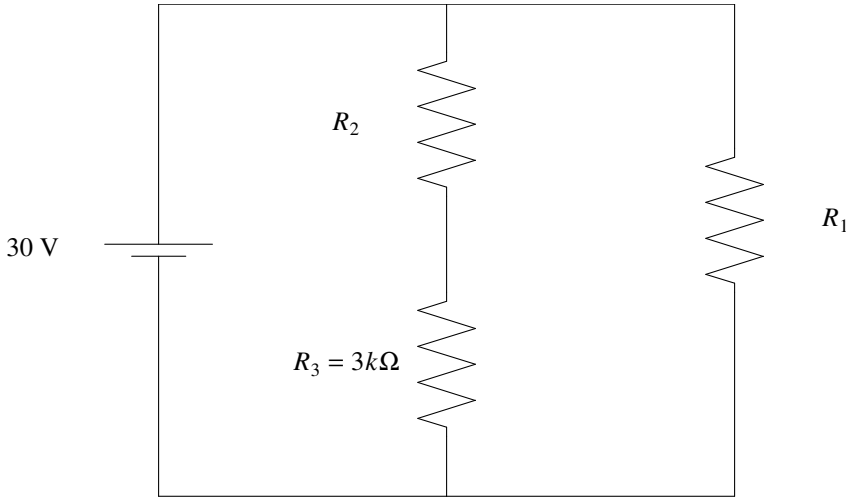
Problem 3: (30 pts.) In the circuit in the figure below, the power dissipated in the 3.00 kΩ resistor is 108 mW.

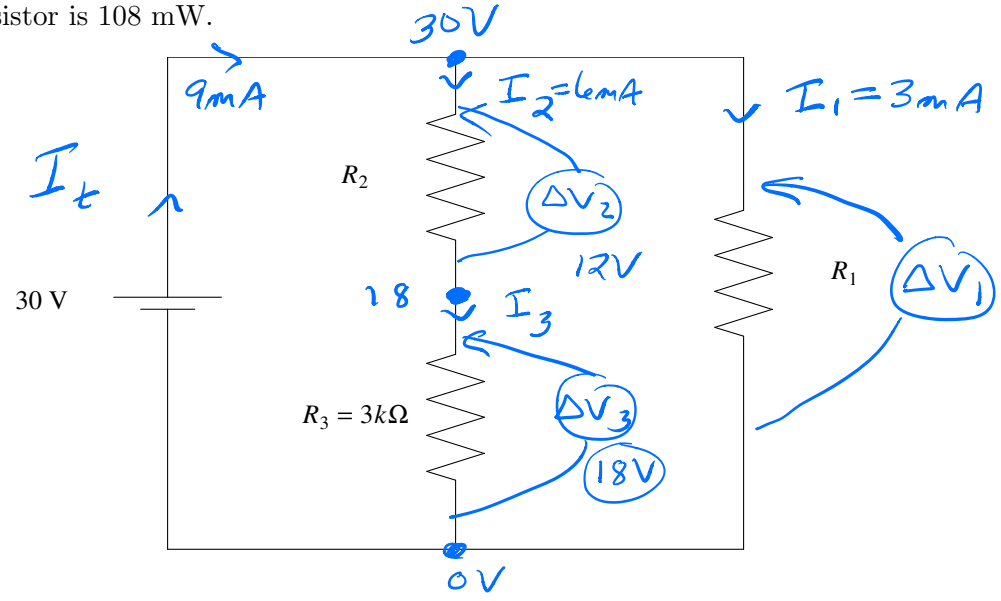


a. (10 pts.) What is the current through resistor R_3?

b. (10 pts.) What is the voltage across resistor R_2?

c. (10 pts.) The total power delivered by the battery is 270 mW. What is the resistance of R_1?

Problem 3: (30 pts.) In the circuit in the figure below, the power dissipated in the 3.00 kΩ resistor is 108 mW.



a. (10 pts.) What is the current through resistor R_3?

$P_3 = 108\,mW = I_3(\Delta V_3) = I_3(I_3 R_3) = I_3^2 R_3$

$I_3 = \sqrt{P_3/R_3} = \sqrt{\frac{108\,mW}{3\,k\Omega}} = 6\,mA$

note: $I_3 = I_2$!

b. (10 pts.) What is the voltage across resistor R_2?

