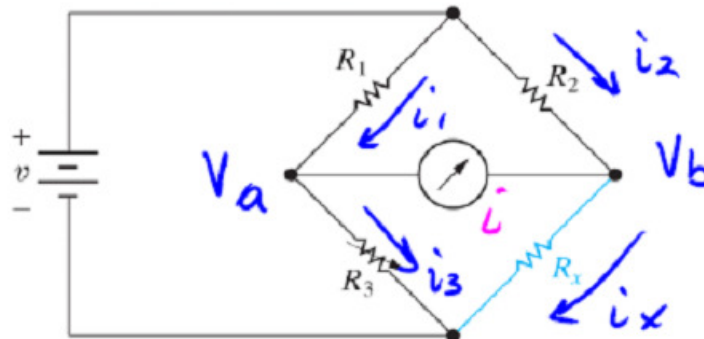


Homework Set #8
DUE Monday, March 27, 2017

1. The Wheatstone Bridge circuit shown below is energized from a 21 V source and is balanced when $R_1 = 800 \Omega$, $R_2 = 1200 \Omega$, and $R_3 = 600 \Omega$.
- What is the value of R_x ?
 - What is the source current?
 - Which resistor absorbs the most power? How much power does it absorb?
 - Which resistor absorbs the least power? How much power does it absorb?



balanced when $V_a = V_b$ and $i = 0$

$$V_a = V_b$$

$$i_3 R_3 = i_x R_x \Rightarrow \frac{i_3}{i_x} = \frac{R_x}{R_3}$$

$$i_1 R_1 = i_2 R_2 \Rightarrow \frac{i_1}{i_2} = \frac{R_2}{R_1} = \frac{i_3}{i_x}$$

$$i_1 = i_3 \quad \text{and} \quad i_2 = i_x$$

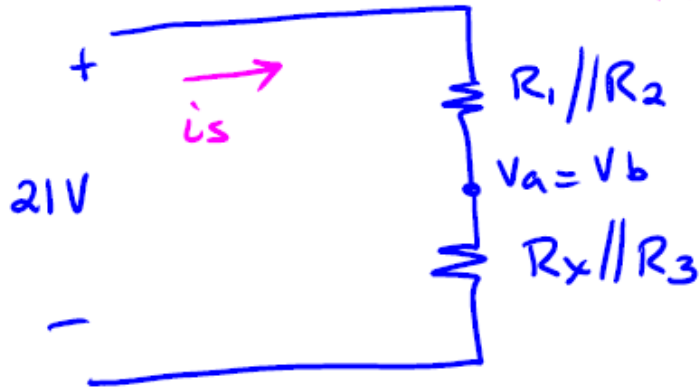
$$\text{so} \quad \frac{R_x}{R_3} = \frac{R_2}{R_1} \quad \frac{R_x}{R_3} = \frac{R_1}{R_2}$$

$$R_x = \frac{R_3 R_2}{R_1}$$

$$a) R_x = \frac{(600)(1200)}{(800)} =$$

$$R_x = 900 \Omega$$

b) equivalent ckt when balanced
Find i_s !

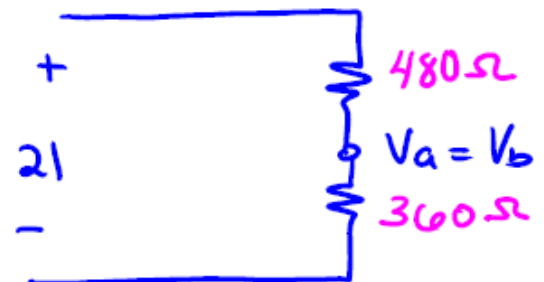


ohm's Law) $21 = i_s (R_1 // R_2 + R_x // R_3)$

$$i_s = \frac{21}{(800 // 1200 + 900 // 600)}$$

$$i_s = 25 \text{ mA}$$

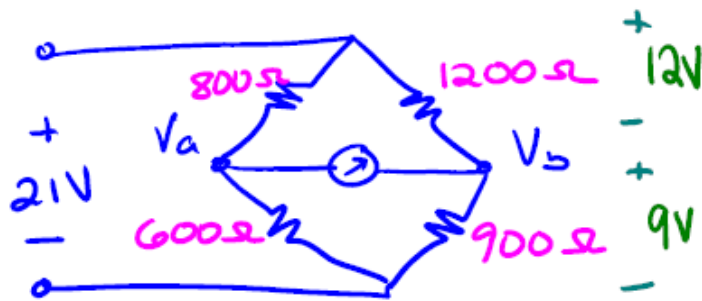
c & d) Find most & least power
find V_a then find P over each resistor



