① Phys 2426 2017-07-11 Lec 5

Cost of Energy

$$\text{Energy} = P_{avg} \Delta t = \int P\,dt$$

Units: $(1\ J) = (1\ W)(1\ s)$

$$(1\ kWh) = (1000\ W)(1\ hr)$$
$$= (1000\ W)(3600\ s)$$
$$= 3.6\ MJ$$

Current cost around here: $0.12 = 1 kWh

Technically rate $= \dfrac{\$0.12}{kWh}$

$$\frac{100}{12}\ \$0.12 = \frac{100}{12}\ 3.6\ MJ$$
$$\$1.00 = 30\ MJ$$

Other Energy Sources:

1 GGE = 33.4 kWh = 120 MJ

If we burn gasoline for heat:

$2.00 → 1 gal gasoline → 120 MJ

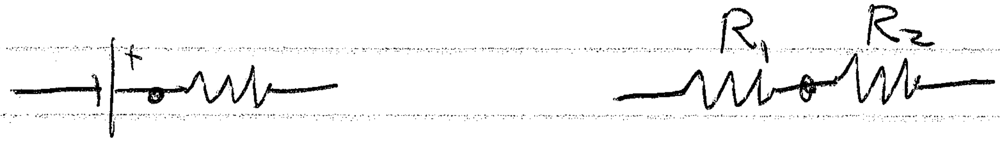
Would cost $4.00 from electricity

If we power an engine: 25% efficient

$2.00 → 120 MJ Heat → 30 MJ Work

Networks of Components

Series • Things connected @ one node, no fork in between.



• All current that goes thru one component also goes thru the other.

Series: $I_1 = I_2 = \ldots$

• Each component gives or takes some energy from each charge.

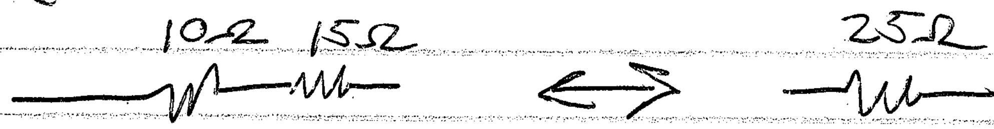
$$\frac{\text{Energy}_{tot}}{q} = \frac{\text{Energy}_1}{q} + \frac{\text{Energy}_2}{q} + \ldots$$

Series: $V_{Tot} = V_1 + V_2 + \ldots$

Effective Resistance: Only I and V_{Tot} known from outside.

$$R_{eq} = \frac{V_{Tot}}{I} = \frac{V_1 + V_2 + \ldots}{I} = \frac{V_1}{I} + \frac{V_2}{I} + \ldots$$

$$R_{eq} = R_1 + R_2 + \ldots$$



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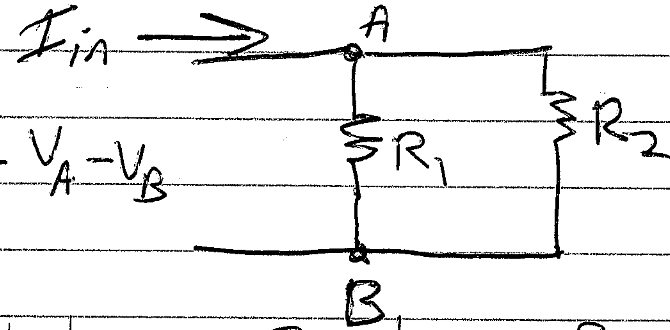
Parallel • Connected at both ends

• Each has the same Voltage (Potential Difference)



$V_1 = V_A - V_B$ $\qquad V_2 = V_A - V_B$

Potential is a function of position

Parallel : $\quad V_1 = V_2 = \ldots$

• The current that enters (I_{in}), splits into the several branches.

Parallel : $\quad I_{Tot} = I_1 + I_2 + \ldots$

• Parallel equivalent Resistance

$$R_{eq} = \frac{V}{I_{Tot}} = \frac{V}{I_1 + I_2 + \cdots} = \frac{V}{\frac{V}{R_1} + \frac{V}{R_2} + \cdots}$$

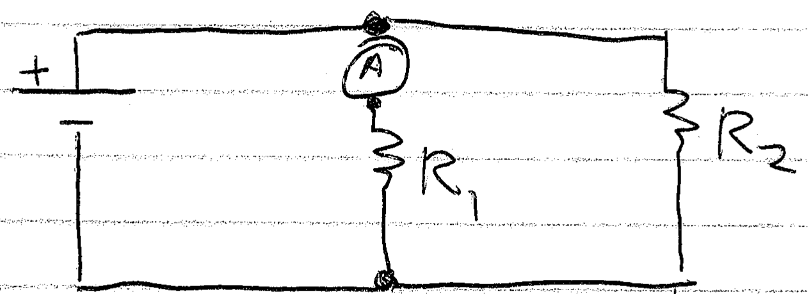
$$R_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \cdots\right)^{-1}$$

④

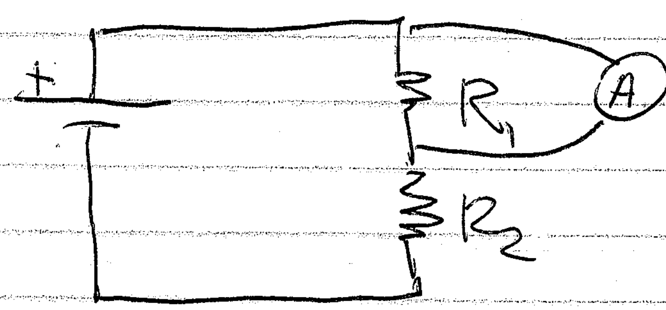
Measurements
- Meter has same value as stuff
- Try not to disturb the stuff.

