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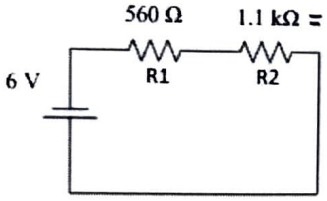
Intro to Digital Fabrication

Electronics Problem Set 1

1 Use the following circuits to practice analyzing series resistance. Determine the requested information and sketch the minimized equivalent circuit



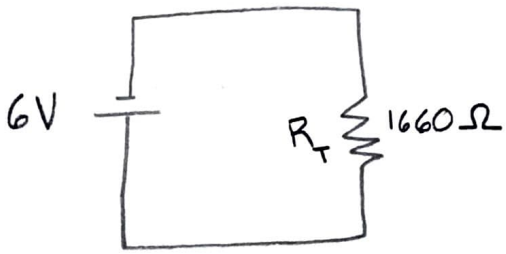
$I = \frac{V}{R}$

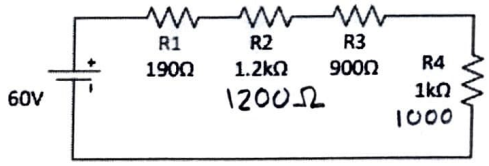
$V = IR$

$P = IV$

R_T = 1660 Ω
I_T = 3.614 mA
V_{R1} = 2.024 V
V_{R2} = 3.976 V
P_{R1} = 7.316 mW
P_{R2} = 14.371 mW
P_T = 21.687 mW

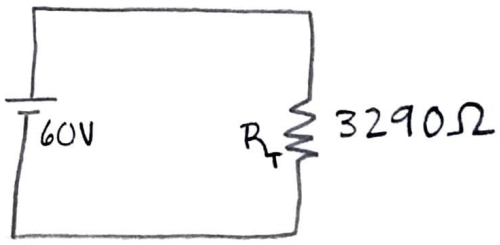
Sketch the equivalent circuit:





R_T = 3290 Ω
I_T = .01824 A
V_{R1} = 3.465 V
V_{R2} = 21.884 V
V_{R3} = 16.413 V
V_{R4} = 18.237 V
P_T = 1.0942 W

Sketch the equivalent circuit:

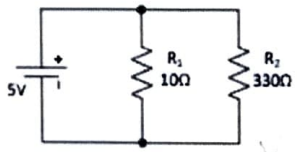


2 Use the following circuits to practice analyzing parallel resistance. Determine the requested information and sketch the minimized circuits.

$I = \frac{V}{R}$

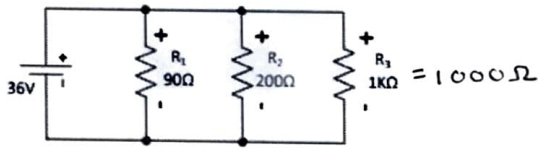
R_T = 9.706 Ω
I_T = .515 A
I_{R1} = .5 A
I_{R2} = 15.151 mA
P_{R1} = 2.5 w
P_{R2} = .0757 w
P_T = 2.576 w

$P = I V$



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

R_T = 58.441 Ω
I_T = .616 A
I_{R1} = .4 A
I_{R2} = .18 A
I_{R3} = .036 A
P_T = 22.176 W



$R_T = \frac{1}{\frac{1}{90} + \frac{1}{200} + \frac{1}{1000}}$

Is the total resistance larger than the largest single resistor or smaller than the smallest resistor? Is this what you would have expected?
The total resistance is smaller than the smallest resistor which makes sense because the charge gets distributed among the different paths

Does the total current equal the sum of the currents through each resistor?

