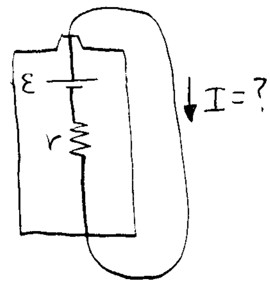
18.1 Given: $\mathcal{E} = 1.5\ V$

$r = 1.0\ \Omega$ (internal resistance)



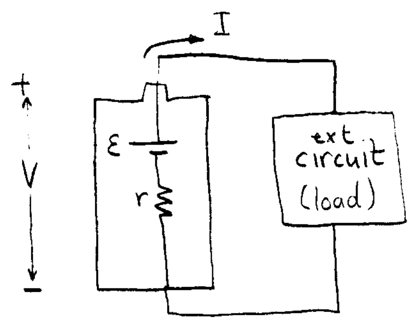
Find: current, I, for a short circuit.

Here: $\mathcal{E} = Ir$

$$\Rightarrow I = \frac{\mathcal{E}}{r} = \frac{1.5\ V}{1.0\ \Omega} = 1.5\ A$$

$$\boxed{I = 1.5\ A}$$

18.3 Given. $\mathcal{E} = 1.5\ V$
$r = 0.05\ \Omega$
$I = 0.5\ A$



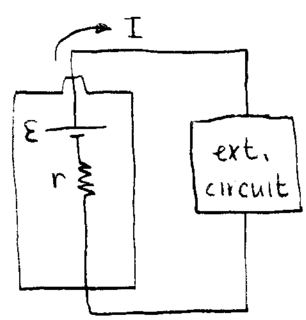
Find. terminal voltage of cell

$V = \mathcal{E} - Ir$ (terminal voltage of a <u>real</u> battery)

$= 1.5\ V - (0.5\ A)(0.05\ \Omega)$

$$\boxed{V = 1.475\ V}$$

18.7 Given. terminal voltage, $V = 8.85\ V$
$r = 0.3\ \Omega$
$I = 0.5\ A$



Find: power dissipated by the internal resistor.

Power dissipated by <u>any</u> resistor is

$P = I^2 R$ (where I is the current through R)

So, in this case,

$$P = I^2 r = (0.5\ A)^2 (0.3\ \Omega) = 0.075\ W$$

$$\boxed{P = 75\ mW}$$

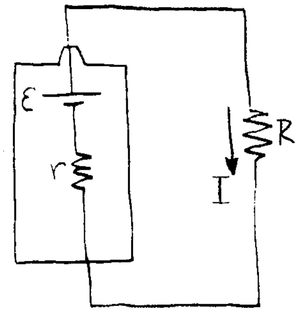
$\boxed{18.9}$ Given: battery:

$\mathcal{E} = 9.0\,V$

$r = 0.2\,\Omega$

$(I = 0.882\,A)$

$R = 10\,\Omega$



Find: total power dissipated.

Solution:

Power is dissipated by resistors: $P = I^2 R$, in general.

The total power dissipated is the sum of the power dissipated by each resistor:

$$P_{tot} = I^2 r + I^2 R$$

Since all the circuit elements are in series, the current is the same everywhere. This current is determined by the emf and the total resistance:

$$I = \frac{\mathcal{E}}{R + r} = \frac{(9.0\,V)}{10\,\Omega + 0.2\,\Omega} = 0.882\,A$$ (which was already given)

Thus, the total power dissipated is

$$P_{tot} = I^2 r + I^2 R = I^2 (r + R) = (0.882\,A)^2 (10.2\,\Omega)$$

$$\boxed{P_{tot} = 7.9\,W}$$

Note that this is also equal to the power delivered by the emf:

$$P = VI = \mathcal{E} I = (9.0\,V)(0.882\,A) = 7.9\,W$$

Find: terminal voltage of battery.

