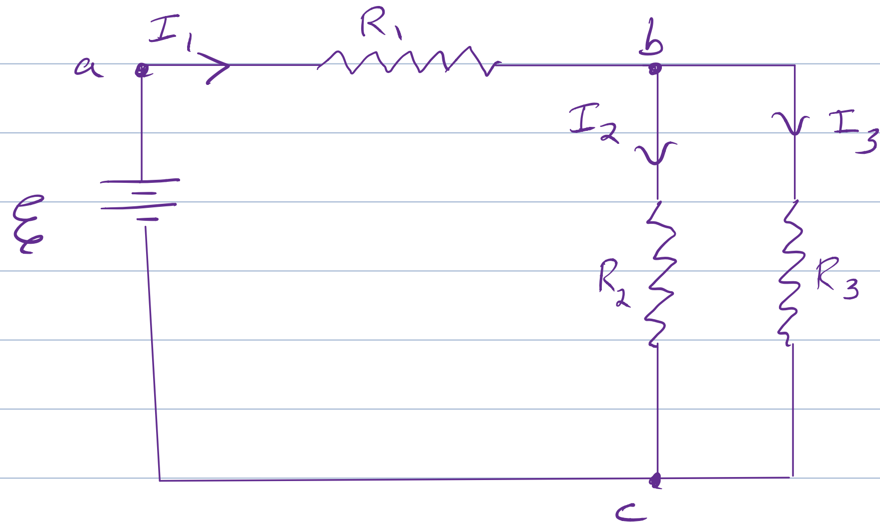
Start with an example:



$\mathcal{E} = 10\,V$ $\quad R_1 = 1\,k\Omega$ $\quad R_2 = 2\,k\Omega$ $\quad R_3 = 3\,k\Omega$

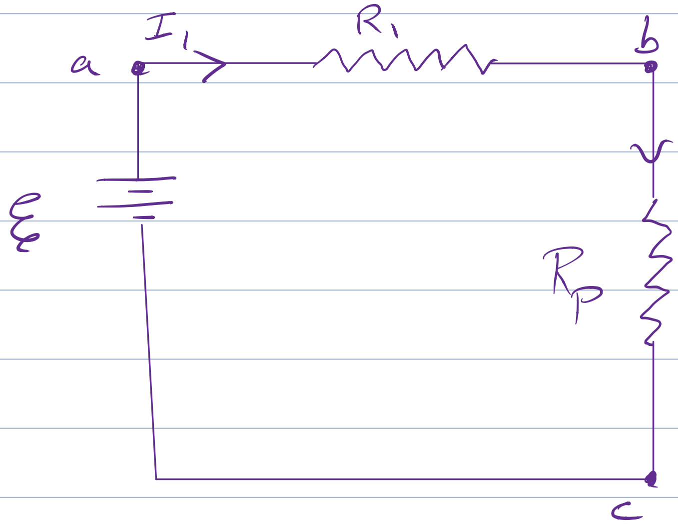
Problem: Find I_1, I_2, and I_3.

(Poll – combinations)

How to start? We would like to use $P = I(\Delta V)$ or $\Delta V = IR$, but we don't know any of the currents or voltage drops.

Plan: try to replace some resistors by series or parallel equivalents till we can figure out some of the currents or voltages.

Note: R_2 and R_3 are in parallel. Replace them by R_p on the way to finding the current delivered by the battery.



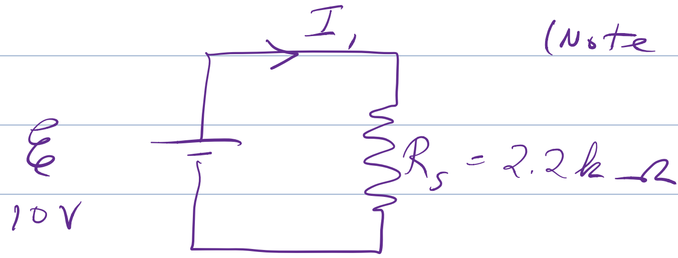
$$\frac{1}{R_p} = \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{2k\Omega} + \frac{1}{3k\Omega} = \frac{5}{6k\Omega}$$

$$R_p = \frac{6}{5}k\Omega = 1.2\,k\Omega$$

Next: Note R_1 and R_p are in series, so as far as the battery is concerned, replace them by the series equivalent $R_s = R_1 + R_p$

