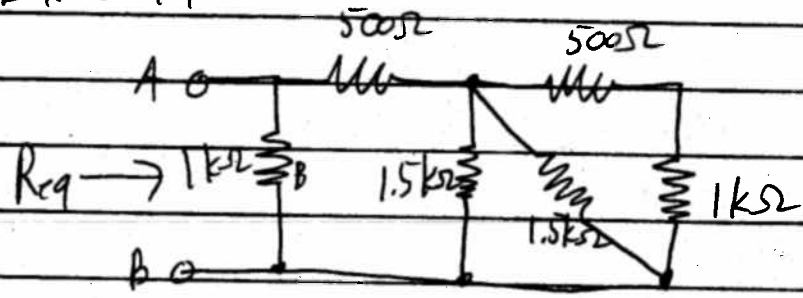
Things that look complicated can often be reduced to a single equivalent resistor:

Ex 2-14



Go to the "Far Side" and work your way back:

$$500\Omega + 1k\Omega = 1.5k\Omega$$

$$1.5k // 1.5k = 0.75k$$

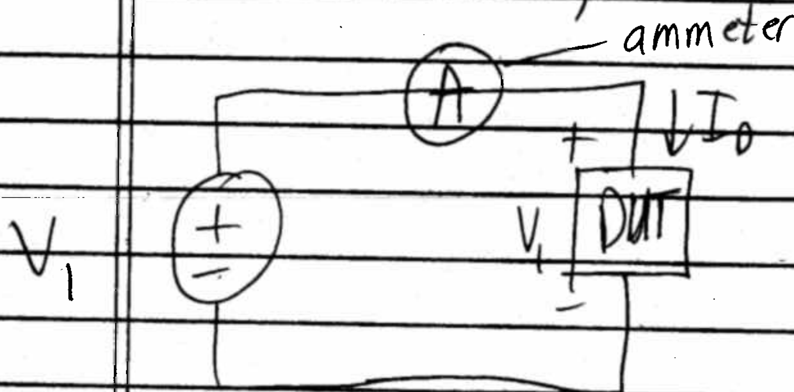
$$.75k // 1.5k = \frac{\left(\frac{3}{4}\right)\left(\frac{3}{2}\right)}{\frac{3}{4}+\frac{3}{2}}k = \frac{9/8}{9/4}k = \frac{1}{2}k\Omega$$

$$\frac{1}{2}k + \frac{1}{2}k = 1k\Omega$$

$$\underline{1k\Omega // 1k\Omega = 500\Omega}$$

It is useful to think about how you would measure the resistance of an unknown device;

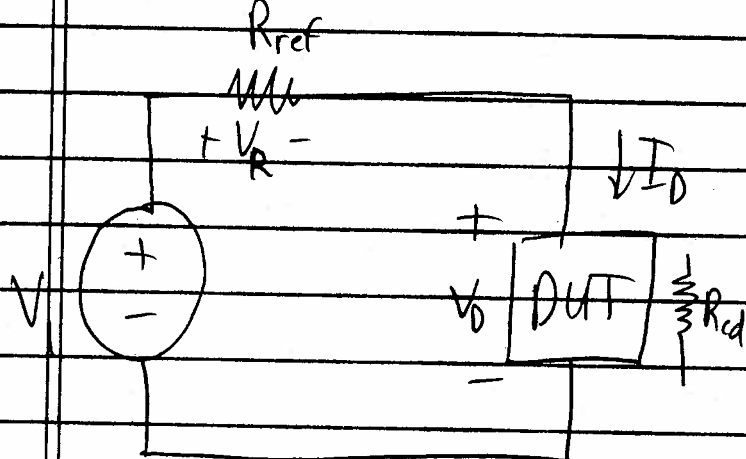
DUT = Device Under Test



① Apply a known voltage across the DUT, V_1.

② Measure the current thru the device I_D

$$R_{eq} = \frac{V_1}{I_D}$$



~~Use Voltage division~~

① Apply known voltage across DUT and R_{ref}.

② Measure V_R across R_{ref}.

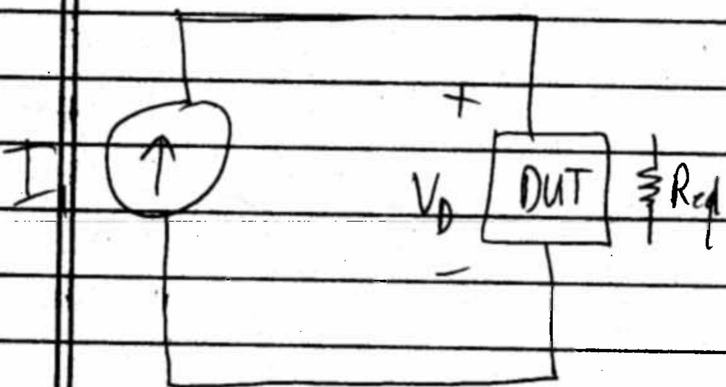
③ Calculate R_{eq} from Voltage Division

