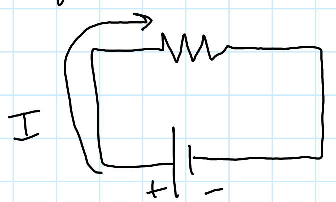
Phy 4B 5/18

Thursday, May 18, 2017 5:30 PM

Current and resistance:

direction of positive charge flow



$$I = \frac{dQ}{dt}$$

units: $\frac{C}{s} = A$ ← ampere

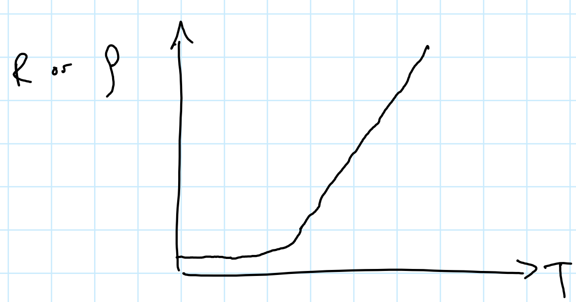
$$R = \rho \frac{l}{A}$$

ρ ← resistivity of the material

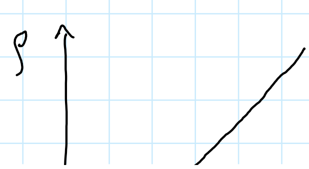
$$R = R_0 \left[1 + \alpha (T - T_0)\right]$$

R_0 ← resistance at T_0

α ← temp. coefficient of resistivity



Superconductors



Super...

Power :

$$P = \frac{\text{energy}}{\text{time}}$$

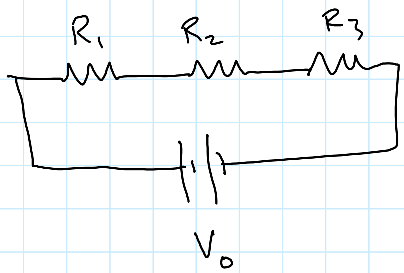
units $\frac{J}{s} = W$ ← watt

$$P = \begin{cases} I V \\ I^2 R \\ \frac{V^2}{R} \end{cases}$$

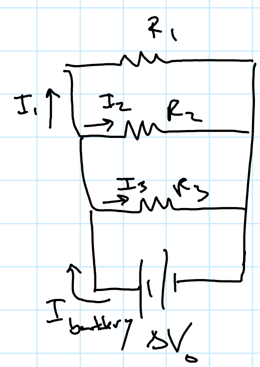
Since $V = IR$

Resistors :

Series



Parallel



Series:

$$\Delta V_1 + \Delta V_2 + \Delta V_3 = \Delta V_0$$

$$I_1 = I_2 = I_3 = I_{battery}$$

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

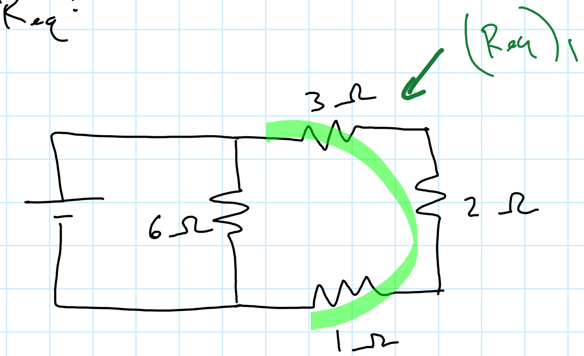
Parallel:

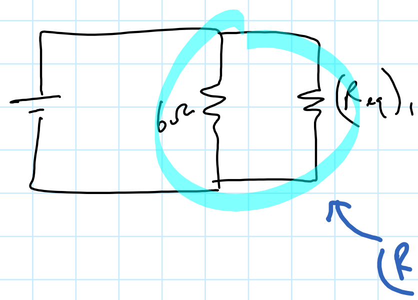
$$\Delta V_1 = \Delta V_2 = \Delta V_3 = \Delta V_0$$

$$I_1 + I_2 + I_3 = I_{battery}$$

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

Find R_{eq}:



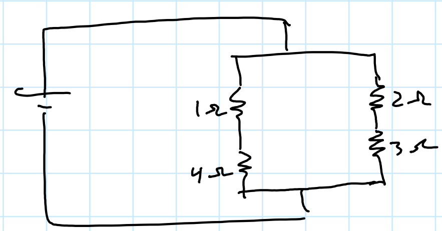


$(R_{eq})_1 = 3+2+1 = 6\ \Omega$

$(R_{eq})_2 = \dfrac{1}{\frac{1}{6}+\frac{1}{6}} = 3\ \Omega$

⇓

⇒



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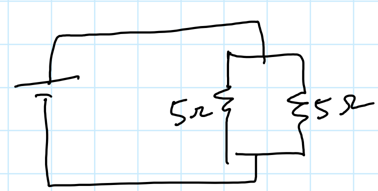

