine the total resistance of the network.

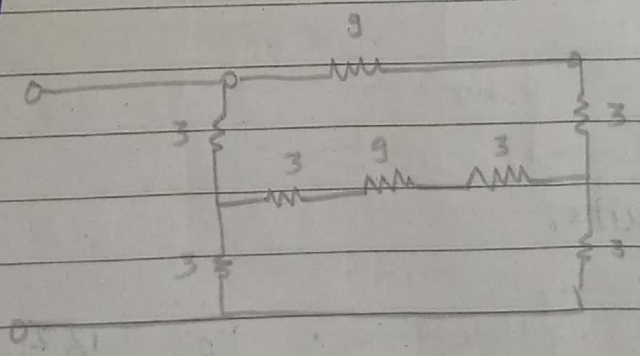
Soln:



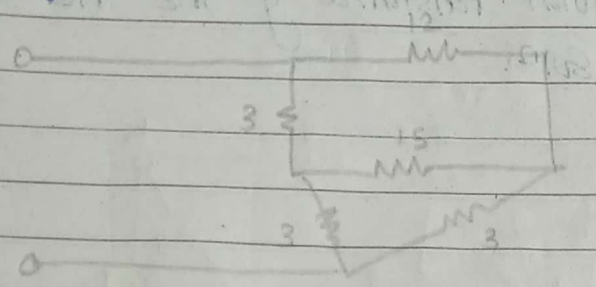
Since e, f, g, h connections doesn't have any resistance between them, they can be considered a single ~~source~~ point 'x'.



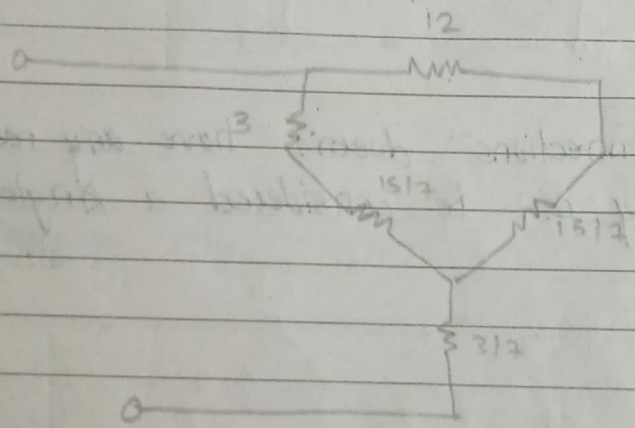
Converting Δ adx and Δ bcx to Δ → Y.



