PY 202 Wed, Feb. 15 reading: 25-6

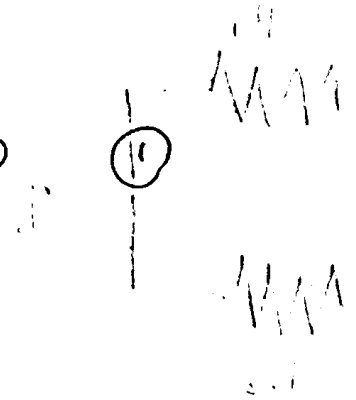
⟹ midterm 2: 24, 25

Kirchhoff

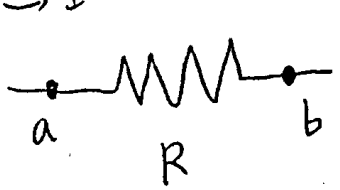
(Friday: RC circuits)
(Monday: review)

HW 25
1) easy 2) easy 3) Kirchhoff
4) RC 5) R_{eq}, ohm's Law* ← hard
6) Kirchhoff 7) RC

- resitors in parallel } $R_{eq} = ?$ ②
- resistors in series
- P dissipated in resistor? ①
- Kirchhoff's Rules ③



① Power



$V_a > V_b$

move charge dq (ΔQ) from a to b

$\Delta U = \Delta Q (V_b - V_a)$ } energy loss

rate of energy loss

$$\frac{\Delta U}{\Delta t} = \frac{\Delta Q}{\Delta t}(V_b - V_a)$$

$$= I(V_b - V_a)$$

$$\frac{du}{dt} = I(V_b - V_a)$$

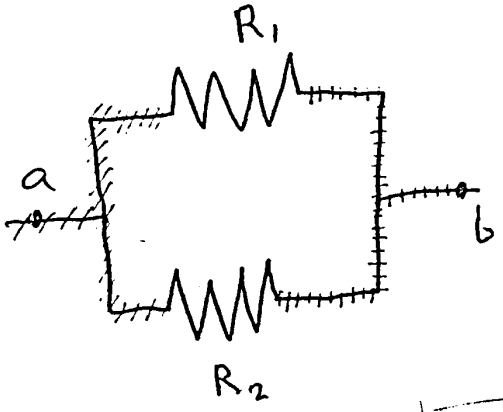
$V = \Delta V = V_b - V_a$

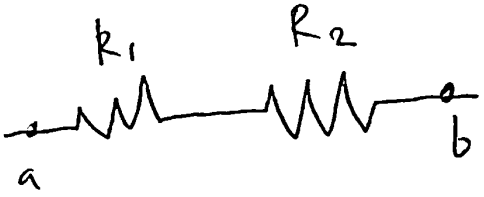
"charge ☺"

