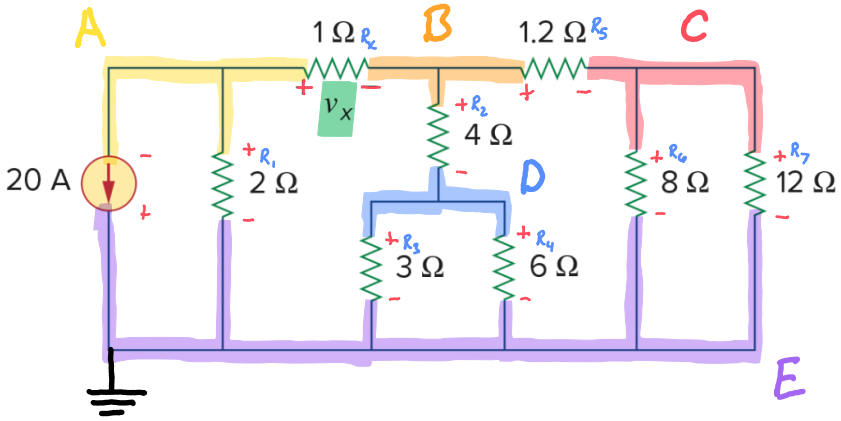
Homework 2
Due: Friday, February 3rd, 2023 by 7PM.

Note: In order to receive full credit, you must show your work and carefully justify your answers. The correct answer without any work will receive little or no credit.

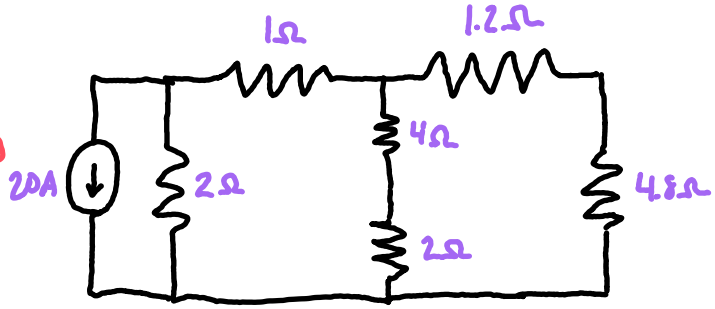
1. Using equivalent resistance, current division, voltage division, and Ohm's Law only, find the voltage vx in the circuit below.



$i_A = 20A$

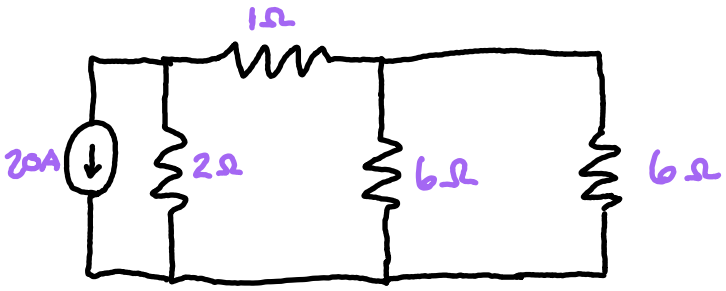
$V_E = 0V$

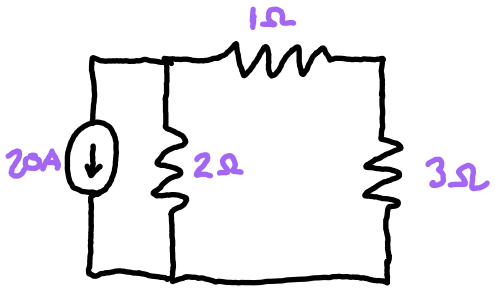
$V_B = V_A - V_C - V_D$



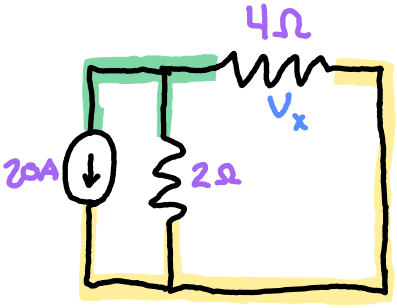
$\frac{1}{\frac{1}{8}+\frac{1}{12}} = 4.8$