$$V_R = \frac{R_{ref}}{R_{ref} + R_{eq}} V_1$$

$$R_{ref} + R_{eq} = R_{ref}\left(\frac{V_1}{V_R}\right)$$

$$R_{eq} = R_{ref}\left(\frac{V_1}{V_R}\right) - R_{ref}$$

$$R_{eq} = R_{ref}\left[\frac{V_1}{V_R} - 1\right]$$

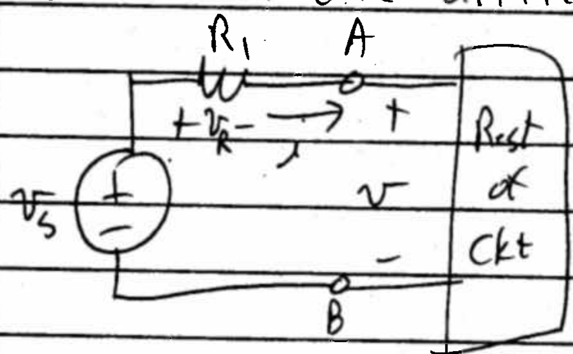


① send known current through DUT

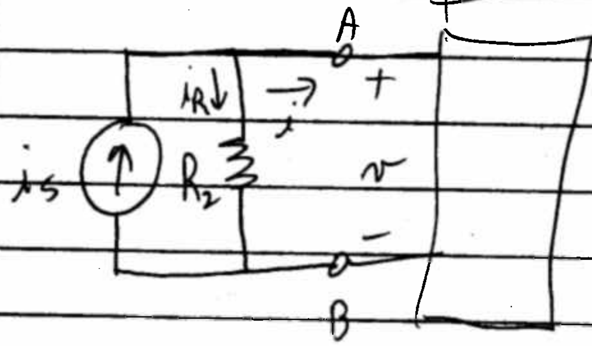
② Measure voltage across DUT

③ $R_{eq} = \frac{V_D}{I_1}$

I have already alluded to Practical Sources, to avoid the difficulties of ideal Sources:



A



B

What if the "Rest of Ckt" is the same in these two cases, then ~~we want v and i to be the same~~ under what values of v_s, i_s, and $R_1 + R_2$ will v and i be the same?

A: KVL: $v_R + v - v_s = 0$

$$v_s = v_R + v$$

Ohm's $v_R = iR_1$

B: KCL: $-i_s + i_R + i = 0$

$$i_s = i_R + i$$

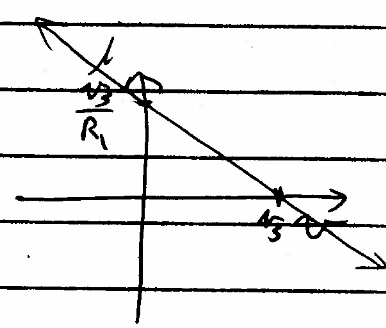
Ohm's $i_R = \frac{v}{R_2}$

A $\rightarrow$ $v_s = iR_1 + v$

$$\frac{v_s - v}{R_1} = i$$

$$i = \frac{v_s - v}{R_1} \longrightarrow$$

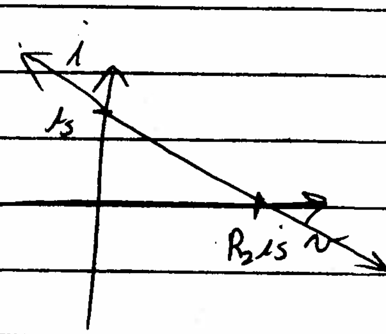
$$i = -\frac{1}{R_1}v + \frac{v_s}{R_1}$$



B $\rightarrow$ $i_s = \frac{v}{R_2} + i$

$$i = i_s - \frac{v}{R_2}$$

$$= -\frac{1}{R_2}v + i_s \longrightarrow$$



We want these to be the same, so the intercepts must be equal, or

y intercepts: $\frac{v_s}{R_1} = i_s$

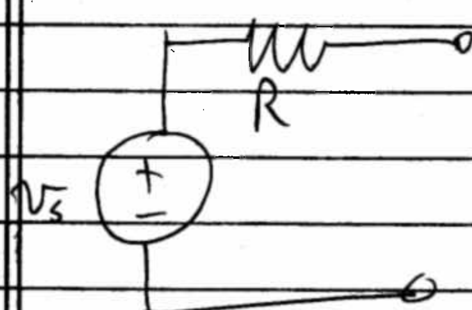
x intercepts: $v_s = R_2 i_s \rightarrow i_s = \frac{v_s}{R_2}$

$$\frac{v_s}{R_1} = \frac{v_s}{R_2} \Rightarrow R_1 = R_2 = R$$

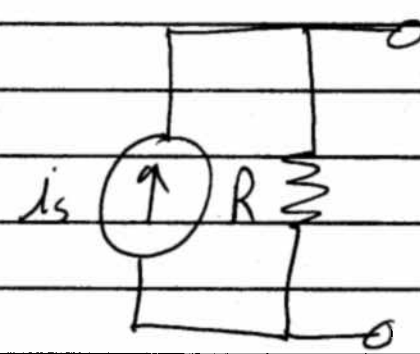
So $\underline{i_s = \frac{v_s}{R}}$

and $\underline{v_s = R_2 i_s}$ like Ohm's Law.