$$P = \frac{du}{dt} = I(V_b - V_a)$$

$$\boxed{P = IV}$$ Power

② R_{eq}, Series and Parallel





Series

Parallel

$V_{AB} = 12$ volts

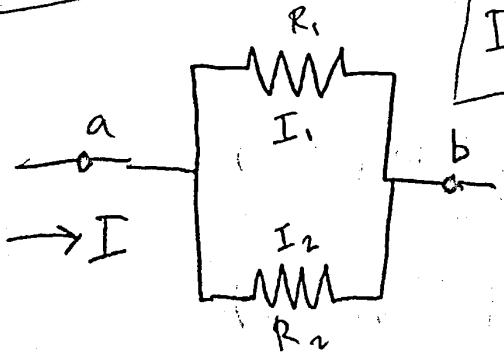
$V_1 = V_2 = V_{AB}$

Ohm's Law

$I = V/R$

$I = \frac{V_{AB}}{R_{eq}} = I_1 + I_2$

$I_1 + I_2 = I$

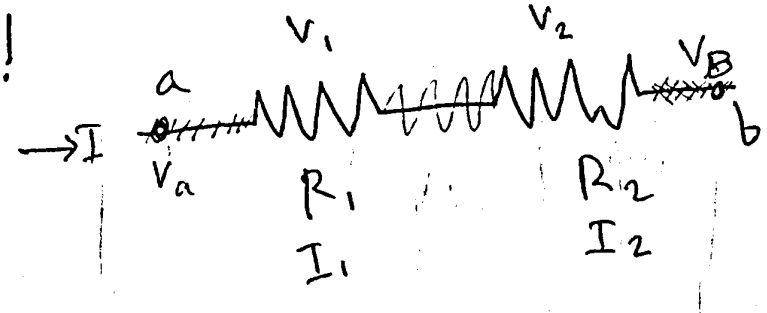


$I_1 = \frac{V_1}{R_1}$, $I_2 = \frac{V_2}{R_2}$

$= \frac{V_{AB}}{R_1}$, $= \frac{V_{AB}}{R_2}$

$I = \frac{V_{AB}}{R_1} + \frac{V_{AB}}{R_2} = \frac{V_{AB}}{R_{eq}} \Rightarrow \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{R_{eq}}$

Series!



$$V_1 + V_2 = V_{ab}$$

$$I_1 = I_2 = I$$

+ Ohm's Law:

$$V_{ab} = I R_{eq}$$

$$V_{ab} = V_1 + V_2 = I R_1 + I R_2$$

$$I(R_1 + R_2) = I R_{eq}$$

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

Parallel: $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$

Series: $R_{eq} = R_1 + R_2$

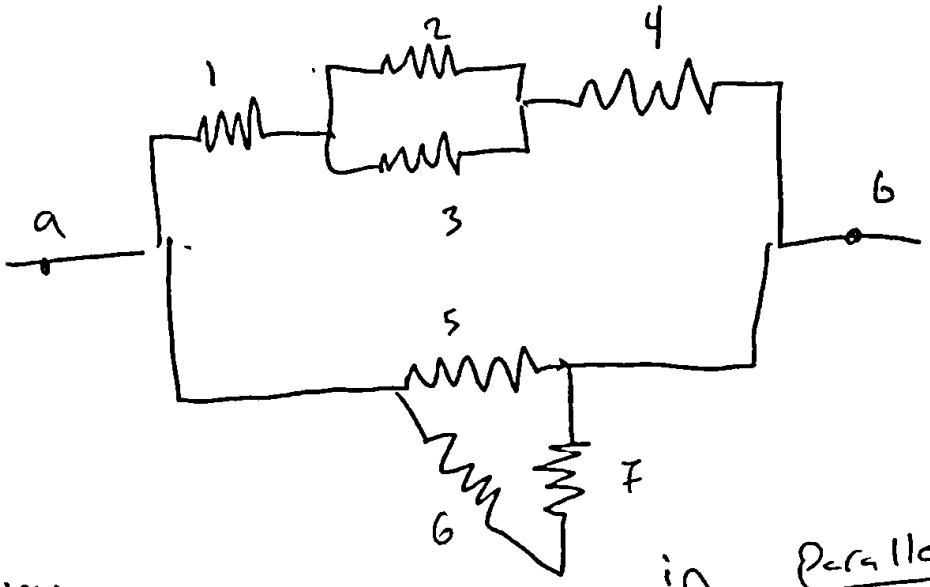
+ Ohm's Law

Method: when are voltages / currents the same!

Caps: when are currents / Q's the same?)

