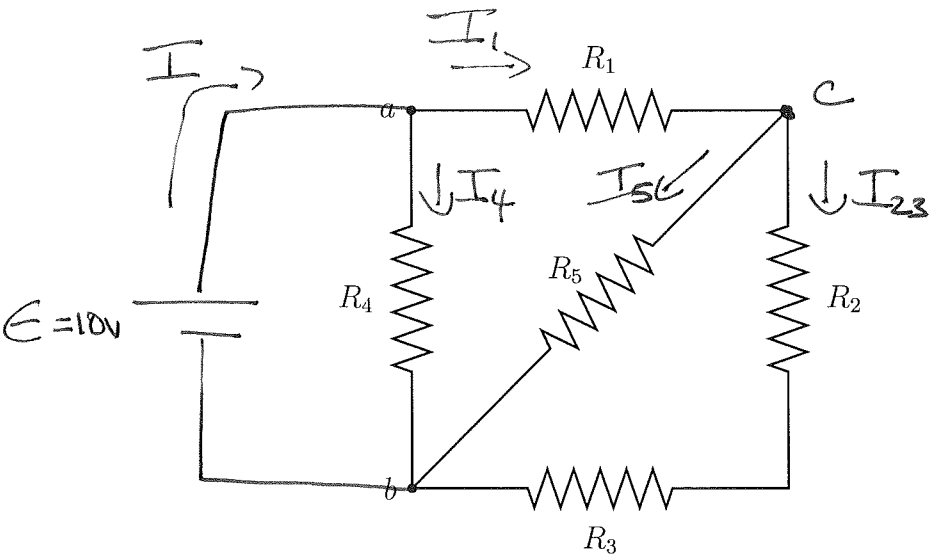
Physics 161 Test 4



$R_1 = 500\,\Omega$
$R_2 = 200\,\Omega$
$R_3 = 400\,\Omega$
$R_4 = 100\,\Omega$
$R_5 = 350\,\Omega$

(a) If a $10\,V$ battery is connected to the points a and b, what is the equivalent resistance for this circuit? *(8 pts)*

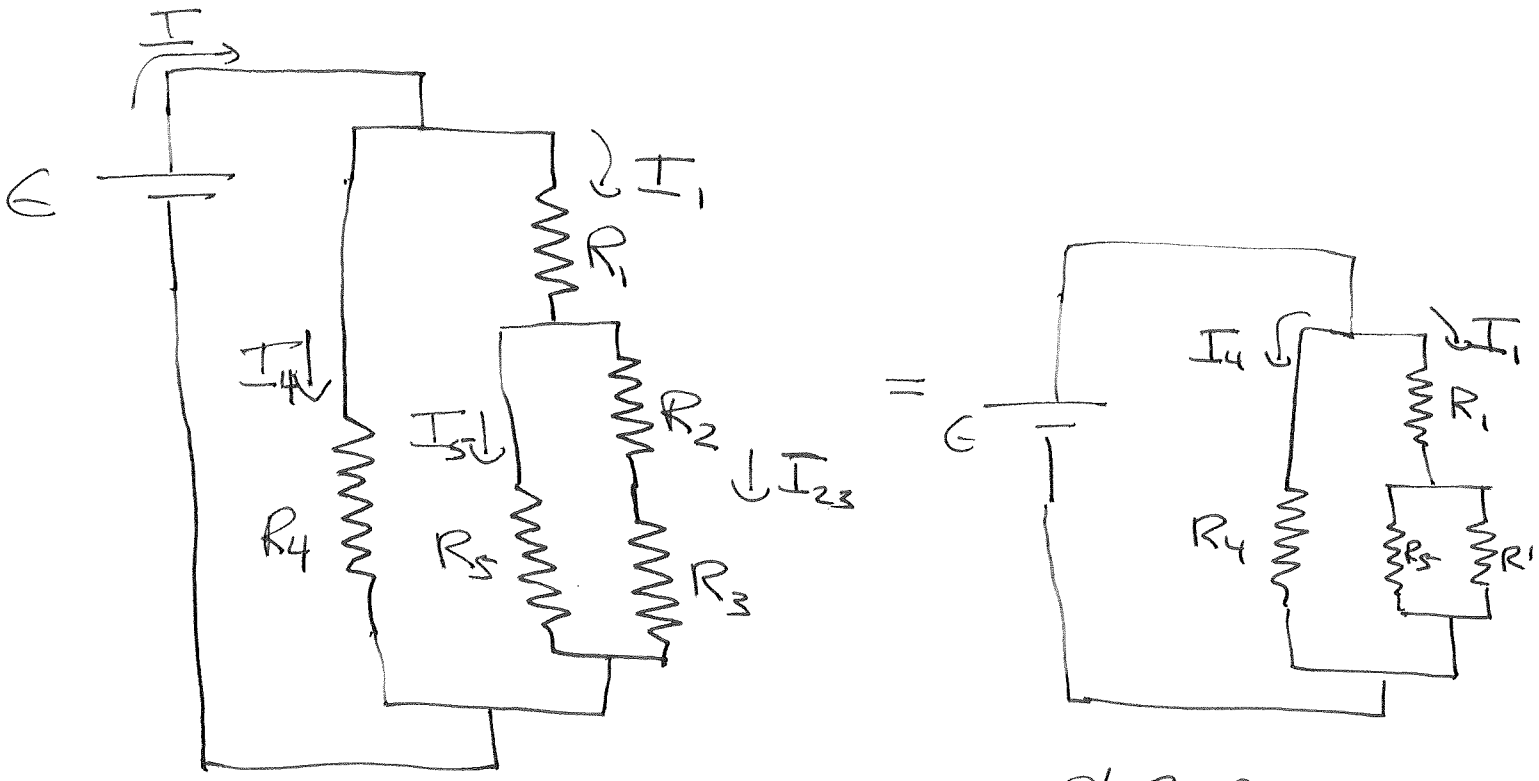
Draw Battery as shown. At "a" Current From Battery splits into I_1 and I_4 as shown. I_1 splits at "c" into I_5 and I_{23} (since all currents recombine at "b")