$\frac{1}{\frac{1}{3}+\frac{1}{6}} = 2$





$\frac{1}{\frac{1}{6}+\frac{1}{6}} = 3$



$I_x = \frac{R_T}{R_x + R_T} I_T$

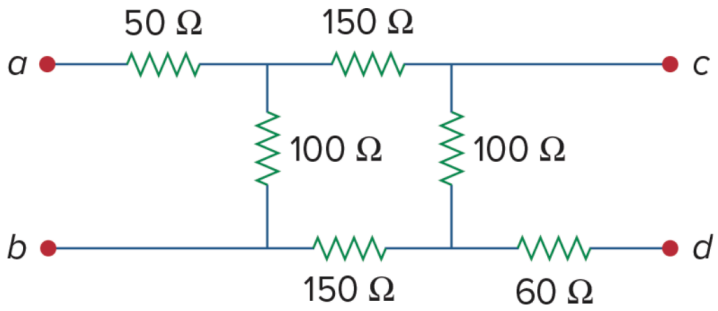
$= \frac{2}{2+4} =$

$I_x = \frac{2}{4+2} 20 = 6.67A$

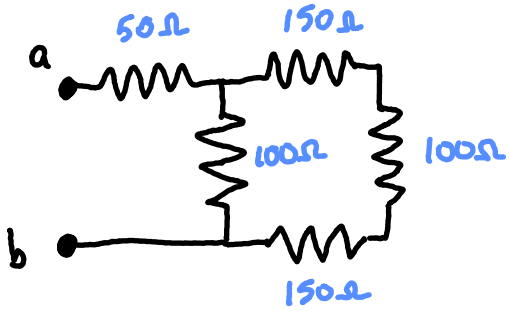
$6.67A \cdot 1\Omega = 6.67V$

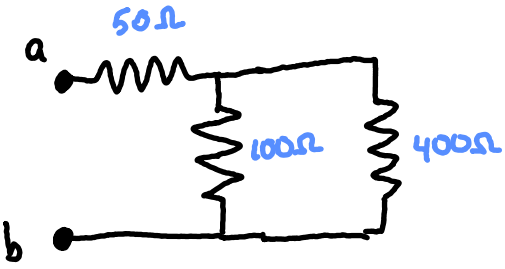
$V_x = 6.67V$

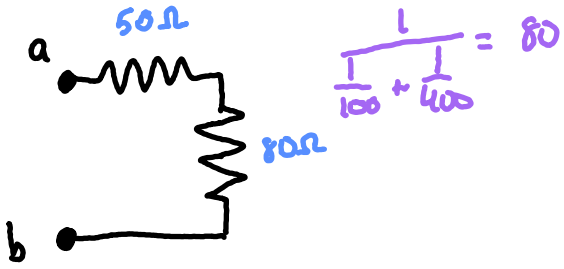
2. For the circuit below:
   A. Find Req from node a and b.
   B. Find Req from node b and c.

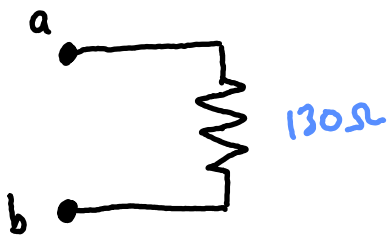


A.



