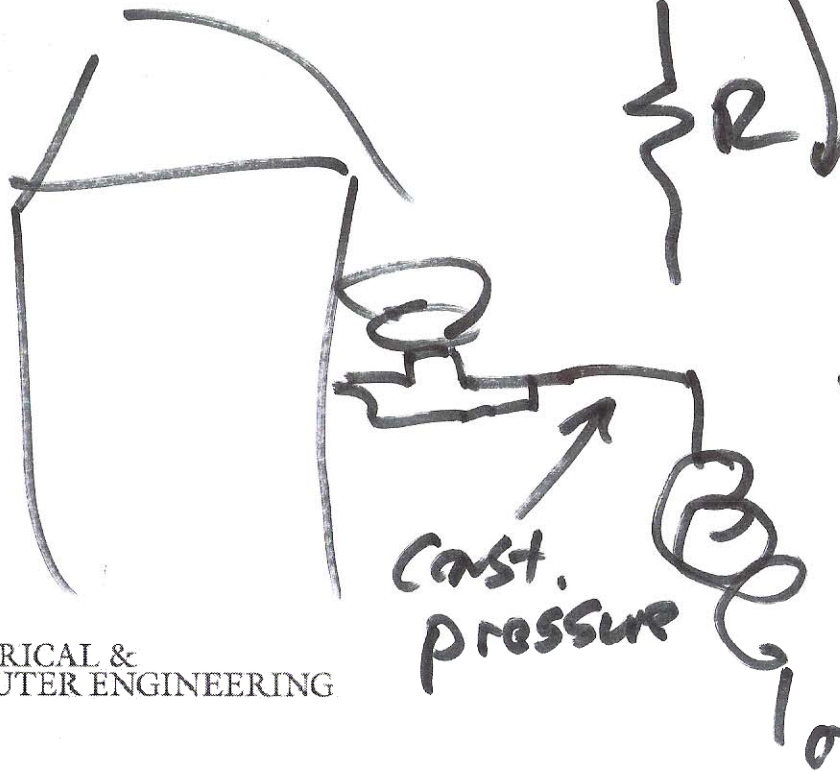
EE 220

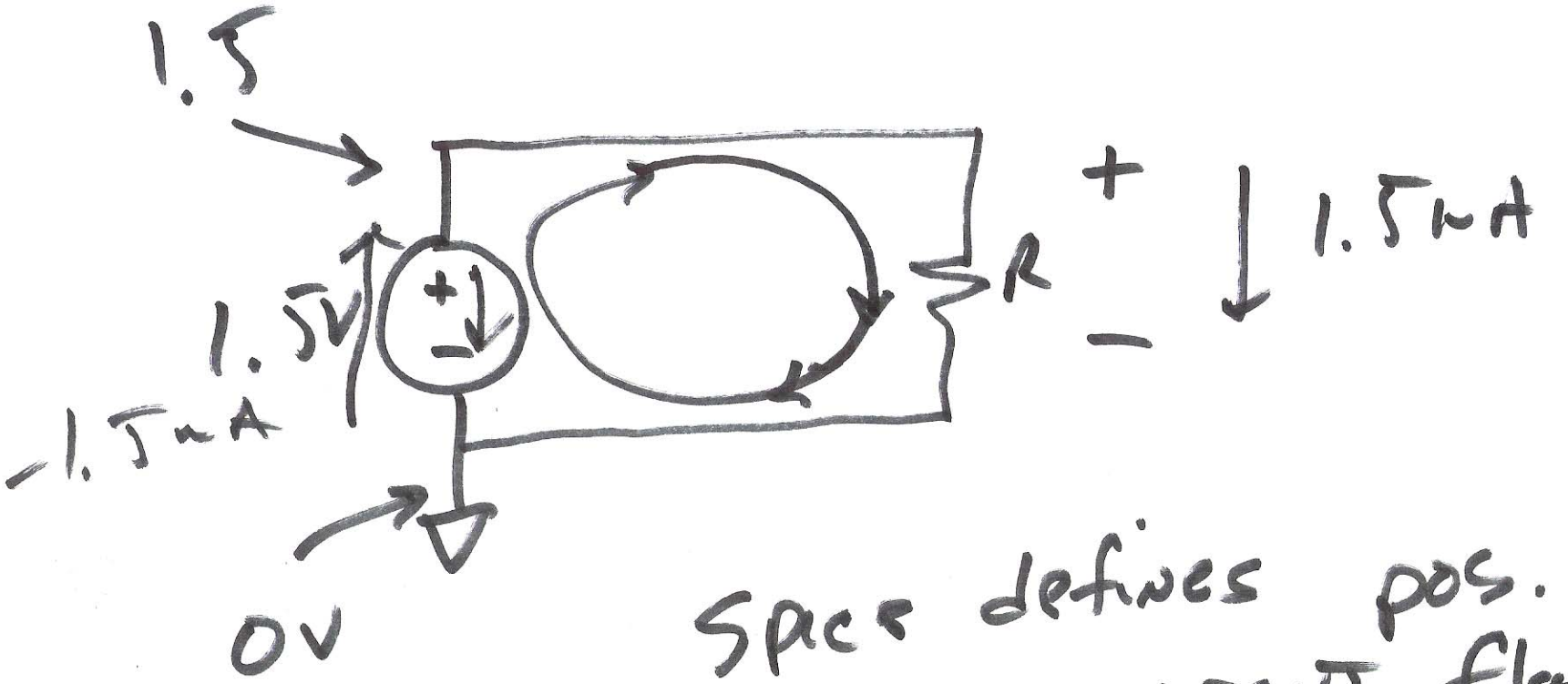
Circuits I

6/9/14

ohm's law

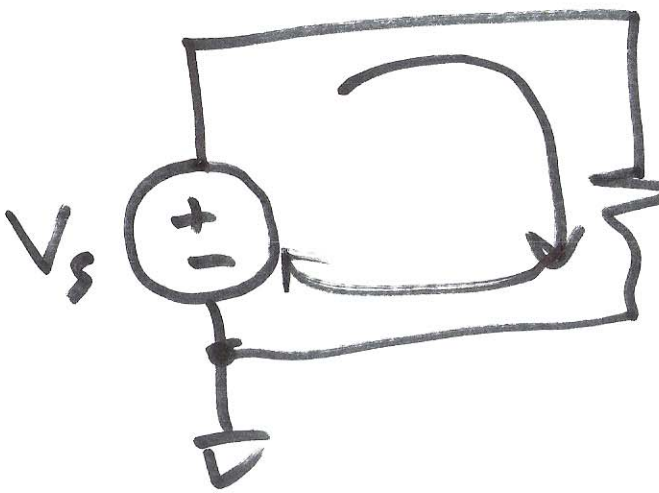
Resistor



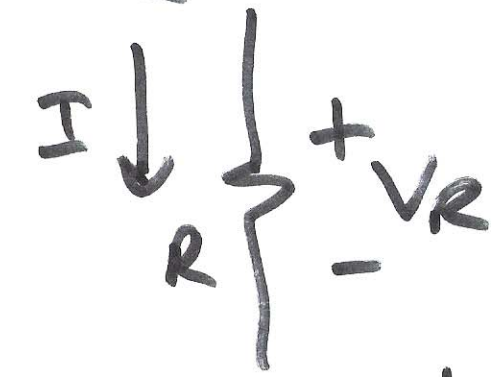


Sign defines pos. current flow as + → −

$V_S - V_R = 0 \Rightarrow V_S = V_R$