$\Rightarrow$ R_2 and R_3 in series. "Finger Test" shows R_5 in parallel with R_2/R_3 combination.

$I_1 = I_5 + I_{23}$ $\Rightarrow$ R_1 in series with $R_2/R_3/R_5$ combination

Finally, Finger Test $\Rightarrow$ R_4 in parallel with everything else

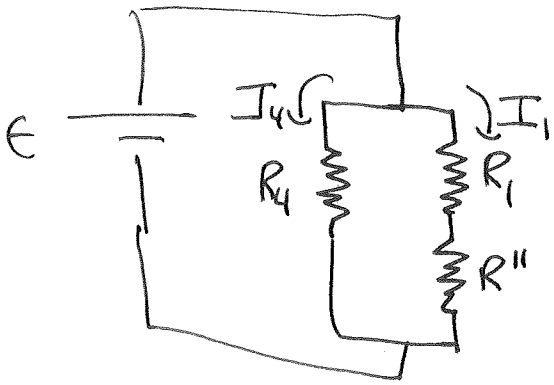
So our Helpful Diagram Looks Like:



$R' = R_2 + R_3 = 200\Omega + 400\Omega$
$= 600\Omega$

R_5 & R' in parallel $\Rightarrow R'' = \frac{R_5 R'}{R_5 + R'} = \frac{(350\Omega)(600\Omega)}{950\Omega} = 221\Omega$

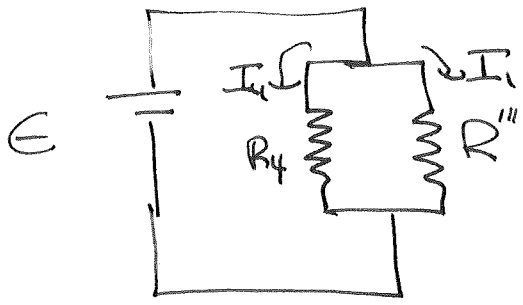
$\frac{4200}{19}\Omega$ to be EXACT



R_1 & R'' in SERIES $\Rightarrow R''' = R_1 + R''$

$R''' = 500\Omega + 221\Omega$
$= 721\Omega \left(\frac{13700}{19}\Omega\right)$

FINALLY:



Parallel $\Rightarrow R_{EQ} = \frac{R_4 R'''}{R_4 + R'''}$

$\Rightarrow R_{EQ} = \frac{(100\Omega)(82\Omega)}{(82\Omega)}$

$\Rightarrow \boxed{R_{EQ} = 87.82\Omega}$

EXACT: $\frac{1370000}{15600} = \frac{13700}{156} = \frac{6850}{78} = \frac{3425}{39}\ \Omega$

b) Which Resistor uses Most Power? What Percentage of Power Supplied by battery?

Power Supplied by battery: $P = I\mathcal{E}$.

$$I = \frac{\mathcal{E}}{R_{EQ}} = \frac{10V}{87.82\Omega} = 0.1139A \quad \therefore P = (0.1139A)(10V) = 1.139 Watt$$

$P = IV \Rightarrow$ Most Current And Highest Voltage uses most Power.

Obvious candidate is R_4 since "Finger test" shows $V_4 = \mathcal{E} = 10V$

$$P_4 = I_4 V_4 = \frac{V_4^2}{R_4} = \frac{(10V)^2}{100\Omega} = 1 Watt$$

$\Rightarrow$ other Resistors using $1.139 Watt - 1 Watt = 0.139 Watt$ in total!

So definitely R_4.

$$\% = \frac{1 Watt}{1.139 Watt} = 87.8\%$$