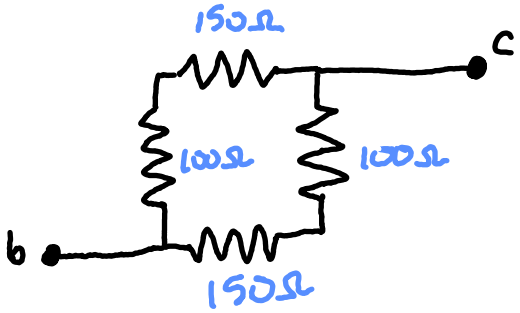


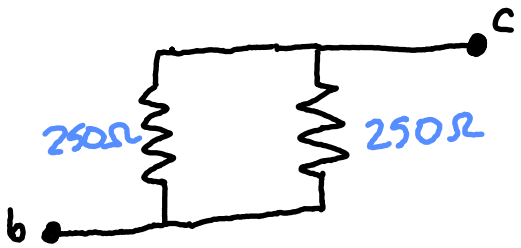


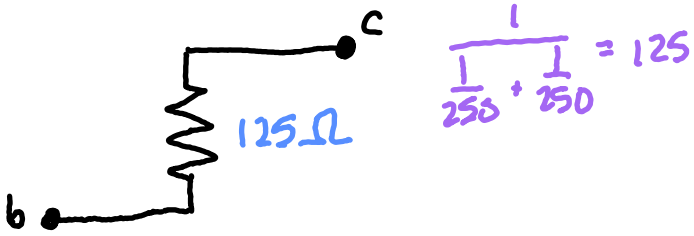


$R_{eq} = 130\,\Omega$

B

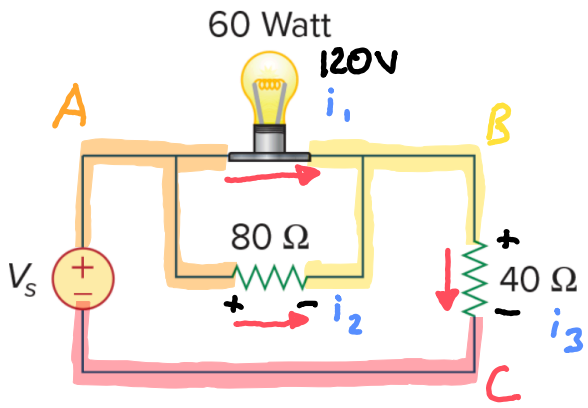






$R_{eq} = 125\,\Omega$

3. The 60 W light bulb is rated at 120 V. Calculate the value of Vs to make the light bulb operate at its rated conditions.



$P = VI$ $\quad P = \frac{V^2}{R}$ $\quad I = \frac{P}{V}$ $\quad .5$

$R = \frac{V^2}{P}$

KCL@ B.

$i_3 = i_1 + i_2$

Ohm's Law $I = \frac{V}{R}$

$\frac{V_3}{R_3} = \frac{1}{2} + \frac{V_2}{R_2}$

$\frac{V_3}{40} = \frac{1}{2} + \frac{120}{80} = \frac{1}{2} + \frac{3}{2}$

$V_3 = 2 \cdot 40 = 80V$

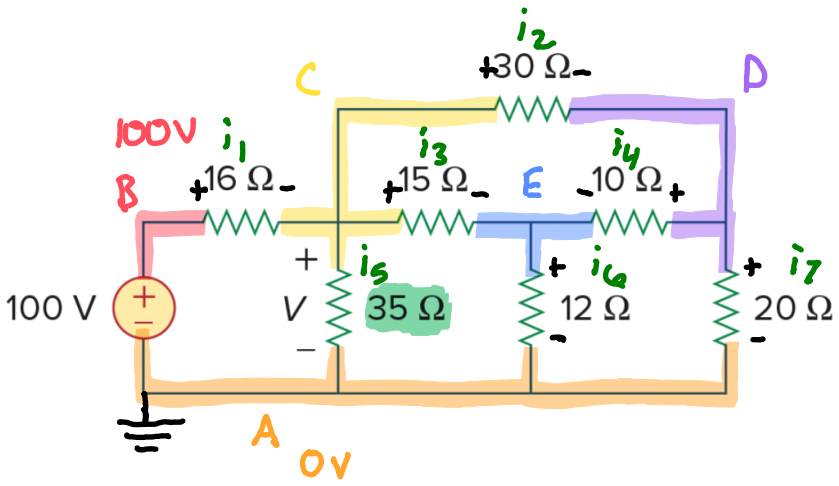
KVL@ C:

$V_s = V_1 + V_3$

$V_s = 120 + 80 = 200V$

$V_s = 200V$

4. Using node voltage analysis to find voltage V across the 35Ω resistor.



KCL @ A:

$i_5 + i_6 + i_7 = 0$

KCL @ C:

$i_1 = i_2 + i_3 + i_5$

$\frac{V_1}{16} = \frac{V_2}{30} + \frac{V_3}{15} + \frac{V_5}{35}$

$65V_1 = 35V_2 + 70V_3 + 30V_5$

$65(V_B - V_C) = 35(V_C - V_D) + 70(V_C - V_E) + 30(V_C)$

$0 = 70V_C - 35V_D - 70V_E + 65V_B$

$V_C = \frac{1}{2}V_D + V_E - \frac{13}{14}V_B$

KCL @ D:

$i_7 = i_2 + i_4$

$\frac{V_7}{20} = \frac{V_2}{30} + \frac{V_4}{10}$

$3V_7 = 2V_2 + 6V_4$

$3V_D = 2(V_C - V_D) + 6(V_E - V_D)$

$0 = 2V_C - 11V_D + 6V_E$

$V_C = \frac{11}{2}V_D - 3V_E$

KCL @ E:

$i_6 = i_3 + i_4$

$\frac{V_6}{12} = \frac{V_3}{15} + \frac{V_4}{10}$

$5V_6 = 4V_3 + 6V_4$

$5V_E = 4(V_C - V_E) + 6(V_E - V_D)$

$0 = 4V_C - 6V_D - 3V_E$

$V_C = \frac{3}{2}V_D + \frac{3}{4}V_E$

$i_1 = 10D$

$V_1 = V_B - V_C$

$V_2 = V_C - V_D$

$V_3 = V_C - V_E$

$V_4 = V_E - V_D$

$V_5 = V_C$

$V_6 = V_E$

$V_7 = V_D$

$V = 42V$