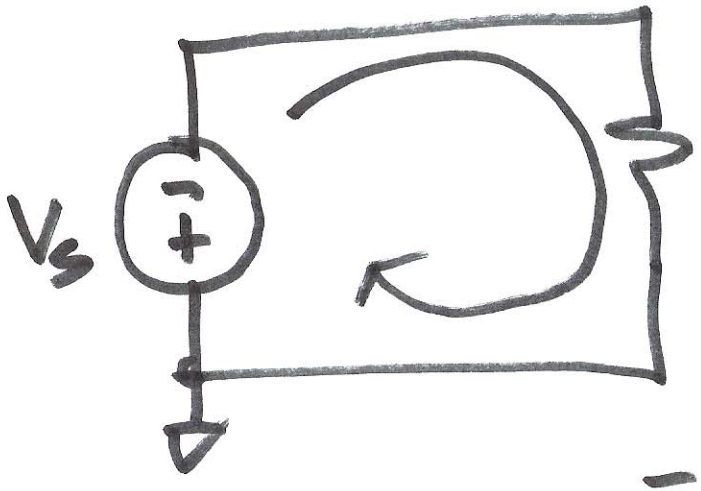


$V_R = V_S \Rightarrow$



$$V_R = I \cdot R$$

$V_S = V_R$



KVL

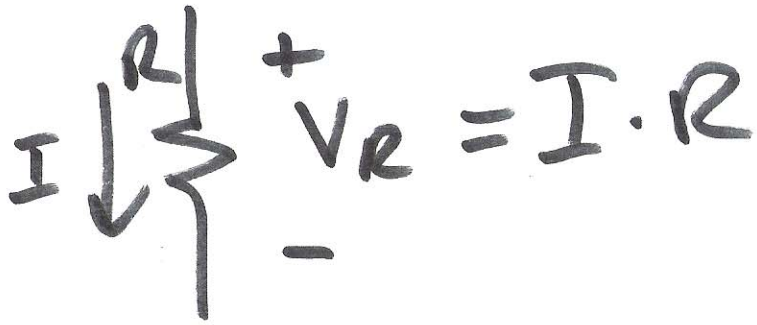
V_S

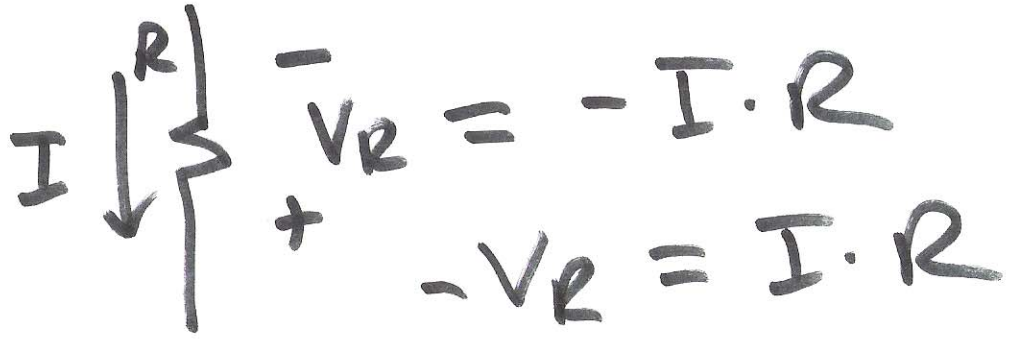
$V_S + V_R = 0$

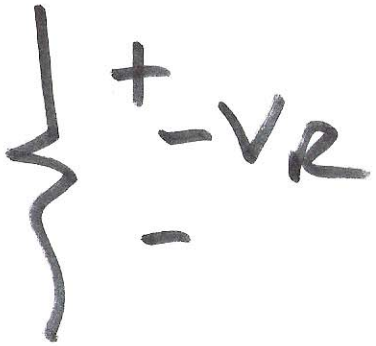
$-V_S + (-V_R) = 0$

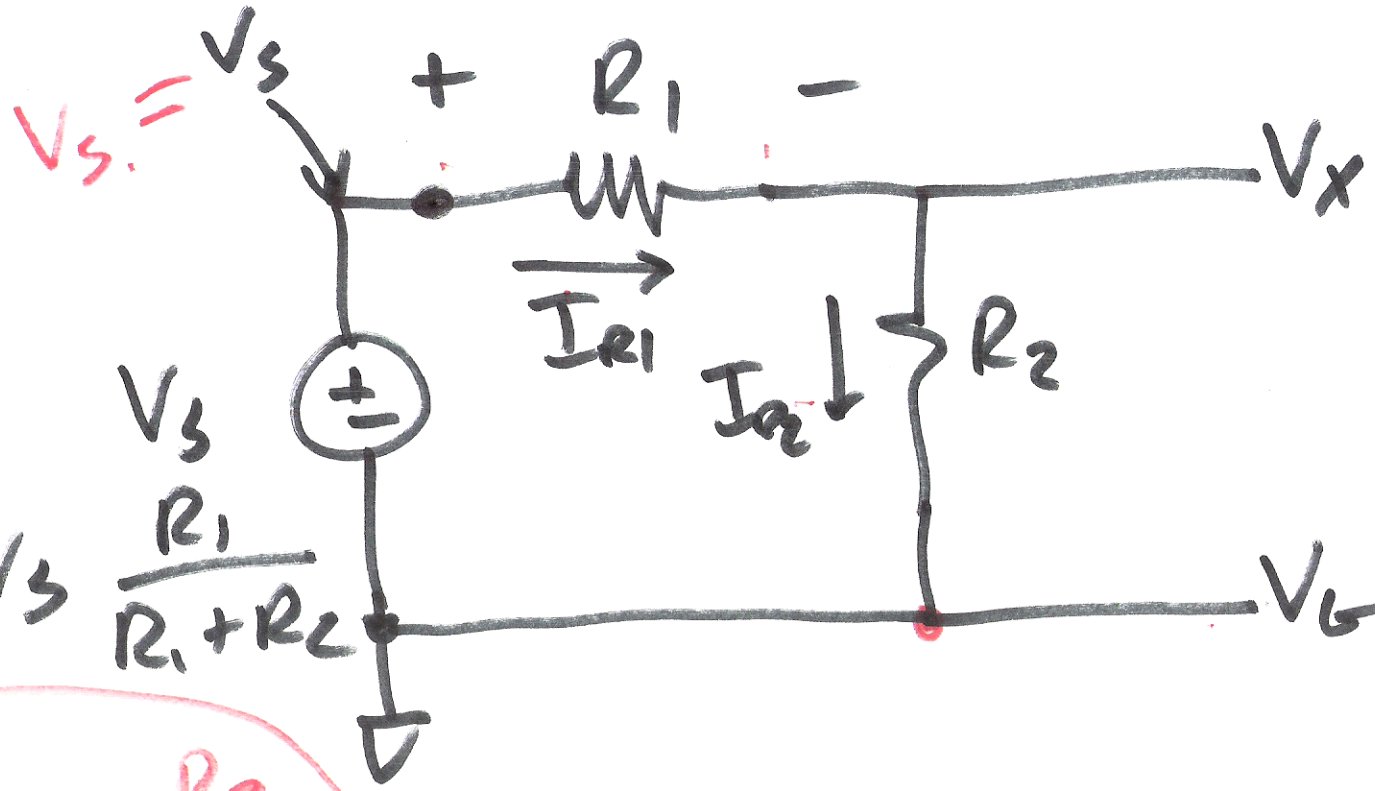
