Electrical Technology

(EE-101-F)

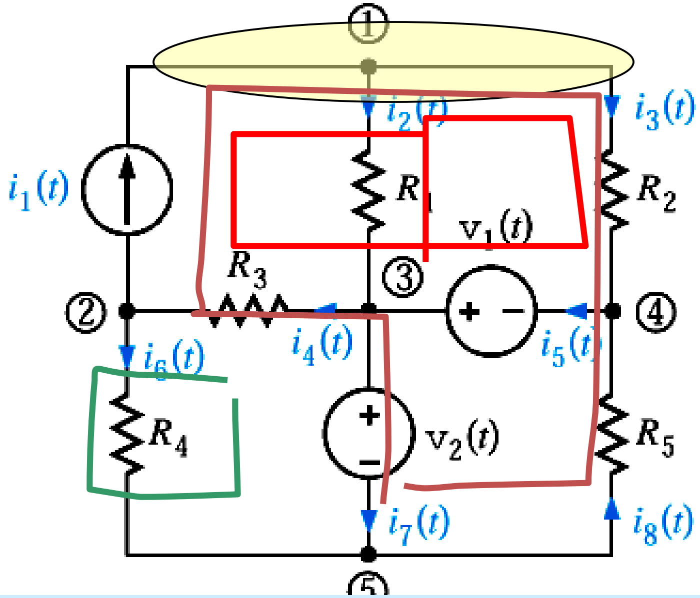
Contents

KIRCHHOFF CURRENT LAW

ONE OF THE FUNDAMENTAL CONSERVATION PRINCIPLES IN ELECTRICAL ENGINEERING

“CHARGE CANNOT BE CREATED NOR DESTROYED”

NODES, BRANCHES, LOOPS



NODE: point where two, or more, elements are joined (e.g., big node 1)

LOOP: A closed path that never goes twice over a node (e.g., the blue line)

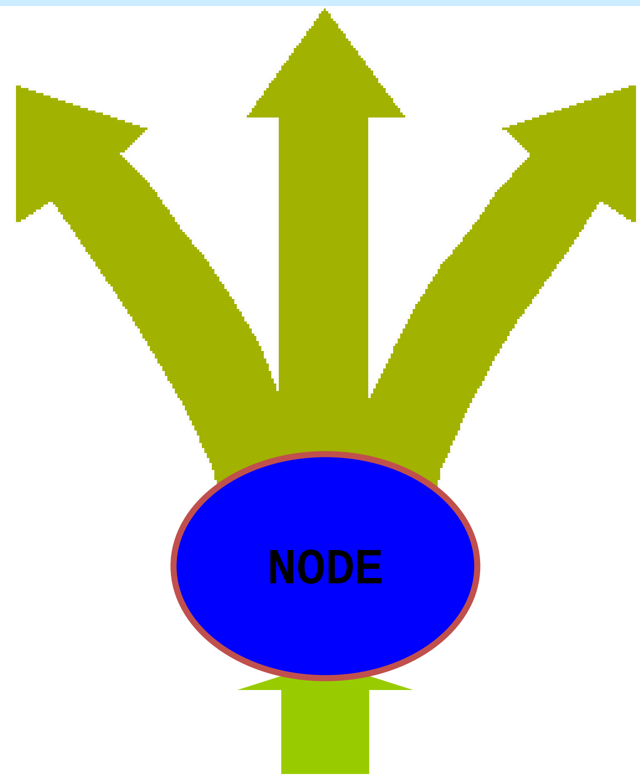
The red path is NOT a loop

BRANCH: Component connected between two nodes (e.g., component R4)

A NODE CONNECTS SEVERAL COMPONENTS. BUT IT DOES NOT HOLD ANY CHARGE.

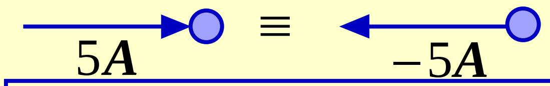
TOTAL CURRENT FLOWING INTO THE NODE MUST BE EQUAL TO TOTAL CURRENT OUT OF THE NODE

(A CONSERVATION OF CHARGE PRINCIPLE)



KIRCHHOFF CURRENT LAW (KCL)

SUM OF CURRENTS FLOWING INTO A NODE IS EQUAL TO SUM OF CURRENTS FLOWING OUT OF THE NODE

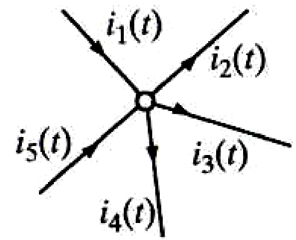


A current flowing into a node is equivalent to the negative flowing out of the node

