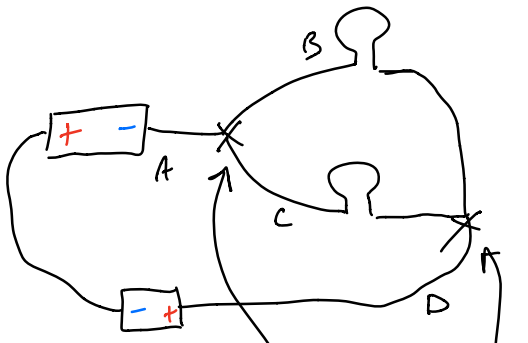
P20: 2, 3, 5, 6, 7 are true

P21:

1, 3, 6, 8, 9 are true

P23:



NODE RULE:

$i_{in} = i_{out}$

$i_A = i_B + i_C$

NODE RULE:

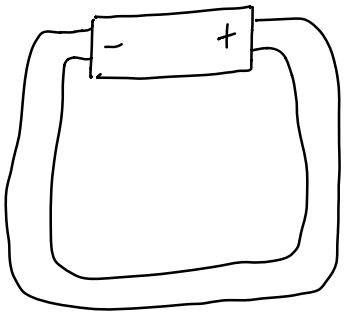
$i_{in} = i_{out}$

$i_B + i_C = i_D$

$i_A = i_D$

P29: 2, 5, 8

P39:



Loop rule:

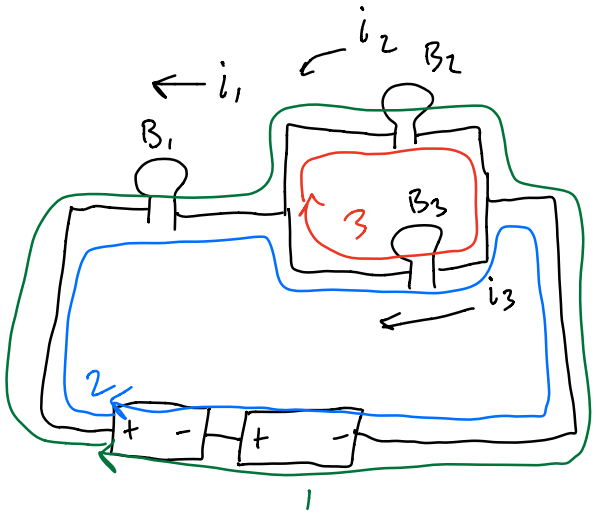
a) $\mathcal{E} - EL = 0$

$EL = \mathcal{E}$

$E = \mathcal{E}/L = 3.33 \frac{V}{m}$

b) Same length, so $E = 3.33 \frac{V}{m}$ still

P44:



a) 3 loops

b)

Loop Rule (1)

$$-E_1L - E_2L + 2\mathcal{E} = 0 \qquad (5)$$

(2)

$$-E_1L - E_3L + 2\mathcal{E} = 0 \qquad (6)$$

(3)

$$-E_2L + E_3L = 0 \qquad (1)$$

c) $i_2 + i_3 = i_1$ (3)

