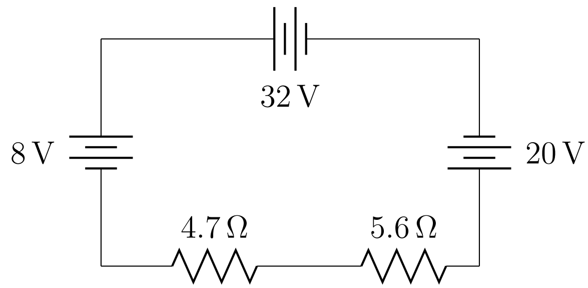
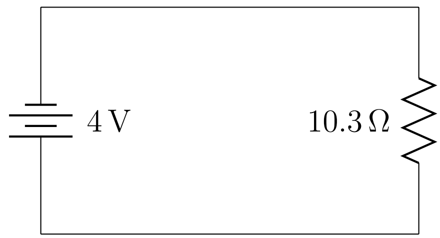
HW: #4

Individual Questions: Chapter 5: 22, 23, 24, 26, 29, 30, 39, 41
Team Questions: Chapter 5: 36 [Use $V_{R1} = (1/5) \cdot V_{R2}$], 45, 48, and 49

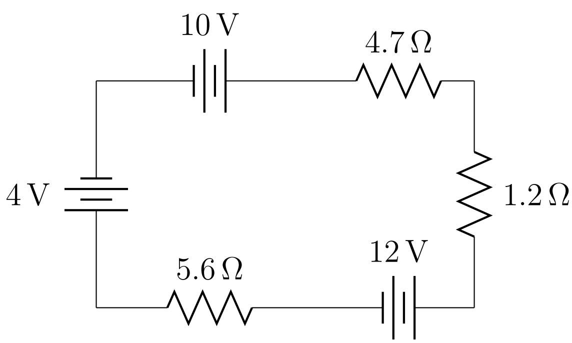
Question 5-22

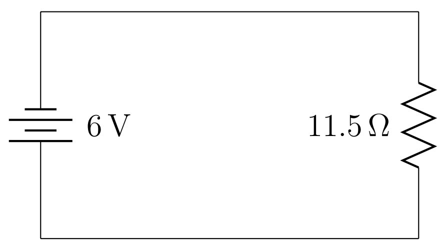
Determine the current I and its direction for each network in Fig.5.109. Before solving for I, redraw each network with a single voltage source.





$$E_T = 20V + 8V - 32V = -4V$$
$$R_T = 4.7\Omega + 5.6\Omega = 10.3\Omega$$
$$I = E_T/R_T = 4V/10.3\Omega = 388.3mA$$
Current is flowing counter clockwise

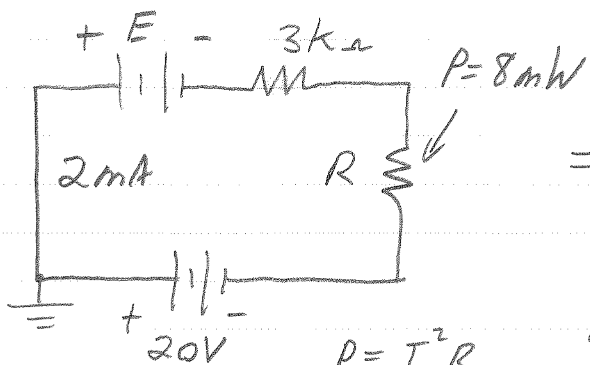


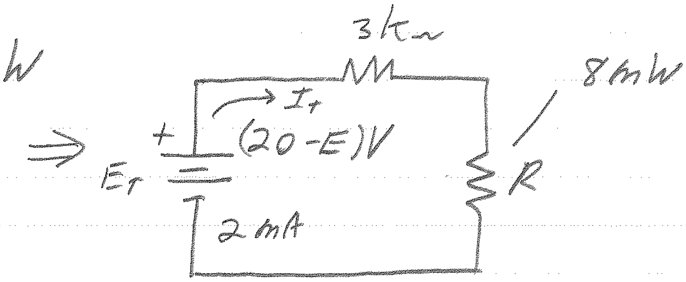


$$E_T = -4V + 10V - 12V = -6V$$
$$R_T = 4.7\Omega + 1.2\Omega 5.6\Omega = 11.5\Omega$$
$$I = E_T/R_T = 6V/11.5\Omega = 521.7mA$$
Current is flowing counter clockwise

~~5-20)~~ FIND "E" + "R" IN EACH NETWORK. FIRST COMBINE THE SERIES SOURCES + INDICATE THE DIRECTION OF CURRENT.