ALGEBRAIC SUM OF CURRENT (FLOWING) OUT OF A NODE IS ZERO

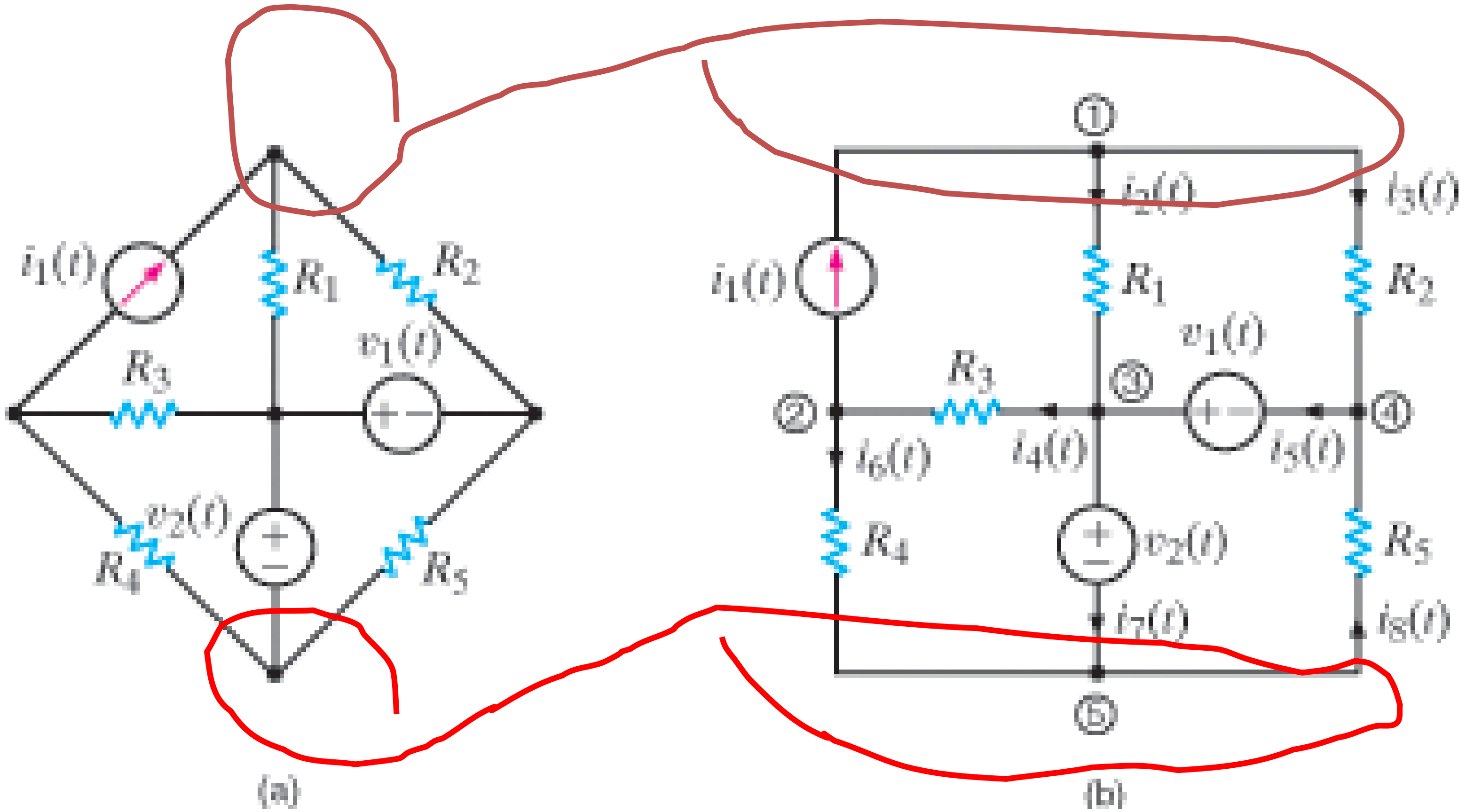
ALGEBRAIC SUM OF CURRENTS FLOWING INTO A NODE IS ZERO

Write the KCL equation for the following node:

