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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 $(1\Omega)(\frac{1}{3}A)+(1\Omega)(\frac{1}{6}A)+(1\Omega)(\frac{1}{3}A)=\frac{5}{6}V\rightarrow\frac{5}{6}\Omega$.