$= -V_S$

$V_S = -V_R$


I
R
+
$V_R = I \cdot R$
−


I
R
−
$V_R = -I \cdot R$
+
$-V_R = I \cdot R$


+
$-V_R$
−



$V_S = V_S$

$V_{R_1} = V_S \dfrac{R_1}{R_1 + R_2}$

$V_X = V_S = \dfrac{R_2}{R_1 + R_2}$

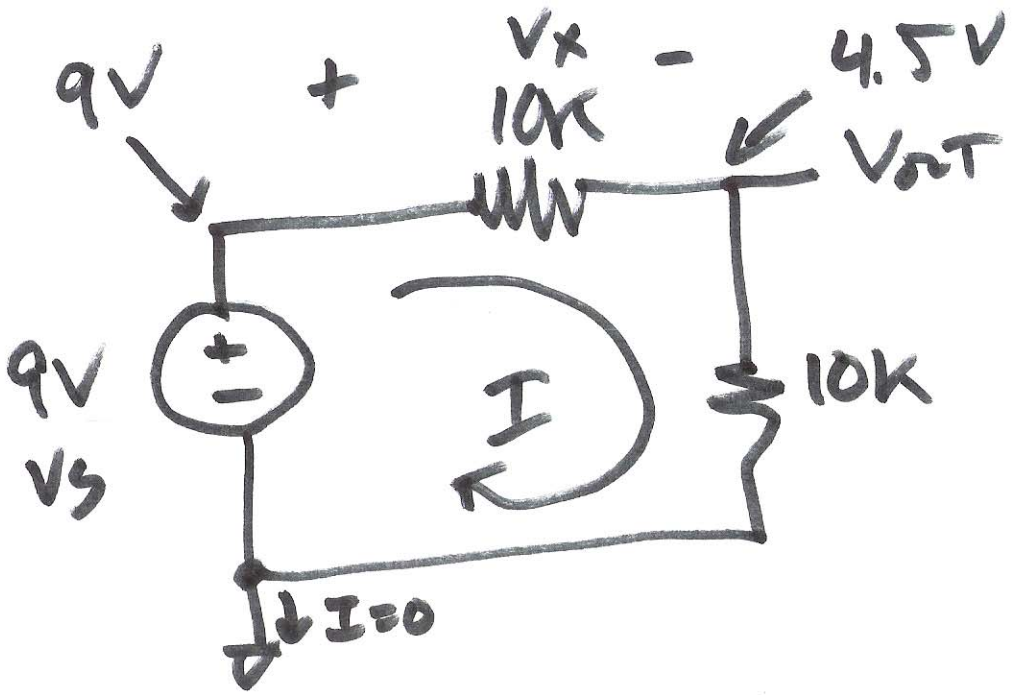
$\dfrac{V_S}{R_1 + R_2} = I = I_{R_1} = I_{R_2}$

