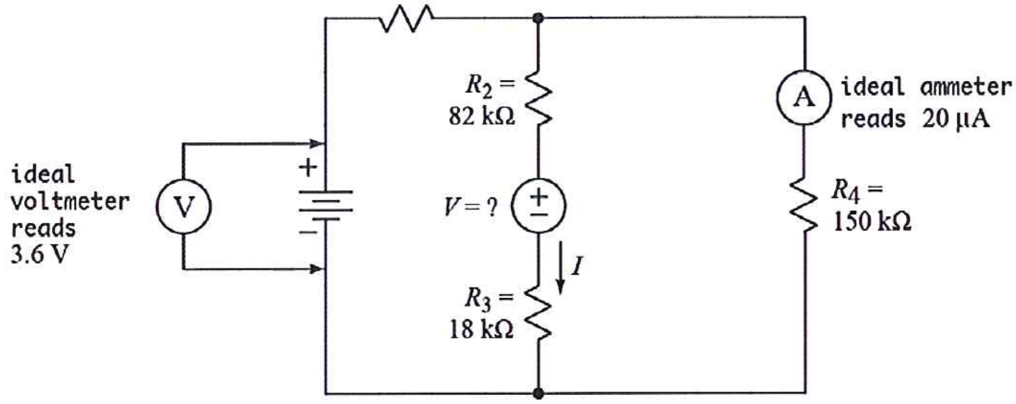
Ex:



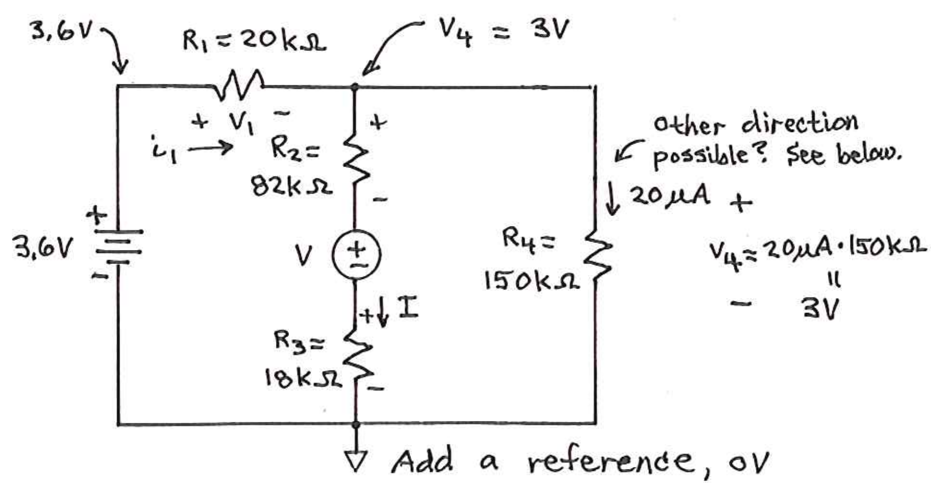
Find the values of the following quantities in the above circuit:

a) I

b) V (the value of the voltage source in the center branch)

c) P_{R1} (the power dissipated by R_1)

sol'n: a) The first step is to redraw the circuit showing the measured values in their usual form.



Using Ohm's law gives a value of 3V across R_4. Adding a reference at the bottom, means the voltage at the top center node is $V_4 = 3V$. The voltage at the top left node is 3.6V. The voltage drop across R_1 is the difference between the top left node and the top center node.

$$V_1 = 3.6V - 3V = 0.6\ V$$

Ohm's law for R_1 gives the total current flowing in the right side of the circuit.

$$i_1 = \frac{V_1}{R_1} = \frac{0.6V}{20k\Omega} = \frac{3}{100}\ mA = 30\ \mu A$$

Using Kirchhoff's current summation law at the top center node yields an equation for current I.

$$i_1 = I + I_{R4}$$

or

$$30\mu A = I + 20\mu A$$

or

$$\boxed{I = 10\ \mu A}$$

Could the current in R_4 be $-20\mu A$? Repeating the above calculations with $v_4' = -3V$, the values for v_1, i_1, and I change, although the logic behind the equations remains unchanged. (Primes designate the new values.)

$$V_1' = 3.6V - -3V = 6.6V$$

$$i_1' = \frac{V_1'}{R_1} = \frac{6.6V}{20\ k\Omega} = 330\ \mu A$$

$$I' = i_1' - i_{R4}' = 330\mu A - -20\mu A = \boxed{350\mu A = I'}$$

b) Voltage V is determined by the total voltage drop across the center branch minus the voltage drops across the resistors. The voltage drops across the resistors is found by using I and Ohm's law.

case I: $i_{R4} = +20\,\mu A$, $I = 10\,\mu A$

$$V_{R2} = I R_2 = 10\,\mu A \cdot 82\,k\Omega = 820\,mV$$

$$V_{R3} = I R_3 = 10\,\mu A \cdot 18\,k\Omega = 180\,mV$$

$$V = V_4 - (V_{R2} + V_{R3}) = 3V - 1V = \boxed{2V = V}$$

case II: $i_{R4}' = -20\,\mu A$, $I' = 330\,\mu A$

$$V_{R2}' = I' R_2 = 330\,\mu A \cdot 82\,k\Omega = 27.06\,V$$

$$V_{R3}' = I' R_3 = 330\,\mu A \cdot 18\,k\Omega = 5.94\,V$$

$$V' = V_4' - (V_{R2}' + V_{R3}') = -3V - 33V = \boxed{-36V = V'}$$

c) Power is the product of current and voltage.

$$P_{R1} = i_1 V_1 = 30\,\mu A\,(0.6V) = \boxed{18\,mW = P_{R1}}$$

$$P_{R1}' = i_1' V_1' = 330\,\mu A\,(6.6V) = \boxed{2.178\,W = P_{R1}'}$$

One interesting observation is that R_1 would have to be a high-power resistor if the latter power is correct.