Q5-23





$P = I^2 R \quad \therefore R = \frac{P}{I^2} = \frac{8mW}{(2mA)^2} = \underline{2k\Omega}$

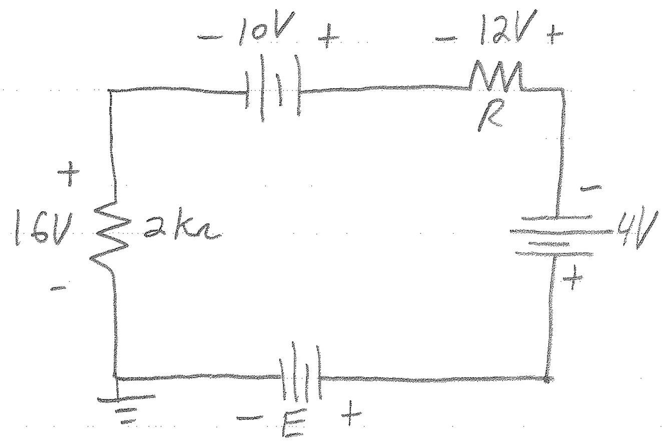
$R_T = 5k\Omega \;,\; I_T = 2\,mA$

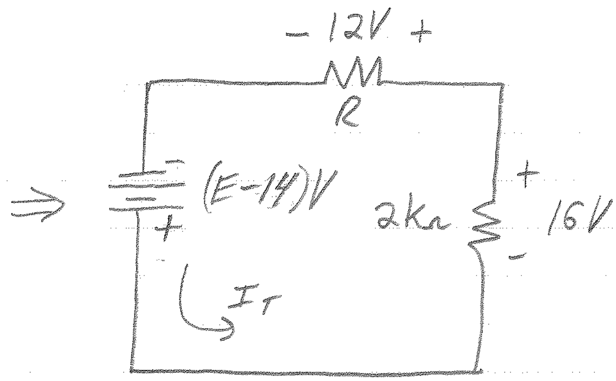
$\therefore E_T = (2mA)(5k\Omega) = \underline{10V}$

$\therefore 10V = 20 - E \;,\; \underline{E = 10V}$

$$\boxed{\begin{array}{l} R = 2k\Omega \\ E = 10V \\ I \Rightarrow CW \end{array}}$$

(b)





$|I| = \frac{16V}{2k\Omega} = \underline{8mA}$

$\therefore R = \frac{12V}{8mA} = \underline{1.5k\Omega}$

$R_T = 3.5k\Omega \;,\; I_T = 8mA$

$\therefore E_T = (8mA)(3500\Omega) = 28V$

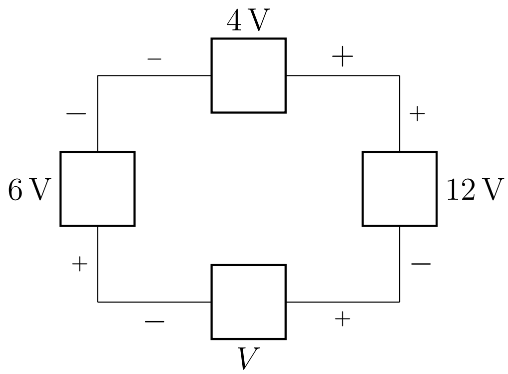
$(E - 14) = 28$

$E = 28 + 14 = 42V$

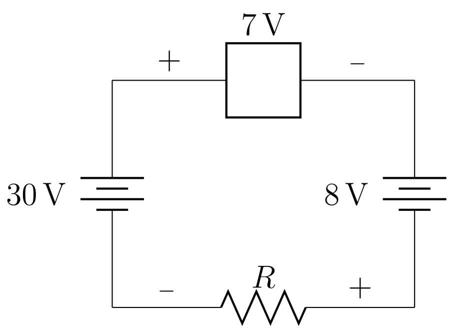
$$\boxed{\begin{array}{ll} R = 1.5k\Omega & I = CCW \\ E = 42V & \end{array}}$$

