KCL (Continued)

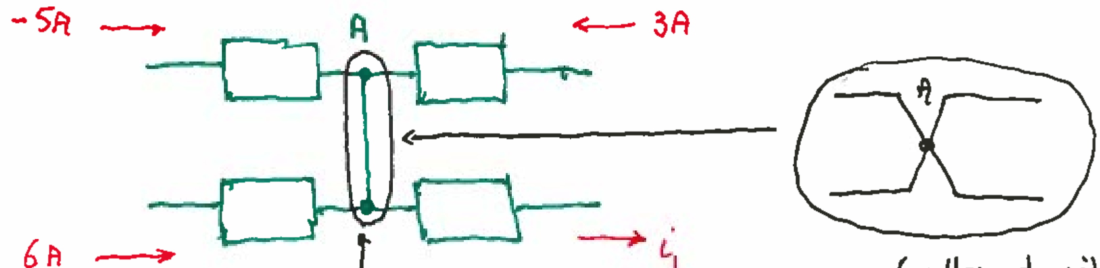
Wednesday, January 20, 2016 (morning)

From our previous example at node A

$$\underbrace{i_1 + i_2}_{\text{entering node A}} - \underbrace{i_3}_{\text{leaving node A}} = 0$$

so $i_3 = i_1 + i_2$ (common-sense interpretation: what goes in must come out!)

Example: Determine i_1



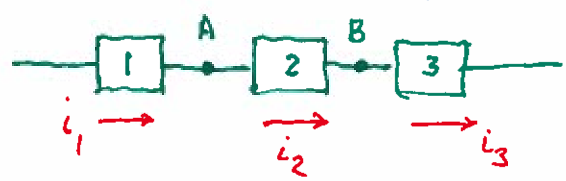
Note this is a single node! Two connection points joined by a conductor.

(collapsed into a single connection point)

KCL at node A: $\underbrace{-5 + 6 + 3}_{\text{entering}} - \underbrace{i_1}_{\text{leaving}} = 0$

Series circuits:

This is a very common and important circuit configuration.



nodes A and B each join exactly two circuit elements.

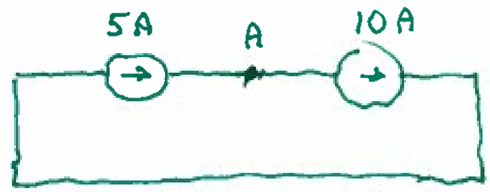
KCL at node A: $i_1 - i_2 = 0$, $i_1 = i_2$

node B: $i_2 - i_3 = 0$, $i_2 = i_3$

Circuit elements in <u>series</u> all have the <u>same current</u>

$$i_1 = i_2 = i_3$$

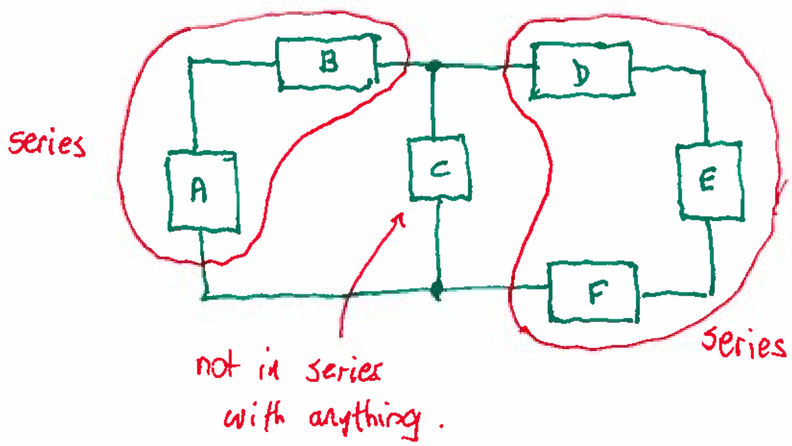
Circuits that violate KCL



Must have the same current when in series. At Node A:

$$5 - 10 \neq 0$$

<u>Example</u> : What's in series here?

