REVIEW - ELECTROSTATICS AND CIRCUITS

- Charge of proton/electron → $\pm 1.6E-19C$
- Like charges repel; unlike charges attract

- Equations
  - Coulomb's Law: $F = \frac{k q_1 q_2}{r^2}$

    $k = 9E9 \frac{N \cdot m^2}{C^2}$ direction comes from drawing

  - Current: $I = \frac{\Delta q}{\Delta t}$

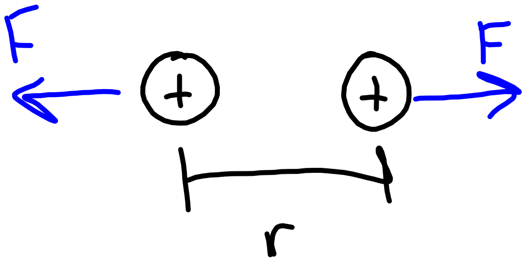
    $1 \text{ Ampere} = 1 \frac{\text{coulomb}}{\text{second}}$

  - Ohm's Law: $V = IR$
  - Electric Power: $P = IV = I^2 R = \frac{V^2}{R}$
  - Equivalent Resistance
    - Series: $R_{eq} = R_1 + R_2 + \ldots$
    - Parallel: $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$

- Variables: [Units]
  - F → Force [Newtons → N]
  - q → charge [Coulombs → C]
  - r → distance between charged particles [meters → m]
  - t → time [seconds → s]
  - I → current [Amperes → A]
  - V → electric potential (voltage, voltage drop) [Volts → V]
  - R → resistance [Ohms → Ω]
  - P → power [Watts → W]
  - R_{eq} → equivalent resistance [ohms → Ω)

Review Sheet

2)



$F = 105\ N$

$k = 9E9\ \frac{N \cdot m^2}{C^2}$

$q_1 = 4E{-6}\ C$

$q_2 = 4E{-6}\ C$

$$F = \frac{k q_1 q_2}{r^2}$$

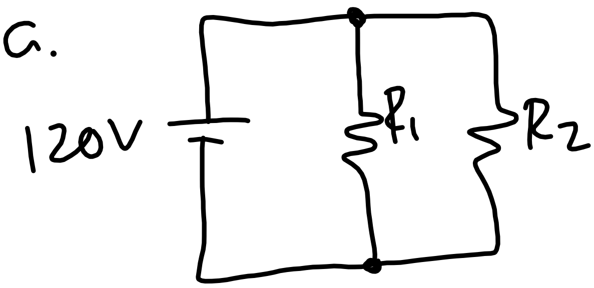
$$r = \sqrt{\frac{k q_1 q_2}{F}}$$

$$= \sqrt{\frac{\left(9E9\ \frac{N \cdot m^2}{C^2}\right)(4E{-6}\ C)(4E{-6}\ C)}{105\ N}}$$

$$= 0.037\ m$$

Power And Parallel Circuits

7) a.



$R_1 \rightarrow$ blender (400W)

$R_2 \rightarrow$ coffee maker

b) $P_1 = I_1 V$

$I_1 = \frac{P_1}{V}$

$= \frac{400\,W}{120\,V}$

$= 3.33\,A$

$P_2 = I_2 V$

$I_2 = \frac{P_2}{V}$

$= \frac{900\,W}{120\,V}$

$= 7.5\,A$

$I_{total} = I_1 + I_2$

$= 3.33\,A + 7.5\,A$

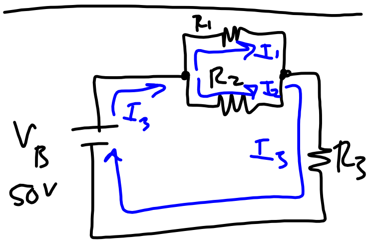
$= 10.83\,A$ BREAKER STILL ON!

