1.12

a) $P_A = -iV = -15 \times 20 = -300\,W$

$P_B = iV = 15 \times 20 = +300\,W$

A generates 300W, which is consumed by B.

∴ Power flow is from A to B.

b) $P_A = -iV = -(-5)(100) = +500\,W$, $P_B = iV = -5 \times 100 = -500\,W$

∴ 500W is generated by B and consumed by A.

∴ Power flow is from B to A.

1.15

a) $P_A = iV = (-40)(12) = -480\,W$

$P_B = -iV = -(-40)(12) = +480\,W$

Power flows from A to B.

∴ B has the dead battery

b) $W = Pt = 480\,W \times (1.5 \times 60\,sec) = 480 \times 1.5 \times 60\ \frac{J}{s} \times s$

$= 43{,}200\,J = 43.2\,kJ$

1.17

a) $P = iV = (50e^{-1600t} - 50e^{-400t})(5e^{-1600t} - 5e^{-400t})10^{-3}$

$= 50 \times 5 \times 10^{-3}\,(e^{-1600t} - e^{-400t})^2$

$P(625\mu s) = P(625 \times 10^{-6}) = 250 \times 10^{-3}\left[e^{-1600 \times 625 \times 10^{-6}} - e^{-400 \times 625 \times 10^{-6}}\right]^2$

$= 250 \times 10^{-3}\left[e^{-1} - e^{-0.25}\right]^2 = 250 \times 10^{-3}\left[0.3679 - 0.7788\right]^2$

$= 4.22 \times 10^{-2}\,W = 42.2\,mW$

a) $P(t) = i(t)\,v(t) = (20 - 20e^{-500t}) \times 10^{-3} \times (100\,e^{-500t})$, $t \geq 0$.

$= 2000 \times 10^{-3} (e^{-500t} - e^{-1000t})$, $t \geq 0$

$= 2\,(e^{-500t} - e^{-1000t})$ ① , $t \geq 0$

To find the maximum power, we first find the time t at which $\frac{dP}{dt} = 0$.

$$\frac{dP}{dt} = 2\,(-500\,e^{-500t} + 1000\,e^{-1000t}) = 0$$

$\therefore\ 1000\,e^{-1000t} = 500\,e^{-500t}$ (Divide by e^{-500t})

$\therefore\ 2\,e^{-500t} = 1 \Rightarrow e^{-500t} = \frac{1}{2} \Rightarrow -500t = \ln\frac{1}{2}$

$$t = \frac{\ln 0.5}{-500} = 1.3863 \times 10^{-3}\ s$$

The power delivered to the circuit is maximum at $t = 1.3863$ mS.

To find the maximum power, we subtitute $t = 1.3863$ mS in eqn. ① $\Rightarrow$

$$P|_{max} = P(1.3863 \times 10^{-3}) = 2\left(e^{-500 \times 1.3863 \times 10^{-3}} - e^{-1000 \times 1.3863 \times 10^{-3}}\right)$$

$$= 2\left(e^{-0.6932} - e^{-1.3863}\right) = 2\,(0.5 - 0.25)$$

$= 0.5\ W$

b) Total energy W delivered to the element is given by:

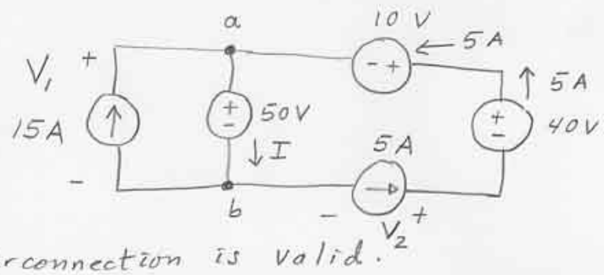
$$W = \int_0^\infty P(t)\,dt$$, because the power is zero for $t < 0$.

$$= \int_0^\infty 2\left(e^{-500t} - e^{-1000t}\right)dt$$

$$= 2\left[\frac{e^{-500t}}{-500} - \frac{e^{-1000t}}{-1000}\right]_0^\infty$$

$$= 2\left[\frac{1}{500} - \frac{1}{1000}\right] = \frac{1}{500} = 2\ mJ$$

2.8



The interconnection is valid.

