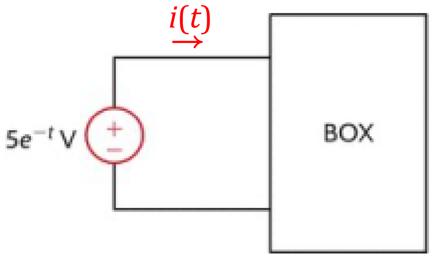
1. **(6 Points) The power absorbed by the BOX in the following figure is $2e^{-2t}$ W. Calculate the amount of charge that enters the BOX between 0.1 and 0.4 seconds.**



$$2\mathrm{e}^{-2\mathrm{t}} = 5\mathrm{e}^{-\mathrm{t}} i$$ 3pts

$$i = \frac{2\mathrm{e}^{-2\mathrm{t}}}{5\mathrm{e}^{-\mathrm{t}}} = 0.4\mathrm{e}^{-\mathrm{t}}\ \mathrm{A}$$

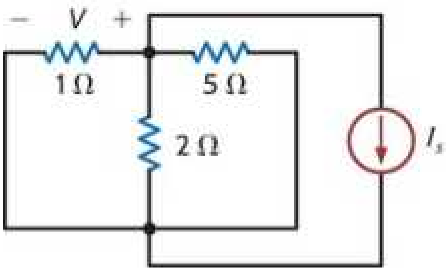
$$\Delta \mathrm{q(t)} = \int_{0.1}^{0.4} i(t)\, dt$$ 2pts

$$= \int_{0.1}^{0.4} 0.4\mathrm{e}^{-\mathrm{t}}\, dt$$

$$= -0.4[\mathrm{e}^{-0.4} - \mathrm{e}^{-0.1}]$$ 1pts

$$= 0.0938\ C$$

2. (6 Points) In the circuit shown below, if V = 6 V, find I_S.



Solution 1) Calculating for each resistor

Current through 1-Ω resistor: $\frac{6\text{V}}{1\Omega} = 6\text{A}$ 1pts

Current through 2-Ω resistor: $\frac{6\text{V}}{2\Omega} = 3\text{A}$ 1pts

Current through 5-Ω resistor: $\frac{6\text{V}}{5\Omega} = 1.2\text{A}$ 1pts

By KCL, $6\text{A} + 3\text{A} + 1.2\text{A} + I_s = 0$ 1pts

$I_s = -10.2\text{A}$ 2pts

Solution 2) Calculating for resistor in parallel

Calculation of total resistor in parallel: $1\Omega \parallel 2\Omega \parallel 5\Omega$ 1pts

$$= \frac{10}{17}\Omega (= 0.588\Omega)$$ 1pts

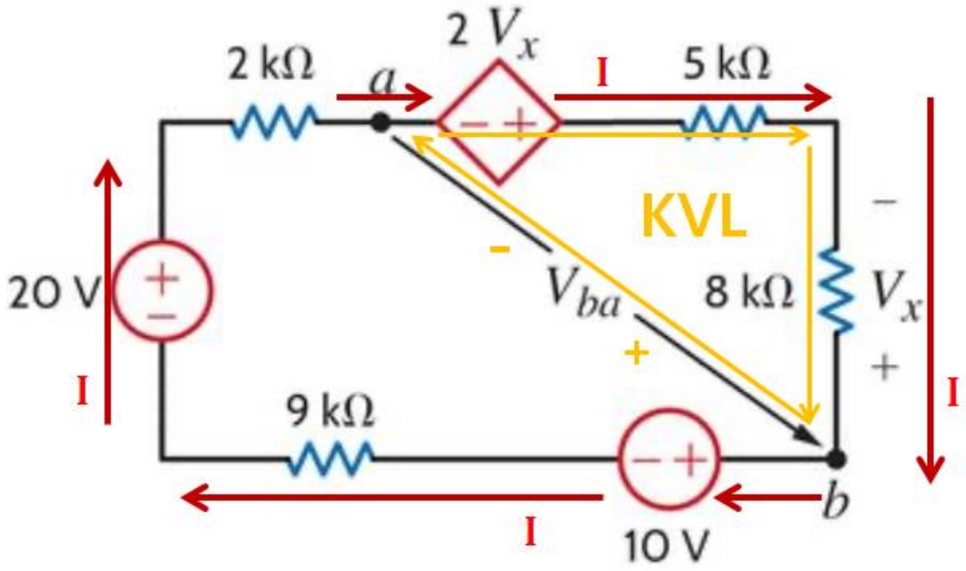
Current through total resistor in parallel: $\frac{6\text{V}}{0.588\ \Omega} = 10.2\text{A}$ 1pts

