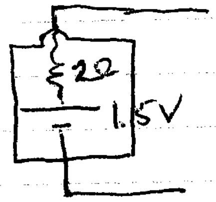
Phys 132 Solutions - HW IVa

Session IV.1

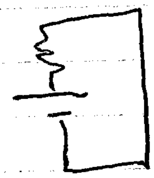
1)

$\Delta V = IR = .25A \cdot 15\Omega = \boxed{3.75\,V}$

2)



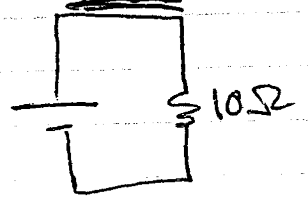
a)



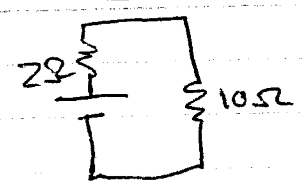
$I = \frac{\Delta V}{R} = \frac{1.5V}{2\Omega} = \boxed{.75A}$

b) Compare

ideal



real

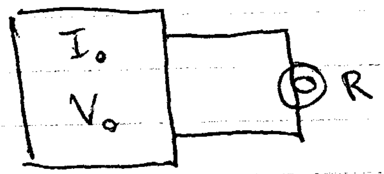


$I_{ideal} = \frac{\Delta V}{R} = \frac{1.5V}{10\Omega} = .15A$

$I_{real} = \frac{1.5V}{12\Omega} = .125A$

real is .025A less than ideal

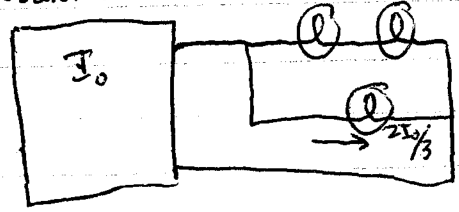
3) We will assume (which is not quite correct!) that each bulb acts like a resistor. Let's define I_o & V_o as those for a single bulb



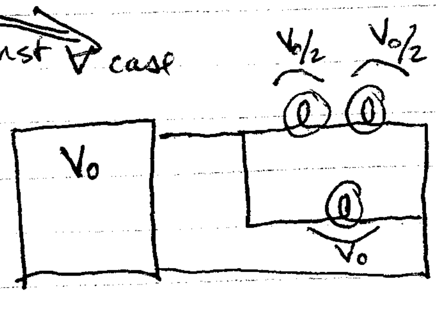
$V_o = I_o R$

Const I case

Current const - splits 2:1

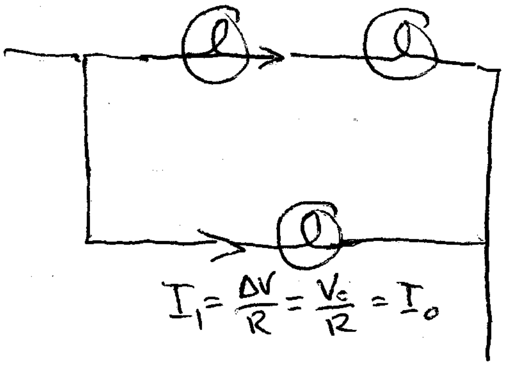


Const V case



So, we know I's in const V case by $\Delta V = IR$, so

$$I_2 = \frac{\Delta V}{R} = \frac{V_0/2}{R} = I_0/2$$



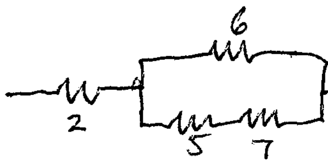
$$I_1 = \frac{\Delta V}{R} = \frac{V_0}{R} = I_0$$

So, more current flows in the constant voltage case ($\frac{3}{2}I_0$) than in the constant current case (I_0). Notice the ratio of currents stays the same:

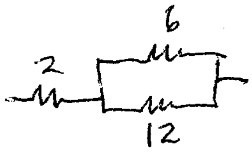
b) $$\frac{I_1}{I_2} = \underbrace{\frac{I_0}{I_0/2}}_{\text{const V case}} = \underbrace{\frac{2I_0/3}{I_0/3}}_{\text{const } I \text{ case}} = 2$$

Session IV.2

1) What is equiv R:



