1. In #1a, referring to loops in circuit. In #1b, referring to nodes in circuit.

1a. **Left:**36-36=0; **Middle:**36+18+(-54)=0; **Right:**-(-54)+30-84=0; **Upper:**48-30-18=0.

1b. **Left:** 12+(-4)+8=16; **Middle:** (-4)+(-10)+14=0; **Right:** 22-10=12.

1c. In alphabet order: (48)(12)+(18)(-4)-(30)(-10)+(36)(16)-(36)(8)-(-54)(14)-(84)(22)=0. All of these check out, so the circuit is valid. Note signs are for power *dissipated.*

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2. KCL holds at lower left node; can't write KVL anywhere, so circuit is valid. **Power supplied:100V:** -(100)(5)=-500W (so dissipated); **60V:** (60)(5)=300W. $20A|| - 25A = -5A$ consistent with other 5A; 60-100=-40V. Get $5A \downarrow || - 40V^{+}_{-}$.

3b. $v_g = (1.6A)(90\Omega) = 144V$. $v_{30\Omega} = (1.6A)(30\Omega) = 48V$. $v_{source} = 144 + 48 = 192V$.

3a. $i_a = 192V/80\Omega = 2.4A$. $i_g = i_a + 1.6A = 2.4 + 1.6 = 4A$. In #3c, all powers in watts.

3c. $P_{80\Omega} = (2.4)^2(80) = 460.8$. $P_{30\Omega} = (1.6)^2(30) = 76.8$. $P_{90\Omega} = (1.6)^2(90) = 230.4$. $P_{source} = (192V)(4A) = 768$ supplied. $460.8 + 76.8 + 230.4 = 768$ checks.

4a,b. **Straightforward way:** $50 - 4(i_a + i_b) - 20i_a = 0$ and $50 - 4(i_a + i_b) - 80i_b = 0$. Solving 2 equations in 2 unknowns$\rightarrow i_a = 2A, i_b = \frac{1}{2}A$. **Clever but easier way:** $20\Omega, 80\Omega$ same voltage$\rightarrow i_a = 4i_b \rightarrow 50 - 4(5i_b) - 80i_b = 0 \rightarrow i_b = \frac{1}{2}A, i_a = 2A$.

4c. $v_o = (80\Omega)i_b = 40V$. OR: $v_o = 50V - (4\Omega)(i_a + i_b) = 50V - (4\Omega)(2A + \frac{1}{2}A) = 40V$.

4d. $P_{4\Omega} = (i_a + i_b)^2(4\Omega) = 25W$. $P_{20\Omega} = i_a^2(20\Omega) = 80W$. $P_{80\Omega} = i_b^2(80\Omega) = 20W$.

4e. $P_{50V} = (50V)(i_a + i_b) = 125W$ supplied. $125 = 25 + 80 + 20$ checks.

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5. Has to be current source i_s and resistor R in parallel (in series$\rightarrow$constant current). $i_t = v_t/R - i_s$ (Norton equivalent circuit: $i_s \uparrow ||R$). From data: $i_t = 0 \rightarrow 50 = Ri_s$ and $3 = (65V)/R - i_s \rightarrow R = 5\Omega, i_s = 10A$.

6a. $R_{ab} = 2\Omega + 12\Omega||24\Omega + 6\Omega = 16\Omega$. In #6b, everything is in $k\Omega$:

6b. $20||30||24 : G_{eq} = 1/20 + 1/30 + 1/24 = (6 + 4 + 5)/120 = 1/8 \rightarrow R_{eq} = 8 + 7 = 15$. $R_{ab} = 15||30||15 : G_{ab} = 1/15 + 1/30 + 1/15 = (2 + 1 + 2)/30 = 1/6 \rightarrow R_{ab} = 6k\Omega$.

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7. Connect a $1A$ current source as suggested. $1A$ splits into 3 equal currents @$\frac{1}{3}A$, each of which in turn splits into 2 equal currents @$\frac{1}{6}A$, which then recombine similarly. Using KVL, the voltage is $(1\Omega)(\frac{1}{3}A) + (1\Omega)(\frac{1}{6}A) + (1\Omega)(\frac{1}{3}A) = \frac{5}{6}V \rightarrow \frac{5}{6}\Omega$.