By KCL, $10.2\text{A} + I_s = 0$ 1pts

$I_s = -10.2\text{A}$ 2pts

-1pts for incorrect sign

3. (6 Points) In the circuit shown below, the 10-V source absorbs 2.500 mW of power. Calculate (a) V_{ba} and (b) the power absorbed by the dependent voltage source



The 10-V source absorbs 2.500 mW of power :

P_{10V} = 2.500mW (absorbed) = 10·I

$$\rightarrow \ \mathbf{I} = \frac{P_{10V}}{10V} = \frac{2.5mW}{10V} = \mathbf{250uA}$$ (a)1.5pts

$$V_x = 8k\cdot(-\mathrm{I}) = 8k\cdot(-250u) = -2\ V$$ (b)1.5pts

KVL :

$$V_{ba} = V_x + 5k\cdot(-\mathrm{I}) + 2V_X$$

$$= -2 + 5k\cdot(-250u) + 2(-2)$$

$$= -7.25\ V$$ (c)1.5pts

The power absorbed by the dependent voltage source :

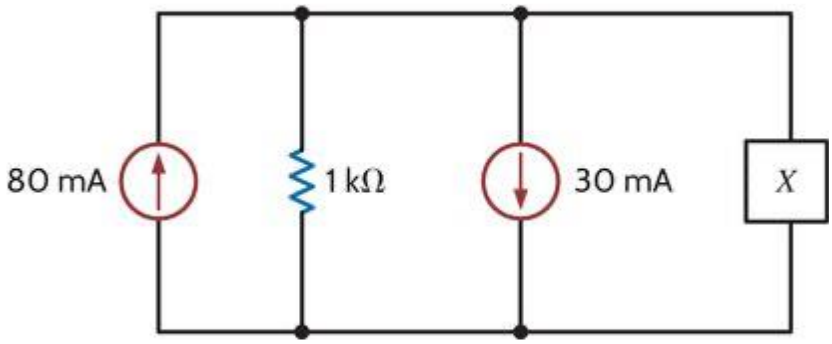
$$P_{2Vx} = 2V_X\cdot(-\mathrm{I}) = 2\cdot(-2\ V)\cdot(-250uA) = 1\ mW$$ (d)1.5pts

In the each partial score,

-0.5pts for incorrect sign (+, -)

-0.5pts for incorrect units (A, V, W) or (m, k, u)

4. (6 Points) (a) Let element X in the following figure be an independent current source, arrow directed upward, labeled I_s. What is I_s if none of the four circuit elements absorb any power? (b) Let element X be an independent voltage source, + reference on top, labeled V_s. What is V_s if the voltage source absorbs no power?



(a) To cancel out the effects of both the 80mA and 30 mA sources, i_s must be set to -50mA. [+2 Points]

(b) From KCL at the top node,

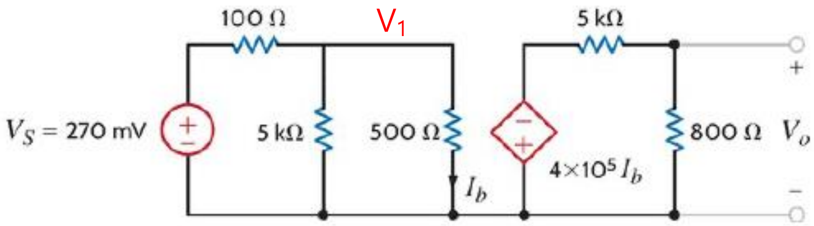
$80\text{mA} - 30\text{mA} - \frac{v_s}{1k} + i_s = 0$. (1) [+2 Points]

We are seeking a value for v_s such that $v_s \cdot i_s = 0$. (2)

Clearly, setting $v_s = 0$ will achieve this. [+1 Points]

From Eq. (1), we also see that $V_s = 50\text{V}$ will work as well. [+1 Points]

5. **(6 points) A typical transistor amplifier is shown below. Find the amplifier gain *G* (i.e., the ratio of the output voltage to the input voltage).**



$$V_1 = \frac{5000||500}{100 + 5000||500} V_S = 0.221V$$

$$I_b = \frac{V_1}{500} = 442\mu\text{A}$$ 2pts

$$\text{V}_\text{o} = -\frac{800}{5000 + 800}(4 \times 10^5 \text{I}_\text{b}) = -24.386V$$ 2pts

$$\text{G} = \frac{V_o}{V_S} = -90.319$$ 2pts

-0.5pts for incorrect calculation