$$V = \mathcal{E} - Ir = (9.0\,V) - (0.882\,A)(0.2\,\Omega)$$

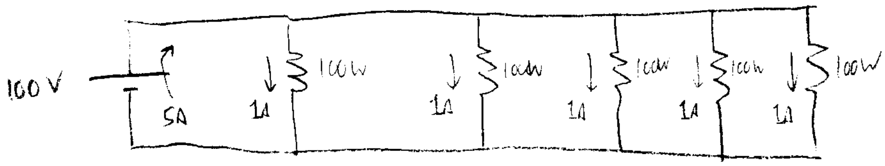
$$\boxed{V = 8.8\,V}$$

$\boxed{18.21}$ $V = 100\ V$

5 100W lamps in parallel

0.1μ

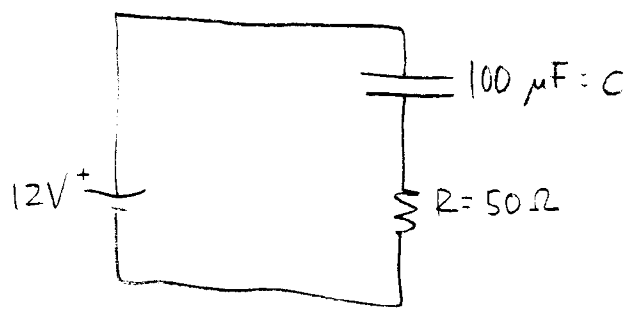
How much current needed?



1 lamp: $P = VI$ $\quad P = 100\ W$, $V = 100\ V$ $\Longrightarrow$ $I = 1\ A$

$$\boxed{I_{tot} = 5\ A}$$

$\boxed{18.57}$



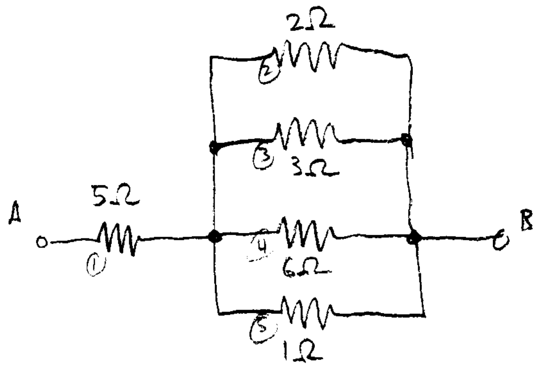
$\tau = RC$

$= (50\ \Omega)(100 \times 10^{-6}\ F)$

$$\boxed{\tau = 0.005\ s} \boxed{= 5.0\ ms}$$

18.27

Find R_{eq}:



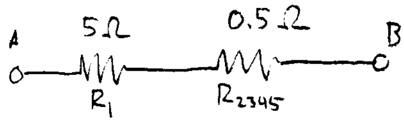
resisters ②, ③, ④, and ⑤ are in parallel with each other:

$$\frac{1}{R_{2345}} = \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5}$$

$$= \frac{1}{2} + \frac{1}{3} + \frac{1}{6} + \frac{1}{1}$$

$$\frac{1}{R_{2345}} = 2 \Rightarrow R_{2345} = \frac{1}{2}\,\Omega$$

series



$$R_{eq} = R_1 + R_{2345}$$

$$= 5.0\Omega + 0.5\Omega$$

$$\boxed{R_{eq} = 5.5\,\Omega}$$

$\boxed{18.61}$

$C = 1.0\,\mu F$

$R = 2.0\,M\Omega$

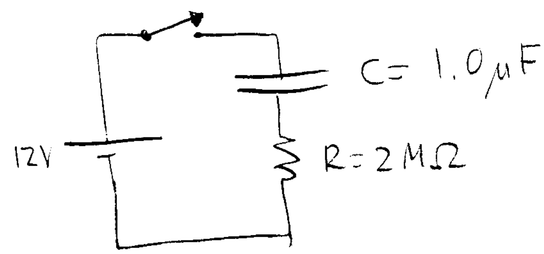
$\mathcal{E} = V = 12.0\,V$

$\boxed{RC}$

Voltage

$V @ \tau = RC$

$V(t=\tau) = 0.37\,V_i$



$$I = \frac{\mathcal{E}}{R} e^{-t/RC}$$

$$@\ t=0 \qquad I(t=0) = I_i = \frac{\mathcal{E}}{R} e^{-0} = \frac{\mathcal{E}}{R} = I_i$$

$$I(t) = I_i\, e^{-t/RC}$$

t when $I(t) = 0.37\,I_i$?