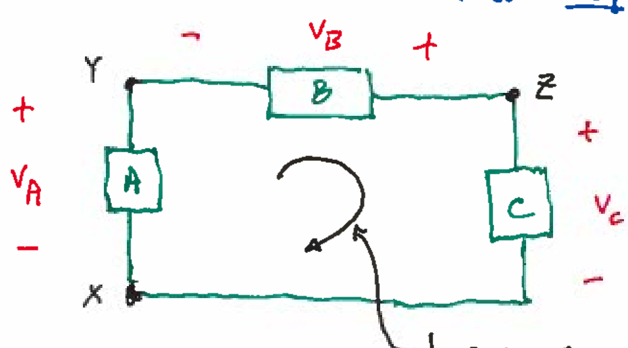


Examine all connection points (nodes), and identify ones at which only <u>two</u> circuit elements are joined.

<u>Kirchoff's voltage Law</u> (KVL)

Derives from conservation of energy.

Consider circuit elements in a closed <u>loop</u>

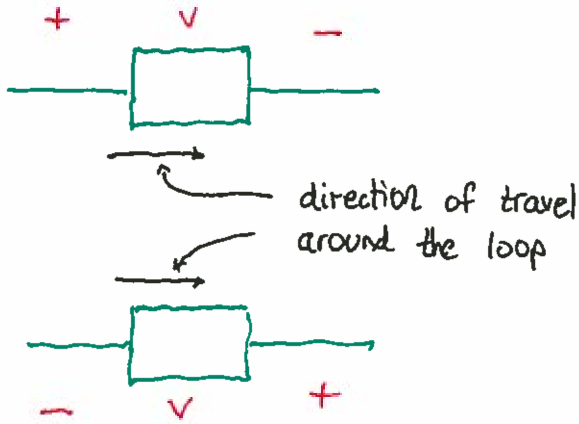


<u>loop</u> : a closed path starting at a node and finishing back at the same node.

$$X \rightarrow Y \rightarrow Z \rightarrow X$$

KVL states : $\boxed{\text{Algebraic sum of all voltages around a loop must be zero}}$

Choose a consistent way to sum voltages. By convention:



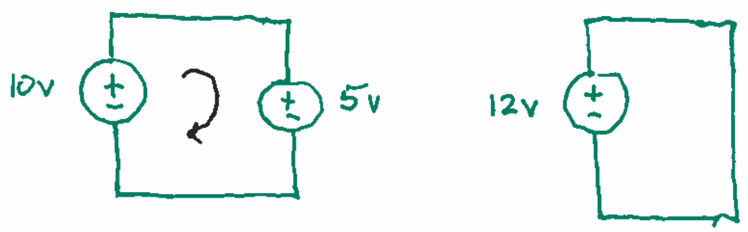
Add v

Subtract v

Therefore, KVL around our above loop gives

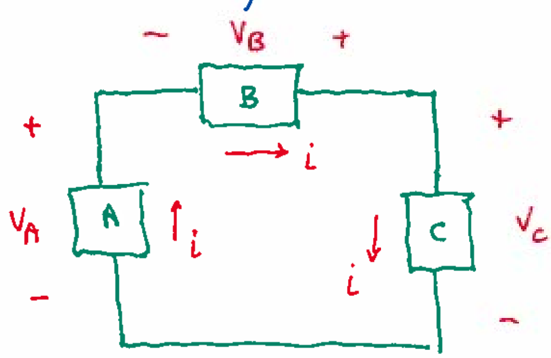
$$-V_A - V_B + V_C = 0$$

Circuits that violate KVL.



$-10 + 5 \neq 0$ $\qquad$ $-12 \neq 0$

KVL and power and energy



There must be at all times energy balance (generated must equal absorbed). Hence at any time, net power must be zero.

Circuit element	power
A	$-V_A i$
B	$-V_B i$
C	$V_c i$

Using passive reference convention

$$-V_A i - V_B i + V_c i = 0$$

or $$i(-V_A - V_B + V_c) = 0$$

Assuming $i \neq 0$, $$\boxed{-V_A - V_B + V_c = 0}$$ KVL