Question 5-24

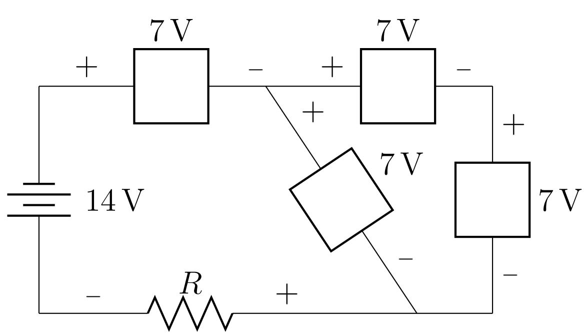
Using Kirchhoff's voltage law, find the unknown voltage for the circuits in Fig. 5.111.



$$\text{KVL: } -6+4-12-V=0$$
$$V=-6+4-12$$
$$V=\boxed{-14V}$$



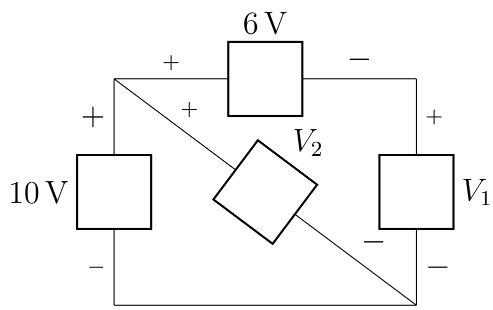
$$\text{KVL: } 30-7-8-V=0$$
$$V=30-7-8$$
$$V=\boxed{15V}$$



$$\text{KVL: } -14-22-V_1+12=0$$
$$V=-14-22+12$$
$$V=\boxed{-24V}$$
$$\text{KVL: } -14-22-V_2-12+12=0$$
$$V_2=-14-22-12+12=0$$
$$V_2=\boxed{-36V}$$

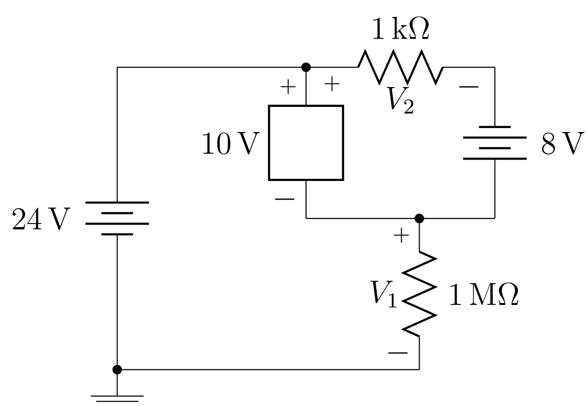
Question 5-26

Using Kirchhoff's voltage law, determine the unknown voltages for the series circuits in Fig. 5.113.



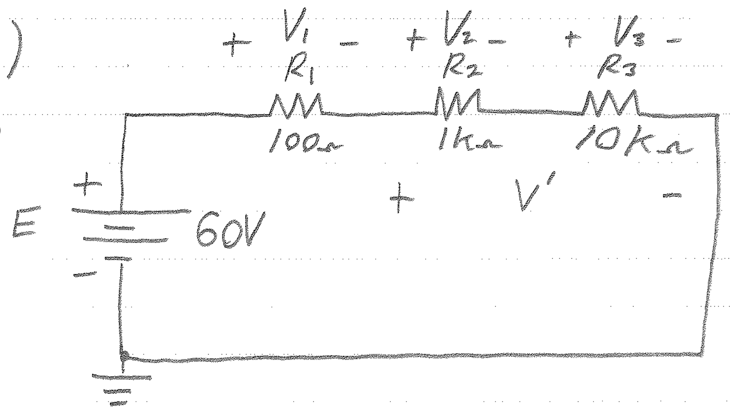
$$\text{KVL: } 10 - 6 - V_1 = 0$$
$$V_1 = 10 - 6$$
$$V_1 = \boxed{4V}$$

$$\text{KVL: } 10 - V_2 = 0$$
$$10 - V_2 = 0$$
$$V_2 = \boxed{10V}$$



$$\text{KVL: } 24 - 10 - V_1 = 0$$
$$V_1 = 24 - 10$$
$$V_1 = \boxed{14V} \text{ KVL: } 10 - V_2 + 8 = 0$$
$$V_2 = 10 - V_2 + 8$$
$$V_2 = \boxed{18V}$$

~~5-26)~~ **Q5-29**



(a) BY INSPECTION, WHICH RESISTOR WILL RECEIVE THE LARGEST SHARE OF APPLIED VOLTAGE? WHY?

