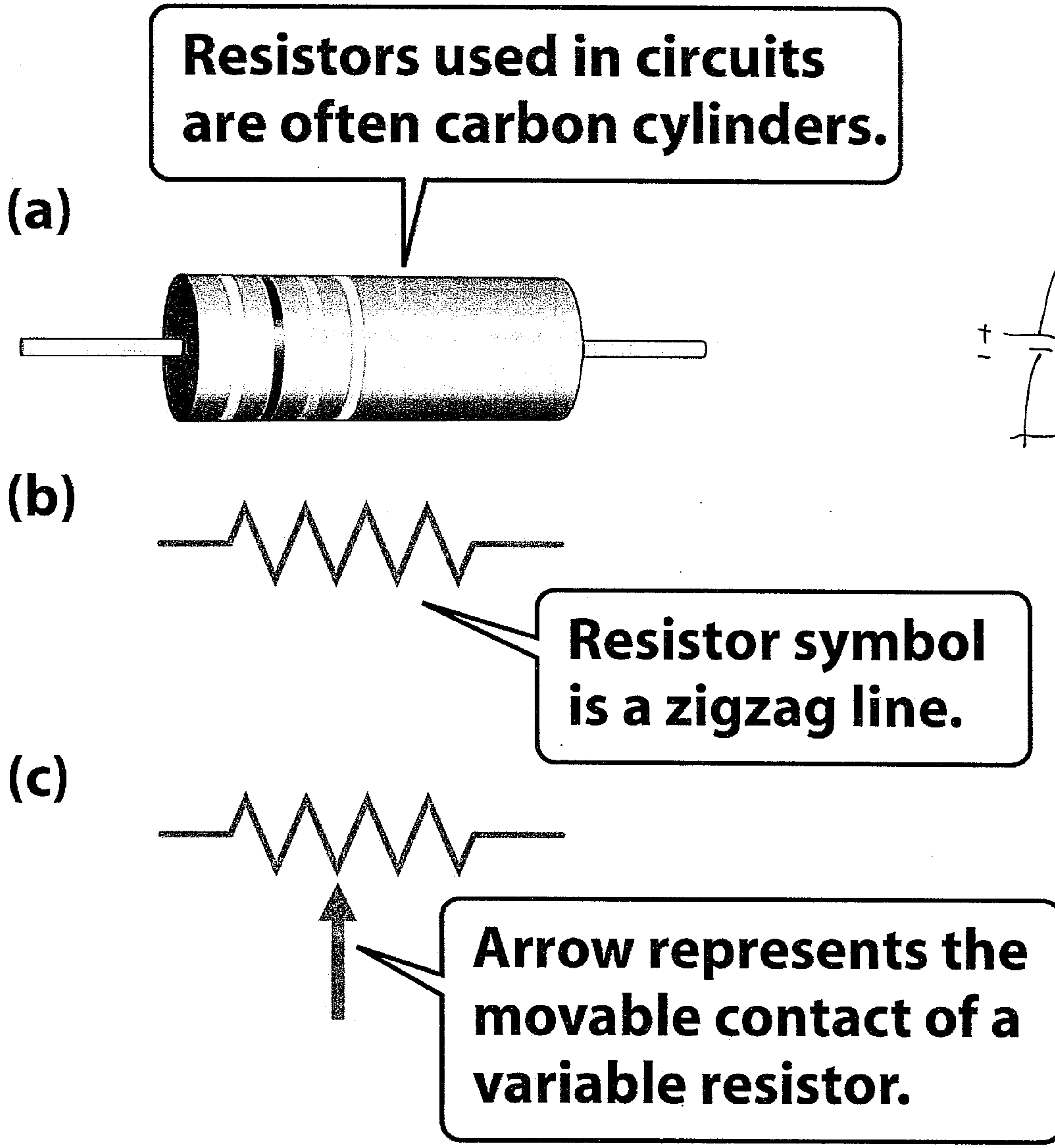
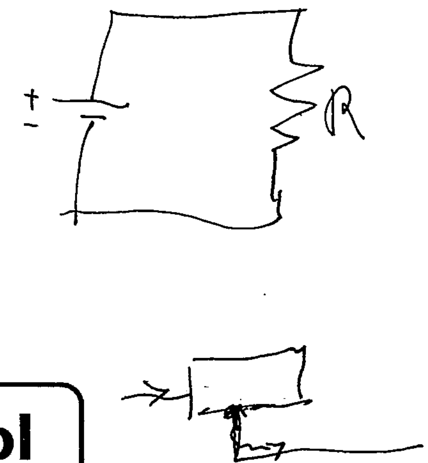
Lecture # 15

DC - circuits





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Black	0	
Brown	1	
Red	2	
Orange	3	
yellow	4	
green	5	
blue	6	
Violet	7	
gray	8	
white	9	
Gold	10^{-1}	±5%
Silver	10^{-2}	±10%
None	–	±20%