→ + Cap Law

ex



in series:

R_1, R_{23}, R_4

R_6, R_7

in parallel:

R_{1234}, R_{567}

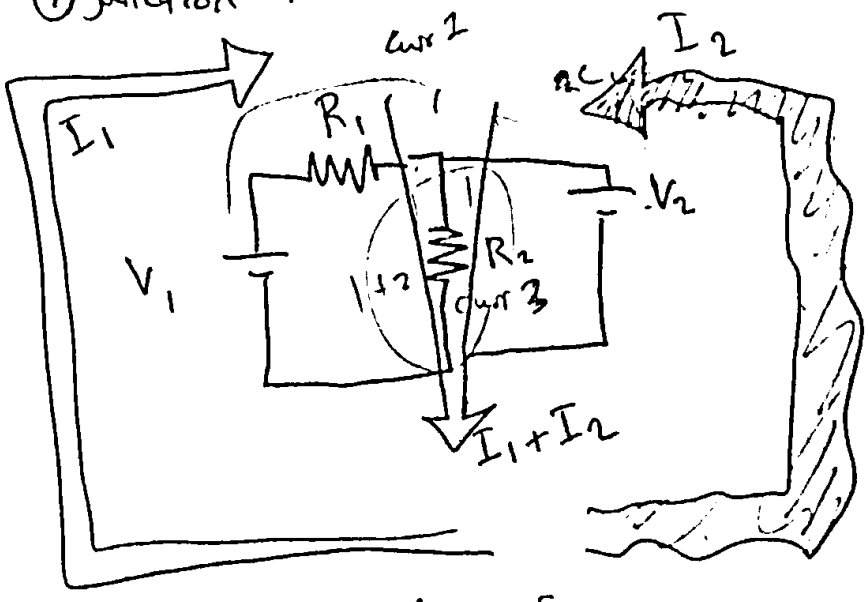
R_5, R_{67}

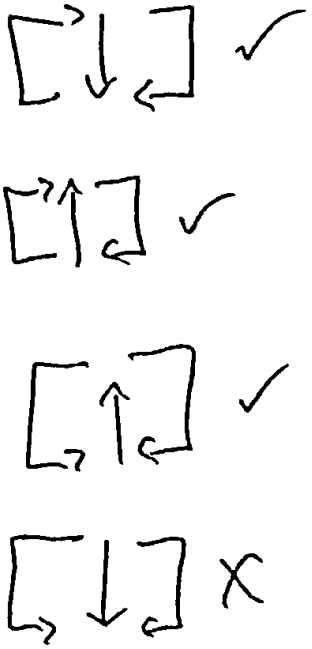
R_2, R_3

③ Kirchhoff's Rules

① junction rule

② loop rule





Labels, directions free — just be consistent!

① Junction Rule

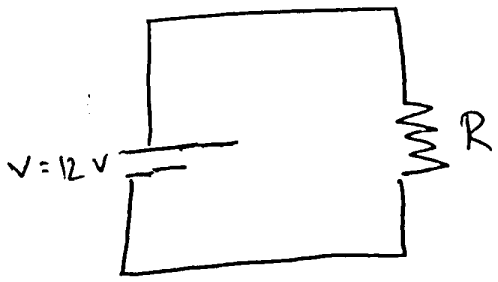
$$\sum I_{\text{into junction}} = \sum I_{\text{out of junction}}$$

② (Loop Rule)

$\sum V_i = 0$

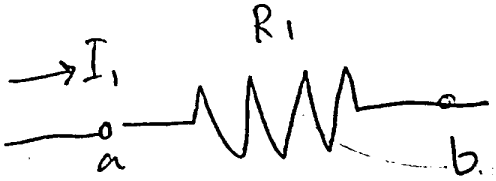
$+$: low → high Potential
$-$: high → low potential

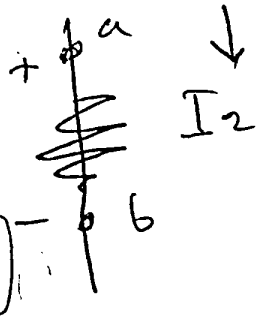
} based on direction thru loop



$V_R = 12V = V$

$V_R - V = 0$





identify high/low Potential sides :

junction rule

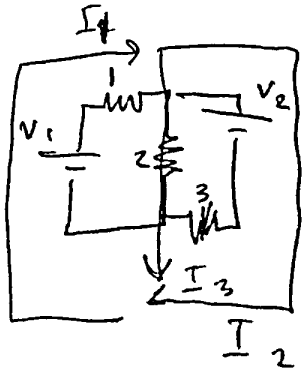
$$I_1 = I_2 + I_3$$

★ use loops and junction rule to solve for unknown currents

Left loop (clockwise)