$$0.37\,\cancel{I_i} = \cancel{I_i}\, e^{-t/RC}$$

$$0.37 = e^{-t/RC}$$

$$\ln 0.37 \quad -t/RC$$

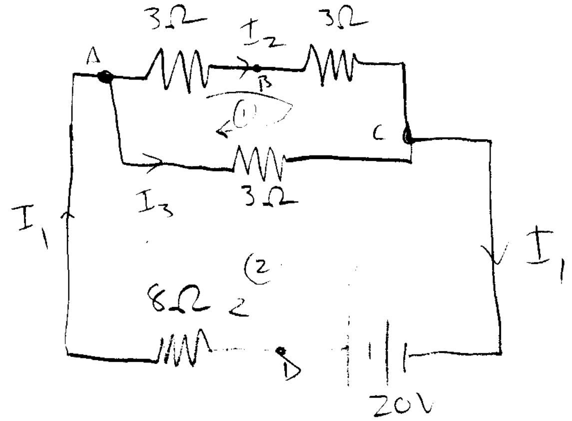
$$t = -RC \ln 0.37$$

$$= -(2\times10^{6}\,\Omega)(1.0\times10^{-6}\,F)\ln 0.37$$

$$\boxed{t = 1.99\,s}$$

$$\boxed{t = \tau = RC = 2\,s}$$

$\boxed{18.77}$



Node A:

$$I_1 = I_2 + I_3$$

Loop I:

$$3I_2 + 3I_2 - 3I_3 = 0$$

Loop 2:

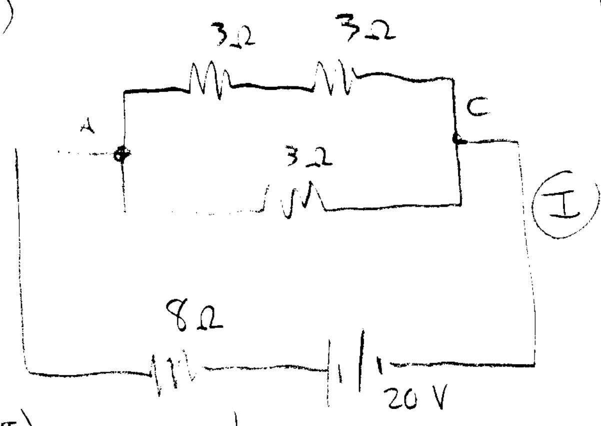
$$3I_3 - 20V + 8I_1 = 0$$

$$\left.\begin{aligned} I_1 - I_2 - I_3 &= 0 \\ 6I_2 - 3I_3 &= 0 \\ 8I_1 \qquad + 3I_3 &= 20 \end{aligned}\right\} \Rightarrow \begin{Bmatrix} I_1 \\ I_2 \\ I_3 \end{Bmatrix} = \begin{Bmatrix} 2 \\ 2/3 \\ 4/3 \end{Bmatrix} A$$

= OR =

Note: This is similar to quiz #4, questions 1(a-b)

$$I_1 = \frac{20V}{10\Omega} = 2A \quad \text{(from IV)}$$



$$V_{AC} = 2\Omega \times 2A = 4V \quad \text{(from III)}$$

$$I_2 = \frac{4V}{6\Omega} = 2/3\,A \quad \text{(from II)}$$

$$I_3 = \frac{4V}{3\Omega} = 4/3\,A$$