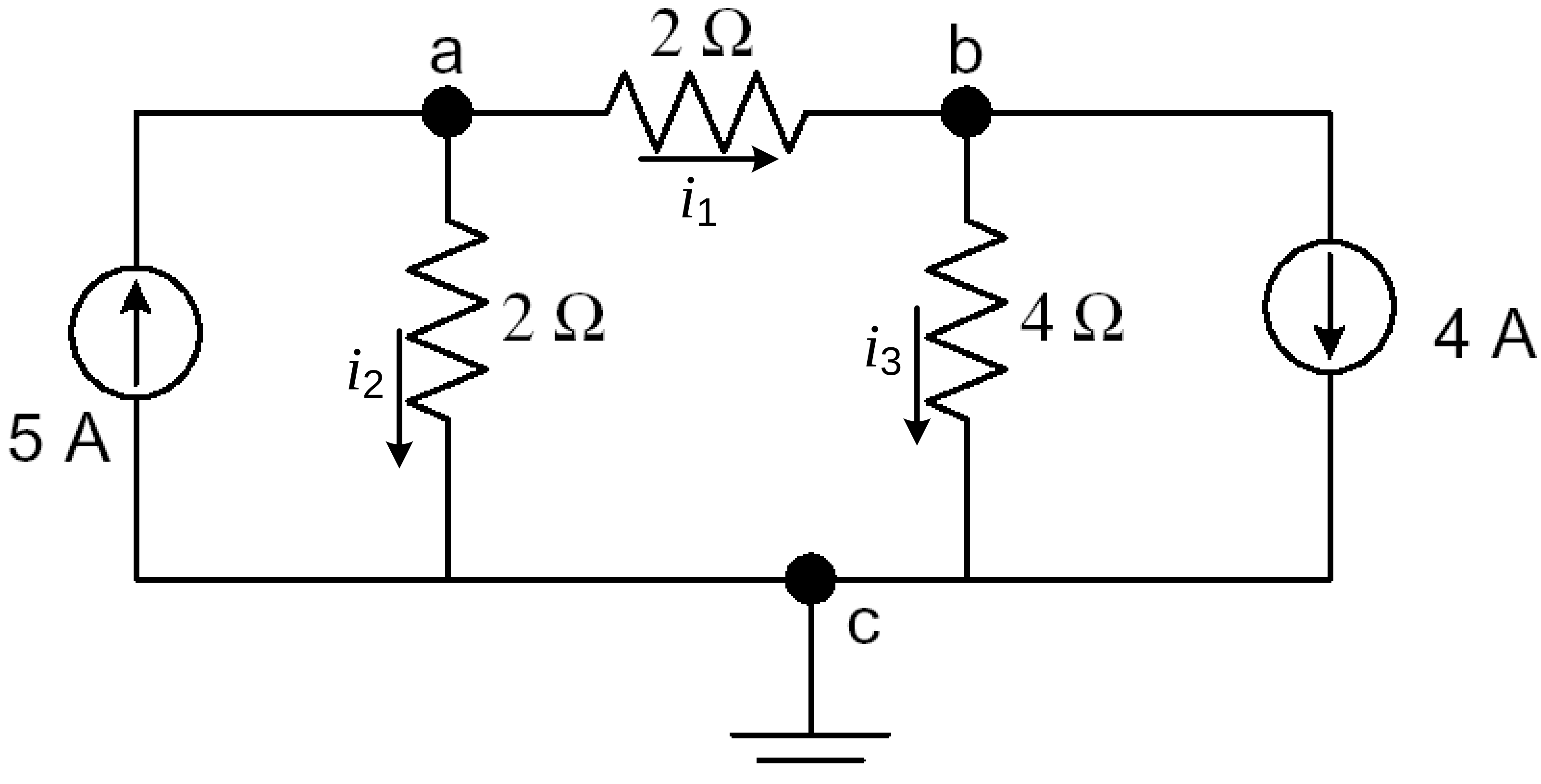


$$i_1(t) - i_2(t) - i_3(t) - i_4(t) + i_5(t) = 0$$

A node is a point of connection of two or more circuit elements.
It may be stretched out or compressed for visual purposes…
But it is still a node



EXAMPLE : NODAL ANALYSIS



CLASS TO SOLVE THIS NODAL PROBLEM.
START WITH KCL AT NODES a AND b

KCL at NODE a: $$5A - i_1 - i_2 = 0 = 5A - \frac{(v_a - v_b)}{2} - \frac{v_a}{2} = 0$$

KCL at NODE b: $$i_1 - i_3 - 4A = 0 = \frac{(v_a - v_b)}{2} - \frac{v_b}{4} - 4A = 0$$

SOLVE THE SECOND NODAL EQUATION FOR v_b:

$$v_b = \frac{2}{3}(v_a - 8A)$$

SUBSTITUTE v_b INTO THE FIRST NODAL EQUATION

$$5A - v_a + \left[\frac{1}{2}\right]\left[\frac{2}{3}\right]\left[v_a - 8A\right] = 0$$

AND FINALLY : $$v_a = \left[\frac{7}{2}\right] Volt$$

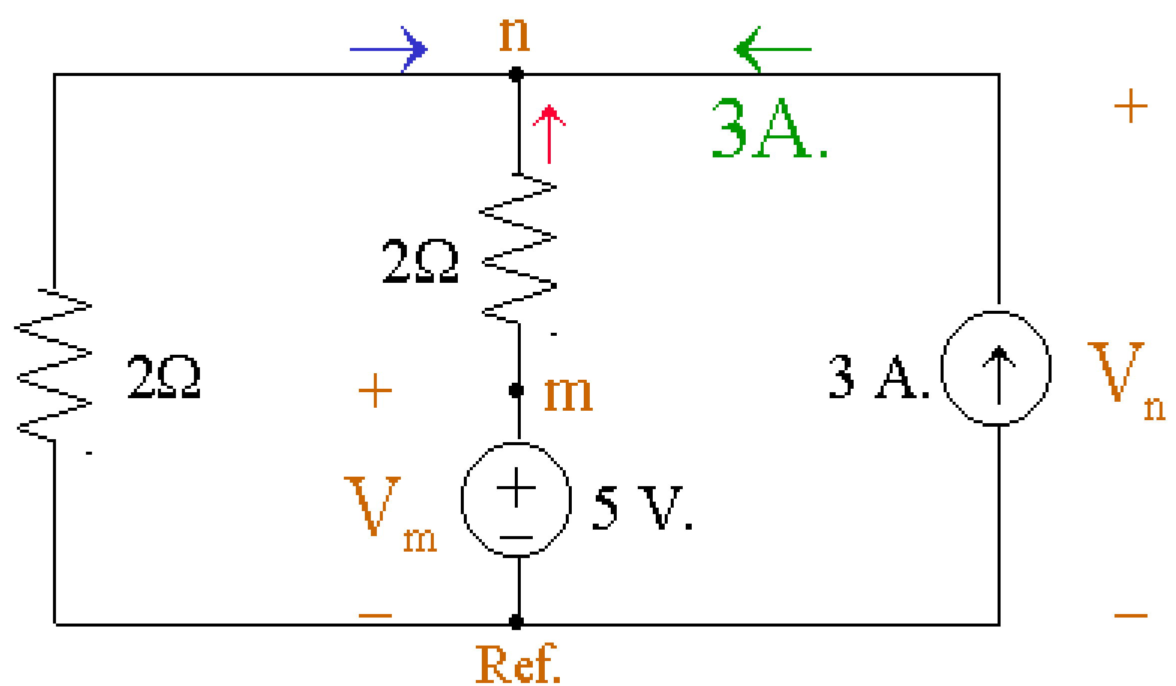
3.5 Node Voltage Analysis: Example 3-5

There are three nodes (m, n and the Ref. node)

V_m is known to be 5 V. (by inspection or by KVL)

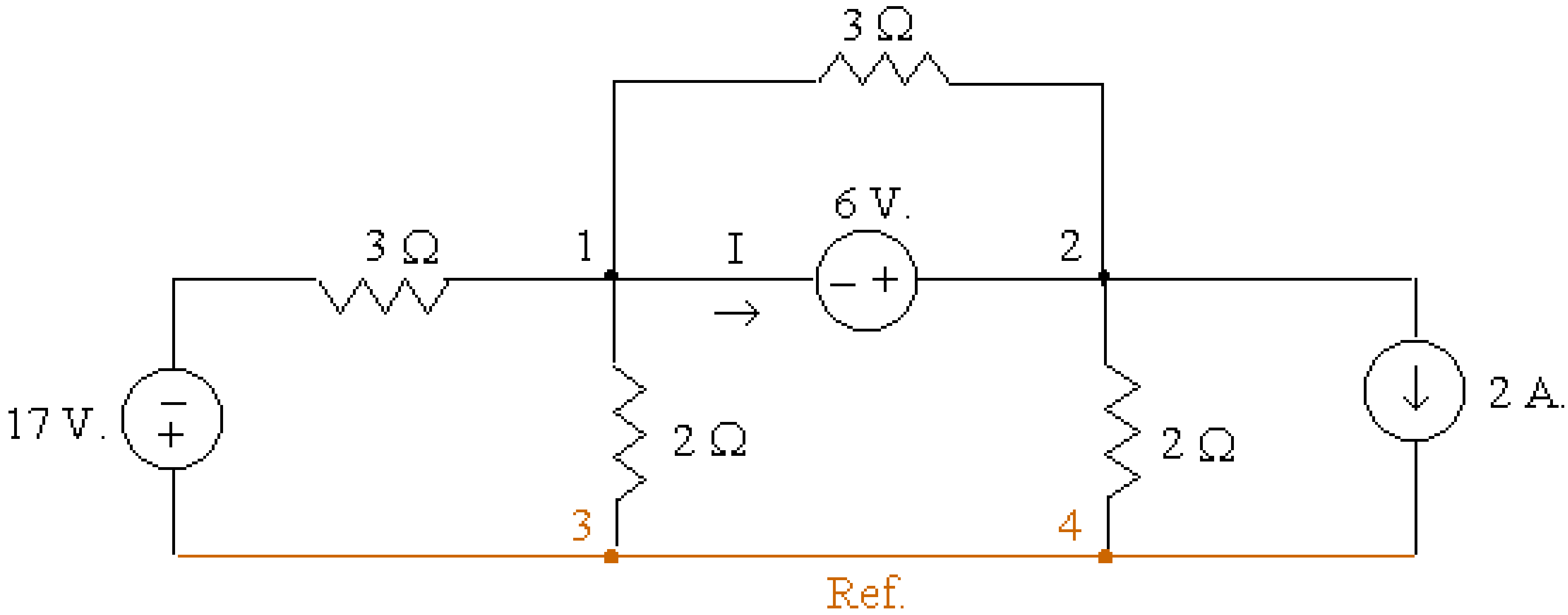
Write KCLs at nodes where the voltage is *unknown*

KCL at node n: $(0V. - V_n)/2\Omega + (5V. - V_n)/2\Omega + 3A. = 0$ A. —which has solution $V_n = 5.5$ V.



3.5 Node Voltage Analysis: Example 3-6

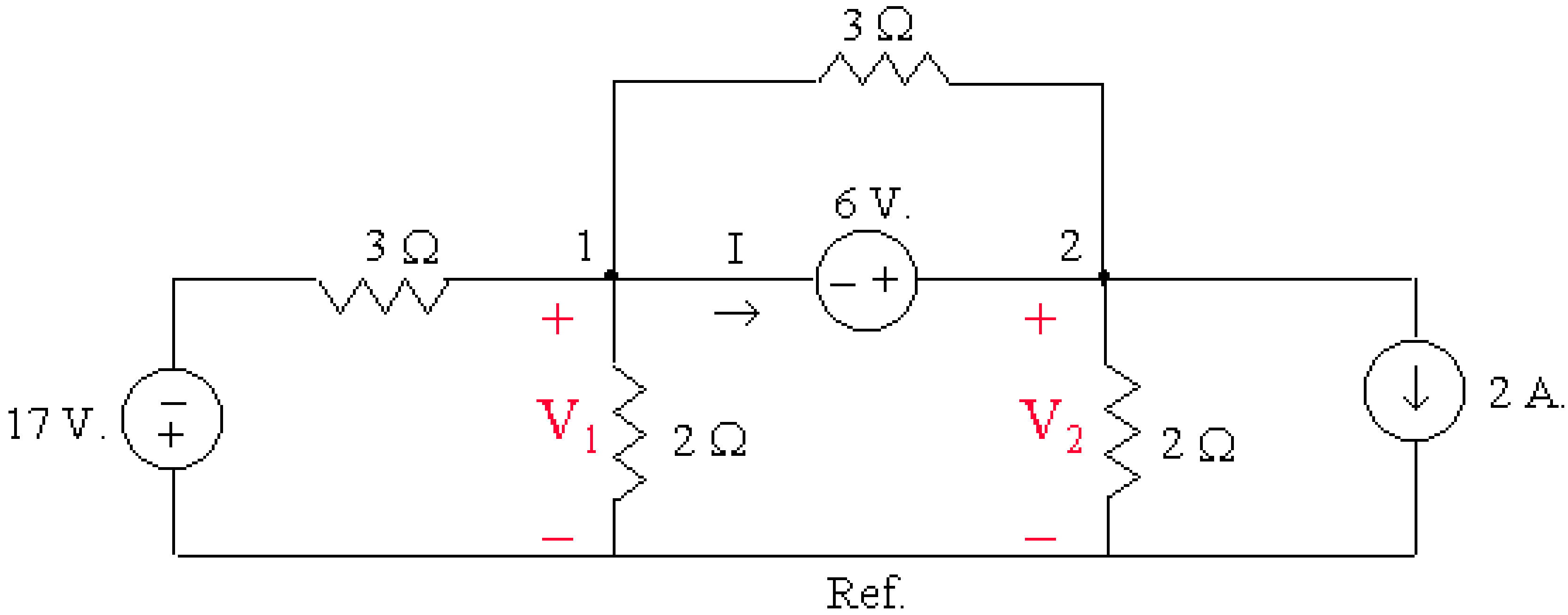
Find I using nodal analysis



The first step is to (arbitrarily) establish the "bottom" (physical nodes 3 and 4) of the circuit as the (electrical) reference node (Ref.)

Example 3-6 cont.

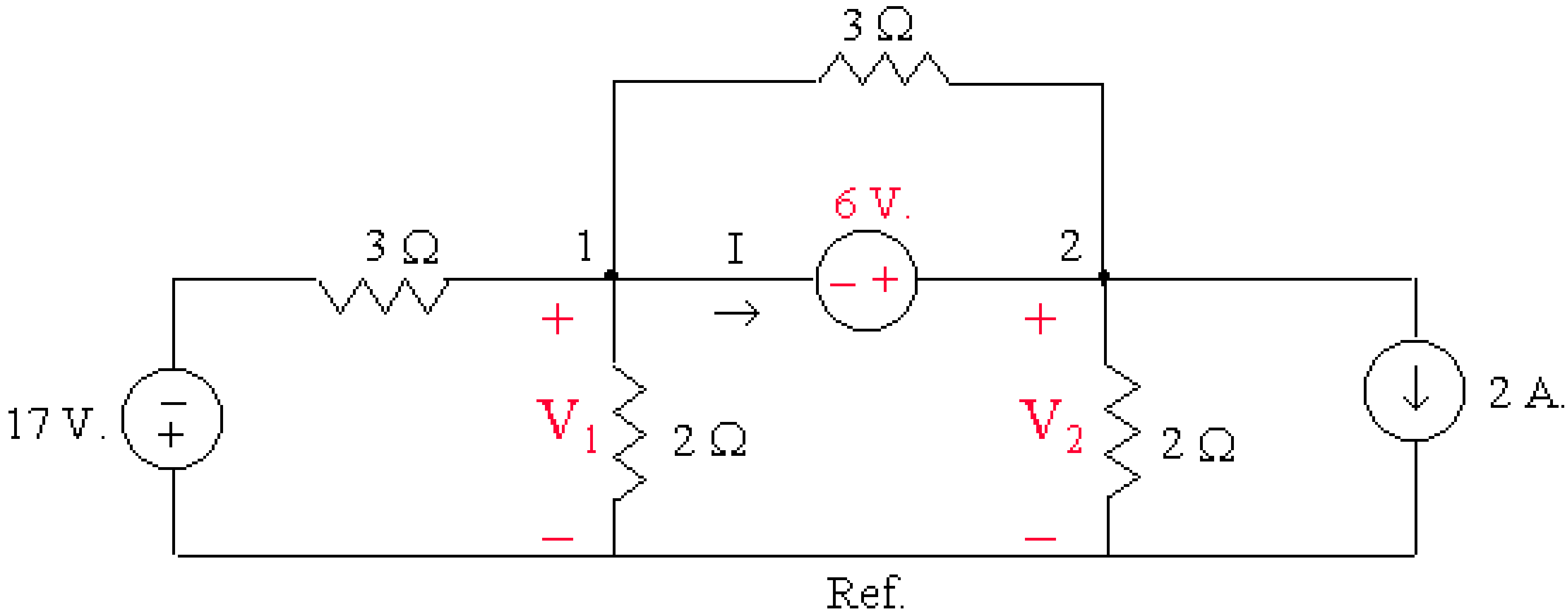
(Find I using nodal analysis)



The node voltages V_1 and V_2 are with respect to the reference (bottom) node as shown

Example 3-6 cont.

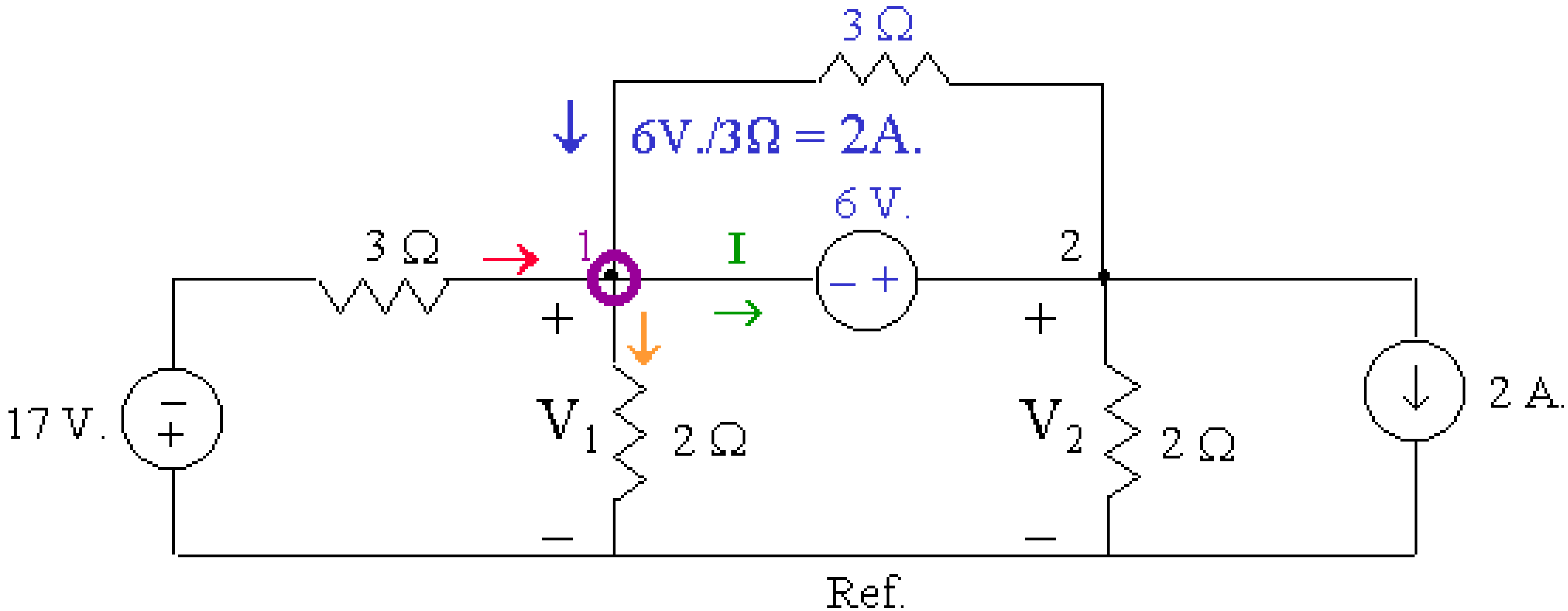
(Find I using nodal analysis)



KVL: $V_1 + 6\text{ V.} - V_2 = 0\text{ V.}$ $\therefore$ $V_2 = V_1 + 6$ (A.)

Example 3-6 cont.

(Find I using nodal analysis)

