

OUTLINE

LAST TIME: CH 2

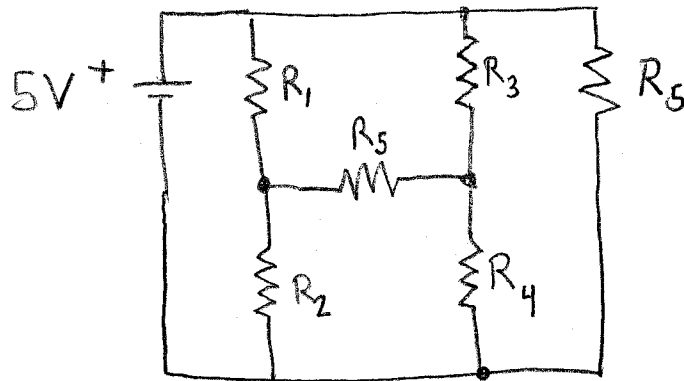
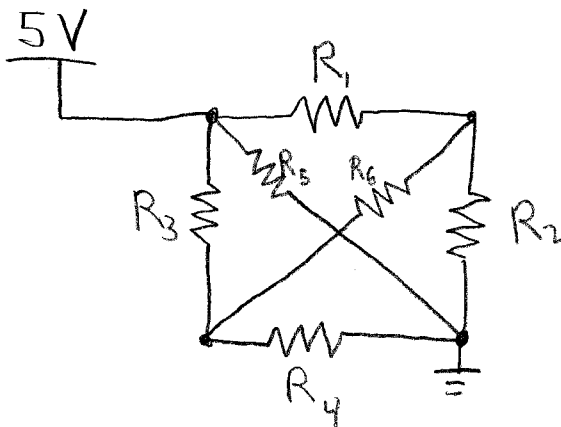
- CHARGE
- CURRENT
- RESISTANCE, OHM'S LAW
- POWER ← (FINISH THIS TIME)

TODAY: CH. 3 (AND A BIT OF 4)

- CIRCUIT DIAGRAMS
- KIRCHOFF'S LAWS
- SERIES & PARALLEL

BRAD

Q: ARE THESE TWO DRAWINGS THE SAME, OR ARE THEY DIFFERENT?

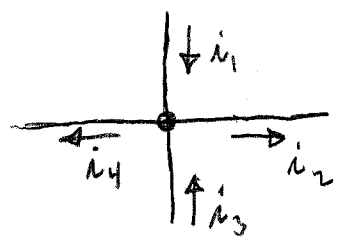


KIRCHOFF'S CURRENT LAW (KCL)

A NODE IS DEFINED AS A PLACE WHERE SEVERAL WIRES COME TOGETHER IN A CIRCUIT. WE COMMONLY IGNORE NODES WITH LESS THAN 3 WIRES (COMPARE FAISLER'S DEFINITION).

KCL: CURRENTS COMING INTO A NODE ADD TO ZERO. (WHY? DISCUSS...)

EXAMPLE

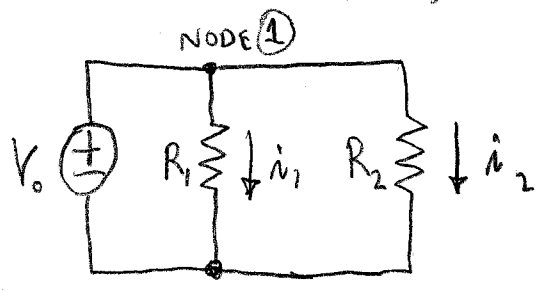


$$i_1 + i_3 - i_2 - i_4 = 0$$

DISCUSS: WHAT DO THE DIRECTIONS OF THE ARROWS ACTUALLY MEAN?

EXAMPLE

GIVEN V_0, R_1, R_2 FIND i_0



$$i_1 = V_0 / R_1$$

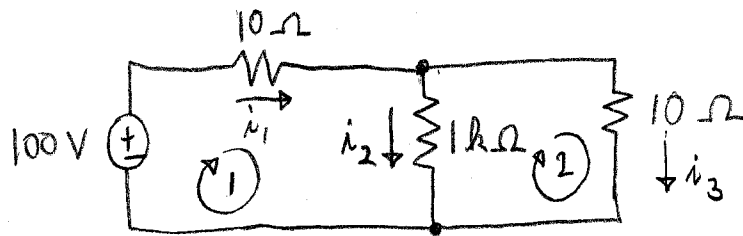
$$i_2 = V_0 / R_2$$

$$\text{KCL } \textcircled{1}: i_0 = i_1 + i_2 = V_0 \left(\frac{1}{R_1} + \frac{1}{R_2} \right)$$

NOTE: THE OTHER NODE GIVES THE SAME EQUATION FOR KCL.