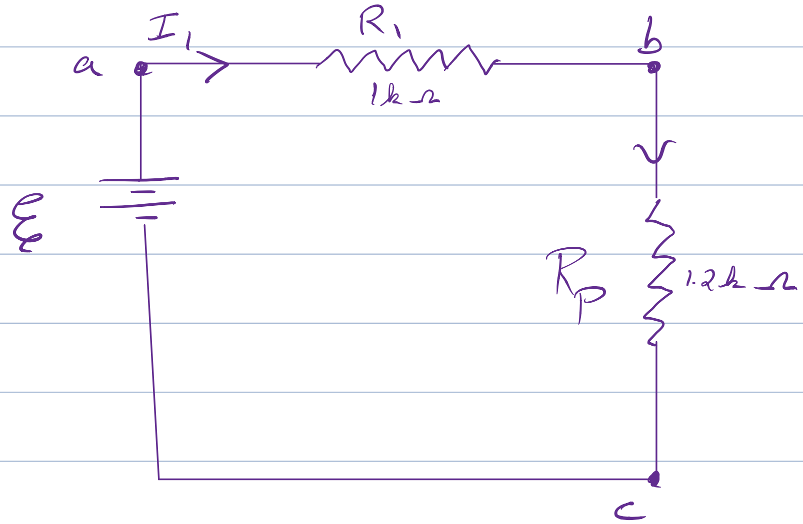
$$R_s = 1k\Omega + 1.2k\Omega = 2.2\,k\Omega.$$

(Note this is still I_1).



$$I_1 = \frac{\mathcal{E}}{R_s} = \frac{10V}{2.2k\Omega} = 4.55\,mA$$

Now, start rebuilding the more complex circuit.



Question: what is the voltage at point b?

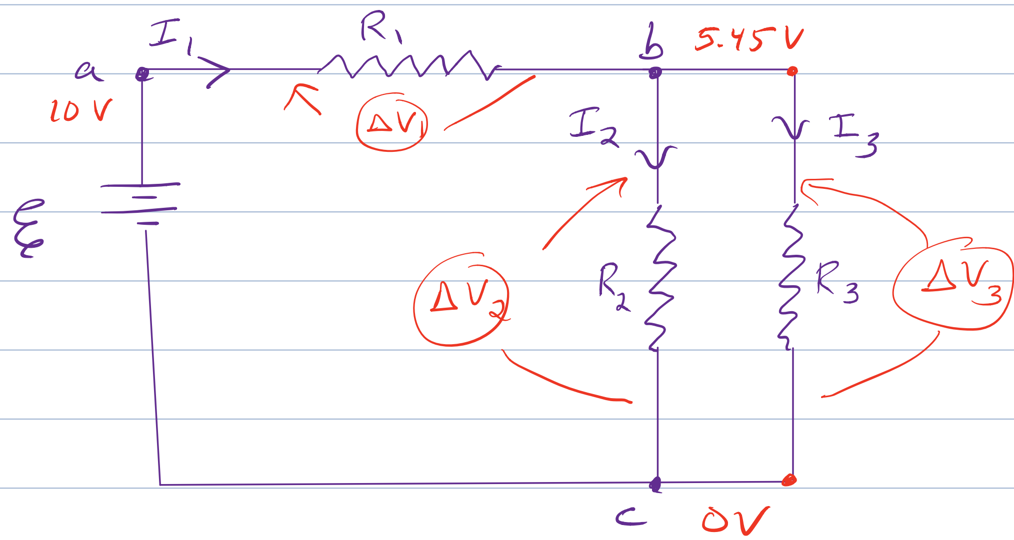
$$\Delta V_1 = I_1 R_1 = (4.55\,mA)(1k\Omega) = 4.55\,V$$

$$\Delta V_2 = I_1 R_p = (4.55\,mA)(1.2k\Omega) = 5.45\,V$$

$\therefore$ V at b = 5.45V

and $\Delta V_1 = 10V - 5.45V = 4.55V$ ✓

Lastly, return to original circuit:



Poll: how do voltages ΔV_2 and ΔV_3 compare?
how do the currents I_2 and I_3 compare?

Look at resistor R_2: $\Delta V_2 = I_2 R_2$

$$I_2 = \frac{\Delta V_2}{R_2} = \frac{5.45\,V}{2\,k\Omega} = 2.73\,mA$$

Look at resistor R_3: $\Delta V_3 = I_3 R_3$

$$I_3 = \frac{\Delta V_3}{R_3} = \frac{5.45\,V}{3\,k\Omega} = 1.82\,mA$$

Note: $I_1 \stackrel{?}{=} I_2 + I_3$ (KCL)

$$4.55\,mA \stackrel{?}{=} 2.73\,mA + 1.82\,mA$$

$$4.55\,mA = 4.55\,mA \quad ✓$$

Power considerations: check: is

$$\mathcal{E} I_1 = P_1 + P_2 + P_3 \ ?$$

$$P_{\mathcal{E}} = \mathcal{E} I_1 = (10V)(4.55\,mA) = 45.50\,mW$$

$$P_1 = I_1^2 R_1 = (4.55\,mA)^2 (1\,k\Omega) = 20.70\,mW$$
$$P_2 = I_2^2 R_2 = (2.73\,mA)^2 (2\,k\Omega) = 14.91\,mW$$
$$P_3 = I_3^2 R_3 = (1.82\,mA)^2 (3\,k\Omega) = 9.94\,mW$$

total: $45.55\,mW$

These match to within our roundoff error.

See posted examples for chapter 23

ch 23-combo-1
ch23-appliance

} to be discussed in class as time permits. (There are more examples on line.)