1. Radio: $12.5 = V_T(\frac{6.25}{R_T+6.25})$. Headlights: $11.7 = V_T(\frac{0.65}{R_T+0.65})$.

   Solving 2 equations in 2 unknowns$\rightarrow$ $V_T = 12.6V$ and $R_T = 0.05\Omega = 50m\Omega$.

2a. Node equation at a: $1.5 = \frac{V_a}{60+20} + \frac{V_a-30}{40} \rightarrow V_a = 60V \rightarrow V_{OC} = V_a\frac{60}{60+20} = 45V$.

2a. Node equation at a: $1.5 = \frac{V_a}{20} \quad + \frac{V_a-30}{40} \rightarrow V_a = 30V \rightarrow I_{SC} = \frac{V_a}{20} = 1.5A$.

2b. Setting 30V$\rightarrow$short and 1.5A$\rightarrow$open$\rightarrow$ $R_T = 60||(40+20) = 30\Omega$.

   This is consistent with the results of (a): $R_T = \frac{V_{OC}}{I_{SC}} = \frac{45V}{1.5A} = 30\Omega$.

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3. $8mA||20k\Omega||30V = 30V$. Thevenin$\{30V, 15k\Omega\}$ $\rightarrow$Norton$\{2mA, 15k\Omega\}$.

   Combining current sources and resistors$\rightarrow$Norton$\{-8mA, 30||15 = 10k\Omega\}$.

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4. Since no independent sources, Thevenin equivalent has $V_T = 0$ (pure resistor).

   Connect up 1V source: Node eqn.$\rightarrow$ $\frac{V-1}{20} + \frac{V}{80} + \frac{V-40(-V/80)}{16} = 0 \rightarrow V = 0.32V$.

   $I = \frac{1-0.32}{20} + \frac{1-40i_\Delta}{60} = 0.034A + \frac{1-40(-0.32/80)}{60} = 0.0533A \rightarrow R_T = \frac{1V}{0.0533A} = 18.75\Omega$.

5a. This is what "maximum power transfer" *isn't*. $R_o = 0$ maximizes $P_{6\Omega} = i^2(6\Omega)$.

5b. This is what it *is*. Now we vary the load, not the source, resistance. $R_o = 6\Omega$.

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6. Thevenin equivalent resistance=Norton equivalent resistance=$10k\Omega$, so load=$10k\Omega$.

7a. $V_T = 30(\frac{8||8+8}{2+(8||8+8)}) = \frac{180}{7}V$. $I_{SC} = \frac{30V}{2\Omega} = 15A$. $R_T = 2||(8||8+8) = 2||12 = \frac{12}{7}\Omega$.

7b. KVL: $\frac{180}{7} - \frac{12}{7}I - \frac{96}{I} = 0 \rightarrow I^2 - 15I + 56 = 0 \rightarrow I = 7A, 8A \rightarrow V = \frac{96}{7}V, 12V$

   Note there are *two* possible solutions, since the i-v characteristic is nonlinear.