$V_{R_1} = V_S - V_X$

$= V_S - V_S \cdot \dfrac{R_2}{R_1 + R_2}$

$V_X = I \cdot R_2 = V_S \cdot \dfrac{R_2}{R_1 + R_2}$

$\rightarrow V_S \dfrac{R_1 + R_2}{R_1 + R_2} - V_S \dfrac{R_2}{R_1 + R_2}$



All currents and voltages

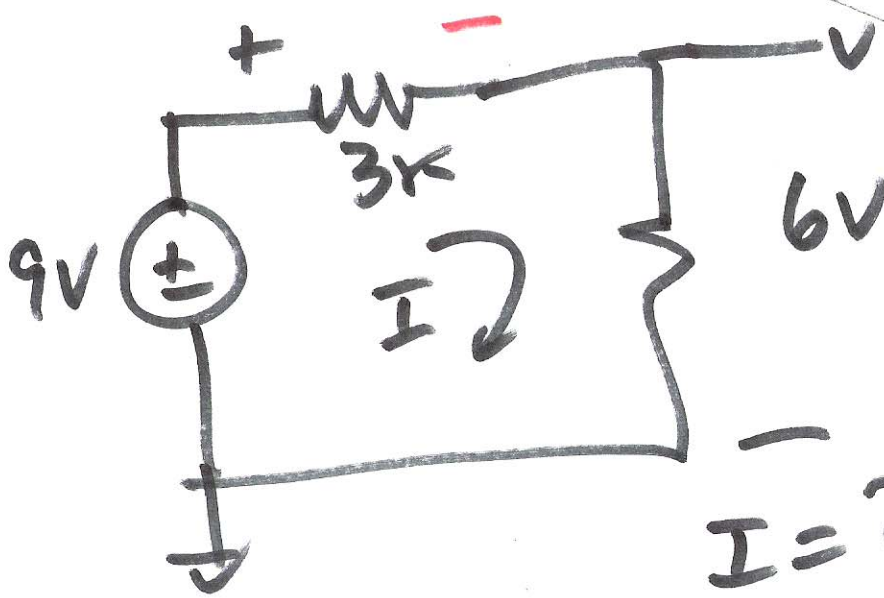
$$I = \frac{9}{10K + 10K} = 450\mu A = 0.45mA$$

$$V_{oT} = 10K \cdot 450\mu A$$

$$= 4.5V$$

$$V_x = V_s - V_{oT}$$

$$= 9 - 4.5 = 4.5V$$

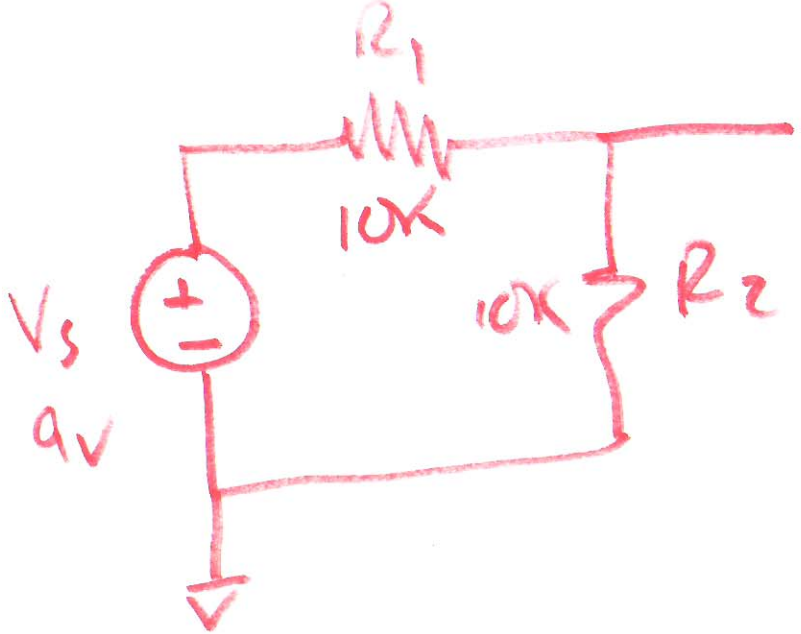


I = ?

V_{3K} = ?