R_3, THE LARGEST RESISTANCE
SINCE $V_x = E \dfrac{R_x}{R_T}$ — Largest R ⇒ Largest V_x

~~5-26)~~ **Q5-29** (b) HOW MUCH LARGER WILL V_3 BE COMPARED TO V_2 & V_1?

$$\boxed{\begin{aligned} V_3 &= 10 \times V_2 \\ V_3 &= 100 \times V_1 \end{aligned}}$$

, SINCE $R_3 = 10 \times R_2$
$R_3 = 100 \times R_1$

(c) FIND THE VOLTAGE ACROSS R_3

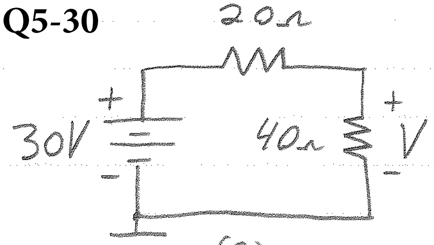
$$V_{R_3} = E\left(\frac{R_3}{R_T}\right) = 60V\left(\frac{10k\Omega}{11.1k\Omega}\right) = \boxed{54.1V}$$

(d) FIND V'

$$V' = E\left(\frac{R'}{R_T}\right) = 60V\left(\frac{11k\Omega}{11.1k\Omega}\right) = \boxed{59.5V}$$

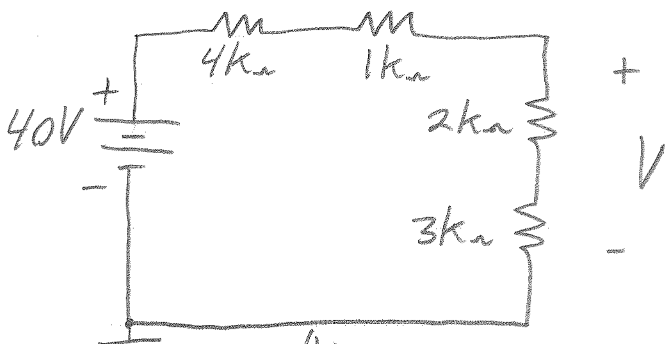
5-~~27~~) FIND "V" IN EACH CASE USING VOLTAGE DIVIDER

Q5-30



(a)

$$V_{40\Omega} = 30V\left(\frac{40\Omega}{60\Omega}\right) = \boxed{20V}$$

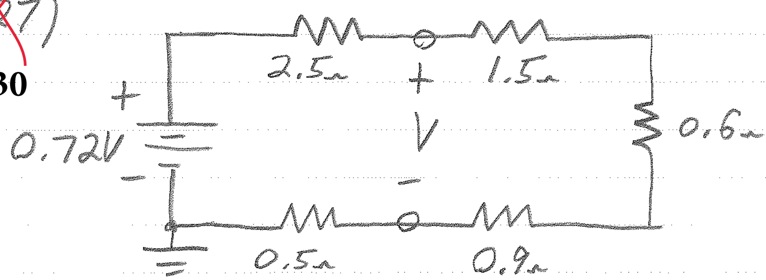


(b)

$$V = 40V\left(\frac{5k\Omega}{10k\Omega}\right) = \boxed{20V}$$

5-~~27~~)

Q5-30



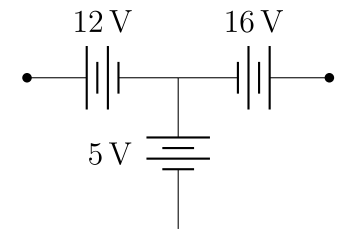
(c)

$$V = 0.72V\left(\frac{3\Omega}{6\Omega}\right)$$

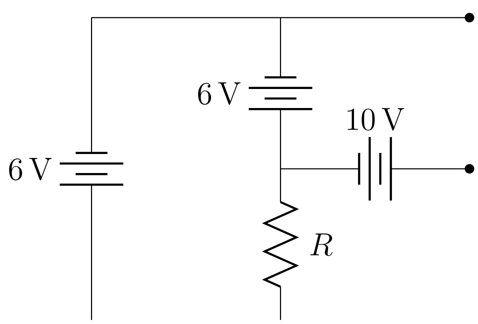
$$\boxed{V = 360\,mV}$$

Question 5-39

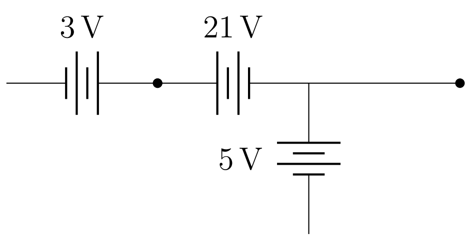
Determine the voltages V_a, V_b, and V_{ab} for the networks in Fig. 5.125