Now solve

Loop 1

$$2\mathcal{E} - E_1L - E_2L = 0$$

$i = nAuE$

$$2\mathcal{E} - \frac{i_1}{nAu}L - \frac{i_2}{nAu}L = 0$$

Loop 3

$$-E_2L + E_3L = 0$$

$$E_2 = E_3$$

$$\frac{i_2}{nAu} = \frac{i_3}{nAu}$$

$$i_2 = i_3$$

$$i_1 = i_2 + i_3 = 2i_2$$

$$2\mathcal{E} - \frac{2i_2}{nAu}L - \frac{i_2}{nAu}L = 0$$

$$2\mathcal{E} = \frac{3i_2L}{nAu}$$

$$i_2 = \frac{2}{3}\frac{\mathcal{E}}{L}nAu$$

$$i_1 = \frac{4}{3}\frac{\mathcal{E}}{L}nAu$$

$$i_3 = i_2$$

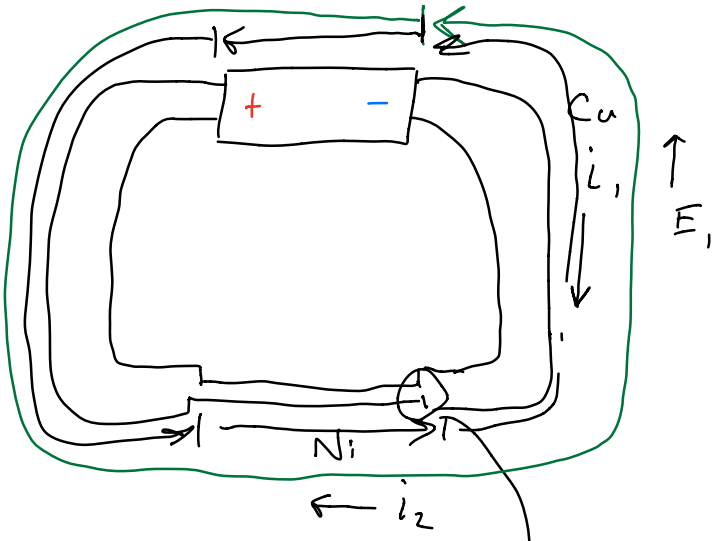
$$E_1 = nAu\,i_1$$

$$E_2 = nAu\,i_2$$

$$E_3 = nAu\,i_3$$

plug in for $\mathcal{E}, L, n, A, u$

P 46:



Node Rule

$$i_1 = i_2$$

$$n_1 A_1 u_1 E_1 = n_2 A_2 u_2 E_2$$

Loop Rule:

$$+\mathcal{E} - E_1 L_1 - E_2 L_2 - E_1 L_1 = 0$$

$$\mathcal{E} - 2E_1 L_1 - E_2 L_2 = 0$$

$$E_1 = \frac{n_2 A_2 u_2}{n_1 A_1 u_1} E_2$$

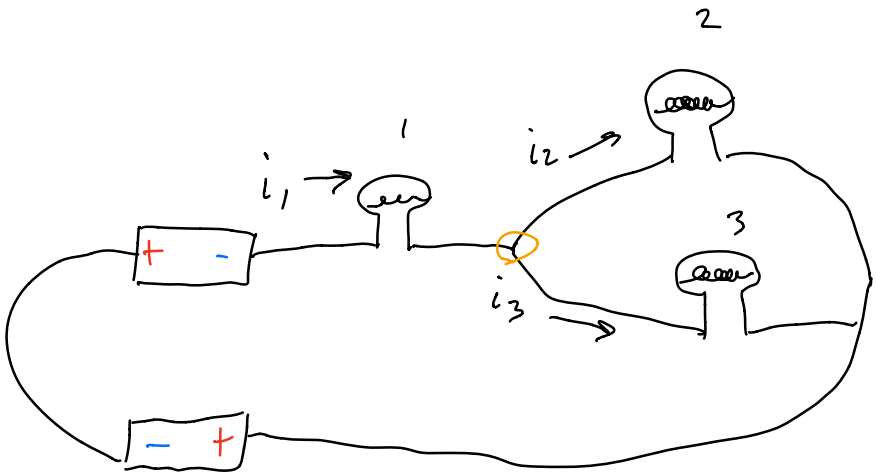
$$\mathcal{E} - 2L_1 \frac{n_2 A_2 u_2}{n_1 A_1 u_1} E_2 - E_2 L_2 = 0$$

$$\mathcal{E} = E_2 \left[\frac{2L_1 n_2 A_2 u_2}{n_1 A_1 u_2} + L_2 \right]$$

$$E_2 = \frac{\mathcal{E}}{\left[\frac{2L_1 n_2 A_2 u_2}{n_1 A_1 u_1} + L_2 \right]}$$

$$E_1 = \frac{n_2 A_2 u_2}{n_1 A_1 u_1} E_2$$

P47:

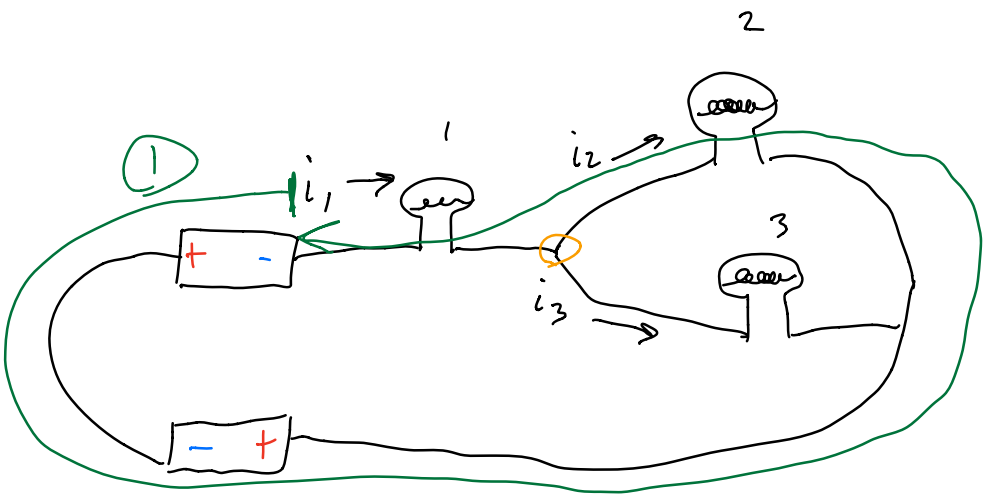


- Bulbs made of same material (n, u are same)
- Bulb filaments have same length L
- Ignore connecting wires

NODE RULE

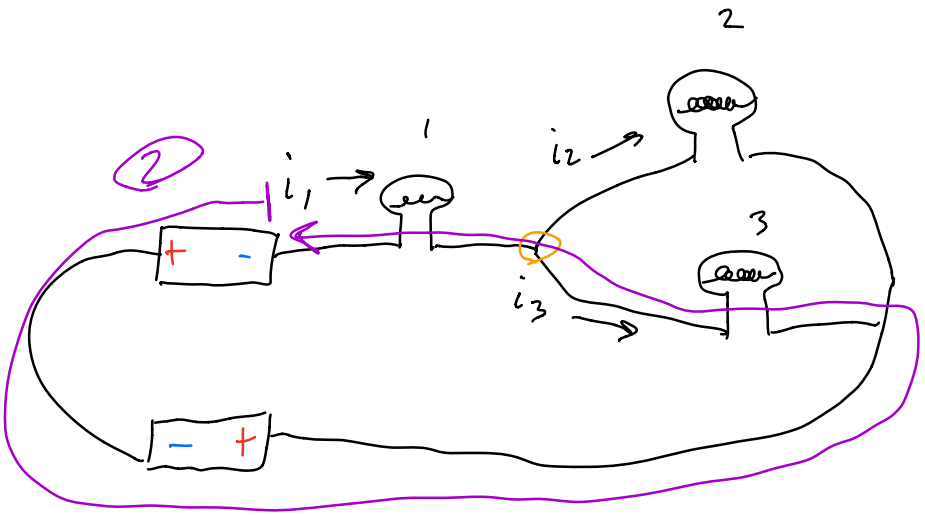
$$i_1 = i_2 + i_3$$

LOOP RULE



(1)

$$+2\mathcal{E} - E_2 L - E_1 L = 0$$



(2)

