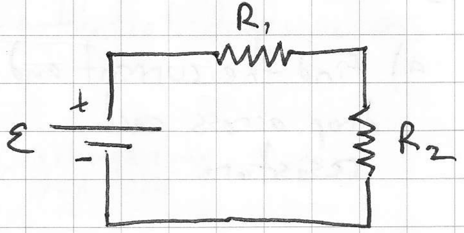
$\boxed{\text{ex}}$ Consider $\mathcal{E} = 12\,V$, $R_1 = 1.5\,\Omega$ and $R_2 = 3.5\,k\Omega$
What is the power dissipated by R_2 in this circuit?



$$P = I^2 R_{2\cancel{eq}}$$

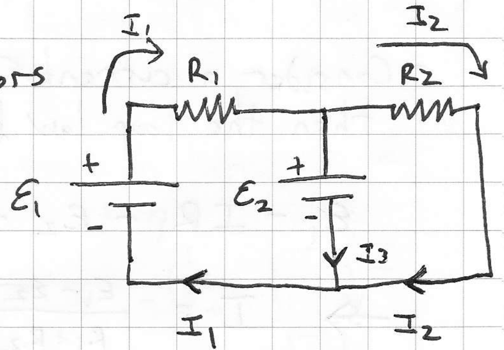
where $I = \dfrac{V}{R_{eq}} = \dfrac{V}{R_1 + R_2}$

$$\rightarrow P = \left(\frac{V}{R_1+R_2}\right)^2 R_2 = \left(\frac{12}{1.5\,k\Omega + 3.5\,k\Omega}\right)^2 (3.5\,k\Omega)$$

$$= 2.0 \times 10^{-2}\,W$$

(note that heat will also be dissipated by R_1 too) $\therefore$

$\boxed{\text{ex}}$ Solve for I_1 and I_2 in the two resistors of the circuit.



- Left loop (clockwise)

$$\mathcal{E}_1 - I_1 R_1 - \mathcal{E}_2 = 0$$

- Right loop (clockwise)

$$\mathcal{E}_2 - I_2 R_2 = 0$$

- Junction rule: $I_1 = I_2 + I_3$

NOTE: we will make an assumption about the direction of the currents (so to apply the loop rules)

$\rightarrow$ Can solve these eqns: for I_1 and I_2 (we don't need I_3 via the junction rule)

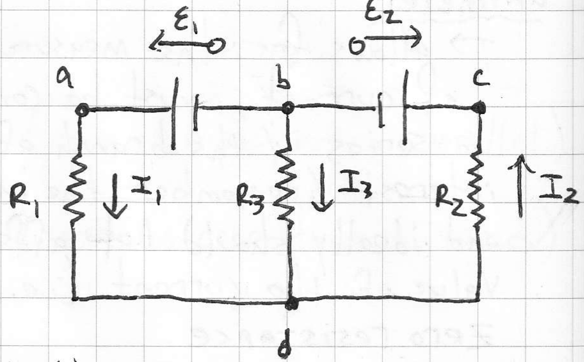
$$I_1 = \frac{\mathcal{E}_1 - \mathcal{E}_2}{R_1}, \quad I_2 = \frac{\mathcal{E}_2}{R_2}$$

$\therefore$

2/5/13

kirchoff's Laws

ex Use the ~~[illegible]~~ kirchoff's Laws to determine the currents I_1, I_2 and I_3



NOTE: we arbitrarily chose the direction of the currents. This provides a reference and the ultimate direction of the current should correctly emerge from our solution

make sure to correctly keep track of your chosen ref. direction!

Left loop: $\mathcal{E}_1 - I_1 R_1 + I_3 R_3 = 0$

Right loop: $-I_3 R_3 - I_2 R_2 - \mathcal{E}_2 = 0$

(NOTE that we went counter-clockwise through both loops)

Junction rule: $I_1 + I_3 - I_2 = 0$
(say, at point d)

→ Now we have three eqns. w/ three unknowns. Algebraically we can solve for the currents in terms of the resistances and potential diffs.

When the smoke clears (don't worry about doing this on a test for 1410)

$$I_1 = \frac{\mathcal{E}_1 (R_2 + R_3) - \mathcal{E}_2 R_3}{R_1 R_2 + R_2 R_3 + R_1 R_3}$$

$$I_2 = \frac{\mathcal{E}_1 R_3 - \mathcal{E}_2 (R_1 + R_3)}{R_1 R_2 + R_2 R_3 + R_1 R_3}$$

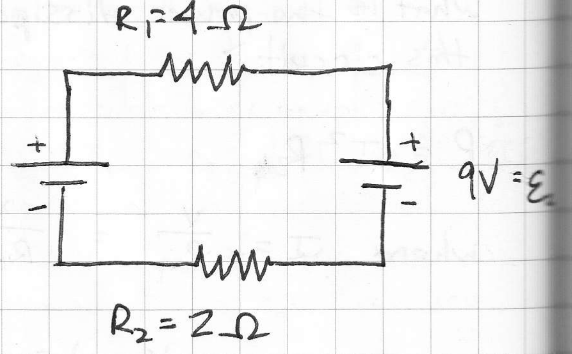
$$I_3 = \frac{-\mathcal{E}_1 R_2 - \mathcal{E}_2 R_1}{R_1 R_2 + R_2 R_3 + R_1 R_3}$$

NOTE: $I_3 < 0$
(so we chose the ref. direction wrong no matter what $\mathcal{E}$ and R values are!

