19.33 (2e)

$R_1 = 1500\,\Omega$

$R_2 = 3500\,\Omega$ Q: power dissipated in R_2?

$\mathcal{E} = 12$ V

strategy: $P = \Delta V \cdot I$

$\therefore$ need ΔV and I

I from Ohm's law for equivalent circuit:

R_1, R_2 = series resistors $\therefore$ $R_{eq} = R_1 + R_2$

$$I = \frac{\mathcal{E}}{R_{eq}} = \frac{\mathcal{E}}{R_1 + R_2} = \frac{12}{4800} \text{ A}$$

$$I = 2.5 \text{ mA}$$

ΔV from voltage divider idea

Kirchhoff loop rule: $\mathcal{E} \underbrace{- R_1 I}_{\Delta V_1} \underbrace{- R_2 I}_{\Delta V_2} = 0$

$12 - 1500 \cdot 2.5\times10^{-3} + \Delta V_2 = 0$ need ΔV_2!

$$\Delta V_2 = -12 + 3.75 = -8.25 \text{ V}$$

$\underline{\underline{P_2}} = |\Delta V_2| \cdot I = 8.25 \cdot 2.5\times10^{-3} = 20.6$ mW

$\underline{\underline{= 21 \text{ mW}}}$

Note: R_1 also dissipates power! It is less,

since $|\Delta V_1| = 3.75$ V $\therefore$ $P_1 = 9.4$ mW

19.38 (2e) same circuit

$I = 0.15\,A$

$R_1 = 1500\,\Omega$

$R_2 = 2500\,\Omega$

Loop rule: $\mathcal{E} - R_1 I - R_2 I = 0$

$$\mathcal{E} = (1500 + 2500) \cdot I$$

$$= 4000 \cdot 0.15\,A$$

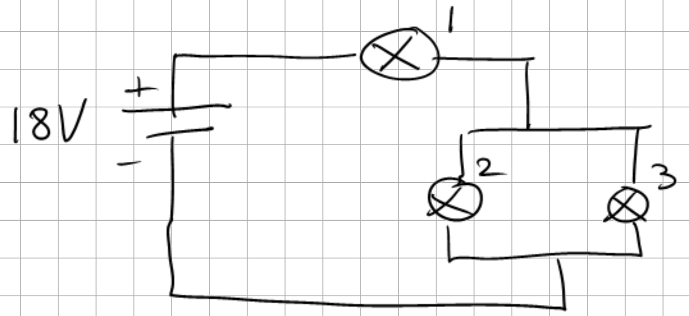
$$\mathcal{E} = 600\,V$$

Alternative solution: $R_{eq} = R_1 + R_2 = 4000\,\Omega$

$$|\Delta V_{R_{eq}}| = \mathcal{E}$$

$$\mathcal{E} = R_{eq}\, I \quad \ldots$$

19.40

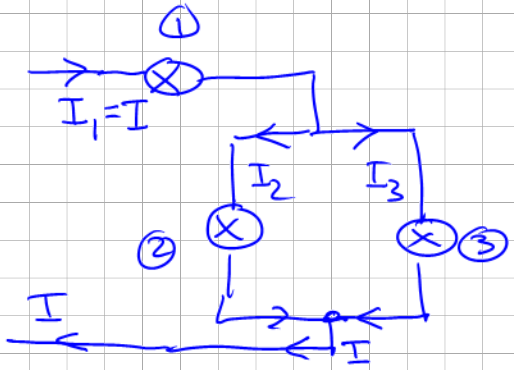


1, 2, 3 = identical bulbs = resistors

$R_i = 200\,\Omega \quad (i = 1, 2, 3)$

Find I_1 and I_2

Conceptual:



Since $R_2 = R_3$ and they are parallel → same voltage drop

$\therefore \quad I_2 = I_3 = \frac{I}{2}$

$$R_{23}^{eq} = \frac{R_2 R_3}{R_2 + R_3} = \frac{R}{2} = 100\,\Omega$$

$$R_{tot}^{eq} = R_1 + \frac{R}{2} = \frac{3}{2} R = 300\,\Omega$$

$$I = \frac{\mathcal{E}}{R} = \frac{18}{300} = 0.06\ \text{A} \qquad I_1 = 0.06\,\text{A}$$

$$I_2 = I_3 = 0.03\ \text{A}$$

Also: how bright? ⟶ power $= \Delta V \cdot I$

(as magnitudes)

$\Delta V_1 + \Delta V_2 = \mathcal{E}$

$R I + \frac{R}{2} I = \mathcal{E}$

voltage divider!

$12\,V + 6\,V = 18\,V$

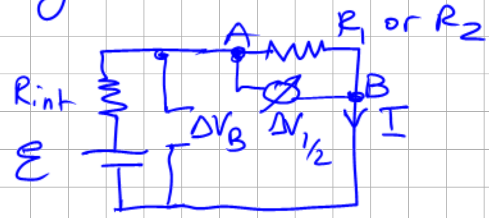
$P_1 = 12\,V \cdot 0.06\,A$

$P_2 = 6\,V \cdot 0.03\,A$ ⟵ 4 times less power!

Week 16 (1st ed.) has 19.40 = 19.52 in 2e

19.58 (2e) Real battery check

$\Rightarrow$



$R_1 = 750\,\Omega \qquad \Delta V_{AB} = 6.5\text{ V}$

$R_2 = 2500\,\Omega \qquad \Delta V_{AB} = 9.5\text{ V}$

$\Bigg\} \; I_{1/2} = \dfrac{\Delta V_{AB,1/2}}{R_{1/2}} \rightarrow$ ③, ④

Find R_{int} and $V_0 = \mathcal{E}$

Kirchhoff loop: $\mathcal{E} - R_{int} I - \Delta V_{AB} = 0 \rightarrow$ ①, ②

two times $\rightarrow$ two unknowns $(\mathcal{E}, R_{int})$ can be solved for

$\rightarrow$ ① $\quad \mathcal{E} - R_{int} I_1 - \Delta V_{AB,1} = 0 \qquad I_1 = \dfrac{\Delta V_{AB,1}}{R_1}$ ③

② $\quad \mathcal{E} - R_{int} I_2 - \Delta V_{AB,2} = 0 \qquad I_2 = \dfrac{\Delta V_{AB,2}}{R_2}$ ④

①' : $\quad \mathcal{E} - R_{int} \dfrac{\Delta V_{AB,1}}{R_1} - \Delta V_{AB,1} = 0$

②' : $\quad \mathcal{E} - R_{int} \dfrac{\Delta V_{AB,2}}{R_2} - \Delta V_{AB,2} = 0$

$\Big\}$ $-$ and call $V_1 = \Delta V_{AB,1}$, $V_2 = \Delta V_{AB,2}$

⑤ $\quad -R_{int}\left(\dfrac{V_1}{R_1} - \dfrac{V_2}{R_2}\right) - V_1 + V_2 = 0$

$\quad R_{int} \dfrac{R_2 V_1 - R_1 V_2}{R_1 R_2} + V_1 - V_2 = 0$

$\quad R_{int} = \dfrac{(V_2 - V_1) R_1 R_2}{R_2 V_1 - R_1 V_2} \rightarrow \dfrac{(9.5 - 6.5)\, 750 \cdot 2500}{2500 \cdot 6.5 - 750 \cdot 9.5} = 616\,\Omega$

insert into ①' $\quad \mathcal{E} = +V_1 + R_{int} \dfrac{V_1}{R_1} = +6.5 + \dfrac{616 \cdot 6.5}{750} = 11.8\text{ V}$

$\therefore \quad R_{int} = 620\,\Omega \qquad \mathcal{E} = 12\text{ V}$

$\leftarrow$ "lousy" battery (meant for very low currents)