$V_{3K} = 9 - 6 = 3$

$\frac{3K}{3K} = I = 1mA$

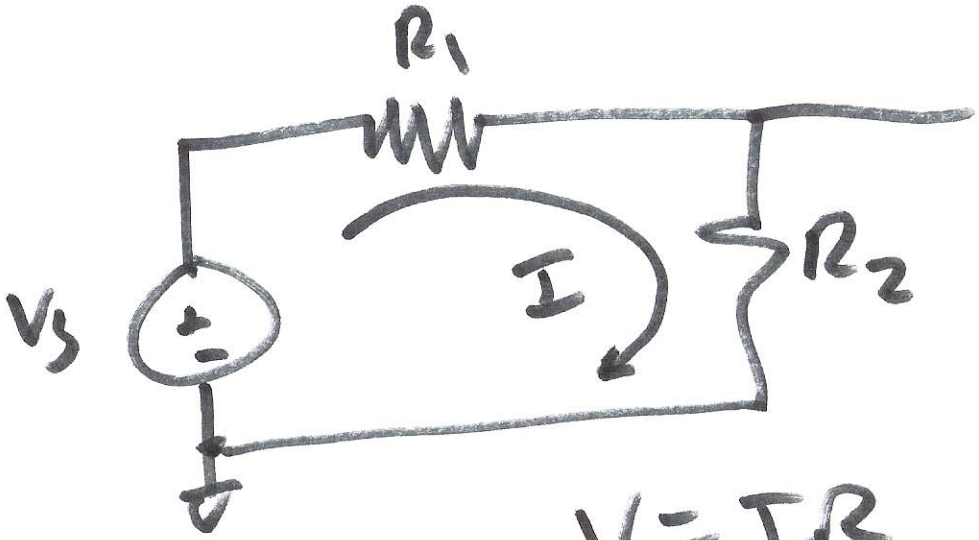


$$V_{RT} = V_S \cdot \frac{R_2}{R_1+R_2} = 9 \cdot \frac{10K}{20K}$$

$$V_{RT} = 4.5V$$

$$V_{R1} = V_S \cdot \frac{R_1}{R_1+R_2} = 4.5V$$

$$I = \frac{V_S}{R_1+R_2}$$



$$V_{OUT} = V_S \cdot \frac{R_2}{R_1 + R_2}$$

Voltage divider equation

$V = IR$

$I = \frac{V}{R}$

Quiz: Show how to derive the voltage divider equation!

$$I = \frac{V_S}{R_1 + R_2}$$

$$V_{OUT} = I \cdot R_2$$

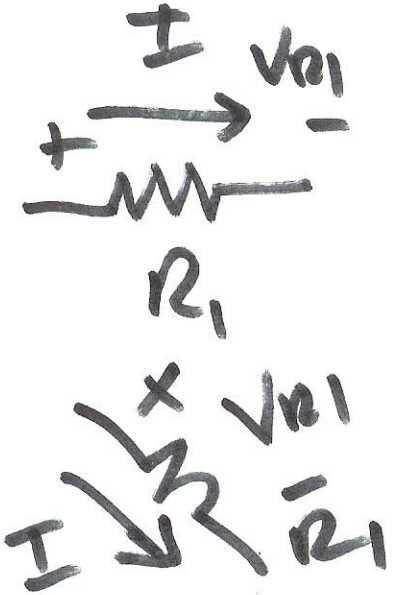
$$V_{OUT} = V_S \cdot \frac{R_2}{R_1 + R_2}$$

$$V_{R1} = V_S \cdot \frac{R_1}{R_1+R_2}$$

Do it two ways!