KIRCHOFF'S VOLTAGE LAW (KVL)

THE SUM OF VOLTAGE CHANGES AROUND ANY CLOSED LOOP IS ZERO. (POTENTIAL DIFFERENCES ARE PATH INDEPENDENT)



$$\text{KVL } \textcircled{1}: 100\text{V} - i_1 10\Omega - i_2 1\text{k}\Omega = 0$$

$$\Rightarrow i_1 + 100i_2 = 10\text{A}$$

$$\text{KVL } \textcircled{2}: i_2 1\text{k}\Omega - i_3 10\Omega = 0$$

$$\Rightarrow i_3 - 100i_2 = 0$$

$$\text{KVL } \textcircled{3}: 100\text{V} - i_1 10\Omega - i_3 10\Omega = 0$$

$$\Rightarrow i_1 + i_3 = 10\text{A}$$

NOTE: $\textcircled{1} - \textcircled{3} \rightarrow 100i_1 - i_3 = 0$, SAME AS $\textcircled{2}$

Q: WE HAVE BUT 2 EQUATIONS, AND 3 UNKNOWN. WHAT NOW?

A: USE KCL: $i_1 = i_2 + i_3$

$$\text{COMBINE WITH } \textcircled{3} \Rightarrow i_2 = 10\text{A} - 2i_3$$

$$\text{SUBSTITUTE THIS INTO } \textcircled{2}: i_3 - 100(10\text{A} - 2i_3) = 0$$

$$\Rightarrow i_3 = 4.9751\text{A}$$

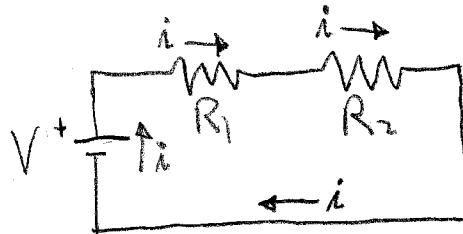
$$i_2 = 10\text{A} - 2i_3 = 0.049751\text{A}$$

$$i_1 = i_2 + i_3 = 5.0249\text{A}$$

DISCUSS
SIGNIFICANT
FIGURES

WHEN 2 OR MORE PARTS ARE WIRED END-TO-END,
WE SAY THEY ARE IN SERIES.

EXAMPLE
BATTERY IN
SERIES WITH
2 RESISTORS



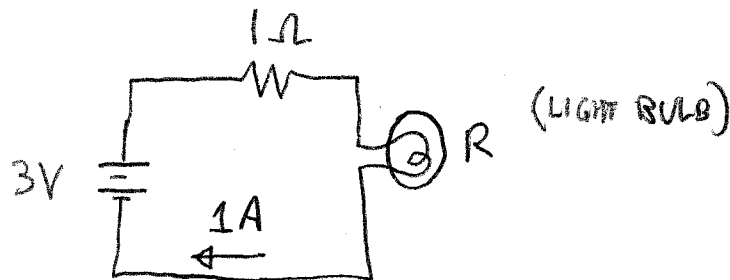
ELEMENTS IN
SERIES SHARE THE
SAME CURRENT.

$$\text{KVL: } V - iR_1 - iR_2 = 0$$

$$\therefore i = \frac{V}{R_1 + R_2} \leftarrow \text{EQUIVALENT RESISTANCE}$$

RESISTORS IN SERIES ADD: $R_{\text{TOT}} = R_1 + R_2 + \dots + R_N$

EXAMPLE



Q: WHAT IS THE RESISTANCE R?

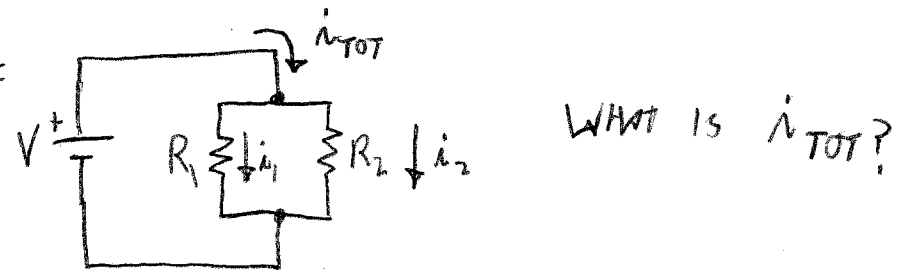
$$\text{A: } \frac{3V}{1\Omega + R} = 1A \Rightarrow R = 2\Omega$$

Q: WHAT IS THE POWER DISSIPATED IN THE BULB?

$$\text{A: } P = iV = i^2R = (1A)^2(2\Omega) = 2W$$

TWO OR MORE COMPONENTS ARE SAID TO BE IN PARALLEL IF THEY ARE ALL WIRED TOGETHER AT BOTH ENDS.

