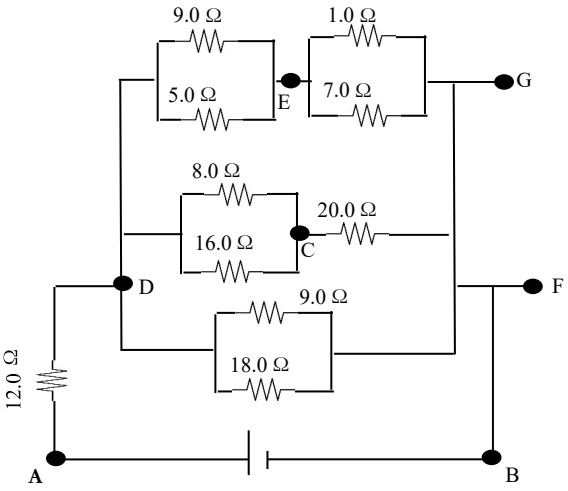
Week 8 Challenge Homework Solutions

Question 1

The current in the 8.00-Ω resistor in the drawing in 0.500 A.

(a) Find the current in the 20.0-Ω, 12.0-Ω, and both 9.0Ω resistors.
(b) Find the voltage drop and indicate which point is at a higher potential for following: between points **G** and **F**, **A** and **B**, **A** and **E**, and **E** and **C**.
(c) A brand new standard household 9-V battery has about the same potential energy as a 2200 lb car at the top of a 1200-ft-high hill. How long will the circuit operate if its voltage source is replaced with a 9-V battery?

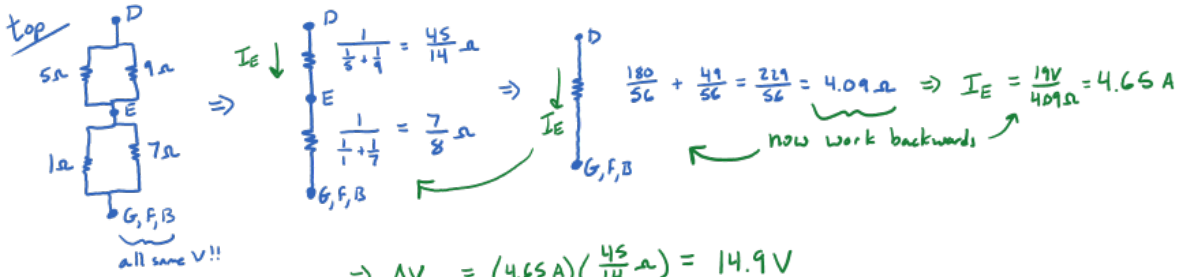


(a) $I_8 = 0.5\,A \Rightarrow \Delta V_8 = 4\,V \Rightarrow \Delta V_{16} = 4\,V \Rightarrow I_{16} = 0.25\,A$

$I_{20} = I_8 + I_{16} = \boxed{0.75\,A = I_{20}} \Rightarrow \Delta V_{20} = 15\,V \Rightarrow \Delta V_{DF} = 19\,V$

$\Rightarrow \Delta V_{9bot} = 19\,V \Rightarrow \boxed{\Delta I_{9bot} = \frac{19}{9}\,A = 2.11\,A} \Rightarrow I_{18} = \frac{1}{2} I_{9bot}$

$= 1.06\,A$



$\Rightarrow \Delta V_{DE} = (4.65\,A)\left(\frac{45}{14}\,\Omega\right) = 14.9\,V$

$\Delta V_{9top} = 14.9\,V$

$\Rightarrow \boxed{I_{9top} = \frac{14.9\,V}{9\,\Omega} = 1.66\,A}$

$\Delta V_{12} = 102.8\,V$

$I_E = I_{9top} + I_5$

$I_{12} = I_{18} + I_{9bot} + I_{20} + I_E = \boxed{8.57\,A = I_{12}}$

(b) $G \to F$

$\Delta V = 0\ V$

$V_G = V_F$

$A \to B$

$V_A > V_B$

$-\Delta V_{BA} = \Delta V_{AB} = \Delta V_{12} + \Delta V_{9bot}$

$= -122\ V$

$A \to E$ $\quad V_A > V_E$

$\Delta V_{AE} = \Delta V_{12} + \Delta V_{9top}$

$= 118\ V$

$E \to C$ $\quad V_C > V_E$

$\Delta V_{EC} = -\Delta V_{9bot} + \Delta V_8$

$= 10.9\ V$

(c) $U^g_{car} = mgh = (2200\ lb)(9.8\ m/s^2)(1200\ ft)$

$\times \left(\frac{1\ kg}{2.2\ lb}\right)\left(\frac{1\ m}{3.30\ ft}\right)$

$= 3.56 \times 10^6\ J$

$R_{circuit} = \frac{\Delta V_{BA}}{I_{car}} = \frac{122\ V}{8.57\ A} = 14.2\ \Omega$

($I_{car} = I_{12}$)

$P = \frac{\Delta V^2}{R} = \frac{(9V)^2}{14.2\ \Omega} = 5.70\ W$

$P = \frac{\Delta U}{\Delta t} \Rightarrow \Delta t = \frac{\Delta U}{P} = \frac{3.56 \times 10^6\ J}{5.70\ J/s} = 6.25 \times 10^5\ s$

$= 10,400\ min = 173\ hr = 7.2\ days$