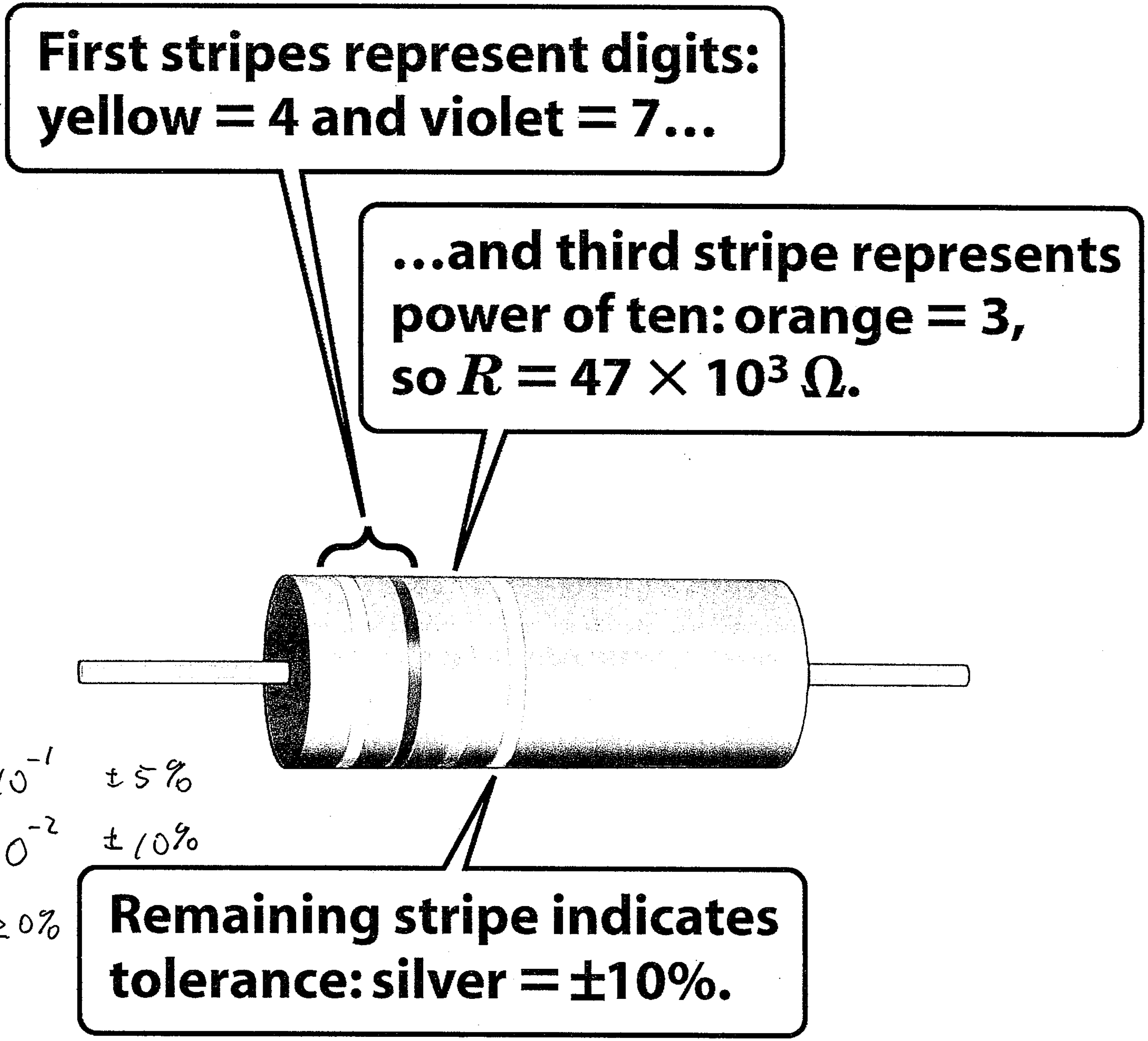

Figure 27-13 Physics for Engineers and Scientists 3/e

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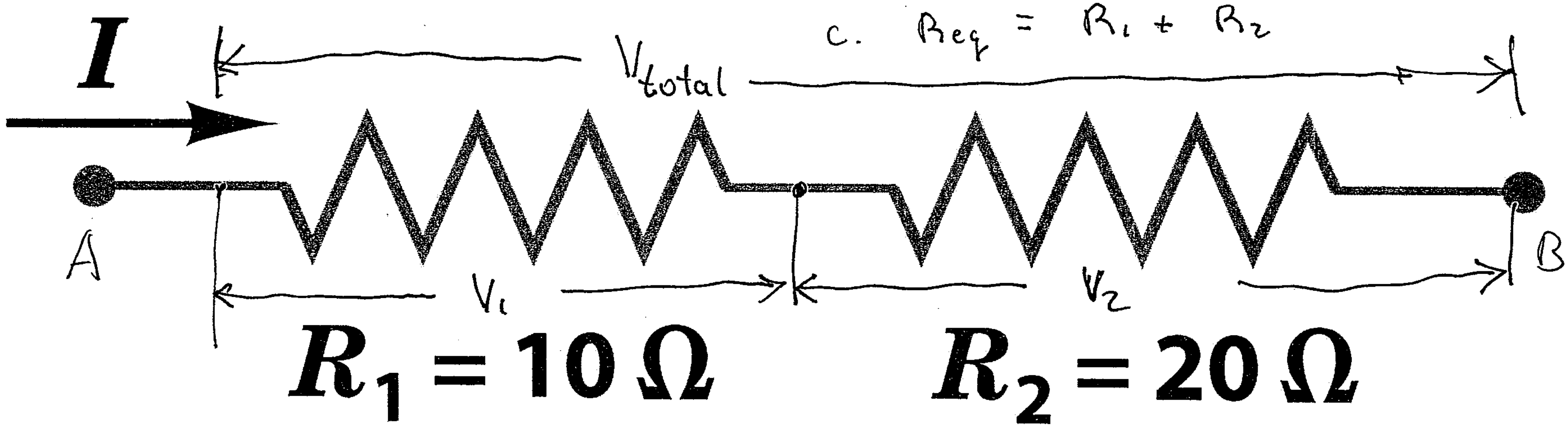
Resistors in series

a. Current the same in each resistor

b. $V_{total} = V_1 + V_2$

c. $R_{eq} = R_1 + R_2$



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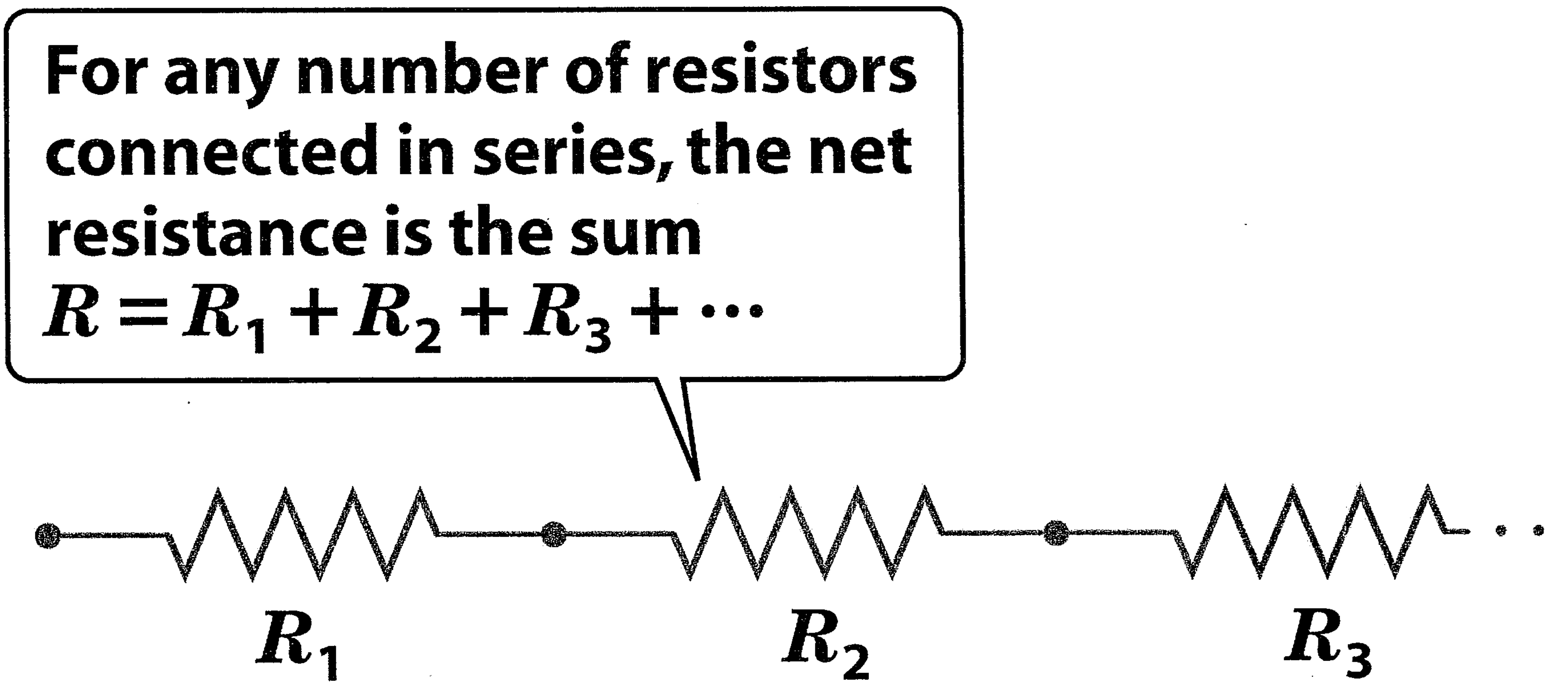
$$V_{total} = V_1 + V_2$$