So, from the point of view of the "Rest of the Ckt", these two are identical:

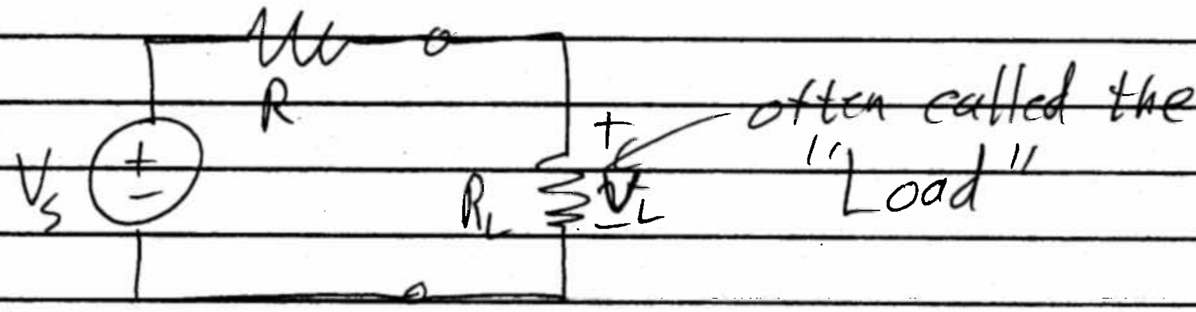


and



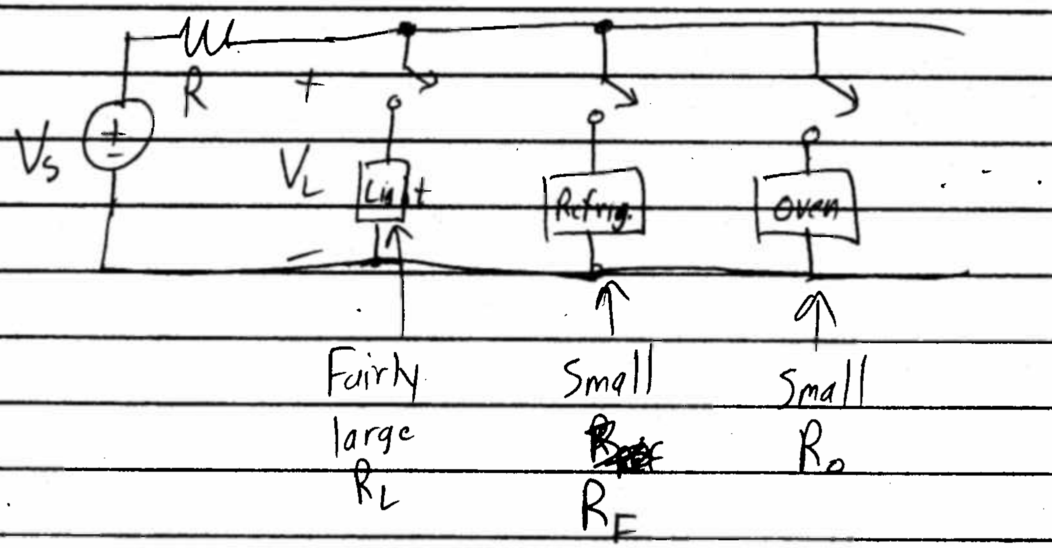
where $\underline{\underline{v_s = R i_s}}$

Now we can see why the lights dim when the refrigerator turns on:



Voltage Division: $V_L = \frac{R_L}{R + R_L} V_s$

~~When~~ Devices in your house are in parallel:



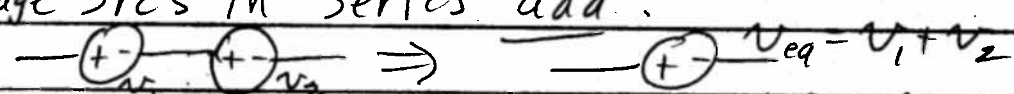
Add a small R_F in parallel with a large R_L gives a small R_L,

$$V_L = \frac{R_L}{R + R_L} V_S$$ → decrease R_L and you decrease V_L. ⇒ dimming of Light.

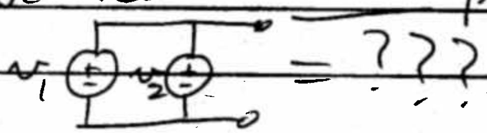
decrease V_L → decrease I_L ⇒

We haven't said it yet, but here it is:

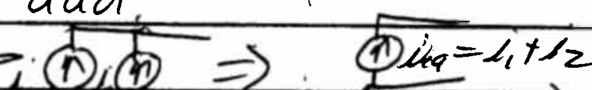
Ideal Voltage Srcs in series add:



Voltage Srcs are never put in parallel. (No need or impossible)



Ideal Current Srcs in parallel add:



Current Srcs are never put in series. (No need or impossible)