EXAMPLE



KCL: $i_{TOT} = i_1 + i_2$

KVL: $V - i_1 R_1 = 0 \Rightarrow i_1 = V/R_1$

$V - i_2 R_2 = 0 \Rightarrow i_2 = V/R_2$

$\therefore i_{TOT} = \frac{V}{R_1} + \frac{V}{R_2} = V \left(\frac{1}{R_1} + \frac{1}{R_2} \right)$

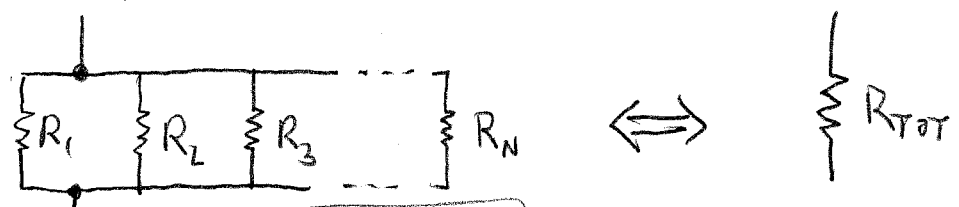
SUPPOSE WE WRITE THIS AS:

$i_{TOT} = \frac{V}{R_{TOT}}$ (AN "EQUIVALENT RESISTANCE"),

THEN $\frac{1}{R_{TOT}} = \frac{1}{R_1} + \frac{1}{R_2}$

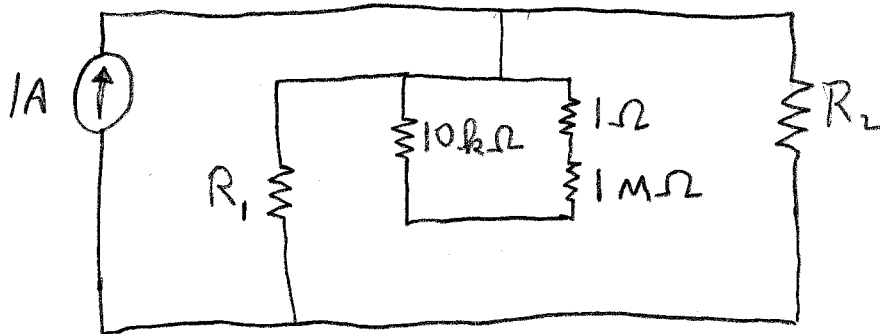
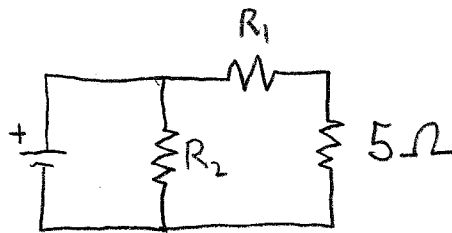
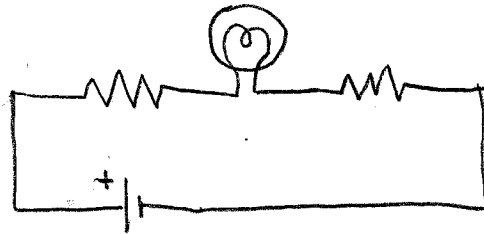
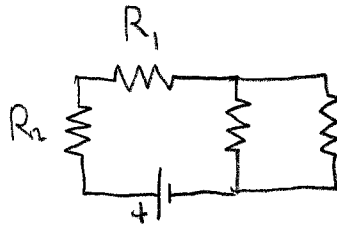
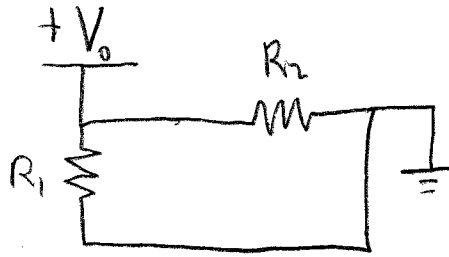
$R_{TOT} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$

MORE GENERALLY:



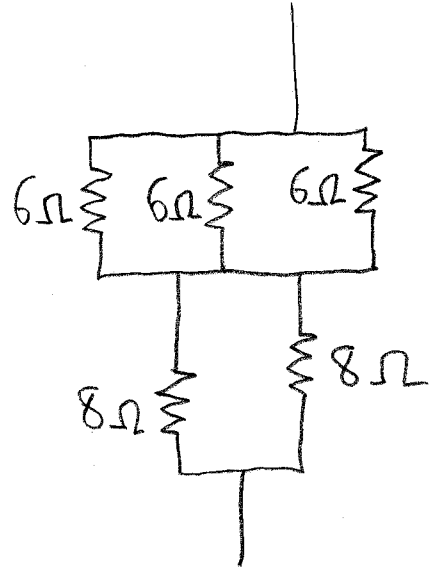
$R_{TOT} = \frac{1}{\sum_{l=1}^N \frac{1}{R_l}}$

EXERCISE : ARE R_1 & R_2 IN SERIES, PARALLEL, OR NEITHER?



ANSWERS: PARALLEL, SERIES, SERIES, NEITHER, PARALLEL

EXERCISE: FIND THE TOTAL RESISTANCE



} $R_{TOT} = ?$

CAMPAD

IN PARALLEL ARE 2Ω . THE 2 8Ω RESISTORS,
 ALSO IN PARALLEL, ARE 4Ω . THE 2Ω COMBINATION
 IS IN SERIES WITH THE 4Ω COMBINATION.

ANSWER: $R_{TOT} = 6\Omega$. THE 3 6Ω RESISTORS