$$I R_{eq} = I R_1 + I R_2$$



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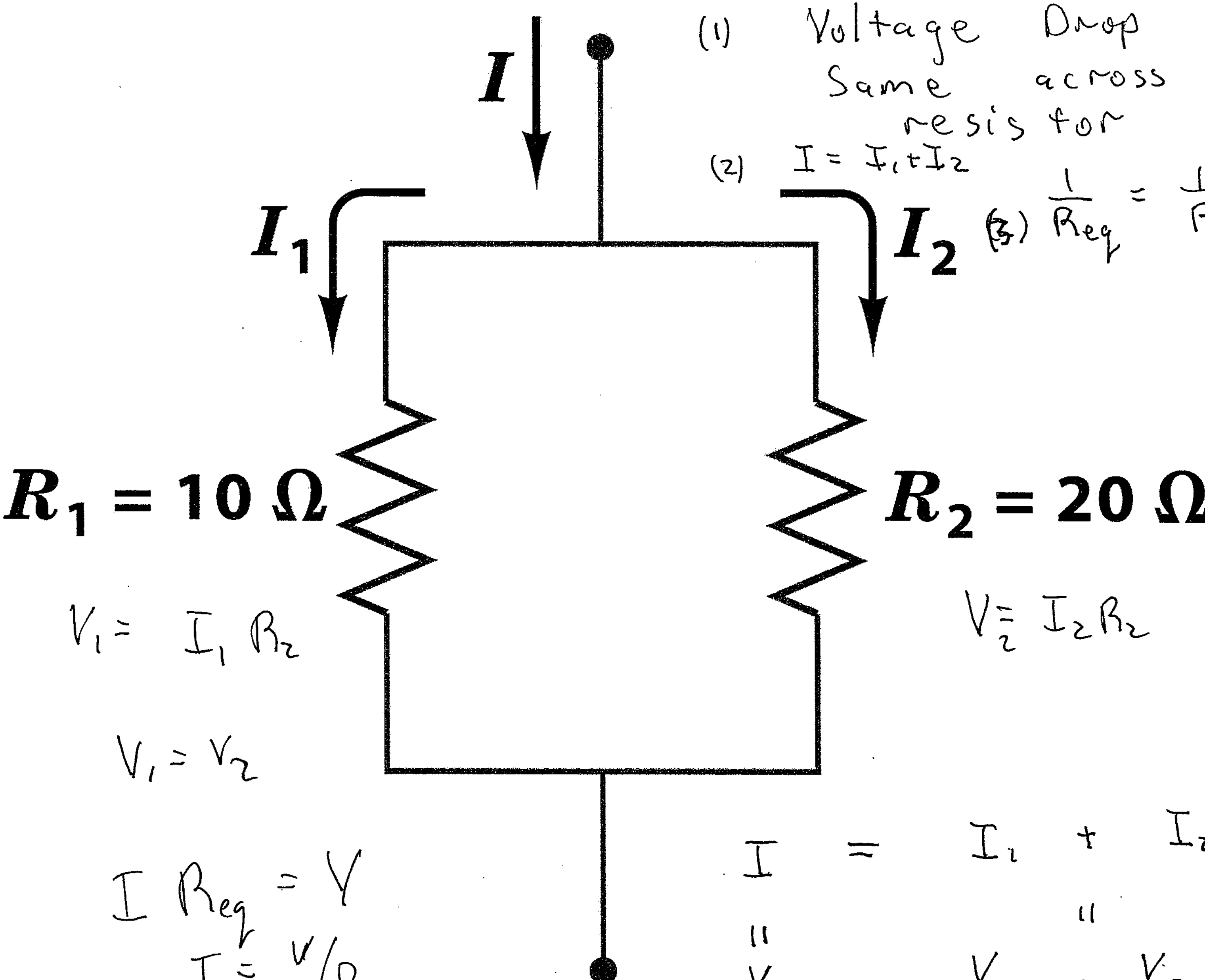
Resistors in Parallel

(1) Voltage Drop the Same across each resistor

(2) $I = I_1 + I_2$

(3) $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$



$V_1 = I_1 R_2$

$V_2 = I_2 R_2$

$V_1 = V_2$

$I R_{eq} = V$

$I = V / R_{eq}$

$I = I_1 + I_2$

$\frac{V}{R_{eq}} = \frac{V}{R_1} + \frac{V}{R_2}$

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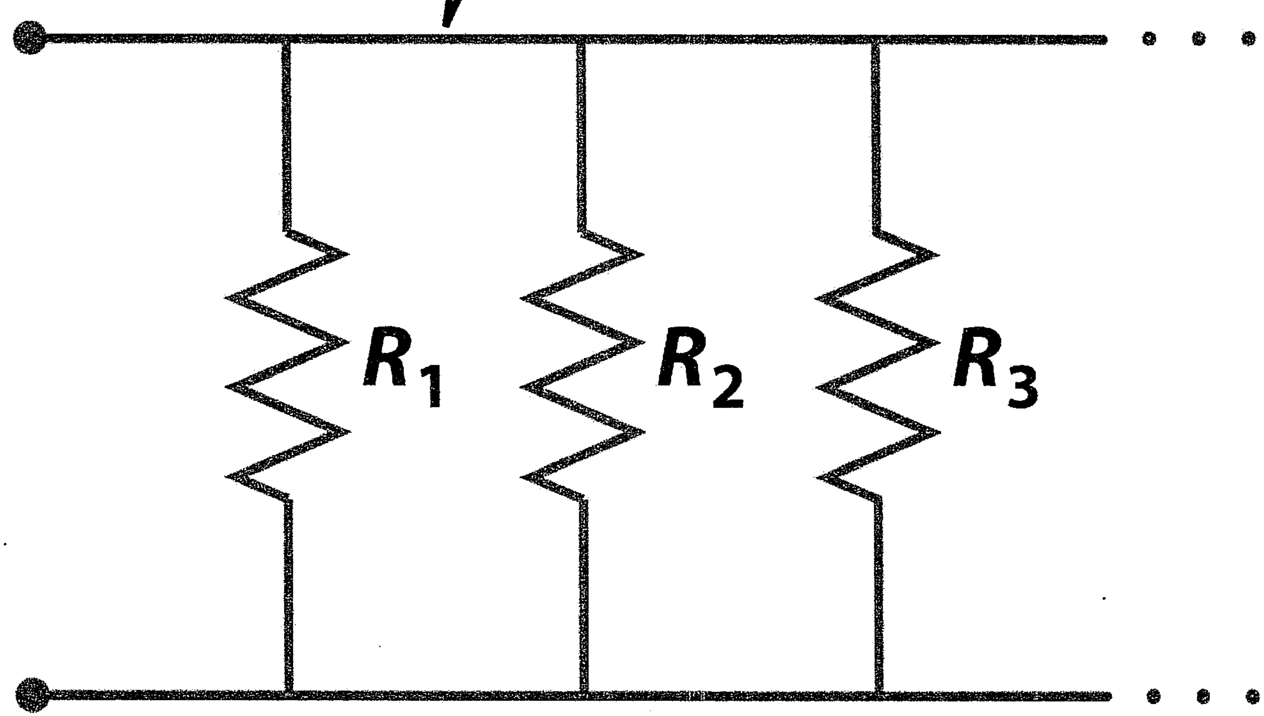
For resistors connected in parallel, the inverse of the net resistance is the sum of the inverses of individual resistances,

$$1/R_{eq} = 1/R_1 + 1/R_2 + 1/R_3 + \cdots$$



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Composite resitance of circuit.