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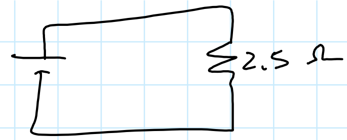
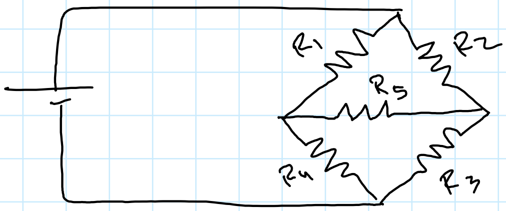




$R_1 = 1\ \Omega$

$R_2 = 2\ \Omega$

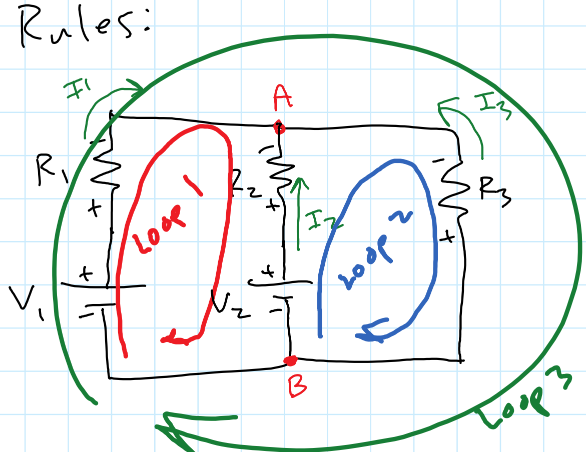
$R_3 = 3\ \Omega$

$R_4 = 5\ \Omega$

$R_5 = 5\ \Omega$

We Need Kirchhoff's Rules

Kirchhoff's Rules:



given: R_1, R_2, R_3

V_1 and V_2

Find: I_1, I_2, I_3

1) Define the current direction in each branch (just guess)

2) Junction Rule: $\sum I_{in} = \sum I_{out}$

at junction A: $\sum I_{in} = \sum I_{out}$

$$I_1 + I_2 + I_3 = 0$$

at junction B:

$$0 = I_1 + I_2 + I_3$$

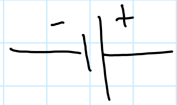
same as junction A

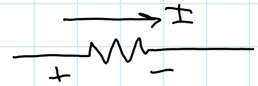
No New information

3) Mark high voltage side of each device with "+"

" Low " " " " " " "−"

" Low " " " " " " —

battery 

resistor: 

I flows from high to low potential

4) Loop Rule: $\sum \Delta V_{loop} = 0$

Loop 1: $+V_1 - I_1 R_1 + I_2 R_2 - V_2 = 0$

Loop 2: $+V_2 - I_2 R_2 + I_3 R_3 = 0$

3 equation → solve for 3 unknowns

Let $R_1 = 0.01\ \Omega$

$R_2 = 1\ \Omega$

$R_3 = 0.06\ \Omega$

$V_1 = 12\ V$

$V_2 = 10\ V$

$I_3 = -171\ A$

$I_2 = -0.283\ A$

To solve for I_1:

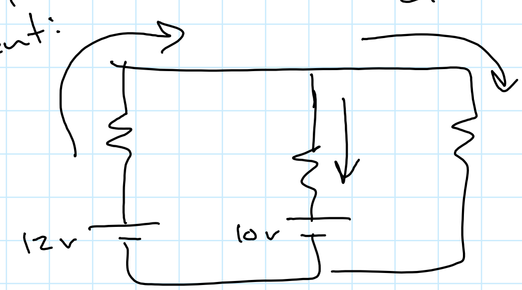
$I_1 + I_2 + I_3 = 0$

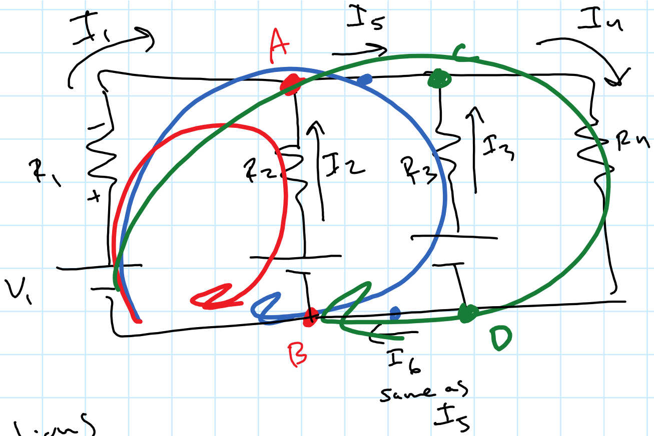
$I_1 + (-0.283) + (-171) = 0$

Keep the Negative sign until you have finished solving for everything

$I_1 = +171.283\ A$

Actual Flow of current:





Junctions

A: $I_1 + I_2 = I_5$

B: $I_6 = I_1 + I_2$

$\}$ $I_5 = I_6$

Junction A + B are the same

C: $I_3 + I_5 = I_4$

D: $I_4 = I_3 + I_5$

Junction C + D are the same

2 junction Rules:

$I_3 + I_5 = I_4$

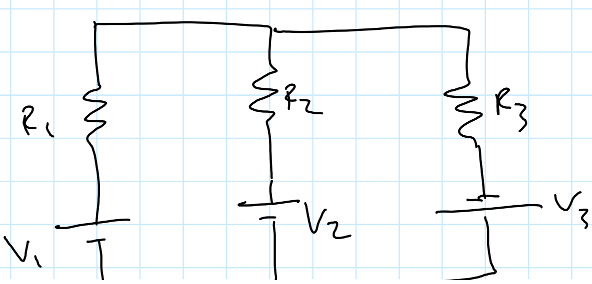
$I_1 + I_2 = I_5$

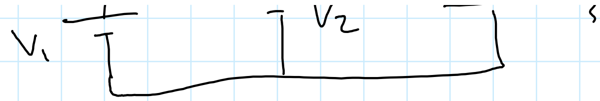
3 Loops

$\}$ 5 equations to solve for 5 unknowns

Problem: given: $R_1, R_2, R_3, V_1, V_2, V_3$

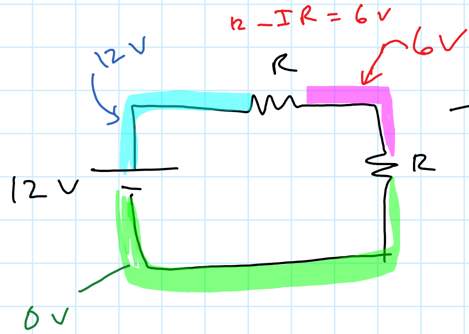
find: I_1, I_2, I_3

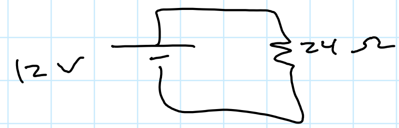




Let R = 12 Ω, find I for each circuit

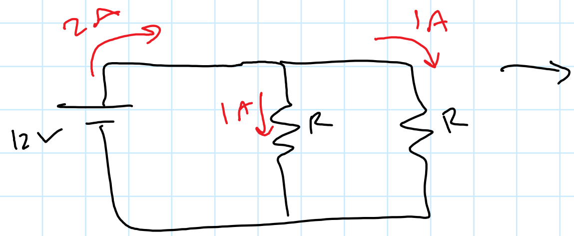
A)

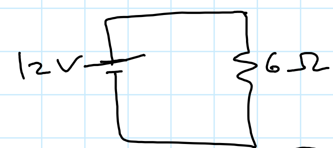




$I = \frac{V}{R} = 0.5\ A$

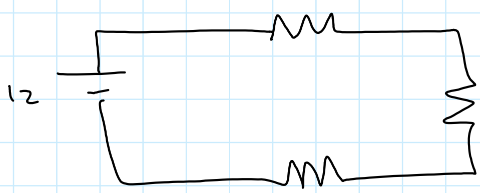
B)





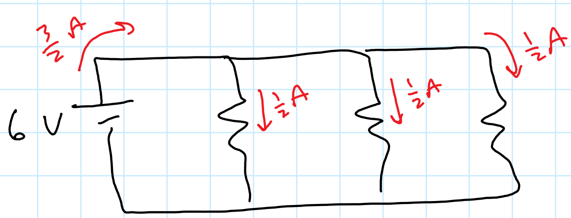
$I = \frac{12\ V}{6\ Ω} = 2\ A$

C)



$I = \frac{12\ V}{36\ Ω} = \frac{1}{3}\ A$

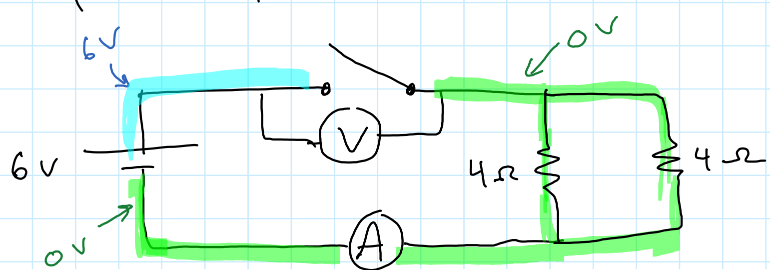
D)

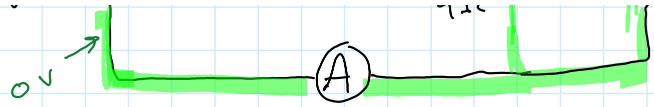


$I_{battery} = \frac{3}{2}\ A$

What do the meters read when the switches are open and/or closed?

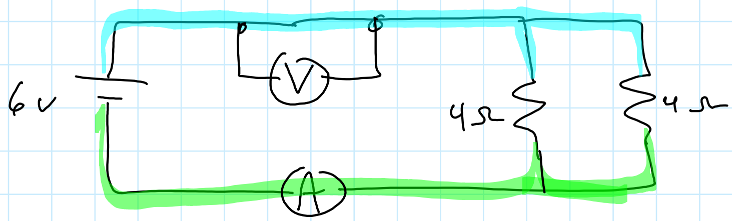
Open:





	V	A
open	6	0
closed	0	3

closed:



Ideal:

Voltmeter has infinite resistance

Ammeter has zero resistance