EE 202-151
HW 1 (Due Monday 14-Sept by 1:00 PM)
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P 1.24 [a]

$$q = \text{area under } i \text{ vs. } t \text{ plot}$$
$$= \left[\tfrac{1}{2}(5)(4) + (10)(4) + \tfrac{1}{2}(8)(4) + (8)(6) + \tfrac{1}{2}(3)(6)\right] \times 10^3$$
$$= [10 + 40 + 16 + 48 + 9]10^3 = 123{,}000 \text{ C}$$

[b]

$$w = \int p\,dt = \int vi\,dt$$
$$v = 0.2 \times 10^{-3}t + 9 \qquad 0 \le t \le 15 \text{ ks}$$

$0 \le t \le 4000s$

$$i = 15 - 1.25 \times 10^{-3}t$$
$$p = 135 - 8.25 \times 10^{-3}t - 0.25 \times 10^{-6}t^2$$
$$w_1 = \int_0^{4000} (135 - 8.25 \times 10^{-3}t - 0.25 \times 10^{-6}t^2)\,dt$$
$$= (540 - 66 - 5.3333)10^3 = 468.667 \text{ kJ}$$

$4000 \le t \le 12{,}000$

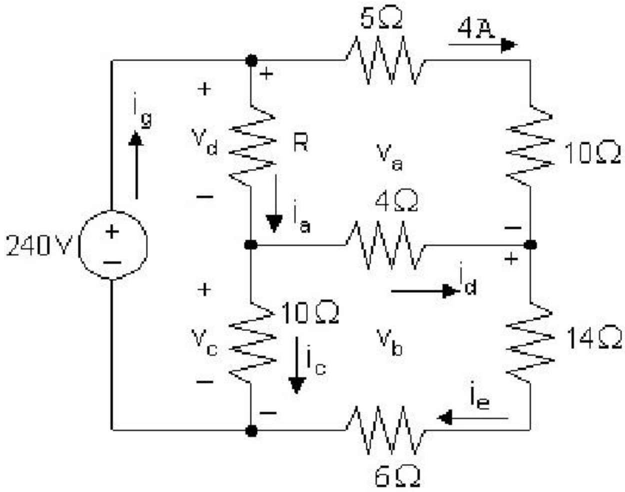
$$i = 12 - 0.5 \times 10^{-3}t$$
$$p = 108 - 2.1 \times 10^{-3}t - 0.1 \times 10^{-6}t^2$$
$$w_2 = \int_{4000}^{12{,}000} (108 - 2.1 \times 10^{-3}t - 0.1 \times 10^{-6}t^2)\,dt$$
$$= (864 - 134.4 - 55.467)10^3 = 674.133 \text{ kJ}$$

$12{,}000 \le t \le 15{,}000$

$$i = 30 - 2 \times 10^{-3}t$$
$$p = 270 - 12 \times 10^{-3}t - 0.4 \times 10^{-6}t^2$$
$$w_3 = \int_{12{,}000}^{15{,}000} (270 - 12 \times 10^{-3}t - 0.4 \times 10^{-6}t^2)\,dt$$
$$= (810 - 486 - 219.6)10^3 = 104.4 \text{ kJ}$$

$$w_T = w_1 + w_2 + w_3 = 468.667 + 674.133 + 104.4 = 1247.2 \text{ kJ}$$

P 2.23 **[a]**



$v_a = (5 + 10)(4) = 60\,\text{V}$

$-240 + v_a + v_b = 0 \qquad \text{so} \qquad v_b = 240 - v_a = 240 - 60 = 180\,\text{V}$

$i_e = v_b/(14 + 6) = 180/20 = 9\,\text{A}$

$i_d = i_e - 4 = 9 - 4 = 5\,\text{A}$

$v_c = 4i_d + v_b = 4(5) + 180 = 200\,\text{V}$

$i_c = v_c/10 = 200/10 = 20\,\text{A}$

$v_d = 240 - v_c = 240 - 200 = 40\,\text{V}$

$i_a = i_d + i_c = 5 + 20 = 25\,\text{A}$

$R = v_d/i_a = 40/25 = 1.6\,\Omega$

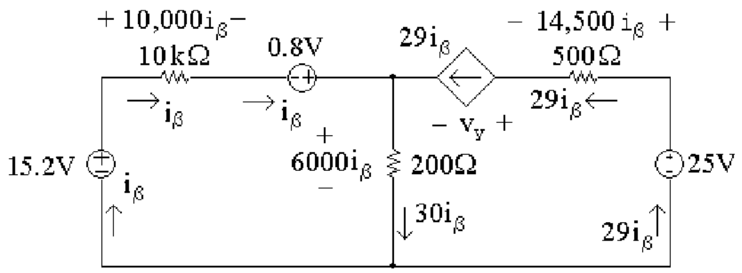
[b] $i_g = i_a + 4 = 25 + 4 = 29$ A

p_g (supplied) $= (240)(29) = 6960$ W

P 2.28 First note that we know the current through all elements in the circuit except the 200 Ω resistor (the current in the three elements to the left of the 200 Ω resistor is i_β; the current in the three elements to the right of the 200 Ω resistor is $29i_\beta$). To find the current in the 200 Ω resistor, write a KCL equation at the top node:

$$i_\beta + 29i_\beta = i_{200\,\Omega} = 30i_\beta$$

We can then use Ohm's law to find the voltages across each resistor in terms of i_β. The results are shown in the figure below:



[a] To find i_β, write a KVL equation around the left-hand loop, summing voltages in a clockwise direction starting below the 15.2V source:

$$-15.2\,\text{V} + 10{,}000i_1 - 0.8\,\text{V} + 6000i_\beta = 0$$

Solving for i_β

$$10{,}000i_\beta + 6000i_\beta = 16\,\text{V} \qquad \text{so} \qquad 16{,}000i_\beta = 16\,\text{V}$$

Thus,

$$i_\beta = \frac{16}{16{,}000} = 1\,\text{mA}$$

Now that we have the value of i_β, we can calculate the voltage for each component except the dependent source. Then we can write a KVL equation for the right-hand loop to find the voltage v_y of the dependent source. Sum the voltages in the clockwise direction, starting to the left of the dependent source:

$$-v_y - 14{,}500i_\beta + 25\,\text{V} - 6000i_\beta = 0$$

Thus,

$$v_y = 25\,\text{V} - 20{,}500i_\beta = 25\,\text{V} - 20{,}500(10^{-3}) = 25\,\text{V} - 20.5\,\text{V} = 4.5\,\text{V}$$

[b] We now know the values of voltage and current for every circuit element. Let's construct a power table:

Element	**Current (mA)**	**Voltage (V)**	**Power Equation**	**Power (mW)**
15.2 V	1	15.2	$p = -vi$	-15.2
10 kΩ	1	10	$p = Ri^2$	10
0.8 V	1	0.8	$p = -vi$	-0.8
200 Ω	30	6	$p = Ri^2$	180
Dep. source	29	4.5	$p = vi$	130.5
500 Ω	29	14.5	$p = Ri^2$	420.5
25 V	29	25	$p = -vi$	-725

The total power generated in the circuit is the sum of the negative power values in the power table:

$$-15.2\,\text{mW} + -0.8\,\text{mW} + -725\,\text{mW} = -741\,\text{mW}$$

Thus, the total power generated in the circuit is 741 mW. The total power absorbed in the circuit is the sum of the positive power values in the power table:

$$10\,\text{mW} + 180\,\text{mW} + 130.5\,\text{mW} + 420.5\,\text{mW} = 741\,\text{mW}$$

Thus, the total power absorbed in the circuit is 741 mW and the power in the circuit balances.