1. Consider the circuit shown below with currents, node-voltages, and a reference labeled.

   \[ \begin{array}{c}
   v_a \\
   4 \Omega \\
   v_b \\
   3 \Omega \\
   v_c \\
   120V \\
   18 \Omega \\
   6 \Omega \\
   i_s \\
   i_1 \\
   i_2
   \end{array} \]

   (a) Use series and parallel simplifications to find the currents \( i_s \), \( i_1 \), and \( i_2 \) as labeled.
   (b) Calculate the power consumed by all elements (denote as \( p_{120V} \), \( p_{4\Omega} \), \( p_{18\Omega} \), \( p_{3\Omega} \), \( p_{6\Omega} \)) in the circuit and confirm they sum to zero.
   (c) Determine the node-voltages \( v_a \), \( v_b \), and \( v_c \) as labeled.
   (d) Show how an ammeter should be connected to measure the current \( i_1 \).
   (e) Show how an ohmmeter should be connected to measure the equivalent resistance connected to the voltage source.

2. Consider the circuit shown below with voltages, node-voltages and a reference labeled.

   \[ \begin{array}{c}
   v_s \\
   7.2 \Omega \\
   v_a \\
   30 \Omega \\
   v_b \\
   64 \Omega \\
   v_1 \\
   6 \Omega \\
   v_2 \\
   10 \Omega \\
   v_c
   \end{array} \]

   (a) Use series and parallel simplifications to find the voltages \( v_s \), \( v_1 \), and \( v_2 \) as labeled.
   (b) Calculate the power consumed by all elements (denote as \( p_{5A} \), \( p_{30\Omega} \), \( p_{7.2\Omega} \), \( p_{64\Omega} \), \( p_{6\Omega} \), \( p_{10\Omega} \)) in the circuit and confirm they sum to zero.
   (c) Determine the node-voltages \( v_a \), \( v_b \), and \( v_c \) as labeled.
   (d) Show how a voltmeter should be connected to measure the voltage \( v_1 \).
   (e) Show how an ohmmeter should be connected to measure the resistance of only the 64\( \Omega \) resistor.
3. The circuit shown below contains a 24V source and three lamps. The lamps are denoted by $A$, $B$, and $C$, and are rated to consume $p_A = 10\text{W}$, $p_B = 15\text{W}$, and $p_C = 20\text{W}$ of power, respectively. If the voltage source consumes $-30\text{W}$ of power, which lamp has burned out?