Apply KCL at node b $\Rightarrow$ $I = 15 + 5 = 20\ A$

" KVL around the outer circuit $\Rightarrow$

$$-V_1 - 10 + 40 + V_2 = 0$$, but $V_1 = 50V$

$$\therefore\ -50 - 10 + 40 + V_2 = 0 \Rightarrow V_2 = 20V$$

$$P_{15A} = -iV = -15 \times 50 = -750\,W \text{ (generated)}$$

$P_{50V} = IV = 20 \times 50 = 1000\,W$ (dissipated)

$P_{10V} = IV = 5 \times 10 = 50\,W$ (")

$P_{40V} = -IV = -5 \times 40 = -200\,W$ (generated)

$P_{5A} = -IV = -5 \times 20 = -100\,W$ (generated)

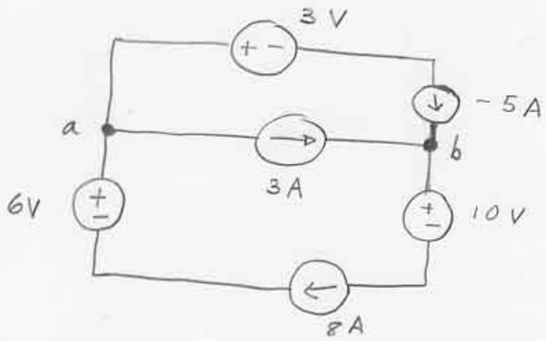
Total power generated $= 750 + 200 + 100 = 1050\,W$.

" " dissipated $= 1000 + 50 = 1050\,W$.

∴ Total power generated = Total power dissipated

= total power developed in the circuit $= 1050\,W$.

2.10



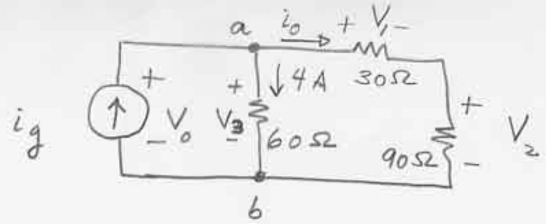
KCL is not satisfied at terminal a, because:

$$\left.\begin{array}{l} \sum i_{entering} = 8 \\ \sum i_{leaving} = 3 + (-5) = -2 \end{array}\right\} \sum i_{entering} \neq \sum i_{leaving}$$

∴ Interconnection is invalid.

2.16

a)



Ohm's law $\Rightarrow V_3 = +IV = 4 \times 60 = 240V$

KVL $\Rightarrow -V_3 + V_1 + V_2 = 0 \Rightarrow -240 + V_1 + V_2 = 0$

Ohm's law $\Rightarrow -240 + 30i_o + 90i_o = 0$

$\therefore 120 i_o = 240 \Rightarrow i_o = \frac{240}{120} = 2A$

KCL at node a $\Rightarrow i_g = 4 + i_o = 4 + 2 = 6A$.

b) $V_o = V_3 = 240V$

c) $P_{i_g} = -i_g V_o = -6 \times 240 = -1440W$ (generated).

$P_{60\Omega} = i^2R = (4)^2 \times 60 = 960W$

$P_{30\Omega} = i^2R = (2)^2 \times 30 = 120W$

$P_{90\Omega} = i^2R = (2)^2 \times 90 = 360W$

$\therefore \sum P_{gen} = 1440W$

$\sum P_{dis} = 960 + 120 + 360 = 1440W$

$\therefore \sum P_{gen} = \sum P_{dis} = 1440W$