e.g. 26-3.

A 60-W and a 100-W light bulbs are connected in series.

which one is brighter? The 60-W one!

why? The specifications of 60-W and 100-W.

assumes a voltage of 120 V.

when the light bulbs are made. R is fixed,

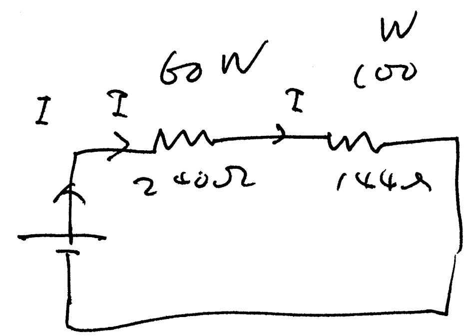
NOT the power!

The power depends on voltage : $P = \frac{V^2}{R}$.

brightness.

In series, $V \neq 120\,V$. P is NOT 60 W. or 100 W any more.

$\boxed{\cancel{R_{60} = \frac{120^2}{60} =}}$



$$R_{60} = \frac{120^2}{60} = 240\,\Omega$$

$$R_{100} = \frac{120^2}{100} = 144\,\Omega.$$

In series.. $R_{Total} = 240 + 144 = 384\,\Omega$.

current. $I = \frac{V}{R} = \frac{120}{384} = 0.3125\,A$.

$$V_{60} = R_{60} \cdot I = 240 \times 0.3125 = 75\,V$$

$$V_{100} = R_{100}\, I = 144 \times 0.3125 = 45\,V.$$

Actually power :

$$P_{60} = \frac{V_{60}^2}{R_{60}} = \frac{75^2}{240} = 23.4 \text{ W}$$

$$P_{100} = \frac{V_{100}^2}{R_{100}} = \frac{45^2}{144} = 14.1 \text{ W}.$$

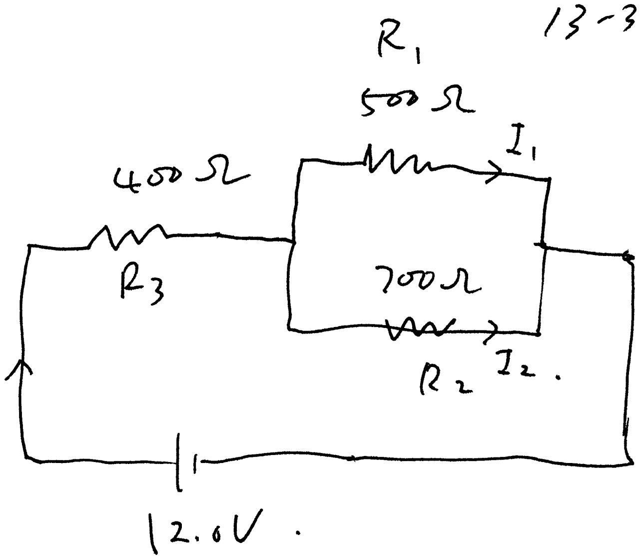
$$\therefore \quad \underset{\substack{\uparrow \\ \text{brighter.}}}{P_{60}} > P_{100}$$

OR: $P_{60} = R_{60} I^2 = 240 \times 0.3125^2 = 23.4 \text{ W}$

$P_{100} = R_{100} I^2 = 144 \times 0.3125^2 = 14.1 \text{ W}.$

e.g. 26-4.

Find $I = ?$



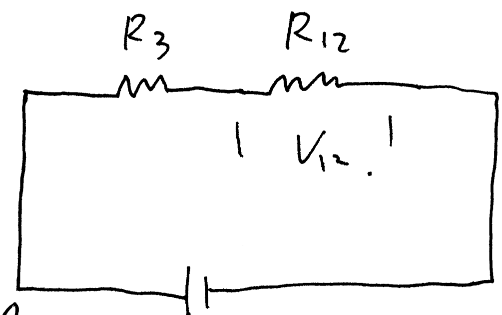
$R_{12} = R_1 \parallel R_2$

$$\frac{1}{R_{12}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{R_2 + R_1}{R_1 R_2}$$

$$R_{12} = \frac{R_1 R_2}{R_1 + R_2} = 290\ \Omega$$

⇓ equivalent.

$$R_{Total} = R_1 + R_{12}$$
$$= 400 + 290$$
$$= 690\ \Omega.$$



$$I = \frac{V_{Total}}{R_{Total}} = \frac{12}{690} = 0.0174 A$$
$$= 17\ mA.$$

e.g. 26-5 Find $I_1 = ?$ $\quad I_1 = \frac{V_1}{R_1} = \frac{V_{12}}{R_1}$.