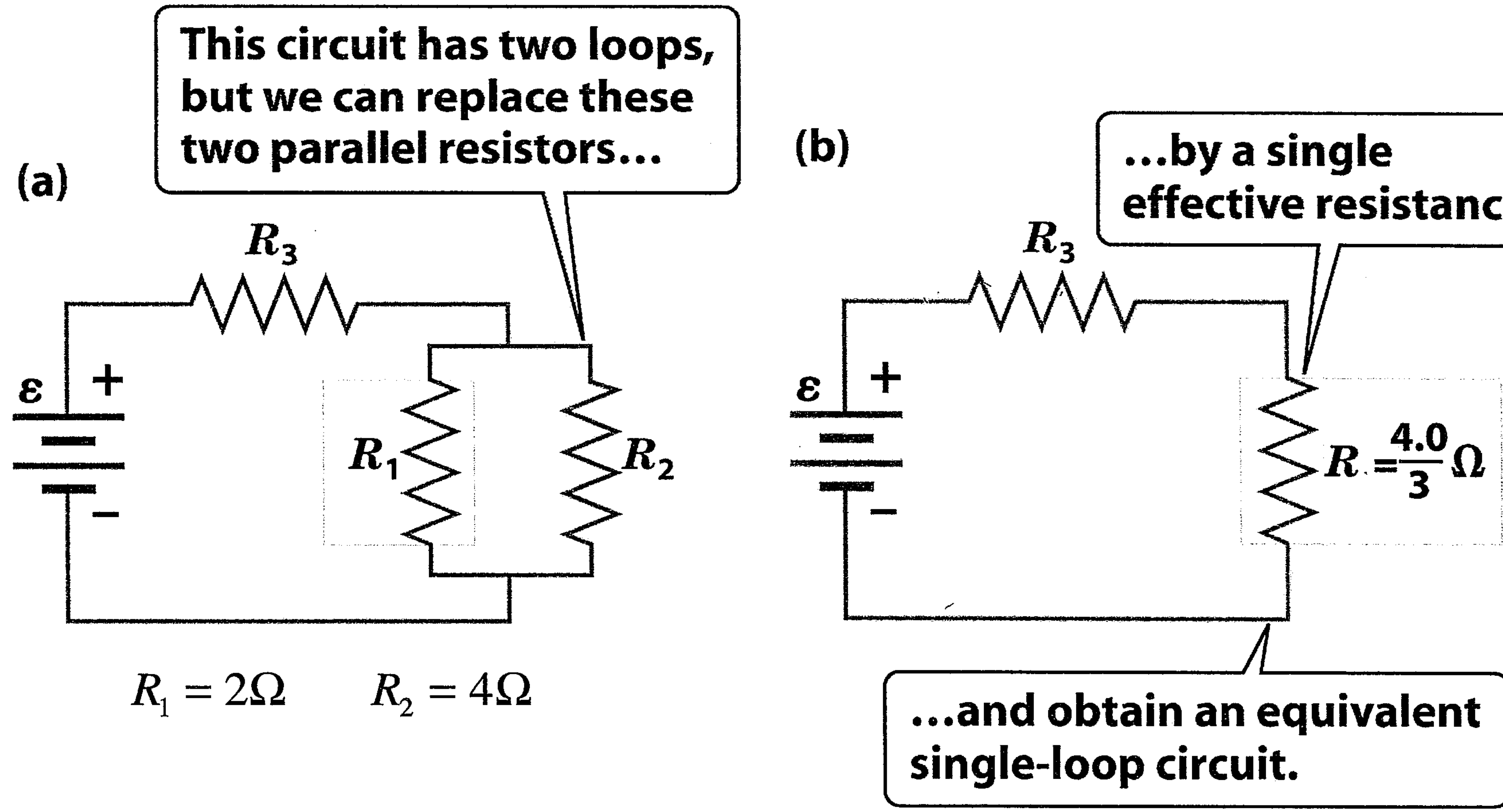

Figure 28-13 Physics for Engineers and Scientists 3/e

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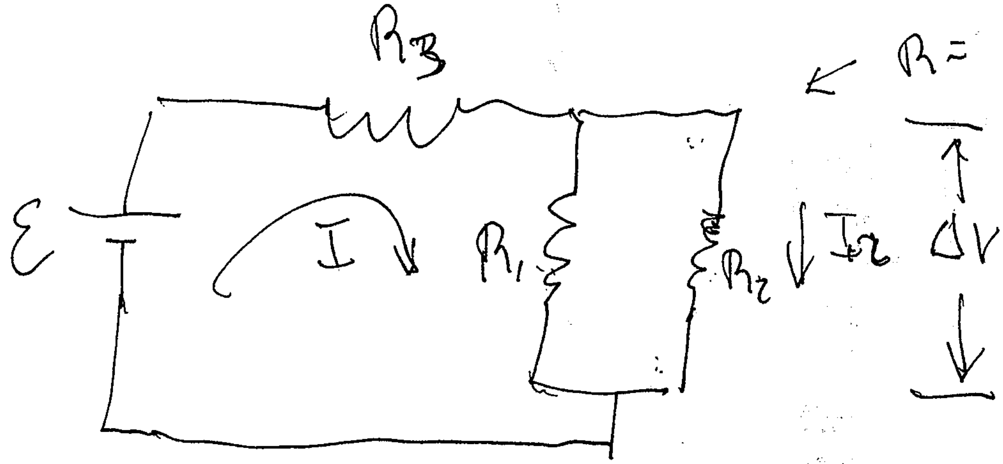
$R_{eqt} = R_3 + R$

Current Through battery $= I_{bat} = \frac{\mathcal{E}}{R_{eq}}$

Current Through R_2?



$$R = \frac{R_2 R_1}{R_1 + R_2}$$

$$I = \frac{\varepsilon}{R_3 + \frac{R_2 R_1}{R_1 + R_2}}$$

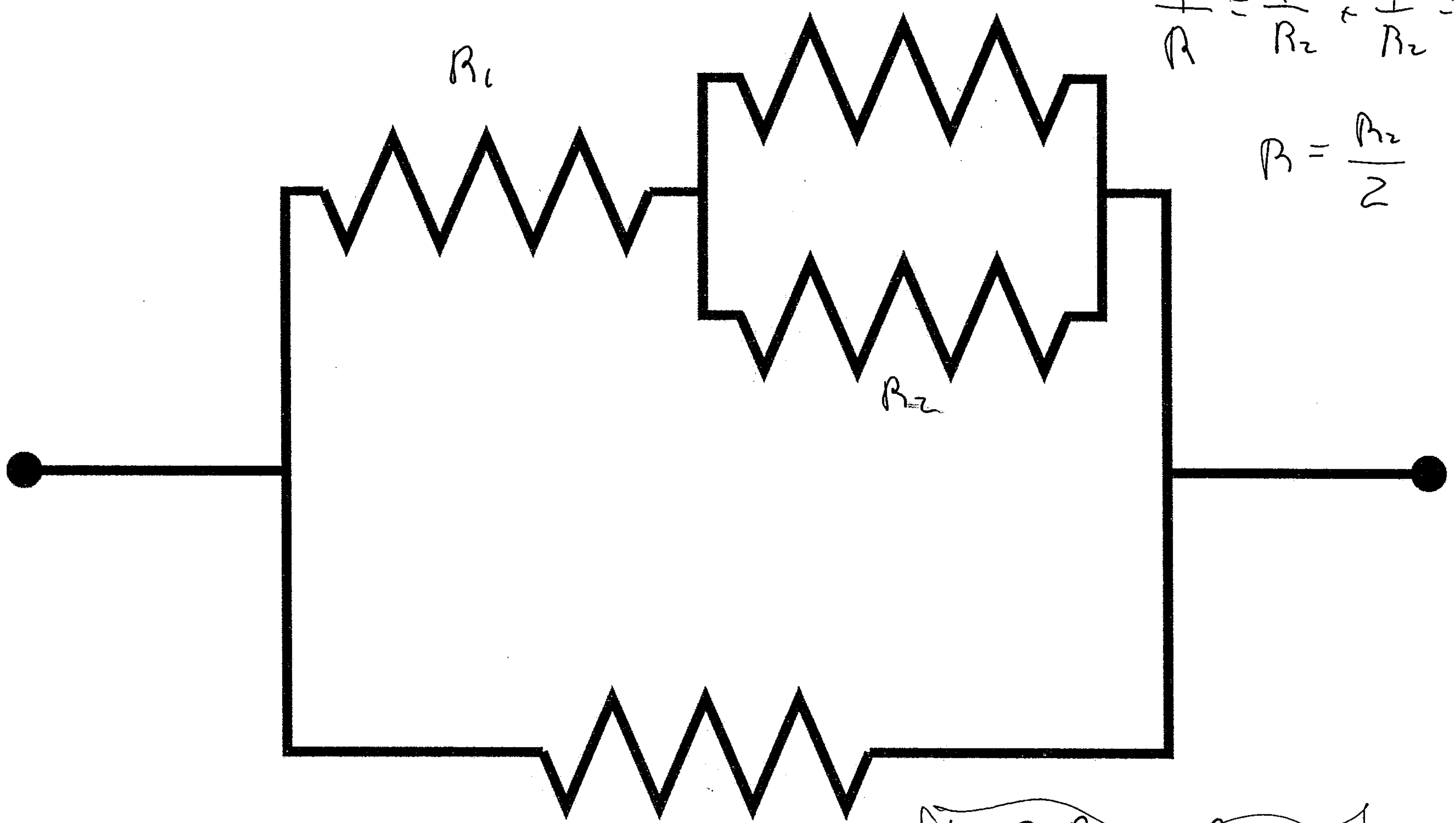
$$\Delta V = I R = \frac{\varepsilon}{R_3 + \frac{R_2 R_1}{R_1 + R_2}} \cdot \frac{R_2 R_1}{(R_1 + R_2)}$$

