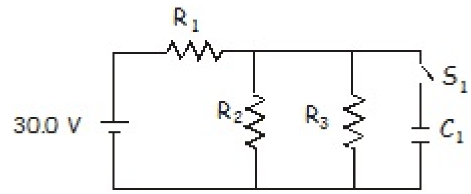
Name: ______________________

1. Three resistors are arranged in a circuit as shown. There is also a switch and a capacitor. R_1 is 25.0 Ω, R_2 is 25.0 Ω, R_3 is 45.0 Ω, and C_1 has the value of 1.25 μF. (a) When S_1 is open, what is the total current? (b) What is the voltage drop for R_1? (c) Switch S_1 is now closed for a long time. What is the charge Q on the capacitor? (d) What is the potential energy stored in the capacitor?



a. $R_{23} = (R_2^{-1} + R_3^{-1})^{-1}$

$= ((25.0\ \Omega)^{-1} + (45.0\ \Omega)^{-1})^{-1} = 16.0714286\ \Omega$

$R_{tot} = R_1 + R_{23}$

$= 25.0\ \Omega + 16.0714286\ \Omega = 41.0714286\ \Omega$

$I_{tot} = V/R_{tot}$

$= 30.0\ V/41.0714286\ \Omega = 0.73043478\ A =$ **0.730 A or 730 mA**

b. $V_1 = R_1 I_{tot} = 25.0\ \Omega \cdot 0.73043478\ A = 18.26087\ V =$ **18.3 V**

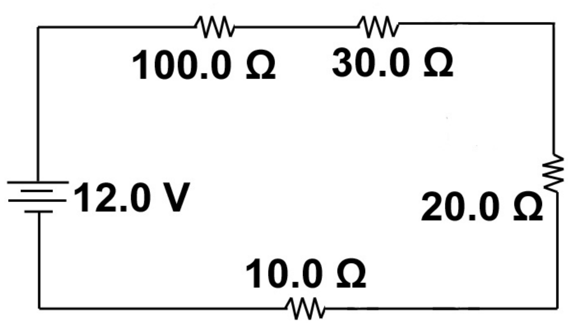
c. $V_C = V_{23} = 30.0\ V - 18.26087\ V = 11.73913\ V$

$Q = CV = 1.25\times10^{-6}\ F \cdot 11.73913\ V = 1.46739125\times10^{-5}\ C =$ **1.47×10^{-5} C or 14.7 μC**

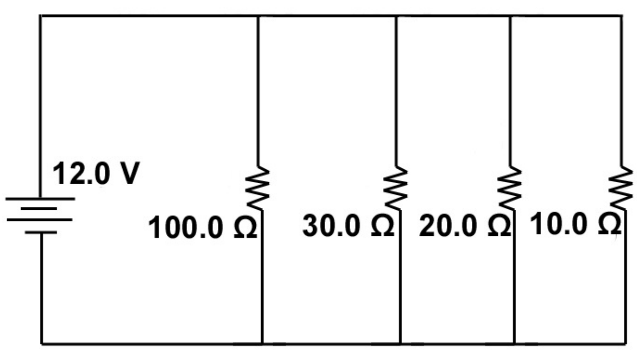
d. $U_C = \frac{1}{2} QV = 0.5 \cdot 1.46739125\times10^{-5}\ C \cdot 11.73913\ V = 8.612948322\times10^{-5}\ J =$ **8.61×10^{-5} J**

2. You are given a 12.0 V battery, and four resistors with the following values: 100.0 Ω, 30.0 Ω, 20.0 Ω, and 10.0 Ω. You also have plenty of wire that has essentially zero resistance. (a) Draw a circuit in which each resistor has current flowing through it, but in which the current from the battery is as small as possible. (b) Now draw a circuit in which the current from the battery is as large as possible. (no short circuiting of the battery, however.)

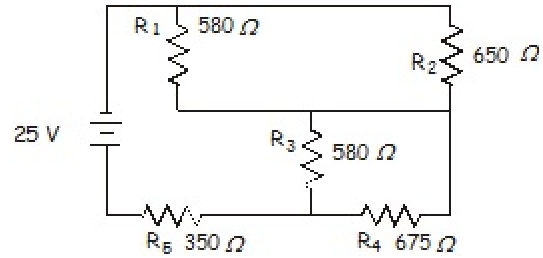
a.



b.



3. Find the: (a) total current, (b) total resistance, (c) power dissipated by R_4.



a. R_1 is parallel with R_2. R_3 is parallel with R_4.