$$I = \frac{V_S}{R_1+R_2}, \quad V_{R1} = I \cdot R_1$$

$$\boxed{V_{R1} = V_S \cdot \frac{R_1}{R_1+R_2}}$$

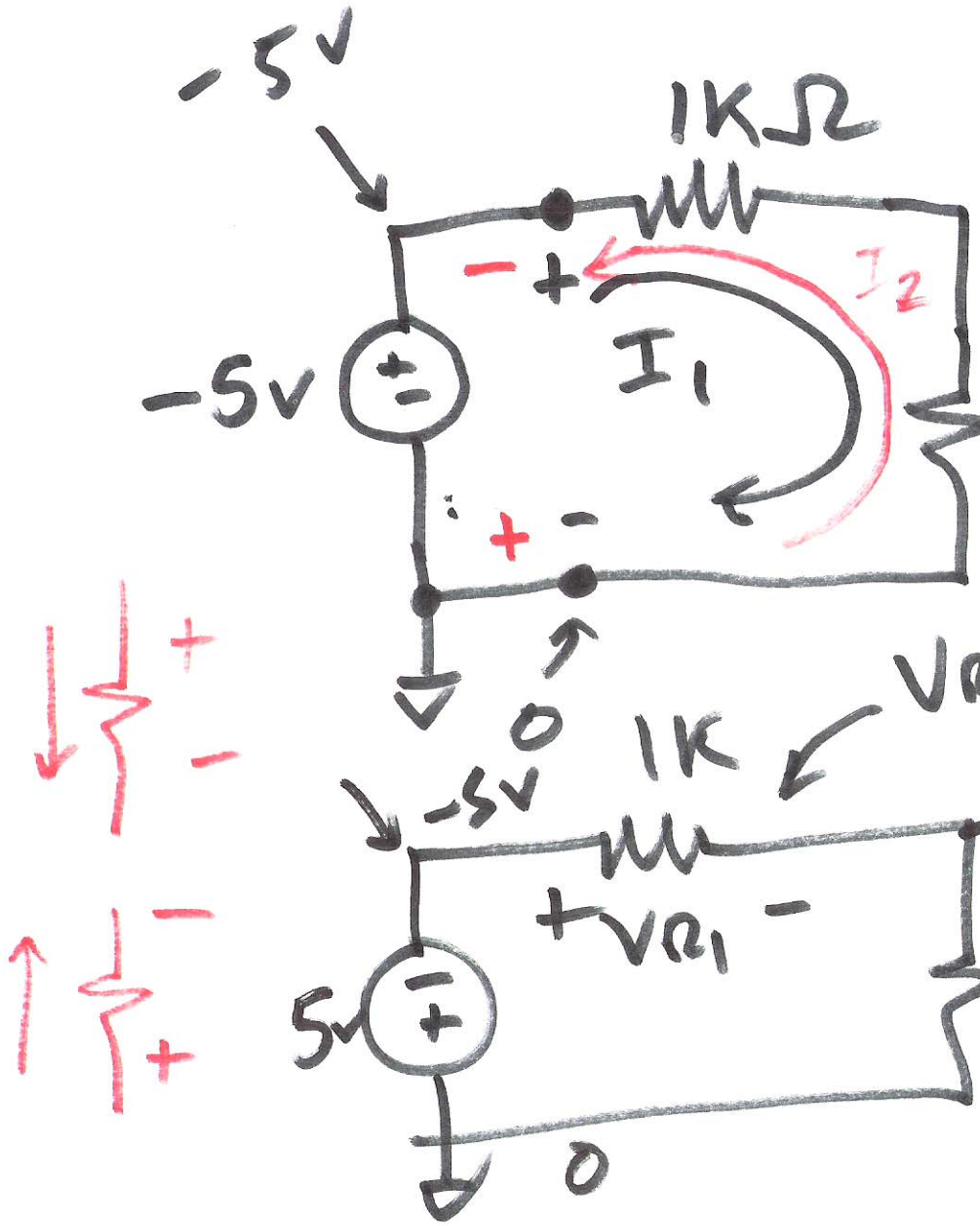


$\Rightarrow$

$$V_{OUT} = V_S \cdot \frac{R_2}{R_1+R_2}$$

$$V_{R1} = V_S - V_{OUT}$$

$$V_{R1} = V_S \cdot \frac{R_1}{R_1+R_2}$$



$$I_1 = \frac{-5-0}{5K} = 1mA$$

$$I_2 = \frac{0-(-5)}{5K}$$

$-5 = -1V$

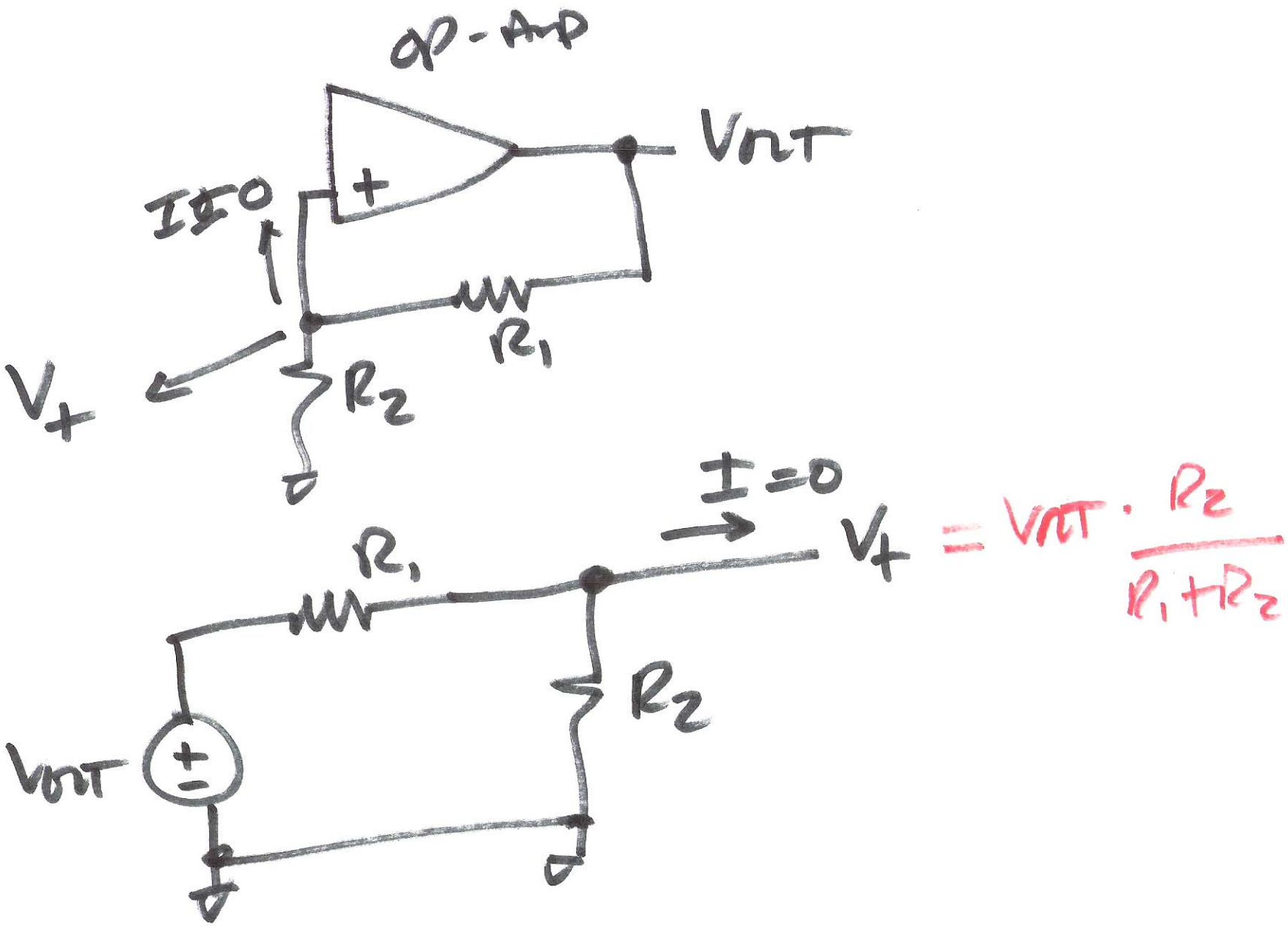
$I_2 = +1mA$

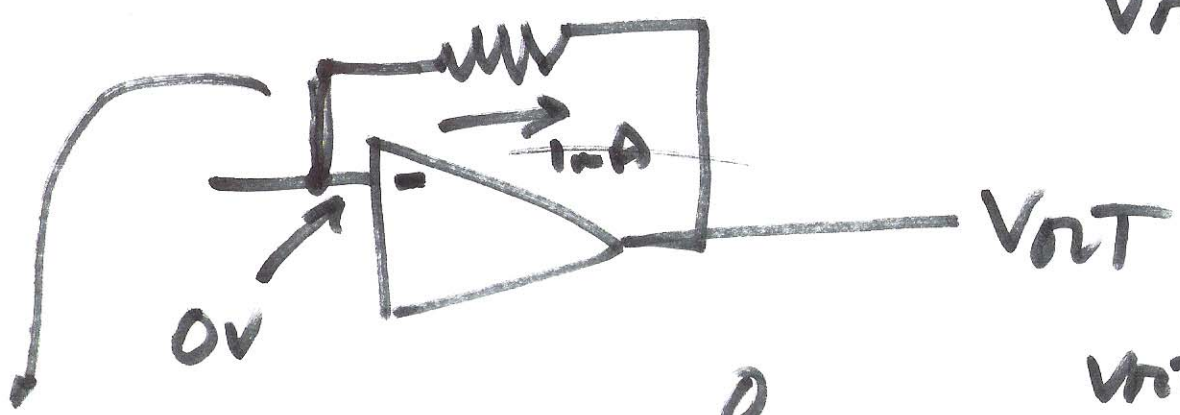
$I_1 = -I_2$

$$V_R = \frac{1K}{1K+4K} \cdot$$