$$+2\mathcal{E} - E_3 L - E_1 L = 0$$

① + ②

$$2\mathcal{E} - E_2 L - E_1 L = 0$$

$$2\mathcal{E} - E_3 L - E_1 L = 0$$

$$2\mathcal{E} - E_2 L - E_1 L = 2\mathcal{E} - E_3 L - E_1 L$$

$$E_2 = E_3$$

$$\boxed{i_1 = i_2 + i_3}$$

$$i = nAuE$$

$$E_2 = E_3$$

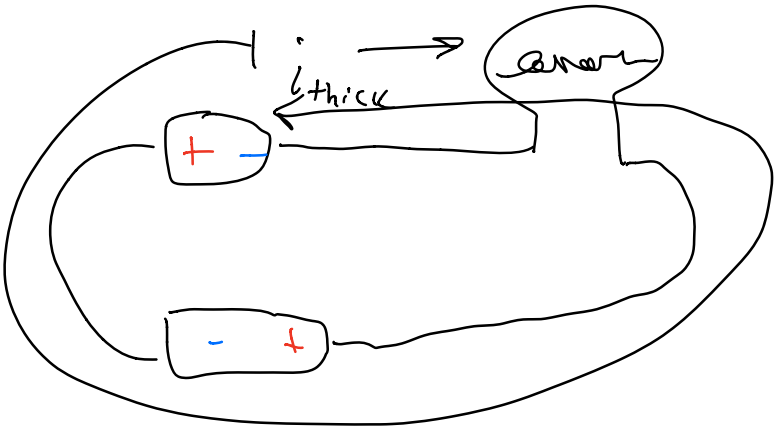
$$\frac{i_2}{nAu} = \frac{i_3}{nAu} \qquad i_2 = i_3$$

$$i_1 = 2 i_2 = 2 i_3$$

$$nA_1 u E_1 = 2 nA_2 u E_2$$

$$E_1 = 2\frac{A_2}{A_1}E_2$$

Single thick bulb



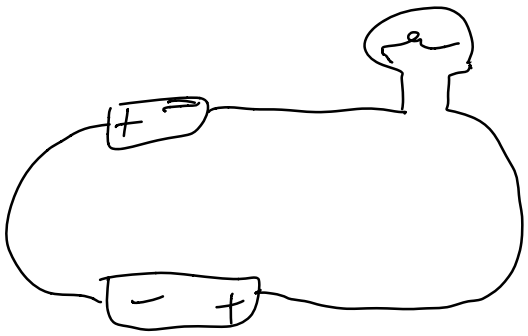
$$2\mathcal{E} - E_{thick}L = 0$$

$$E_{thick} = \frac{2\mathcal{E}}{L}$$

$$i = nAuE$$

$$\frac{i_{thick}}{nA_{thick}u} = \frac{2\mathcal{E}}{L}$$

$$i_{thick} = \frac{2nA_{thick}u\mathcal{E}}{L}$$



$$2\mathcal{E} - E_{thin} L = 0$$

$$E_{thin} = \frac{2\mathcal{E}}{L}$$

$$i_{thin} = \frac{2 n A_{thin} u \mathcal{E}}{L} \qquad (3)$$

$$i_{thick} = \frac{2 n A_{thick} u \mathcal{E}}{L} \qquad (4)$$

$$\frac{i_{thick}}{i_{thin}} = \frac{A_{thick}}{A_{thin}} = 2 = \frac{A_2}{A_1}$$

$$E_1 = 2 \frac{A_2}{A_1} E_2$$

$$E_1 = 4E_2$$

$$2\mathcal{E} - E_2 L - E_1 L = 0$$

$$2\mathcal{E} - E_2 L - 4E_2 L = 0$$

$$2\mathcal{E} = 5E_2 L$$

$$E_2 = \frac{2}{5}\frac{\mathcal{E}}{L}$$

$$E_1 = \frac{8}{5}\frac{\mathcal{E}}{L}$$

$$\frac{i_1}{nA_{thin}u} = \frac{8}{5}\frac{\mathcal{E}}{L}$$

$$i_1 = \frac{8}{5}\left(nA_{thin}u\frac{\mathcal{E}}{L}\right)$$

$$i_{thin} = 2\left(\frac{nA_{thin}u\,\mathcal{E}}{L}\right)$$

$$n A_{thin} u \frac{\mathcal{E}}{L} = \frac{i_{thin}}{2} = \frac{1.5 \times 10^{18}}{2}$$

$$i_1 = \left(\frac{8}{5}\right)\left(\frac{1}{2}\right)\left(1.5 \times 10^{18}\right)$$

$$\frac{4}{5}\left(1.5 \times 10^{18}\right)$$

$$\frac{6}{5} \times 10^{18}$$

$$1.2 \times 10^{18} \ \frac{e^-}{s}$$