loop rule

$$+V_1 - I_1 R_1 - I_3 R_2 = 0$$



right loop (clockwise)

loop rule

$$-V_2 - I_2 R_3 + R_2 I_3 = 0$$

▷ Outside loop (clockwise)

$$V_1 - I_1 R_1 - V_2 - I_2 R_3 = 0 \quad (III)$$

$$(I) + (II) = (III)$$

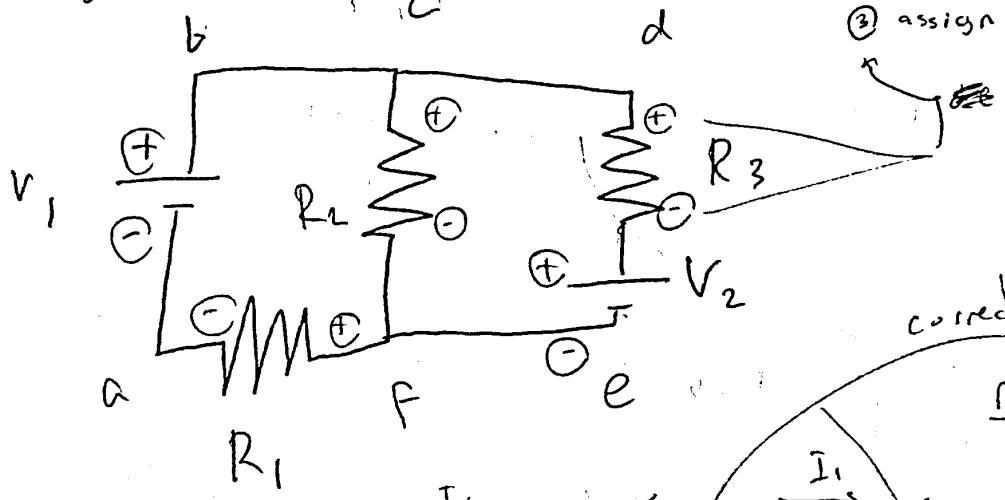
▷ Pick simplest loop rules (fewest terms)

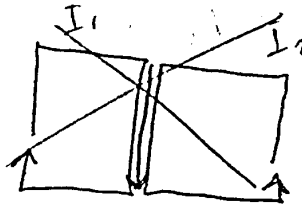
▷ Kirchhoff's rules for N currents
- junction rule → 1 eq.
- loop rule → N-1 eq.

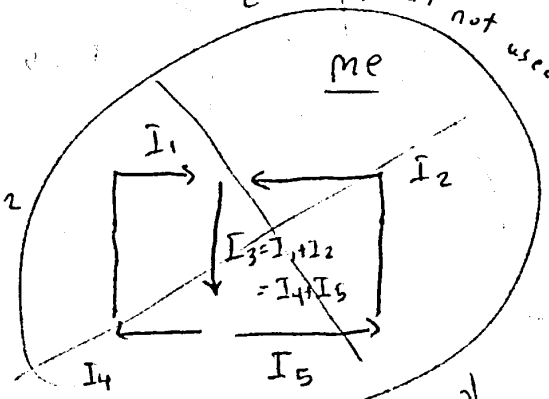
☞ Get enough loop eqns. until you have enough eqns. to find all variables

- label currents
- label high and low potentials

① current directions
② current goes high → low
③ assign V +/-







junction: define currents
at c: $I_1 = I_2 + I_3$
at f:

loop: abcfa (CW): $V_1 - I_2 R_2 - R_1 I_1 = 0$
edefc (CW): $-I_3 R_3 - V_2 + I_2 R_2 = 0$
abcdefa (CW): $V_1 - I_3 R_3 - V_2 - I_1 R_1 = 0$

Pr: F: