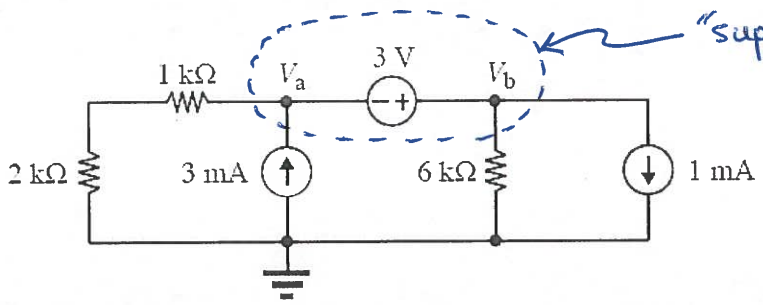
SA 2 [5 marks]

Consider the circuit shown below. Determine the voltages V_a and V_b (with respect to ground) using nodal analysis.



KCL @ supernode: $\frac{V_a}{3k\Omega} - 3mA + \frac{V_b}{6k\Omega} + 1mA = 0$ —(1)

constraint: $V_a + 3V = V_b$ —(2)

(2)→(1): $\frac{V_a}{3k\Omega} - 3mA + \frac{V_a}{6k\Omega} + \frac{3V}{6k\Omega} + 1mA = 0$

$V_a = 3V.$

$V_b = (3V) + (3V) = 6V$ (from (2))

Alternatively (without "supernode"):

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Define I_{ab} flowing from node 'a' to node 'b'.

KCL @ node 'a': $\frac{V_a}{3k\Omega} - 3mA + I_{ab} = 0$ —①

KCL @ node 'b': $-I_{ab} + \frac{V_b}{6k\Omega} + 1mA = 0$ —②

$I_{ab} = \frac{V_b}{6k\Omega} + 1mA$ —③

$V_a + 3V = V_b$ —④

④→③: $I_{ab} = \frac{V_a}{6k\Omega} + \frac{3V}{6k\Omega} + 1mA$ —⑤

⑤→①: $\frac{V_a}{3k\Omega} - 3mA + \frac{V_a}{6k\Omega} + \frac{3V}{6k\Omega} + 1mA = 0$

↳ $V_a = 3V$

$V_b = (3V) + (3V) = 6V$ (from ④)