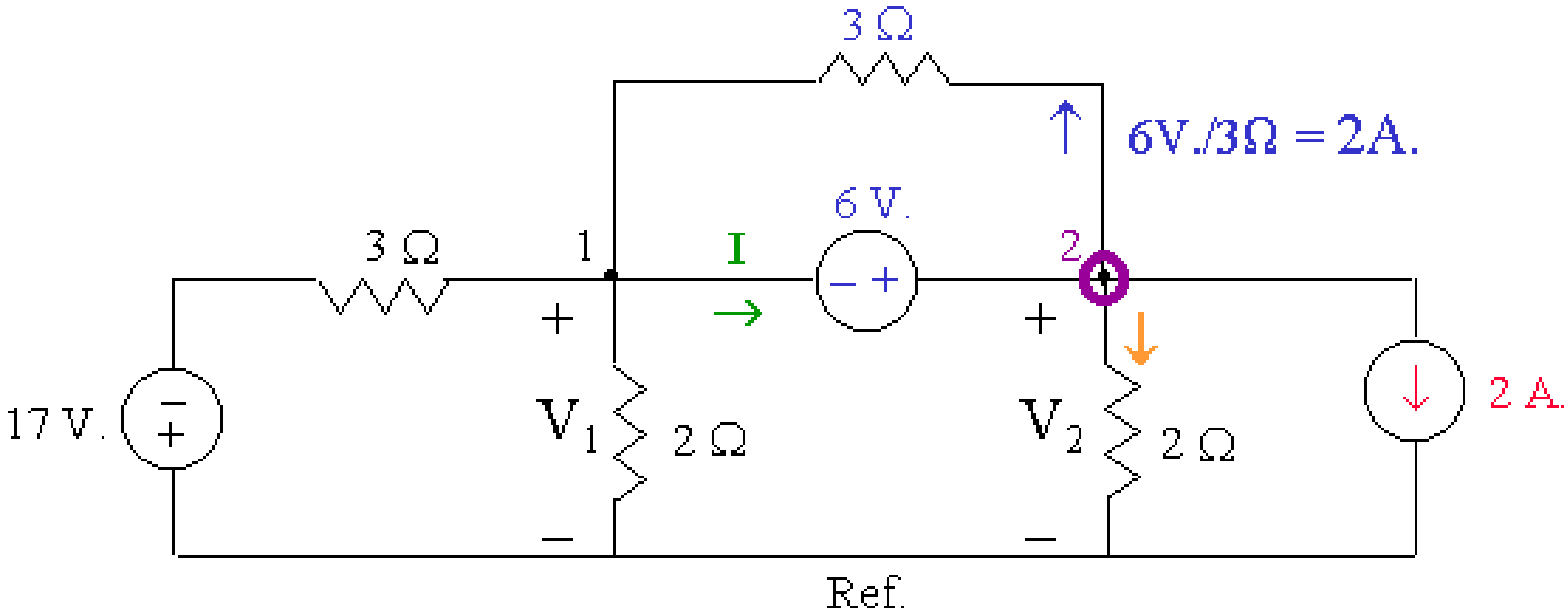


KCL at Node 1:

$$[(-17\text{ V.}) - V_1]/3\Omega + 2\text{ A.} - I - V_1/2\Omega = 0\text{ A.} \quad \text{(B.)}$$

Example 3-6 cont.

(Find I using nodal analysis)

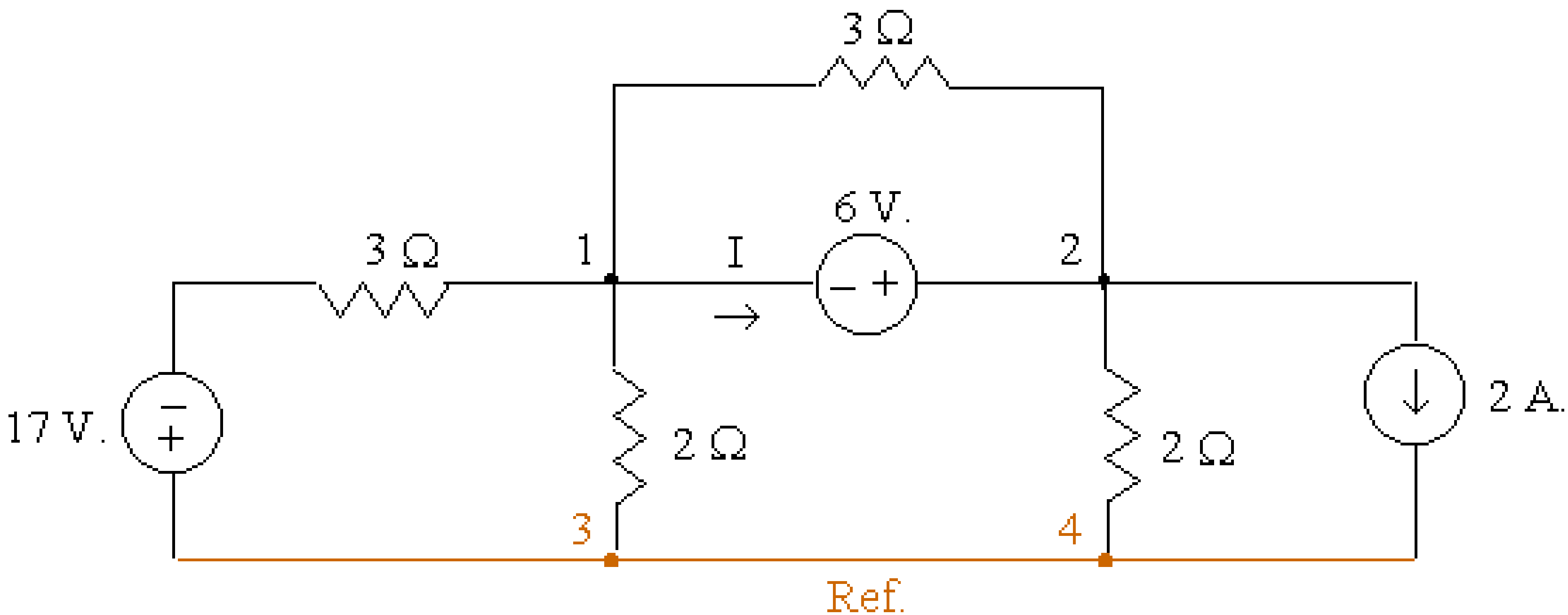


KCL at Node 2:

$$I - 2\text{ A.} - 2\text{ A.} - V_2/2\Omega = 0\text{ A.}\quad \text{(C.)}$$

Example 3-6 cont.

(Find I using nodal analysis)



Equations (A.), (B.) and (C.) have solution:

$V_1 = -8$ V., $V_2 = -2$ V. and I = 3 A.

Ergo, I = 3 A.