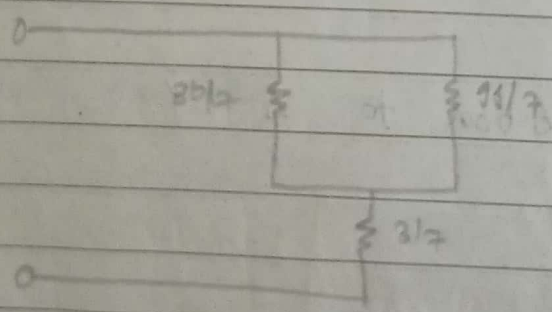
Redrawing the circuit,



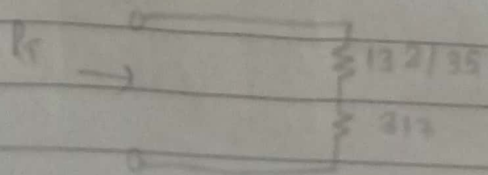
Redrawing the circuit,



Redrawing the circuit,



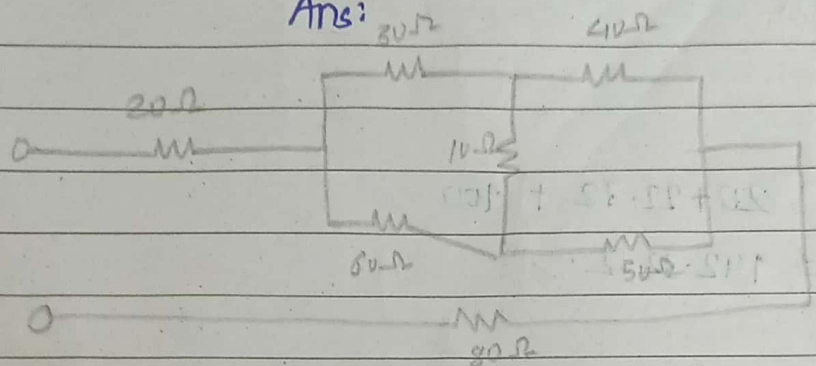
Redrawing the circuits,



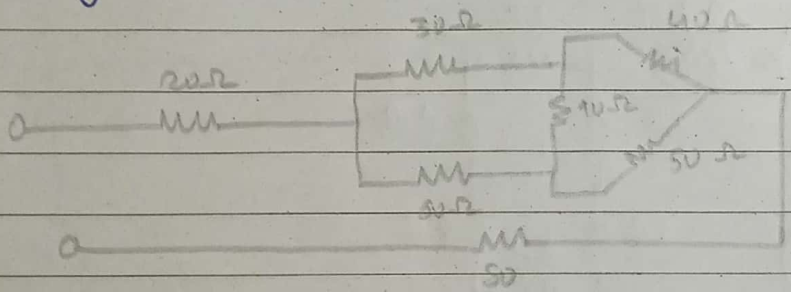
$$\therefore R_T = \frac{132}{35} + \frac{3}{7} = 4.2\,\Omega$$

<Q.11>: Obtain the equivalent resistance R_{ab} of the circuit.

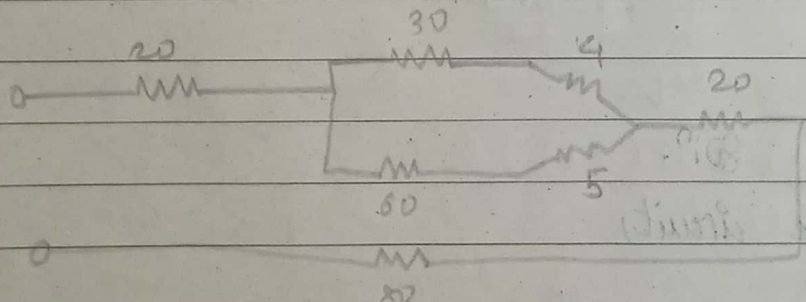
Ans:



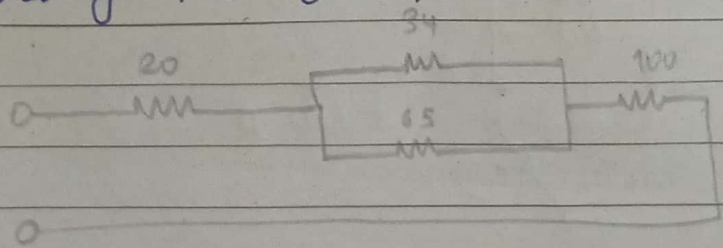
Redrawing the circuit,



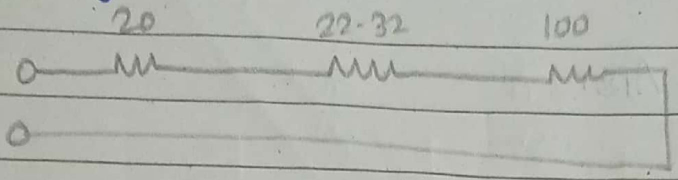
Using $\Delta \rightarrow Y$ conversion.