2/5/13

ex Consider the following circuit

a) Find the current and potential drop across each resistor



b) Make a graph showing how the electrical potential changes around the circuit (starting at $V = 0V$ at the negative terminal of the 6V battery)

Assume ideal wires and batteries (i.e. no interal resistance)

- Consider a current I going around the loop in a clockwise direc[tion] then the loop law has

$$\mathcal{E}_1 - IR_1 - \mathcal{E}_2 - IR_2 = 0$$

$$\rightarrow \quad I = \frac{\mathcal{E}_1 - \mathcal{E}_2}{R_1 + R_2} = \frac{6V - 9V}{4\Omega + 2\Omega} = -0.50\text{ A}$$

(so the current actually flows the other way!)

$$\Delta V_1 = IR_1 \quad \text{(voltage drop across } R_1\text{)}$$
$$= -(-0.5\text{ A})(4\,\Omega) = +2.0\text{ V}$$

[be careful of signs given choice of current direction!

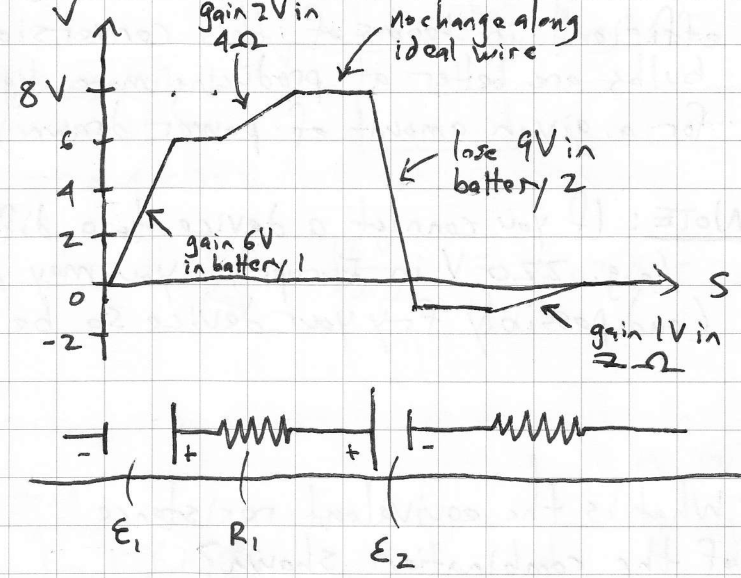
$$\Delta V_2 = -(-0.5\text{ A})(2\,\Omega) = +1.0\text{ V}$$

$\boxed{2/5/13}$

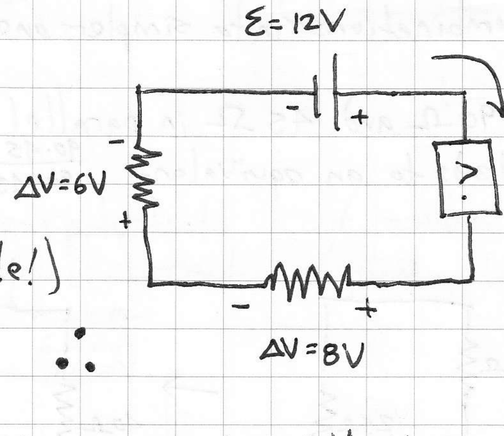
→ because of the way we chose the ref. for the current (and the fact that the 9 V battery overpowers the 6 V battery going the other way), the potential drops across the resistors come out as positive!

◦ let s be the 'distance' around the circuit as measured from the negative terminal of the 6 V battery

∴



$\boxed{ex}$ For the given current direction, what is ΔV across the mystery element?



$\Delta V_? = 2\text{ V}$ (use the loop rule!)

∴

$\boxed{ex}$ How much current is 'drawn' by a 100 W lightbulb connected to a 120 V outlet?

$P = I\Delta V \rightarrow I = \frac{P}{\Delta V} = \frac{100\text{ W}}{120\text{ V}} = 0.833\text{ A}$

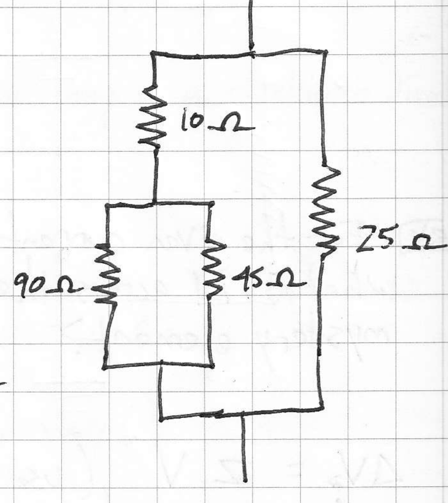
$[\frac{C}{s}]$ [cont. ↓]