$\xRightarrow{\text{series}}$

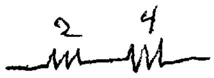


$\Downarrow$ parallel

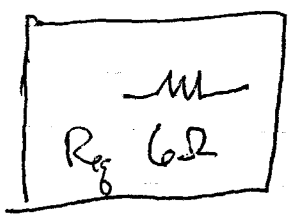
$$\frac{1}{6} + \frac{1}{12} = \frac{1}{R_{eq}}$$

$$\frac{2}{12} + \frac{1}{12} = \frac{3}{12} = \frac{1}{R_{eq}}$$

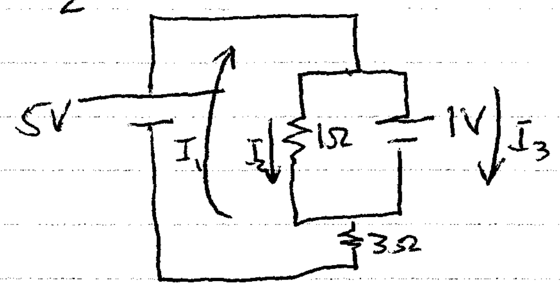
$$R_{eq} = \frac{12}{3} = 4$$



$\xLeftarrow{\text{series}}$



2



Junctions: $I_1 = I_2 + I_3$ a)

$I_2 + I_3 = I_1$ b)

Loops: $5V - I_2 1\Omega - I_1 3\Omega = 0$ 1)

$5V - 1V - I_1 3\Omega = 0$ 2)

$1V - I_2 1\Omega = 0$ 3)

Need to find 3 unknowns - I_1, I_2, I_3 - so need 3 eq'ns.

Need to include each circuit element (R or V) somewhere, & include each current in at least 1 jct eqn,

I'll choose equations a), 1), & 2) (which is not the best choice - a), 2), & 3) is easier.

a) $I_1 = I_2 + I_3$

1) $5V - I_2 1\Omega - I_1 3\Omega = 0$

2) $5V - 1V - I_1 3\Omega = 0 \Rightarrow 4V = I_1 3\Omega \Rightarrow \boxed{I_1 = \frac{4}{3} A}$

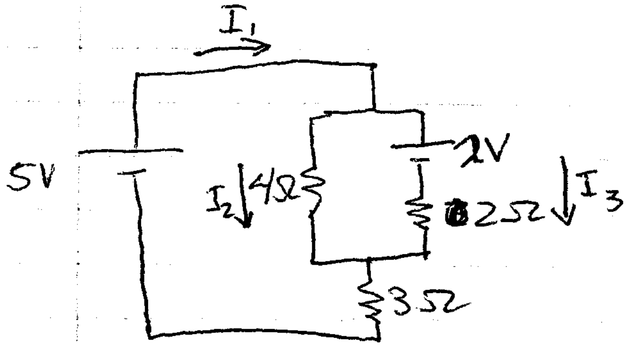
plug that result into 1) to find

$5V - I_2 1\Omega - \frac{4}{3} A \cdot 3\Omega = 0 = 5V - I_2 1\Omega - 4V = 1V - I_2 1\Omega = 0$

so $\boxed{I_2 = \frac{1V}{1\Omega} = 1A}$ then plug those two currents into a:

$\frac{4}{3} A = 1A + I_3 \Rightarrow \boxed{I_3 = \frac{1}{3} A}$

Just as an example – what if we had this circuit:



jct: $I_1 = I_2 + I_3$ a)

loops $5V - I_2 4\Omega - I_1 3\Omega = 0$ 1)

$-2V - I_3 2\Omega + I_2 4\Omega = 0$ 2)

Now, not so simple! Choose to move from 3 eq'ns & 3 unknowns to 2 eq'ns & 2 unknowns by eliminating one current – say I_3.

First – combine a) & 2): $I_3 = I_1 - I_2$ ⇒ plug into 2

$$-2V - (I_1 - I_2) 2\Omega + I_2 4\Omega = 0$$

$$-2V - I_1 2\Omega + I_2 6\Omega = 0 \quad 3)$$

Eq'n 1) never had I_3, so <u>now</u> we have 2 eq'ns & 2 unknowns:

$$-2V - I_1 2\Omega + I_2 6\Omega = 0 \quad 3)$$

$$5V - I_2 4\Omega - I_1 3\Omega = 0 \quad 1)$$

Now let's eliminate I_2. Could solve for I_2 from 3 & substitute into 1, or – multiply 3) by 2:

$$-4V + I_2 12\Omega - I_1 4\Omega = 0$$

and 1) mult. by 3: $15V - I_2 12\Omega - I_1 9\Omega = 0$ and add

$$11V + 0 - I_1 13\Omega = 0 \Rightarrow \boxed{I_1 = \frac{11}{13} A.}$$

Plug that into, say 3)

$$-2V - \left(\frac{11}{13}A\right) 2\Omega + I_2 6\Omega = 0 \Rightarrow I_2 = \left(2V + \frac{22}{13}V\right)/6\Omega = \left(\frac{48}{13}\right)/6 \, A = \boxed{\frac{8}{13}A}$$

Then a): $I_3 = I_1 - I_2 = \frac{11}{13} - \frac{8}{13} = \boxed{\frac{3}{13} A}$