$$V_{12} = I \cdot R_{12} = 0.0174 A \times 290\ \Omega = 5.0\ V$$

$$I_1 = \frac{5.0\ V}{500\ \Omega} = 10\ mA.$$

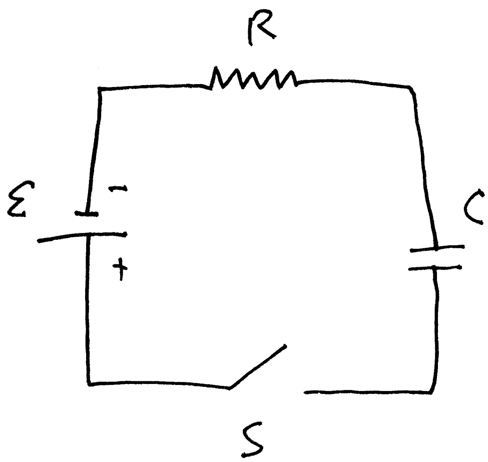
$$I_2 = \frac{5.0\ V}{700\ \Omega} = 7\ mA.$$

e.g. 26-11

$C = 0.30\,\mu F$. $R = 20\,K\Omega$

$= 3\times10^{-7}\,F$. $= 2\times10^{4}\,\Omega$.

$\mathcal{E} = 12\,V$.



a). $\tau = ?$

$$\tau = RC = 3\times10^{-7} \times 2\times10^{4} = 6\times10^{-3}\,s = 6\,ms.$$

b). $$Q_{max} = Q_{final} = CV = 3\times10^{-7}\times12 = 3.6\times10^{-6}\,C$$

$$= 3.6\,\mu C.$$

c). $t = ?$ $\quad Q = 0.99\,Q_{final}$.

$$Q = \underbrace{C\mathcal{E}}_{Q_{final}}\left(1 - e^{-t/\tau}\right) = Q_{final}\left(1 - e^{-t/\tau}\right).$$

Now $Q = 0.99\,Q_{final}$: $\quad 0.99 = 1 - e^{-t/\tau}$.

Solve for t: $\quad 0.01 = e^{-t/\tau}$.

$$-\frac{t}{\tau} = \ln 0.01 = -4.605.$$

$$t = 4.605\,\tau = 27.6\,ms.$$

d). $I = ?$ when $Q = \frac{1}{2} Q_{final}$.

solve for t: $\frac{1}{2} = 1 - e^{-t/\tau}$.

$-\frac{1}{2} = -e^{-t/\tau}$. $0.5 = e^{-t/\tau}$.

$\ln 0.5 = -t/\tau$.

$t = 0.693\,\tau = 4.16$ ms.

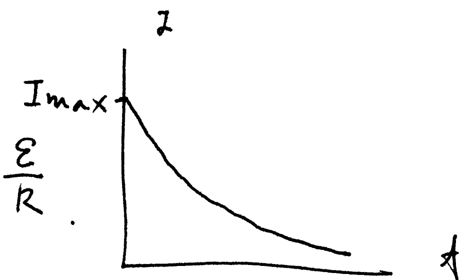
$$I = \frac{\mathcal{E}}{R} e^{-t/\tau} = \frac{12\,V}{20\,k\Omega} e^{-t/\tau}.$$

$$= \frac{12}{2\times10^4} e^{-\frac{4.16\times10^{-3}}{6\times10^{-3}}}$$

$$= 3\times10^{-4}\,A = 0.3\,mA. = 300\,\mu A.$$

e). $I = \underbrace{I_0}_{I_{max}} e^{-t/\tau}$.

$I_{max} = \frac{\mathcal{E}}{R}$.



$$I_0 = \frac{12\,V}{20\,k\Omega} = 0.6\,mA$$

$$= 600\,\mu A.$$

f). $Q = ?$ when $I = 0.2 I_0$. solve for t: $0.2 I_0 = I_0 e^{-t/\tau}$.

$0.2 = e^{-t/\tau}$.

$\ln 0.2 = -t/\tau$.

$t = (1.609)\tau =$

$= 9.657$ ms.

$$Q = C\mathcal{E}(1 - e^{-t/\tau})$$

$$= 3.6(1 - e^{-9.657/6}) \quad (\mu C).$$

$$= 2.88\,\mu C.$$