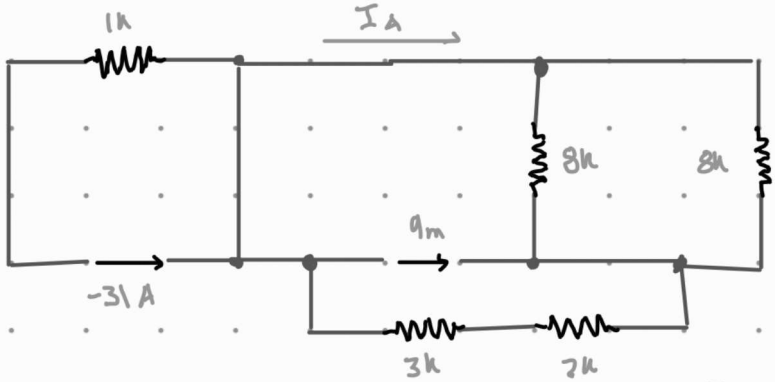
Nodal Analysis: method to solve a circuit by finding all nodal voltages.

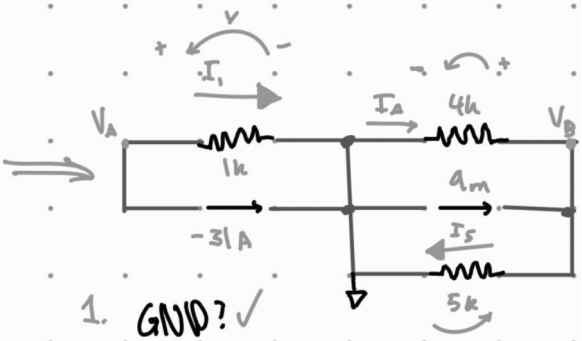
How?

(Pick largest node)

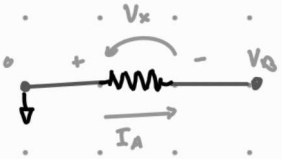
1) Define one node as GROUND in case circuit doesn't have ground defined.
2) Label all other nodes
3) For voltage supplies:
   a. if supply is connected to ground, that node is defined by it
      → SKIP STEP 4 on the nodes that are defined
   b. if supply is between two nodes that are NOT defined, then we say this is a SUPERNODE and we write a SUPERNODE expression relating the two nodes. We also use Step 4 for supernodes.
4) write KCL expressions for all labeled (super)nodes that are undefined
5) write Ohm's laws for all currents as functions of nodal voltages.
6) Write a system of equations with x variables, where x = # nodes − # V supplies − 1
   (# of KCL equations; ground)

Ex: Solve using NA:





1. GND? ✓
2. V_A, V_B
4. KCL: (V_A): $0 = I_1 + (-3I_A)$
   (V_B): $I_A + 9m = I_5$



$V_x = 0 - V_B$

5. $I_1 = V_A / 1k$
   $I_A = -V_B / 4k$
   $I_5 = V_B / 5k$

6. # of KCL = # nodes − # V supplies − 1 → $2 = 3 - 0 - 1$

$$\frac{V_A}{1k} = \frac{3(-V_B)}{4k} \rightarrow 4V_A = -3V_B \rightarrow 4V_A + 3V_B = 0$$

Wrong $$\frac{V_B}{1k} + 9m = \frac{V_B}{5k} \rightarrow 5V_A + 45 = V_B \rightarrow 5V_A - V_B = 45$$

Exam Answer:
$$\begin{bmatrix} 4 & 3 \\ 5 & -1 \end{bmatrix} \begin{bmatrix} V_A \\ V_B \end{bmatrix} = \begin{bmatrix} 0 \\ 45 \end{bmatrix}$$