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

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

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

2a. Node equation at a: \( 1.5 = \frac{V_a}{20} + \frac{V_a-30}{40} \to V_a = 30V \to I_{SC} = \frac{V_a}{20} = 1.5A \).

2b. Setting 30V \to \text{short and 1.5A \to \text{open}} \to R_T = 60||\left(40 + 20\right) = 30\Omega .

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

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

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

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

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

\[ I = \frac{1-0.32}{20} + \frac{1-40i+80}{60} = 0.034A + \frac{1-40(-0.32/80)}{60} = 0.0533A \to R_T = \frac{1V}{0.0533A} = 18.75\Omega \]

5a. This is what “maximum power transfer” isn’t. \( R_o = 0 \) maximizes \( P_{60} = i^2(6\Omega) \).

5b. This is what it is. Now we vary the load, not the source, resistance. \( R_L = 6\Omega \).

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

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

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

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