$\Delta V_2 = I_2 R_2$

$30V - \Delta V_2 - \Delta V_3 = 0$

$30V - \Delta V_3 = \Delta V_2$

$\boxed{\Delta V_2 = 12V}$ (note: $R_2 = 2k\Omega$)

$\Delta V_3 = I_3 R_3 = (6mA)(3k\Omega) = 18V$

c. (10 pts.) The total power delivered by the battery is 270 mW. What is the resistance of R_1?

$\Delta V_1 = I_1 R_1$ what is I_1?

$P_\mathcal{E} = \mathcal{E} I_t = (30V) I_1 = 270\,mW \Rightarrow I_1 = 9\,mA$

KCL: $I_t = I_1 + I_2 \Rightarrow I_1 = I_t - I_2 = 12mA - 9mA$

$I_1 = 3\,mA$

$R_1 = \frac{\Delta V_1}{I_1} = \frac{30V}{3mA} = \boxed{10\,k\Omega = R_1}$

Look at power for an alternate approach.

$P_\mathcal{E} = 270\,mW$

$P_3 = 108\,mW$

$P_2 = I_2(\Delta V_2) = (6\,mA)(12\,V) = 72\,mW$

Then conserve energy

$P_\mathcal{E} = P_1 + P_2 + P_3$

So $P_1 = P_\mathcal{E} - P_2 - P_3$

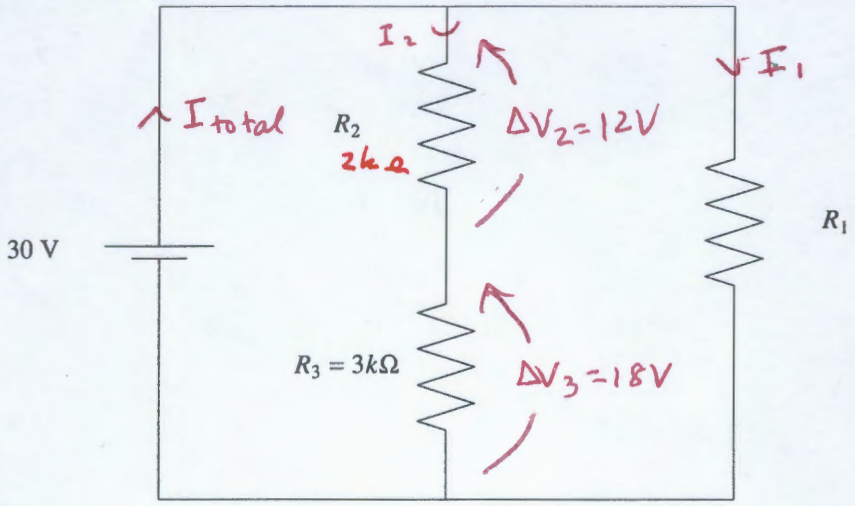
$= 270\,mW - 108\,mW - 72\,mW = 90\,mW$

$P_1 = 90\,mW = I_1(\Delta V_1)$

$I_1 = \frac{90\,mW}{30\,V} = 3\,mA$, as before

$R_1 = \frac{\Delta V_1}{I_1} = \frac{30\,V}{3\,mA} = 10\,k\Omega$, as before

Problem 3: (30 pts.) In the circuit in the figure below, the power dissipated in the 3.00 kΩ resistor is 108 mW.



a. (10 pts.) What is the current through resistor R_3?

$P_3 = (\Delta V_3) I_3 = (I_3 R_3) I_3 = I_3^2 R_3$

$I_3 = \sqrt{P_3/R_3} = \sqrt{108\,mW / 3\,k\Omega} = \boxed{6\,mA}$

b. (10 pts.) What is the voltage across resistor R_2?

$\Delta V_3 = I_3 R_3 = (6mA)(3k\Omega) = 18V$

$\Delta V_2 + \Delta V_3 = 30V \Rightarrow \boxed{\Delta V_2 = 12V}$

(note: this means $R_2 = 2k\Omega$.)

c. (10 pts.) The total power delivered by the battery is 270 mW. What is the resistance of R_1?

$I_{total} = ?$ $\quad \mathcal{E} I_{total} = 270mW$

$I_{total} = \frac{270mW}{30V} = 9mA$

$I_1 = 9mA - 6mA = 3mA$

$\Delta V_1 = I_1 R_1$

$30V = (3mA)(R_1) \Rightarrow \boxed{R_1 = 10\,k\Omega}$

OR: $P_{total} = 270$, $P_2 = 72mW$, $P_3 = 108mW$, $P_1 = 90mW$.