Current - Measure in series.
- Ammeter has $R \approx 0$
  Current freely flows thru ammeter.

Voltage - Measure in parallel
- Voltmeter has $R \approx \infty$
  Voltmeter blocks current.



Measuring current of R_1



Incorrect Method

Kirchoff's Laws

- Generalize Series/Parallel rules for V, I.
- Codify a way to turn circuits into equations.

Pick Variables

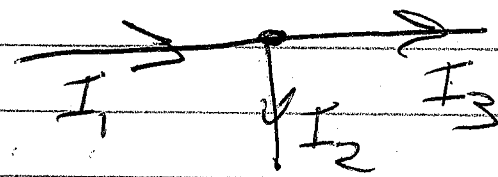
- Voltages of batteries
- Values of Resistors
- Currents in Wires

Alternative to Currents:

- Voltages at nodes
- Mesh Currents

Kirchoff's Current Law (Node or Junction Law)

- What goes in must come out.
- Applies directly to currents.



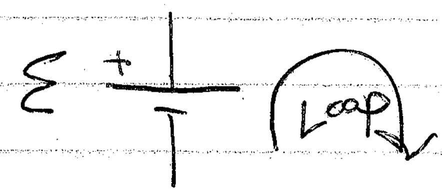
$I_1 = I_2 + I_3$

Kirchoff's Voltage Law (Loop Law)

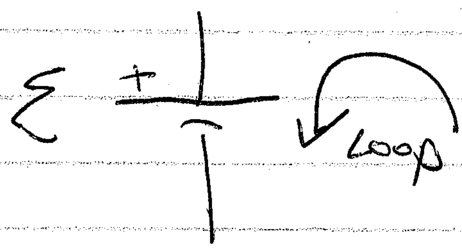
- What goes up must come down.
- Pick a loop - direction - start/end point
- Each component along the loop corresponds to some ΔV.

  Batt: $\Delta V = \pm \mathcal{E}$ Resistor: $\Delta V = \pm IR$
- Total ΔV of a loop is zero.

Path passing a battery:



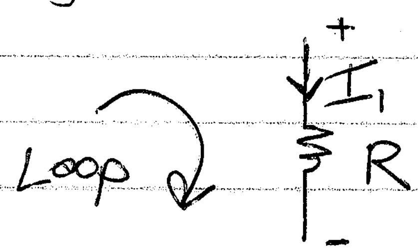
$\Delta V = +\varepsilon$



$\Delta V = -\varepsilon$

Path passing a resistor:

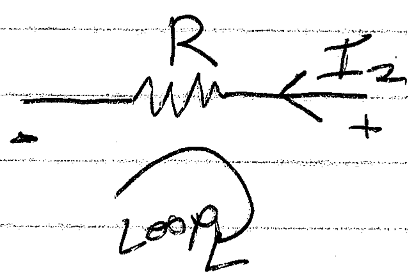
$\Delta V = -I_1 R$



Which end is ⊕ if $I_1 > 0$?

Current flows "down".

If we're going against the current:



$\Delta V = I$ [illegible] R

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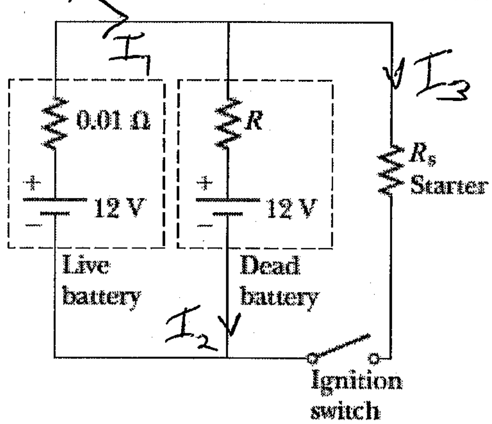
Print Show: All, None ☑ Key ☐ Solution ☐ Help/Hints
☐ Mark ☐ Answer Format Tips

Jumper cables are connected from a fresh battery in one car to charge a dead battery in another car. The figure below shows the circuit diagram for this situation. While the cables are connected, the ignition switch of the car with the dead battery is closed and the starter is activated to start the engine. (Let R = 1.20 Ω and R_s = 0.05 Ω.)



Current: $I_1 = I_2 + I_3$

Outer Loop, CW:

$+(12\,V) - I_1(0.01\,\Omega) - I_3(0.05\,\Omega) = 0$

↑ following current

Left Loop, CW:

$+(12\,v) - I_1(0.01\,\Omega) - I_2(1.2\,\Omega) - 12\,v = 0$

$I_1 = 198.6$ $I_2 = -1.66$ $I_3 = 200.3$

(a) Determine the current in the starter

[ ] 200 A downward

(b) Determine the current in the dead battery.

[ ] 1.66 A upward

(c) Is the dead battery being charged while the starter is operating?

- Yes
- ☑ No (I_2 is negative as drawn)
- There is not enough information.

Question Details

Name (QID): **SerPSET9 28.P.028. (3539297)**
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Textbook
Serway and Jewett, "Physics for Scientists and Engineers, Technology Update", ed.9

Chapter
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