$$I_2 R_2 = \Delta V$$

$$I_2 = \frac{\Delta V}{R_2} = \frac{\varepsilon_1 R_1}{\left(R_3 + \frac{R_2 R_1}{R_1 + R_2}\right)(R_1 + R_2)}$$

$$I_1 = \frac{\varepsilon R_2}{R_3 R_1 + R_3 R_2 + R_2 R_1} \quad \Big| \quad I_2 = \frac{\varepsilon R_1}{R_3 R_1 + R_3 R_2 + R_2 R_1}$$

What is equivalent resistance?



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$$\frac{1}{R} = \frac{1}{R_2} + \frac{1}{R_2} = \frac{2}{R_2}$$

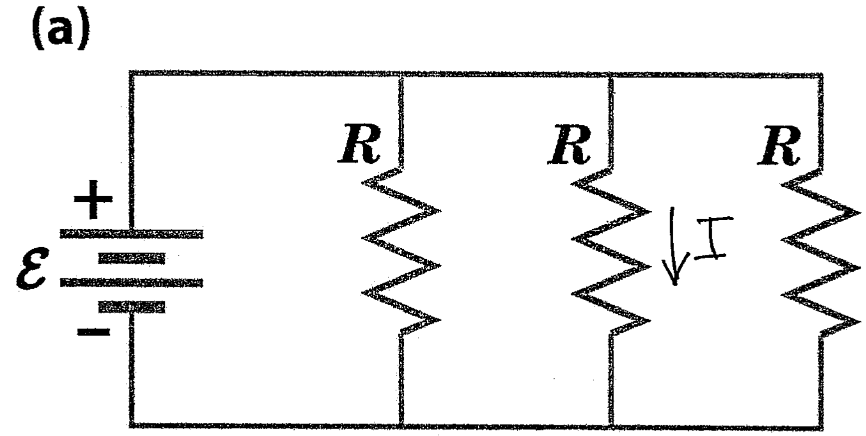
$$R = \frac{R_2}{2}$$

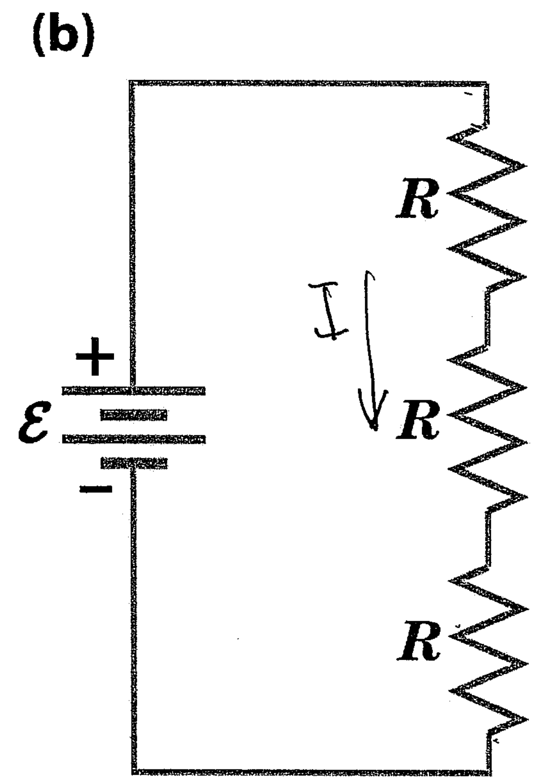
$$R_1 + \frac{R_2}{2}$$

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_1 + \frac{R_2}{2}}$$

1. $2R_1 + R_2$
2. $2R_2 + \frac{R_1}{2}$
3. $2R_1 + R_2/2$

Current, I, Through R?





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$I = ?$

(1) $\frac{\mathcal{E}}{R}$ in (a) ; $\frac{\mathcal{E}}{3R}$ in (b)

(2) $\frac{\mathcal{E}}{3R}$ in (a) ; $\frac{\mathcal{E}}{R}$ in (b)

(3) $\frac{\mathcal{E}}{R}$ in (a) ; $\frac{\mathcal{E}}{R}$ in (b)

Direction of current (flow of positive charge) is also direction of potential *decrease* across resistor.

$\mathcal{E} + IR_1 = 0$

$I = -\frac{\mathcal{E}}{R}$

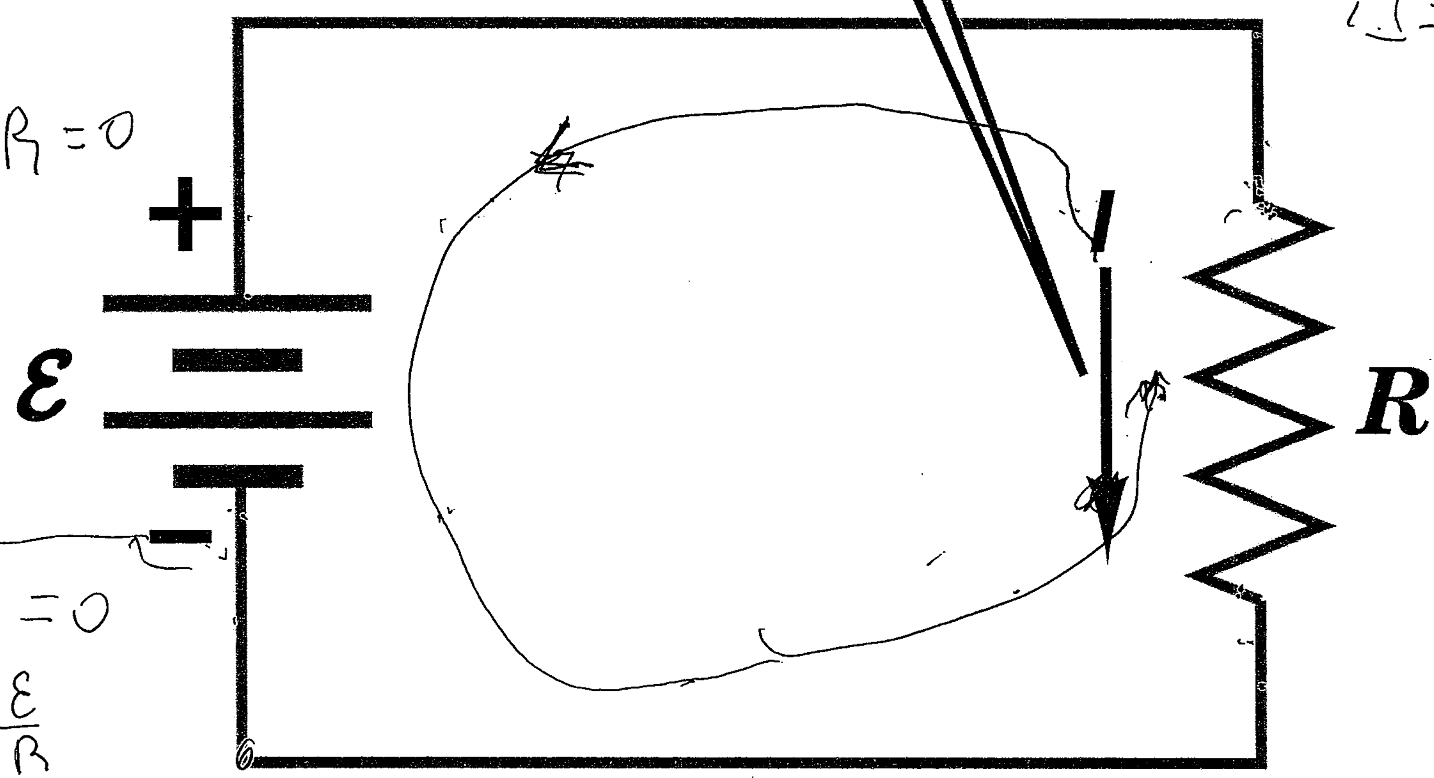
$-\mathcal{E} + IR = 0$

$IR = \mathcal{E}$

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

$-\mathcal{E} - IR = 0$

$I = -\frac{\mathcal{E}}{R}$



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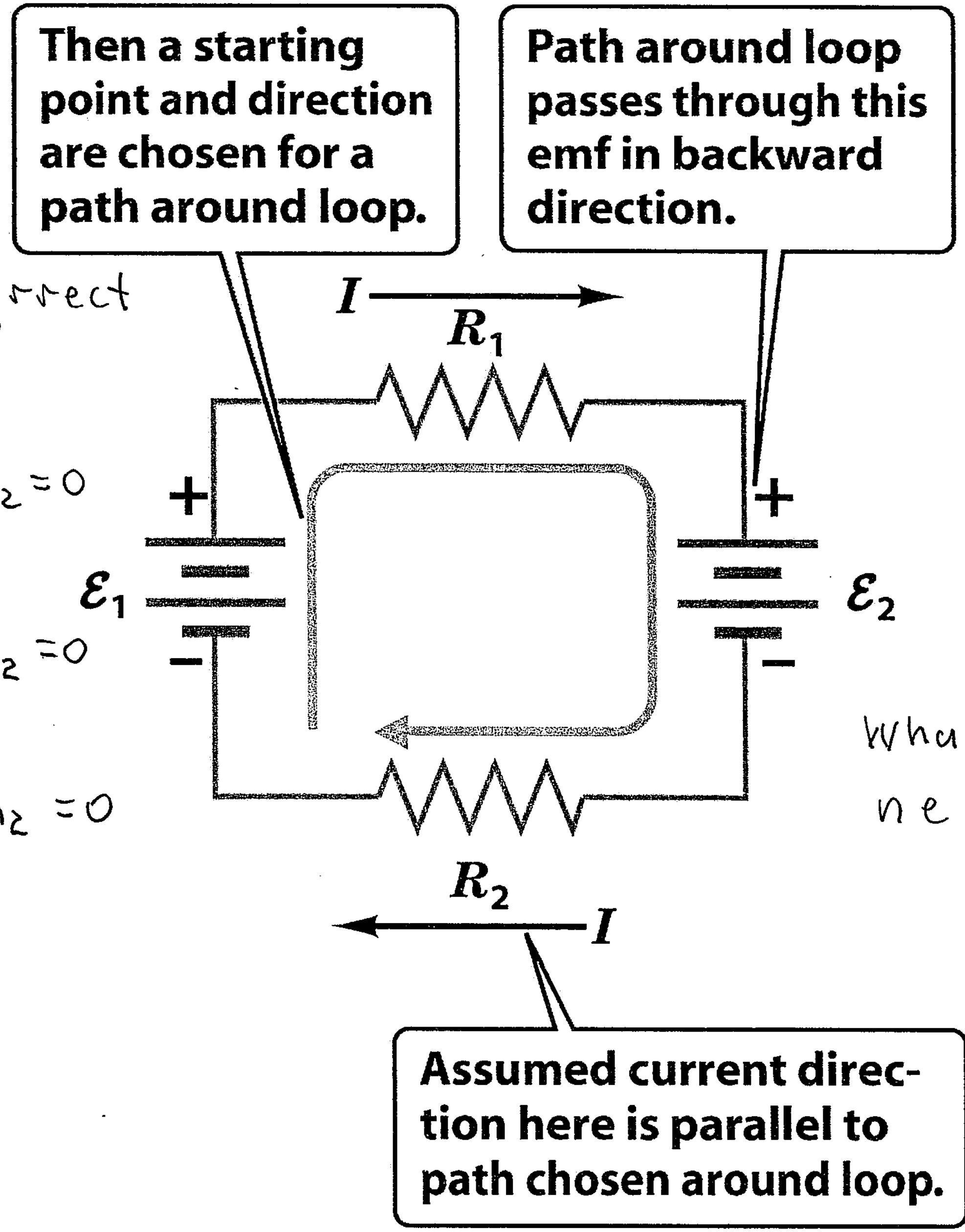
Kirchoff's Voltage law: "Voltage Drop Around a circuit vanishes"

What is correct equation?

a. $\mathcal{E}_1 + IR_1 + \mathcal{E}_2 + IR_2 = 0$

b. $-\mathcal{E}_1 + IR_1 - \mathcal{E}_2 + IR_2 = 0$

c. $-\mathcal{E}_1 + IR_1 + \mathcal{E}_2 + IR_2 = 0$



What does negative I mean?