$I_{R_1} + I_{R_2} = I_T$

$.5 + .015 = .515$ A

$I_{R_1} + I_{R_2} + I_{R_3} = I_T$

$.4 + .18 + .036 = .616$ A

Yes the sum of the currents through each resistor equals the total.

$$R_{3+4} = \frac{1}{\frac{1}{20} + \frac{1}{50}} = 14.286$$

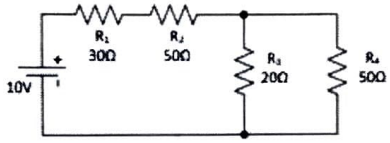
$$R_T = R_1 + R_2 + R_{3+4}$$

3 Analyze the circuits to determine the following. Sketch the minimized equivalent circuit.

R_T = 94.286 Ω

I_T = .106 A

P_T = 1.061 W



$I = \frac{V}{R}$

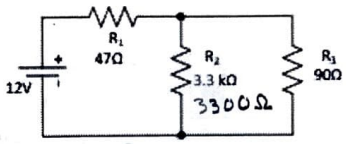
$P = IV$

$$R_{2+3} = \frac{1}{\frac{1}{3300} + \frac{1}{90}}$$

R_T = 134.611 Ω

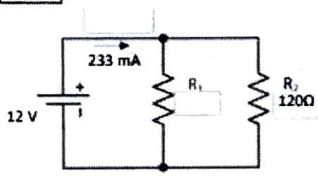
I_T = 89.146 mA

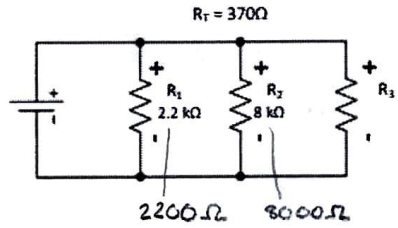
P_T = 1.07 W



$R_T = R_1 + R_{2+3}$

4 Determine the value for the missing component in the following circuits.





R_1 = 90.226 Ω

R_3 = 470.996 Ω

$I_T = .233\ A$

$$\frac{V_2}{R_2} = I_2 = \frac{12}{120} = .1\ A$$

$I_T - I_2 = I_1$

$.233 - .1 = .133$

$$R_1 = \frac{V}{I_1} = \frac{12}{.133}$$

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

$$\frac{370}{1} = \frac{1}{\underbrace{\frac{1}{2200} + \frac{1}{8000}}_{.0005795} + \frac{1}{R_3}}$$

$$370\left(.0005795 + \frac{1}{R_3}\right) = 1$$

$$\frac{1}{R_3} = \frac{1}{370} - .0005795$$

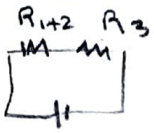
$$\frac{1}{R_3} = .00212$$

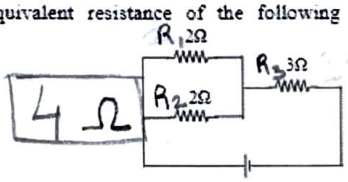
$R_{1+2} = \frac{1}{\frac{1}{2}+\frac{1}{2}} = 1$

$R_T = R_{1+2} + R_3$
$= 1 + 3$

$\frac{1}{\frac{1}{3}+\frac{1}{6}} = 2$ $\quad I_T = \frac{V_T}{R_T} = \frac{6}{2}$

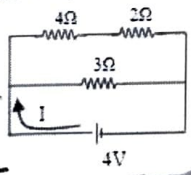
5 Calculate the equivalent resistance of the following compound circuit