$$V_{OUT} = -5V \cdot \frac{4K}{1K+4K}$$

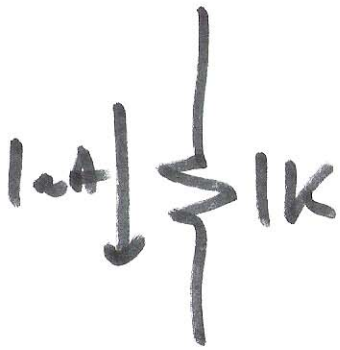
$= -4V$


op-Amp
VOUT
IEO
+
R1
R2
V+
±=0
R1
V+ = VOUT · R2 / (R1+R2)
R2
VOUT
±



$V_R = ?$

$V_{OUT} = ?$



$+ \; 1mA \cdot 1K \; -$

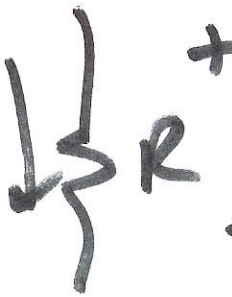
$= 1V$

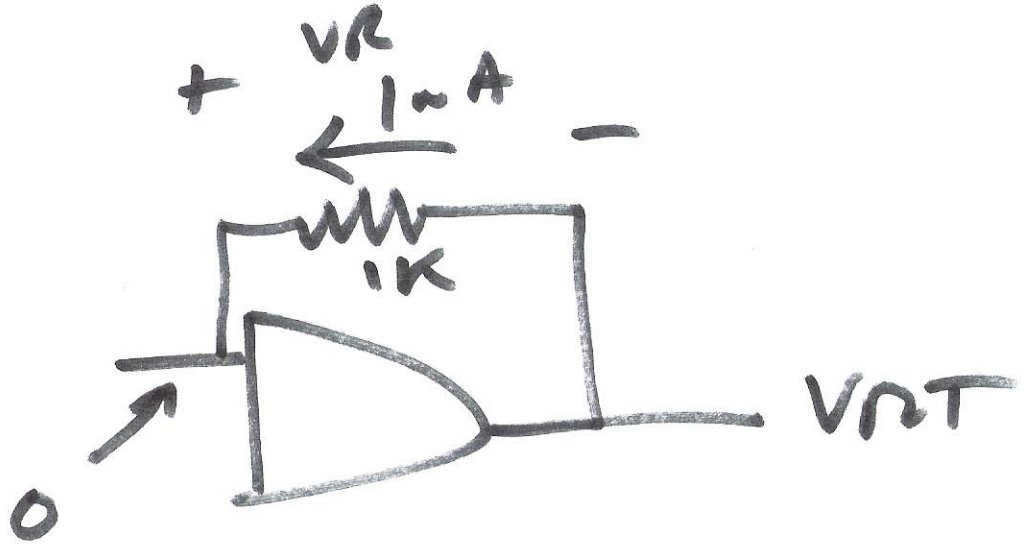
$V_R = V_L^{\,0} - V_R = -V_{OUT}$

$V_R = 1V$

$V_{OUT} = -1V$

$V_R = -V_{OUT}$

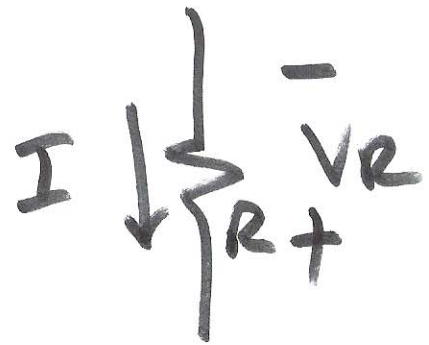


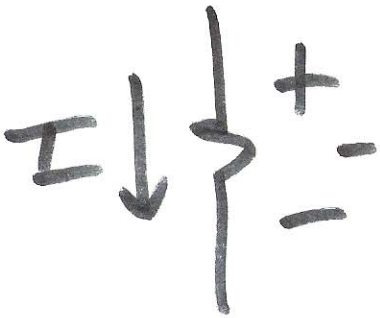


$$V_R = 0 - V_{OUT} = -V_{OUT}$$