$$V_a = 12V + 5V = 17V$$
$$V_b = 16V + 5V = 21V$$
$$V_a b = 17V - 21V = -4V$$



$$V_a = -6V$$
$$V_b = -6V + 6V + 10V = 10V$$
$$V_a b = -6V - 10V = -16V$$

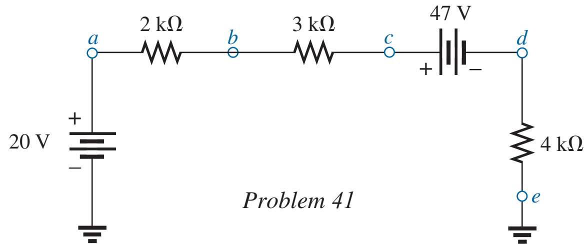


$$-8V + 3V - V_a = 0$$
$$V_a = -8V + 3V = -5V$$
$$V_b = -8V$$
$$V_{ab} = V_a - V_b = -5 - (-8) = 3V$$

Question 5-41

For the network in Fig. 5.127 determine the voltages:

a. V_a, V_b, V_c, V_d, V_e
b. V_{ab}, V_{dc}, V_{cb}
c. V_{ac}, V_{db}



Problem 41

$$I = \frac{47\text{ V} - 20\text{ V}}{2\text{ k}\Omega + 3\text{ k}\Omega + 4\text{ k}\Omega} = \frac{27\text{ V}}{9\text{ k}\Omega} = 3\text{ mA (CCW)}$$

$V_{2k\Omega} = 6$ V, $V_{3k\Omega} = 9$ V, $V_{4k\Omega} = 12$ V

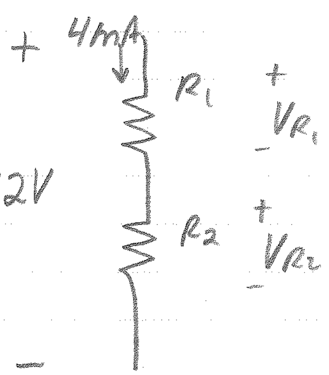
a. $V_a = \mathbf{20\ V}$, $V_b = 20\text{ V} + 6\text{ V} = \mathbf{26\ V}$, $V_c = 20\text{ V} + 6\text{ V} + 9\text{ V} = \mathbf{35\ V}$
$V_d = \mathbf{-12\ V}$, $V_e = \mathbf{0\ V}$

b. $V_{ab} = \mathbf{-6\ V}$, $V_{dc} = \mathbf{-47\ V}$, $V_{cb} = \mathbf{9\ V}$

c. $V_{ac} = \mathbf{-15\ V}$, $V_{db} = -47\text{ V} + 9\text{ V} = \mathbf{-38\ V}$