4 Ω

6 Calculate the equivalent resistance R and the total current I.



6Ω

2Ω = R_T

2A = I_T

$R_T = \frac{1}{\frac{1}{3}+\frac{1}{(4+2)}} = 2$

$V_1 = I_1 R_1 = 4 \cdot 3 = 12$

$V_1 = V_T = V_{2+3}$

$I_T = \frac{V_T}{R_T} = \frac{12}{2} = 6$

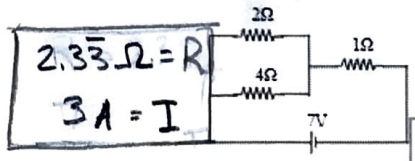
$I_{2+3} = I_T - I_1$
$2 = 6 - 4$

$V_2 = I_{2+3} R_2$
$4 = 2 \cdot 2$

7 Calculate the equivalent resistance R and the total current I

$\frac{1}{\frac{1}{4}+\frac{1}{2}} + 1 = R_T$

$I_T = \frac{V}{R} = \frac{7}{2.33}$

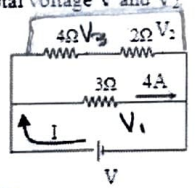


2.33 Ω = R

3 A = I

8 Calculate the the total current I, total voltage V and V_2

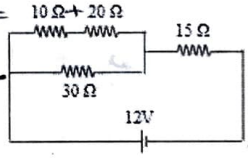
$I_T = 6$ A
$V_T = 12$ V
$V_2 = 4$ V



9 Calculate the equivalent resistance R and the total current I

$30 = 10\Omega + 20\Omega$

$R_T = \frac{1}{\frac{1}{30}+\frac{1}{30}} + 15 = 30\Omega$



$I = \frac{V}{R} = \frac{12}{30} = .4A$

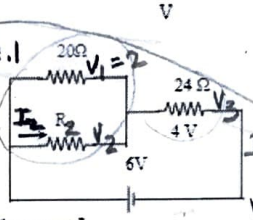
R = 30 Ω
I = .4 A

10 Calculate the R_2, and I_2

$I_2 = I_T - I_1$

$R_2 = V_2 / I_2$

$I_1 = \frac{2}{20} = .1$



$I_T = I_3 = \frac{4}{24} = .167$ A

$V_T = V_{1+2} + V_3$
$6 = V_{1+2} + 4$

$V_{1+2} = 2$
$V_1 = V_2 = 2$

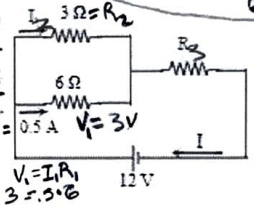
$V_3 = V_T - V_1$
$V_3 = 12 - 3 = 9$

$I_3 = I_T$

$R_3 = V_3 / I_3 = \frac{9}{1.5}$

I = .067 A
R_2 = 30 Ω

11 Calculate the I_2 , R_3, the total current I.



$I_2 = \frac{V_2}{R_2} = \frac{3}{3}$

$I_T = I_1 + I_2$
$.5 + 1$

$V_1 = V_2$
$3 = V_2$

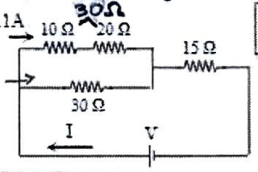
$V_1 = I_1 R_1$
$3 = .5 \cdot 6$

$R_3 = 6\ \Omega$
$I_2 = 1$ A
$I_T = 1.5$ A

12 Calculate the the total current I and total voltage V.

$I_T = I_1 + I_2$
$.1 + .1$

$I_1 = I_2 = 0.1$A



$I_1 = .1$A

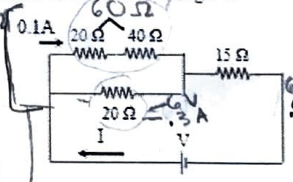
$R_T = \frac{1}{\frac{1}{30}+\frac{1}{30}} + 15 = 30\Omega$

$V_T = I_T R_T$
$.2 \cdot 30$

$I_T = .2$ A
$V_T = 6$ V

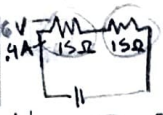
13 Calculate the the total current I and total voltage V.

$R = \frac{1}{\frac{1}{60}+\frac{1}{20}} = 15\Omega$



$V = I R$
$V = .1 \cdot 60 = 6$V

$R_T = 15 + 15 = 30\Omega$



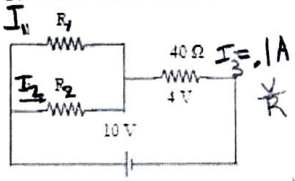
.4A

$V_T = I_T R_T$
$.4 \cdot 30$

$I_T = .4$A
$V_T = 12$ V

14 If $R_1 = R_2$, calculate the R_1, I_2, and the total current I.

$I_1 = I_2$



$I_T = I_3 = I_1 + I_2$
$.1 = 2I_1$
$.05 = I_1 = I_2$

$R_T = \frac{V_T}{I_T} = \frac{10}{.1} = 100\Omega$

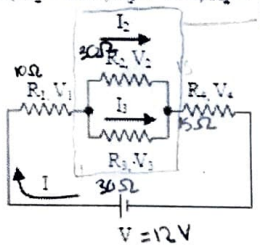
$R_T = 40 + \frac{1}{\frac{1}{R_1}+\frac{1}{R_2}}$