c) $I_{Breaker} = 15\,A$

$I_{extra\,device} = 15\,A - 10.83\,A = 4.17\,A$

$P_{extra\,device} = V I_{extra\,device} = 500\,W$

Combination Circuit



$R_1 = 10\,\Omega$

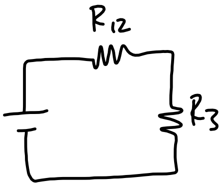
$R_2 = 30\,\Omega$

$R_3 = 20\,\Omega$

Find I_1, I_2, I_3

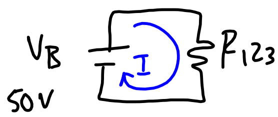
V_1, V_2, V_3

P_1, P_2, P_3



$$\frac{1}{R_{12}} = \frac{1}{R_1} + \frac{1}{R_2}$$

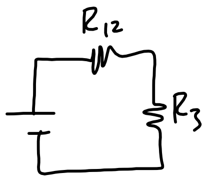
$R_{12} = 7.5\,\Omega$



$R_{123} = R_{12} + R_3$

$= 27.5\,\Omega$

$$I = \frac{V_B}{R_{123}} = \frac{50\,V}{27.5\,\Omega} = 1.82\,A$$

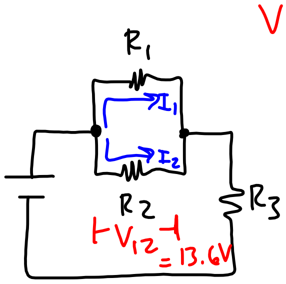


$I_3 = 1.82\,A$

$I_{12} = 1.82\,A$

$V_3 = I_3 R_3 = 36.4\,V$

$V_{12} = V_B - V_3 = 13.6\,V$



$P_3 = I_3 V_3 = 66.2\,W$

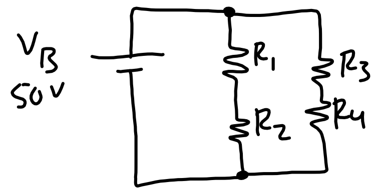
$$I_1 = \frac{V_{12}}{R_1} = \frac{13.6\,V}{10\,\Omega} = 1.36\,A$$

$$I_2 = \frac{V_{12}}{R_2} = \frac{13.6\,V}{30\,\Omega} = 0.45\,A$$

$I_2 = I_3 - I_1$

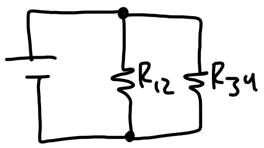
$P_1 = I_1 V_1 = 18.5\,W$

$P_2 = I_2 V_2 = 6.2\,W$



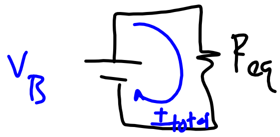
$R_1 = 10\Omega$
$R_2 = 15\Omega$
$R_3 = 5\Omega$
$R_4 = 30\Omega$

Find I_1, I_2, I_3, I_4
V_1, V_2, V_3, V_4
P_1, P_2, P_3, P_4



$R_{12} = R_1 + R_2 = 25\Omega$

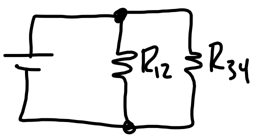
$R_{34} = R_3 + R_4 = 35\Omega$



$$\frac{1}{R_{eq}} = \frac{1}{R_{12}} + \frac{1}{R_{34}}$$

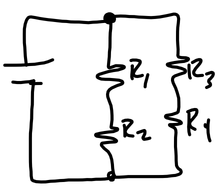
$R_{eq} = 14.58\Omega$

$$I_{total} = \frac{V_B}{R_{eq}} = 3.43\text{ A}$$



$V_{12} = 50V$ $\quad$ $V_{34} = 50\text{ V}$

$$I_{12} = \frac{V_{12}}{R_{12}} = 2A \qquad I_{34} = \frac{V_{34}}{R_{34}} = 1.43A$$



$I_1 = I_2 = I_{12} = 2A$

$I_3 = I_4 = I_{34} = 1.43A$

$V_1 = I_{12}R_1 = 20V$ $\quad$ $V_3 = I_{34}R_3 = 7.15V$

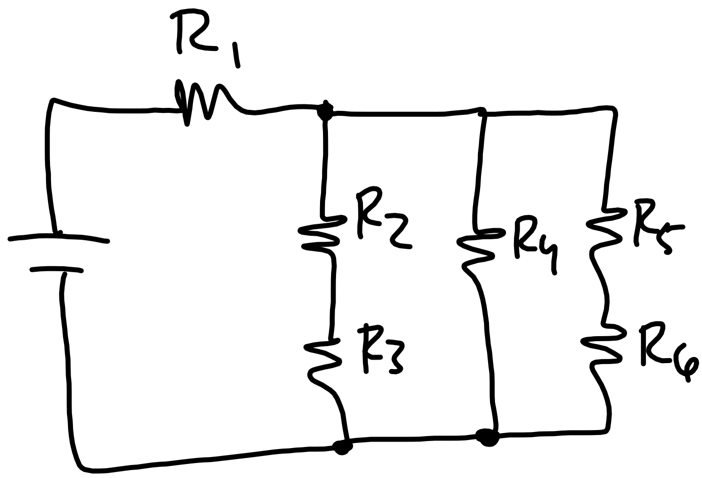
$V_2 = I_{12}R_2 = 30V$ $\quad$ $V_4 = I_{34}R_4 = 42.85V$

$P_1 = I_{12}V_1 = 40W$ $\quad$ $P_3 = I_{34}V_3 = 9.6W$

$P_2 = I_{12}V_2 = 60W$ $\quad$ $P_4 = I_{34}V_4 = 61.4W$

TEST

- Conceptual
  - electric force
  - connecting ammeters and voltmeters
  - Circuits
- Problems
  - Coulomb's Law
  - Series-only circuit
  - Parallel-only circuit
  - Combination circuit (four resistors)


R1
R2
R3
R4
R5
R6