5-~~32~~) DESIGN THE VOLTAGE DIVIDER SUCH THAT $V_{R_1} = \frac{1}{5} V_{R_2}$

Q5-36



$V_{R_1} + V_{R_2} = 72V$

BUT $V_{R_1} = (1/5)\, V_{R_2}$

$\therefore\ 0.2\, V_{R_2} + V_{R_2} = 72V$

$V_{R_2} = 60V$

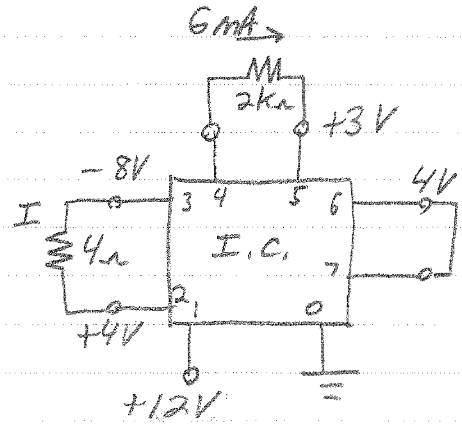
$\&\ V_{R_1} = 12V$

$$R_1 = \frac{12V}{4mA} = \boxed{3k\Omega}$$

$$R_2 = \frac{60V}{4mA} = \boxed{15k\Omega}$$

5~~-41~~) FIND $V_0, V_4, V_7, V_{10}, V_{23}, V_{30}, V_{67}, V_{56}$ & I

Q5-45



$\boxed{V_0 = 0V}$, GROUND

KVL: $V_4 - (2k\Omega)(6mA) - (3V) = 0$

$V_4 = 12V + 3V = \boxed{15V}$

$V_7 = V_6 = \boxed{4V}$

$V_{10} = V_1 - V_0 = 12V - 0V = \boxed{12V}$

$V_{23} = V_2 - V_3 = 4V - (-8V) = \boxed{12V}$

$V_{30} = V_3 - V_0 = -8V - 0V = \boxed{-8V}$

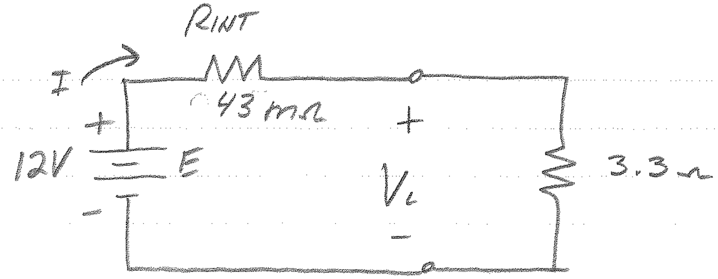
$V_{67} = V_6 - V_7 = 4V - 4V = \boxed{0V}$

$V_{56} = V_5 - V_6 = 3V - 4V = \boxed{-1V}$

$I = \dfrac{4V - (-8V)}{4\Omega} = \dfrac{12V}{4\Omega} =$ $\boxed{3.0A}$ UPWARD (FROM HIGHER TO LOWER POTENTIAL)

~~5-44~~)

Q5-48



(a) FIND V_L:

$$V_L = E\left(\frac{R_L}{R_L + R_{INT}}\right) = 12V\left(\frac{3.3\,\Omega}{3.343\,\Omega}\right)$$

$$= \boxed{11.85\ V}$$

(b) FIND THE VOLTAGE REGULATION OF THE SUPPLY

$$V_R = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100\,\%$$

$$= \frac{12V - 11.85\ V}{11.85\ V} * 100\% = \boxed{1.27\,\%}$$

(c) FIND P_{SOURCE} + P_{RINT} UNDER FULL-LOAD

$$P_{SOURCE} = (E)(I)$$

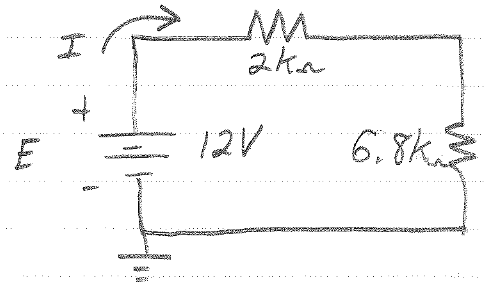
BUT $I = \frac{V_L}{R_L} = \frac{11.85\,V}{3.3\,\Omega} = \underline{\underline{3.59A}}$

$$\therefore\ P_{SOURCE} = (12V)(3.59A) = \boxed{43.1\,W}$$

$$P_{RINT} = I^2 R_{INT} = (3.59A)^2 (43\,m\Omega) = \boxed{554\ mW}$$

5-~~4~~5)

Q5-49



(a) FIND "I"

$$I = \frac{12V}{8.8k\Omega} = \boxed{1.36mA}$$

(b) IF AN AMMETER w/ R_{INT} = 250Ω IS INSERTED TO MEASURE "I" WHAT IS THE NEW CURRENT LEVEL?

$$I' = \frac{12V}{8.8k\Omega + R_{INT}} = \frac{12V}{9{,}050\Omega} = \boxed{1.33mA}$$

(c) IS THIS DIFFERENCE A MAJOR CONCERN IN MOST APPLICATIONS?

$\boxed{NO}$

$$\left(\%\ DIFF = \frac{1.33 - 1.36}{1.36} \times 100\% \Rightarrow \underline{-2.2\%} \right)$$