Redrawing the circuit,

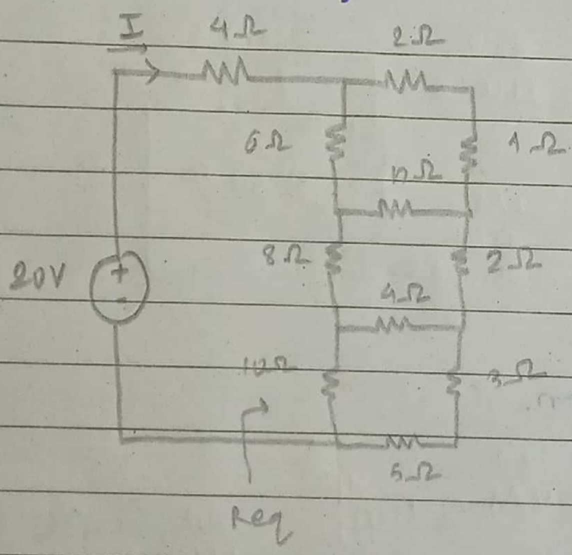


Redrawing the circuit,



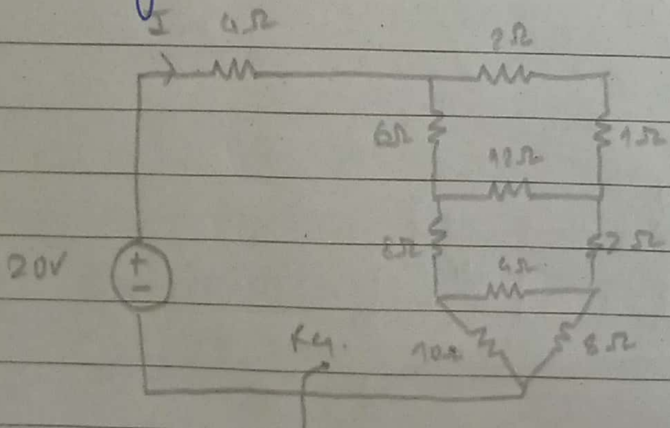
$\therefore R_T = 20 + 22.32 + 100$
$= 142.32\,\Omega$.

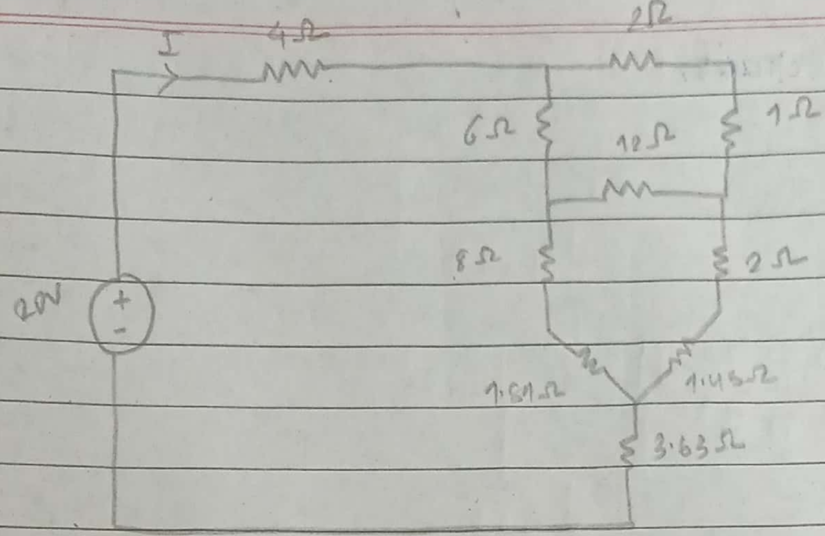
<Q.12>: Find the R_{eq} and I in given circuit.



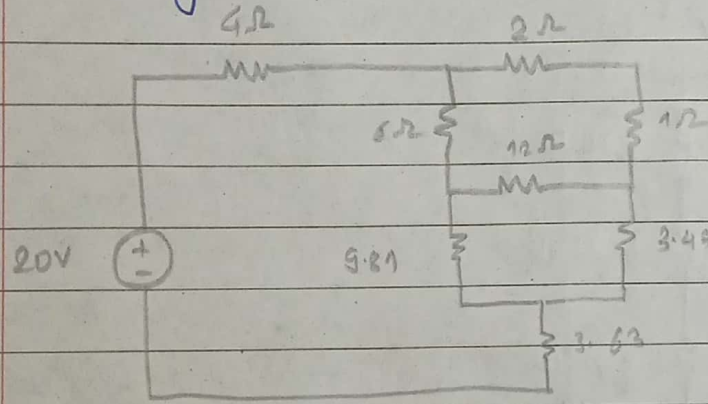
Sol^n:

Redrawing the circuit,

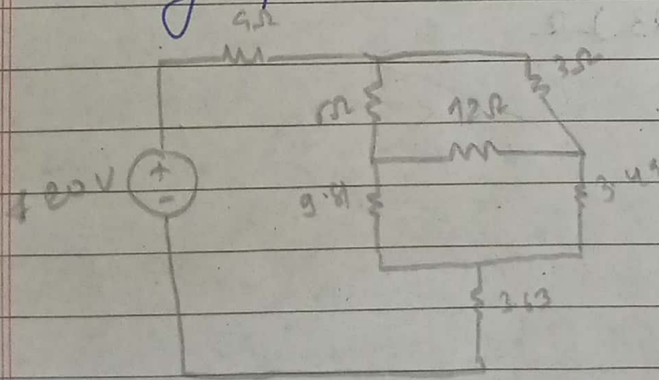




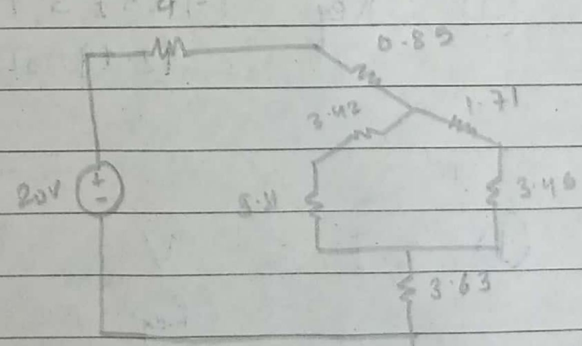
Redrawing the circuit,



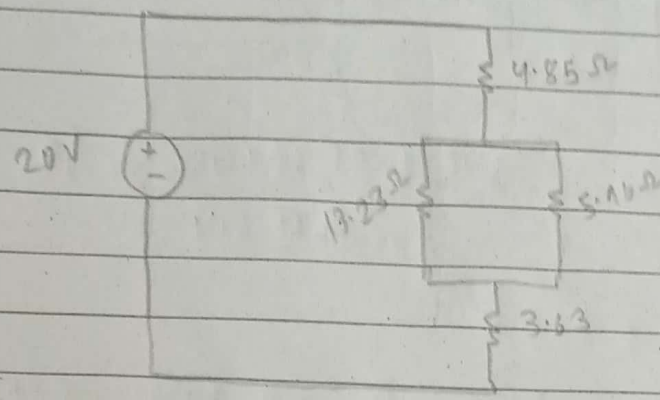
Redrawing the circuit,



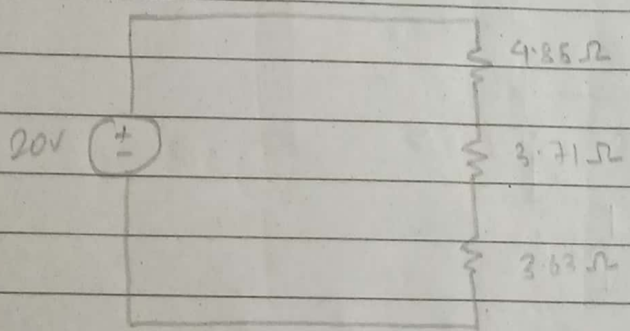
Using Δ-Y conversion.



Redrawing the circuit,



Redrawing the circuit,



(a) $R_{eq} = (4.85 + 3.71 + 3.63)\,\Omega$

$= 12.19\ \Omega$

(b) $I = \dfrac{V}{R_{eq}}$

$= \dfrac{20}{12.19}$ $\quad \therefore I = 1.64\ A$