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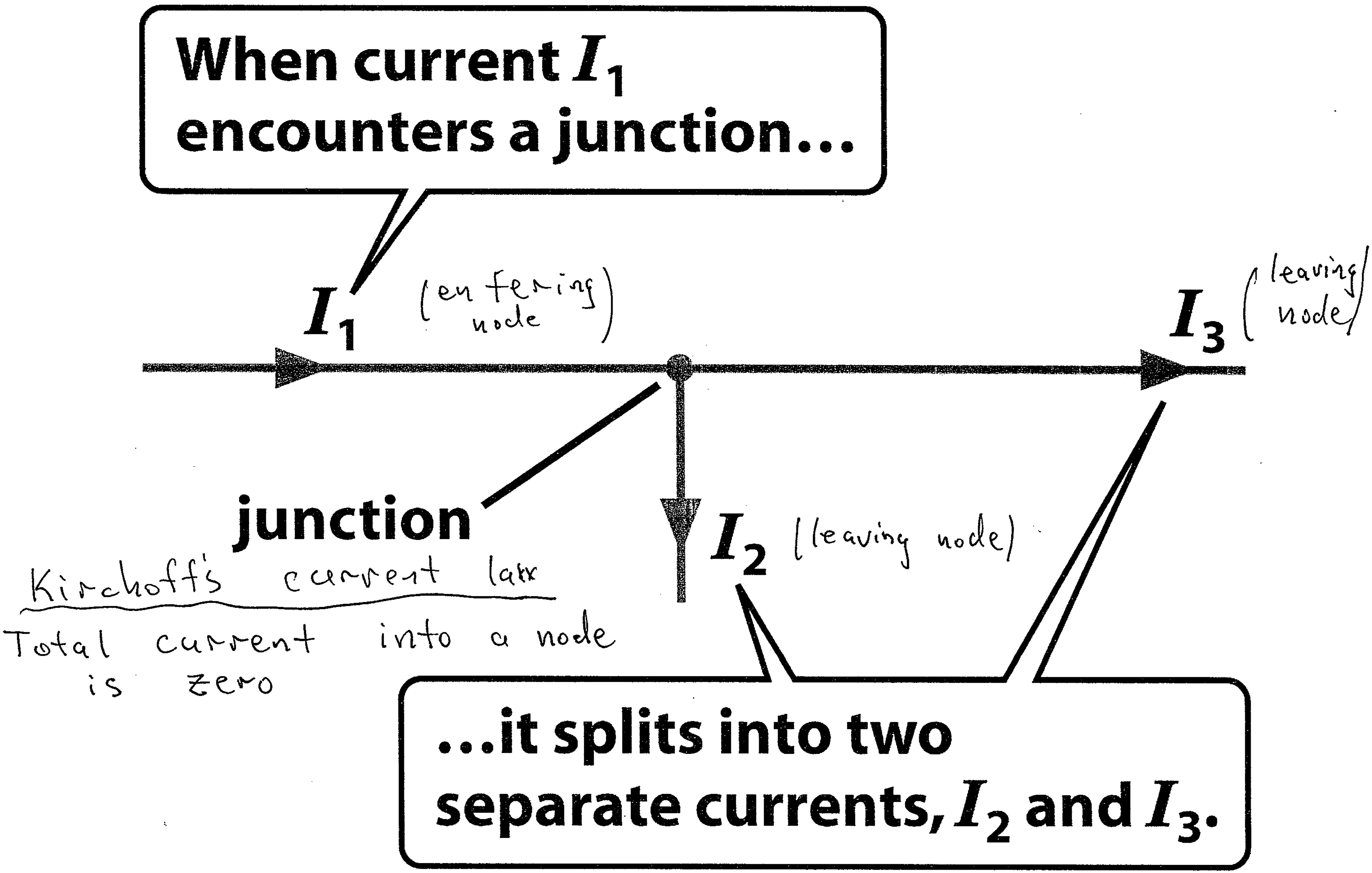