$\boxed{2/5/13}$

$\boxed{\text{ex (cont.)}}$ This 'drawn' current means that 100 J/s are being drawn from the outlet and converted to thermal energy in the filament (which in turn becomes heat and light). Note that some bulb types are more efficient in terms of this conversion (e.g. fluorescent bulbs are better at producing more light than incandescents for a given amount of power drawn)

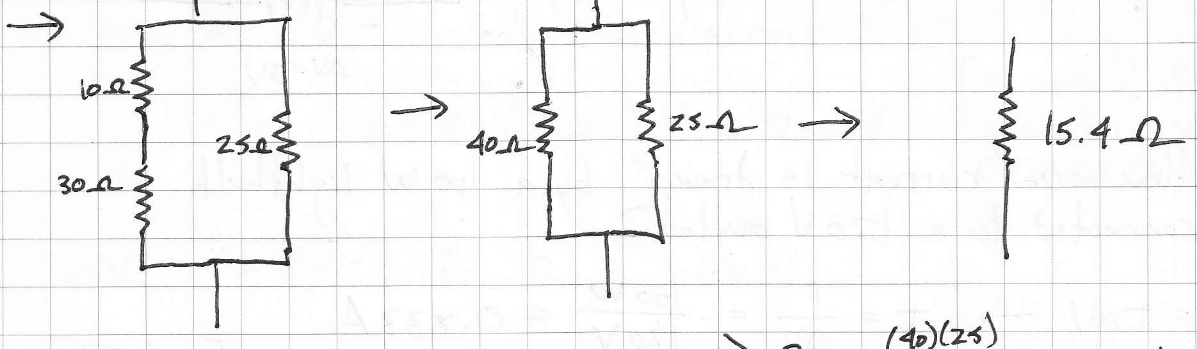
<u>NOTE</u>: If you connect a device to a different potential source (e.g. 220 V in Europe), you may draw more/less power (and possibly fry your device so be careful!)

$\boxed{\text{ex}}$ What is the equivalent resistance of the combination shown?



→ start breaking down the various combinations into simpler ones

eg. 90 Ω and 45 Ω in parallel leads to an equivalent $\frac{90 \cdot 45}{90+45} = 30\,\Omega$

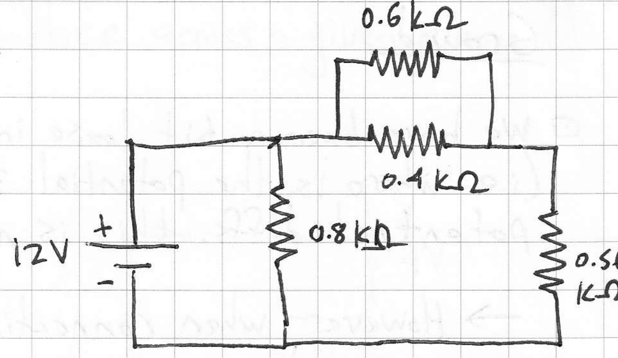


$\rightarrow R_{eq} = \frac{(40)(25)}{(40+25)}\,\Omega = 15.4\,\Omega$

$\boxed{2/5/13}$

$\boxed{\text{ex 1}}$

Find the currents and potential diffs. across all the resistors.

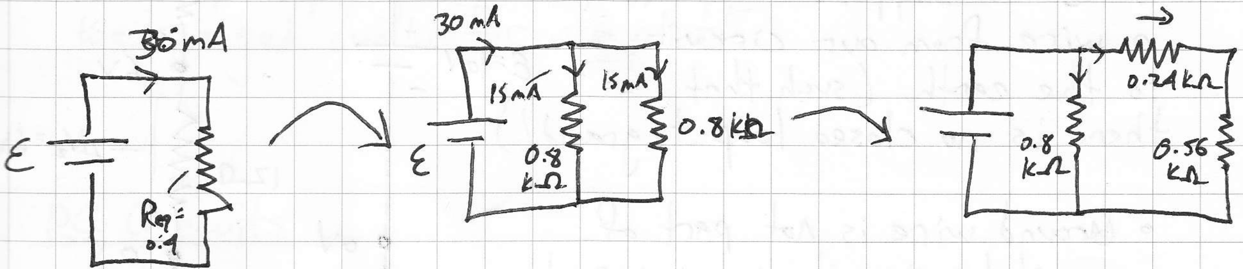


→ First determine R_{eq}

- 0.6 and 0.4 in parallel → 0.24 kΩ
- 0.24 and 0.56 in series → 0.8 kΩ
- 0.8 and 0.8 in parallel → 0.4 kΩ

$\rightarrow R_{eq} = 0.4 \text{ k}\Omega$, $I = \dfrac{\varepsilon}{R_{eq}} = \dfrac{12\text{ V}}{400\ \Omega} = 0.03\text{ A} = 30\text{ mA}$

- Now 'rebuild' the circuit



And so on. Remember that

- parallel resistors have same potential (loop law)
- series resistors have same current (junction law)