$100 - 40 = \frac{1}{\frac{2}{R_1}}$

$60 = \frac{R_1}{2}$ $\quad R_1 = 120$

$R_1 = 120\ \Omega$
$I_2 = .05$ A
$I_T = .1$ A

15 Use the diagram to calculate a) the total resistance in the circuit, b) the total current through the circuit, c) the total power the circuit consume, and d) the current through R_2 (where $R_1 = 10\Omega$, $R_2 = 30\Omega$, $R_3 = 30\Omega$, $R_4 = 15\Omega$, V = 12V)



$R_{2+3} = \frac{1}{\frac{1}{30}+\frac{1}{30}} = 15\Omega$

$R_T = R_1 + R_{2+3} + R_4$
$10 + 15 + 15$

$I_T = V_T / R_T$
$12 / 40$

$P = I V$
$.5 \cdot 12$

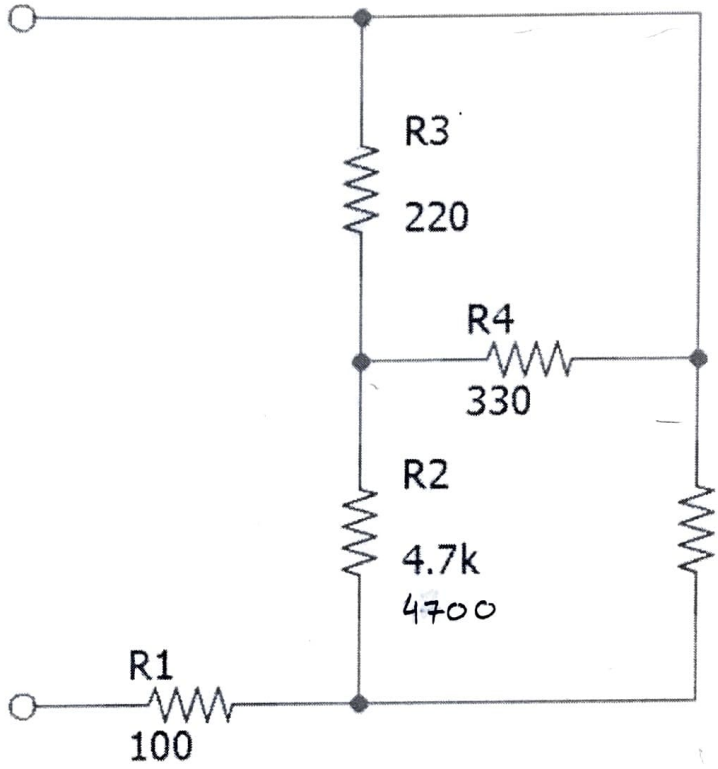
$I_T = I_2 + I_3$
$.3 = 2I_2$

$R_2 = R_3$
$I_2 = I_3$

$R_T = 40\ \Omega$
$I_T = .3$ A
$P_T = 3.6$ W
$I_2 = .15$ A

16

Find the equivalent resistance for the following set of connected resistors:



$$R_{3+4} = \frac{1}{\frac{1}{220} + \frac{1}{330}} \approx 132\ \Omega$$

$$R_{3+4+2} = 132 + 4700 = 4832\ \Omega$$

$$R_{3+4+2+5} = \frac{1}{\frac{1}{4832} + \frac{1}{6800}} \approx 2824.759\ \Omega$$

$$R_T = R_{3+4+2+5} + R_1$$

$$R_T = 2824.75 + 100$$

$$\boxed{R_T = 2924.759\ \Omega}$$