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$$I_1 - I_2 - I_3 = 0$$

or $I_1 = I_2 + I_3$

Write equations for circuit

3 unknowns I_1, I_2, I_3

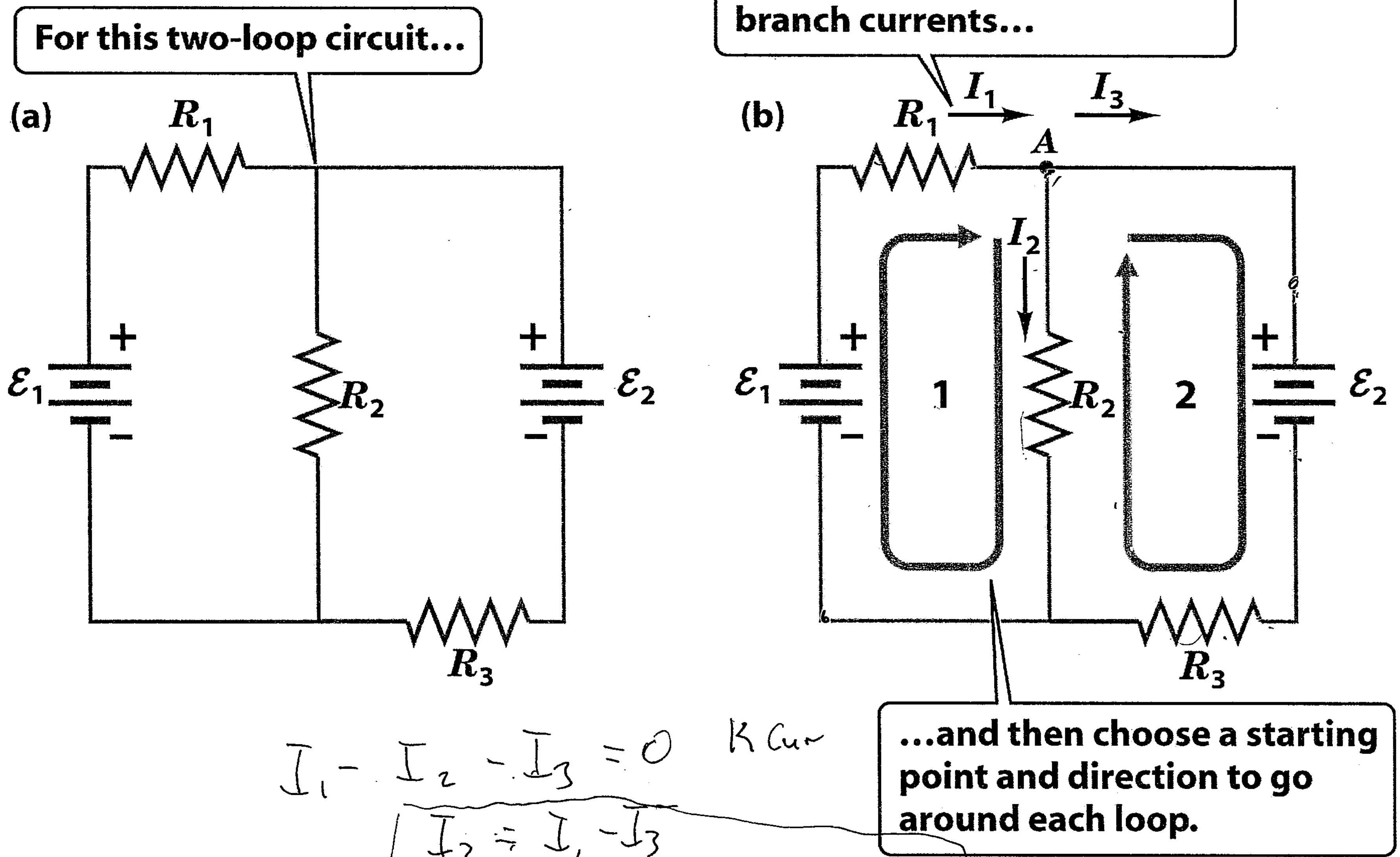

Figure 28-17 Physics for Engineers and Scientists 3/e

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$I_1 - I_2 - I_3 = 0$ K Cur

$I_2 = I_1 - I_3$

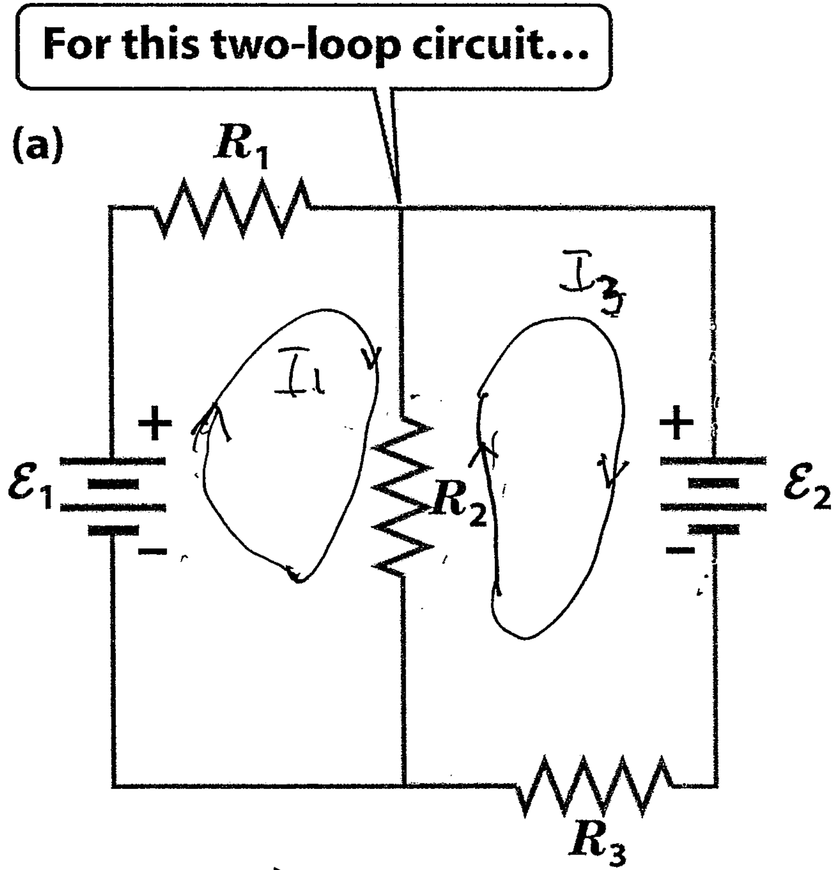
$-\mathcal{E}_1 + I_1 R_1 + I_2 R_2 = 0$

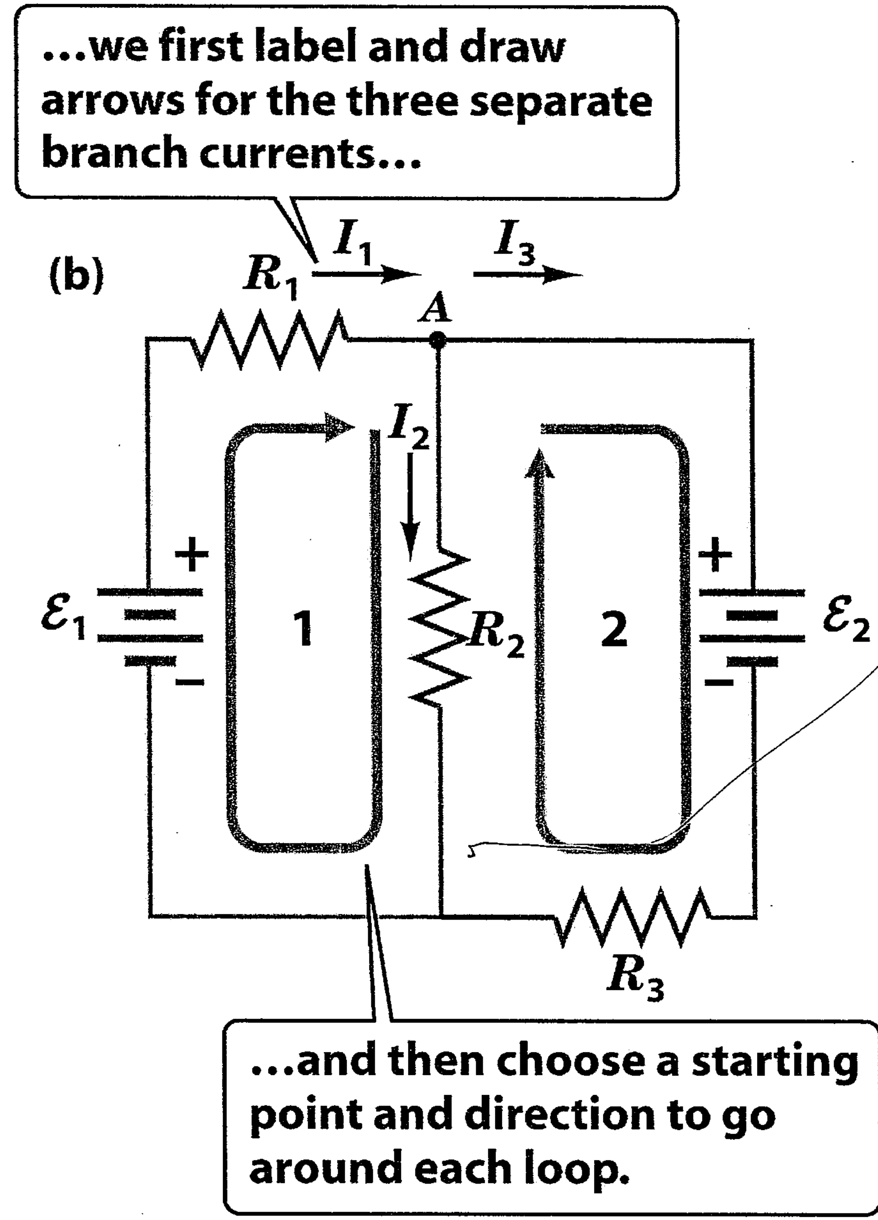
$+\mathcal{E}_1 - I_2 R_2 + I_3 R_3 = 0$

Write Equation for circuit

2 unknowns

I_1 and I_3





$I_2 = I_1 - I_3$

$-\mathcal{E}_1 + I_1 R_1 + R_2(I_1 - I_3) = 0$

Figure 28-17 Physics for Engineers and Scientists 3/e
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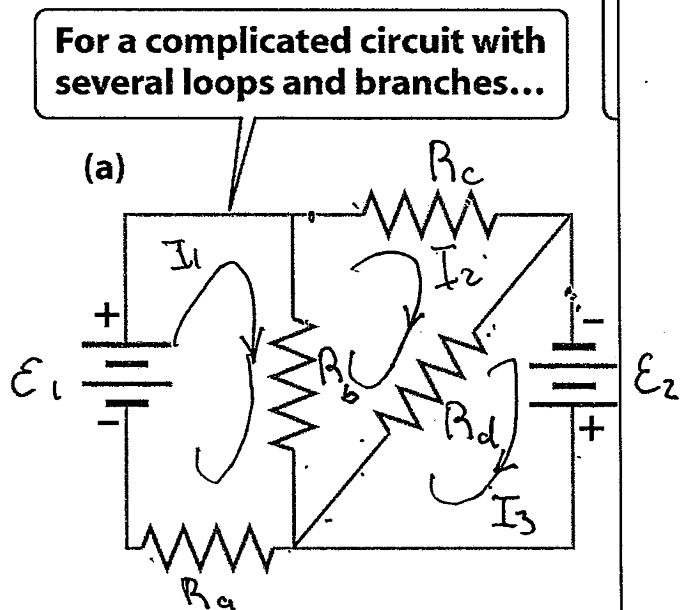
$\mathcal{E}_2 + I_3 R_3 + R_2(I_3 - I_1) = 0$

Write equation for circuit



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$-\mathcal{E}_1 + R_b(I_1 - I_2) + R_a I_1 = 0$

$I_2 R_c + R_d(I_2 - I_3) + R_b(I_2 - I_1) = 0$

$-\mathcal{E}_2 + R_d(I_3 - I_2) = 0$

additional HW

Solve for I_1, I_2, I_3!