$R_{12} = (R_1^{-1} + R_2^{-1})^{-1} = 306.504065\ \Omega$

$R_{34} = (R_3^{-1} + R_4^{-1})^{-1} = 311.9521912\ \Omega$

$R_{tot} = R_{12} + R_{34} + R_5 = 968.4562562\ \Omega$

$I = V/R = 25\text{ V}/968.4562562\ \Omega$

$= 0.025814279\text{ A} =$ $\boxed{0.026\text{ A or } 26\text{ mA}}$

b. $R_{tot} =$ $\boxed{970\ \Omega}$

c. $V_4 = I \cdot R_{34} = 0.025814279\text{ A} \cdot 311.9521912\ \Omega$

$= 8.052820899\text{ V}$

or $V_4 = V_{tot} \cdot (R_{34} / R_{tot})$

$= 25\text{ V} \cdot (311.9521912\ \Omega/968.4562562\ \Omega)$

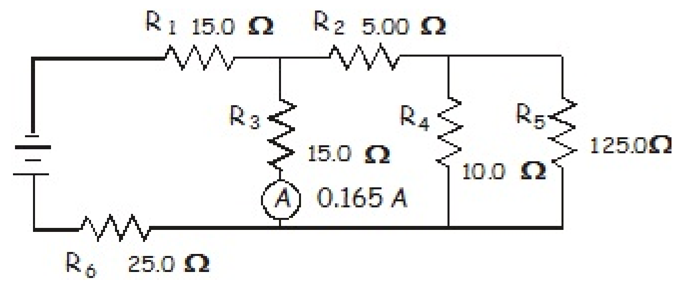
$= 8.052820899\text{ V}$

$P = V^2/R = (8.052820899\text{ V})^2/675\ \Omega = 0.096070999\text{ W} =$ $\boxed{0.096\text{ W or } 96\text{ mW}}$

4. A proton has a velocity of 1.25 x 10^6 m/s. It travels into a magnetic field that has a strength of 1.50 T. What is the maximum force that the proton can experience?

$F_B = qvB\sin\theta = 1.6\times10^{-19}\text{ C} \cdot 1.25\times10^6\text{ m/s} \cdot 1.50\text{ T} =$ $\boxed{3.00\times10^{-13}\text{ N or } 300.\text{ fN}}$

5. A circuit is as shown. Find: (a) the total resistance, (b) the total current, (c) the voltage provided by the battery, and (d) the amount of energy that the battery puts out in 1.00 hours in kWh.



a. $R_T = R_1 + (R_3^{-1} + (R_2 + (R_4^{-1} + R_5^{-1})^{-1})^{-1})^{-1} + R_6$
$= 47.31012658\ \Omega =$ $\boxed{47.3\ \Omega}$
or (in steps):
$R_{245} = R_2 + (R_4^{-1} + R_5^{-1})^{-1} = 14.25925926\ \Omega$
$R_{2345} = (R_3^{-1} + R_{245}^{-1})^{-1} = 7.310126582\ \Omega$
$R_T = R_1 + R_{2345} + R_6 = 47.310126582\ \Omega$

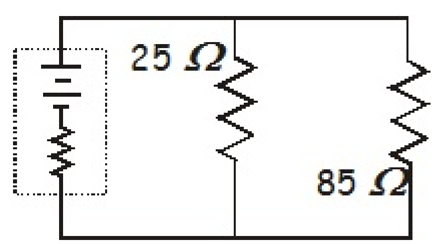
b. $V_{245} = V_3 = R_3 \cdot I_3 = 15.0\ \Omega \cdot 0.165\ A = 2.475\ V$
$I_T = I_3 + I_{245} = I_3 + V_{245}/R_{245} = 0.165\ A + 2.475\ V/14.25925926\ \Omega$
$= 0.3385714286\ A =$ $\boxed{0.339\ A \text{ or } 339\ mA}$

c. $V_{BAT} = V_1 + V_3 + V_6 = R_1 I_T + V_3 + R_6 I_T$
$= 15.0\ \Omega \cdot 0.339\ A + 2.475\ V + 25.0\ \Omega \cdot 0.339\ A = 16.01785714\ V =$ $\boxed{16.0\ V}$

d. $E = P \cdot t = (VI) \cdot t = 16.0\ V \cdot 0.339\ A \cdot 1.00\ h =$ $\boxed{5.424\ Wh \text{ or } 0.005424\ kWh}$

6. A circuit is arranged as shown. The battery has an internal resistance of 2.5 Ω, the source of emf is 15 V. Find: (a) the total current in the circuit, and (b) The voltage provided by the battery.

a. $R_T = (25^{-1} + 85^{-1})^{-1}\ \Omega = 19.31818182\ \Omega$
$I_T = V/(R_T + R_{BAT}) = 15\ V/21.81818182\ \Omega$
$= 0.6875\ A =$ $\boxed{0.69\ A \text{ or } 690\ mA}$



b) $V_{BAT} = V_{EMF} - R_{BAT} \cdot I = 15\ V - 2.5\ \Omega \cdot 0.6875\ A$
$= 13.28125\ V =$ $\boxed{13.3\ V}$