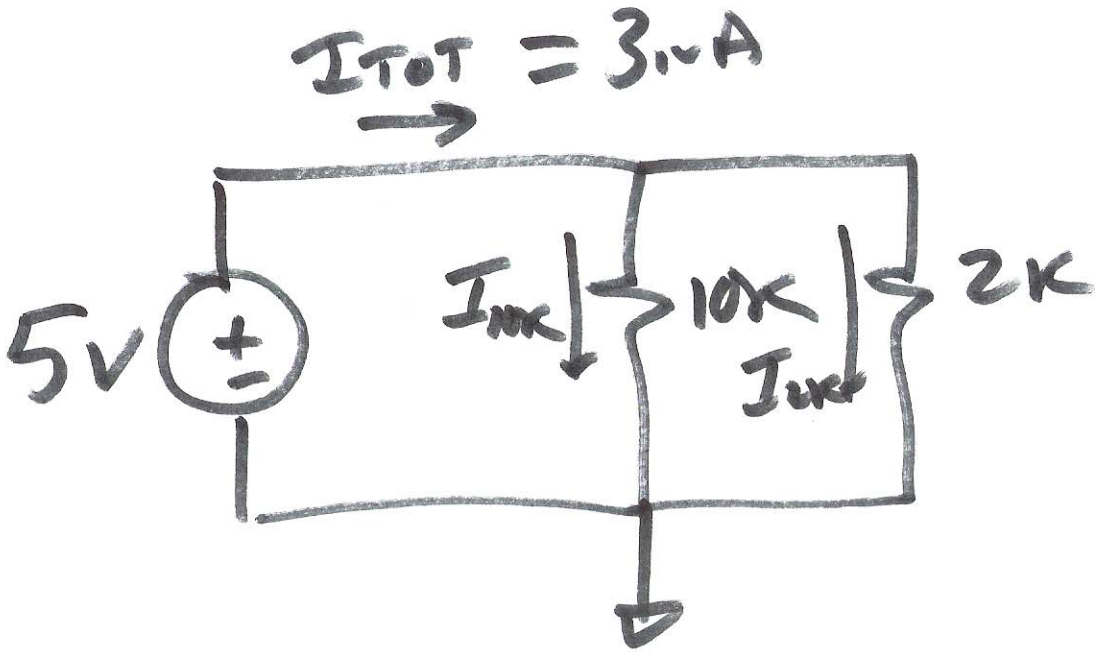
$$V_R = -1mA \cdot 1K = -1V$$

$$V_{OUT} = 1V$$





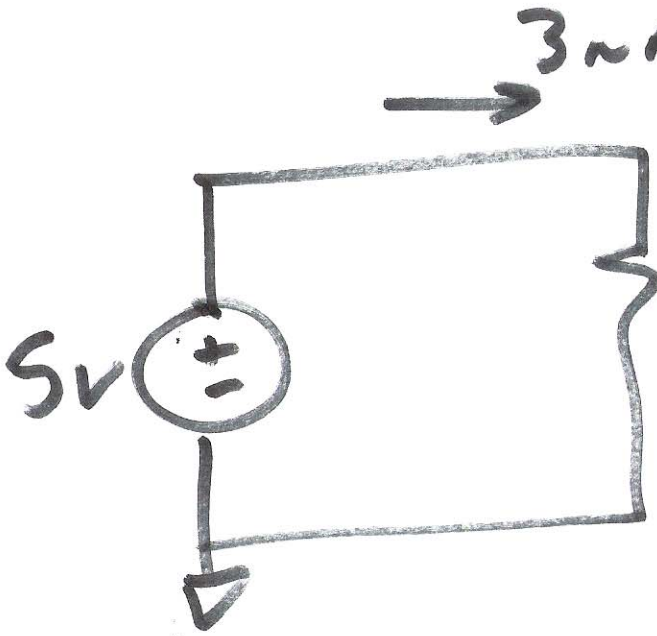
$$V_R = -I \cdot R$$



$$I_{10K} = \frac{5}{10K} = \frac{1}{2}mA$$

$$I_{2K} = \frac{5}{2K} = 2.5mA$$

$$I_{TOT} = 3mA$$



$$R = \frac{5V}{3mA} = 1.66K$$

How fast can I fill the pool with both hoses going at once?

$$\frac{1}{T} = \frac{2}{20} + \frac{1}{20}$$

$$= \frac{3}{20} \rightarrow T = \frac{20}{3} = 6.66 \text{ Hours}$$

$$T = \frac{10 \cdot 20}{10 + 20} = 6.66 \text{ Hou}$$