$$P = \frac{V^2}{R}$$

$$\text{Volt div) } V_a = V_b = 21 \left(\frac{480}{480+360} \right)$$

$$V_a = V_b = 12V$$



$$P_1 = \frac{12^2}{800} = 180 \text{ mW}$$

$$P_2 = \frac{12^2}{1200} = 120 \text{ mW}$$

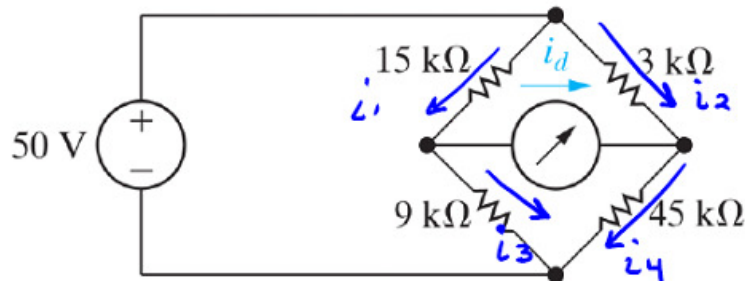
$$P_3 = \frac{9^2}{600} = 135 \text{ mW}$$

$$P_x = \frac{9^2}{900} = 90 \text{ mW}$$

R_1 absorbs the most power
 $P_1 = 180 \text{ mW}$

R_x absorbs the least power
 $P_x = 90 \text{ mW}$

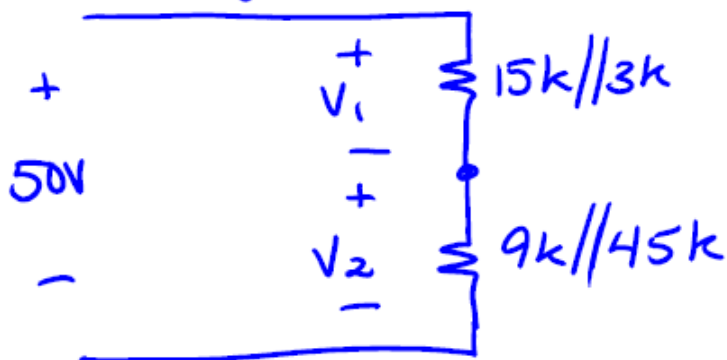
2. Find the detector current (i_d) if the voltage drop across the detector is zero (this means you can put resistors in parallel)



(Ans. $-3\frac{1}{3}$ mA)

Approach: Find currents i_1 & i_3 then use KCL to find i_d

Step 1) Find Voltage using volt divider equivalent ckt if Volt drop across detector is negligible



$$\text{Volt div) } V_2 = 50 \frac{9k//45k}{(9k//45k + 15k//3k)}$$

$$V_2 = 37.5V$$

$$V_1 = 50 - V_2$$

$$V_1 = 12.5 \text{ V}$$

Step 2 Find currents using Ohm's Law

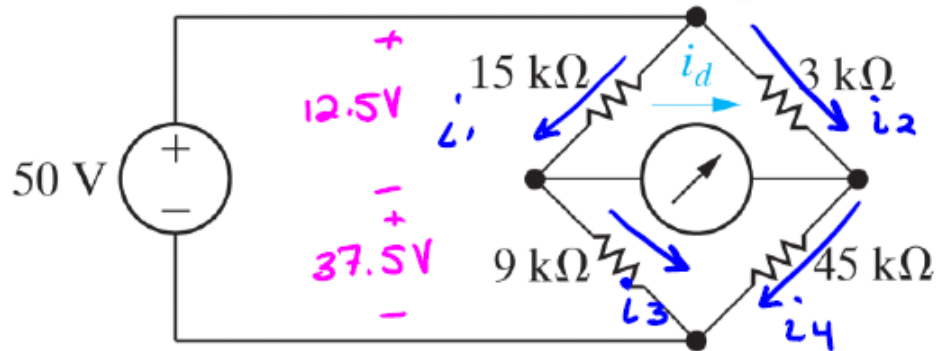


Figure: 03-37-35unP3.49

Copyright © 2008 Pearson Prentice Hall, Inc.

Ohm's Law)

$$i_1 = \frac{12.5}{15k} = 0.833 \text{ mA}$$

$$i_3 = \frac{37.5}{9k} = 4.167 \text{ mA}$$

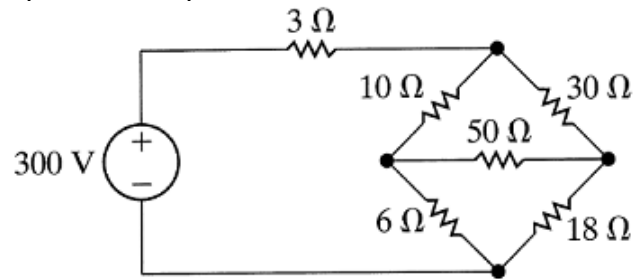
Step 3. Find i_d using KCL

$$\text{KCL) } -i_1 + i_d + i_3 = 0$$

$$i_d = i_1 - i_3$$

$$i_d = -3.33 \text{ mA}$$

3. Find the power dissipated in the $18\ \Omega$ resistor.



(HINT: $6/10=18/30$ means the bridge is balanced and the $50\ \Omega$ resistor is shorted-out.)

This means that the equivalent resistance of the circuit is:

$$R_{\text{eq}} = 3 + (10 + 6) \parallel (30 + 18) = 3 + 12 = 15\ \Omega$$

The source current is $300/15 = 20\ \text{A}$.

The current down through the branch containing the $30\ \Omega$ and $18\ \Omega$ resistors is

$$i_{18} = \frac{12}{30 + 18}(20) = 5\ \text{A}$$

$$\therefore p_{18} = 18(5)^2 = 450\ \text{W}$$