A) Current through the battery as soon as the switch is closed. 
\[ I_0 = \frac{\Delta V}{R} \]
\[ = \frac{50.0V}{200\Omega} = 0.25A \]
(Capacitor is charging)

b) Long time later = capacitor is charged.
\[ I_2 = 0 \]  So 
\[ I_0 = \frac{50.0V}{600\Omega} \]
\[ = 83.3mA \]

(c) Initially, the current through the 600Ω resistor = 0A.
As the capacitor is charged, the current through the 600Ω grows. 
So \( I_{600\Omega} = I_0 \left[ 1 - e^{-t/\tau} \right] \)
Since the 600Ω and the 200Ω are in parallel,
\[ \frac{1}{\frac{1}{R} + \frac{1}{200}} \]
\[ RC = \frac{600}{4} = 150s \]
So \( t = RC = \left( 150s \right) \left( 5.00\mu F \right) = 0.75s \)
The current through the 600 kΩ resistor as $t \to \infty$

\[
\frac{\Delta V}{R} = \frac{\Delta V}{R_1 + R_2}
\]

\[
= 62.5 \text{ mA}
\]

So \[ I_1 = (62.5 \text{ mA}) e^{-t/0.755} \]

\[
\text{600 kΩ}
\]

2)

\[
\begin{array}{c}
\text{1.2 kΩ} \\
\text{1.20 mA} \\
\text{1.2 kΩ} \\
\text{50.0 V} \\
\text{50 MΩ} \\
\end{array}
\]

\[
\text{2.50 MΩ}
\]

a) Again at $t = 0$, \[ I_0 = \frac{50.0 \text{ V}}{1.20 \text{ MΩ}} = 41.7 \times 10^{-6} \text{ A} \]

b) \[
I_b = \frac{50.0 \text{ V}}{600 \text{ kΩ}} = \frac{50.0 \text{ V}}{1.8 \times 10^6 \text{ Ω}} = 8.33 \text{ mA} \]

\[
\text{2.78 mA}
\]

\[
\text{27.8 mA}
\]

\[
50.0 \text{ V} = 50.0 \text{ V}
\]

\[
\text{1.8 MΩ}
\]

\[
\text{1.8} \times 10^6 \Omega
\]

\[
\text{27.8 mA}
\]

\[
\text{27.8 mA}
\]

c) Capacitor is charged. As switch is opened, capacitor discharges through the 600 kΩ resistor.

\[
I = I_0 e^{-t/RC}
\]

\[
I = I_0 e^{-t/600 \times 10^3 \Omega \times 0.5 \mu \text{F}}
\]

\[
I_0 = \frac{\Delta V}{R} = \frac{50.0 \text{ V}}{1.20 \times 10^6 \Omega} = 41.7 \times 10^{-6} \text{ A}
\]

\[
I = (83.3 \text{ mA}) e^{-t/1.505}
\]

\[
\text{50.0 V}^2 = 83.3 \times 10^{-6} \frac{50.0 \text{ V}^2}{600 \times 10^3 \Omega \times 0.5 \mu \text{F}} = 83.3 \text{ mA}
\]
3) \( C = 6.00 \text{mF}, \quad E = 100V, \quad R = 500\Omega \)

As the capacitor is fully charged, \( q = C \Delta V \)

\[ q = C \Delta V = 6.00 \text{mF} \times 100V = 600 \mu \text{C} \]

**Note:** Original diagram was incorrect.

b) The capacitor starts discharging through the resistor as soon as the switch is moved to 'b'.

\[ I = I_0 e^{-t/RC} \]

\[ I_0 = 0.2A \]

\[ RC = (500\Omega) \times (6.00 \text{mF}) = 3.0 \text{ms} \]

\[ I_0 = \frac{E \Delta V}{R} = \frac{(6.00 \text{mF}) \times 100V}{500\Omega} = 1.2 \mu \text{A} \]

\[ I_0 = \frac{100V}{500\Omega} = 0.2A \]

\[ q(t) = q(0) e^{-t/RC} = 600 \mu \text{C} e^{-6.00 \text{mF}/3 \text{ms}} \]

\[ q(6\text{ms}) = 81.2 \mu \text{C} \]
4) a) Capacitor is fully charged.

**Energy Stored in the Capacitor**

\[ U = \frac{1}{2} CV^2 \quad \text{or} \quad U = \frac{1}{2} \frac{Q^2}{C} \]

\[ U = \frac{1}{2} \left( \frac{600 \mu C}{6.00 \mu F} \right)^2 \]

\[ U = \frac{1}{2} \times 3.6 \times 10^4 \times 10^{-12} \times 10^{-6} \]

\[ = 3 \times 10^{-2} J \]

**As the Capacitor discharges, its energy stored decreases in time as**

\[ U = \frac{1}{2C} \left[ Q e^{-t/RC} \right]^2 \]

\[ U(t) = \frac{Q^2}{2C} e^{-2t/RC} \]

\[ Q = 600 \mu C \quad C = 6.00 \mu F \quad RC = 3 \text{ms} \]

5)

\[ C = 0.120 \mu F \quad E = 100V \quad V(4.005) = \frac{E}{2} = 50.0V \]

Capacitor is discharging. So \( \Delta V/C \) is decreasing.

\[ \Delta V(t) = \frac{1}{C} Q e^{-t/RC} \]

\[ \Delta V(4.005) = 50.0V = \left( \frac{12.0 \mu C}{0.120 \mu F} \right) e^{-4} \quad t < RC \]

\[ 50 = e^{-4/2} \]

\[ \ln \left( \frac{4}{2} \right) = -4/2 \]

\[ -4/2 = \ln \left( \frac{2}{1} \right) \]

\[ RC = 0.120 \mu F \quad R \left( 0.12 \mu F \right) = 10.915 \]

\[ R = \sqrt{109 \times 10^6} \quad 90.9 \times 10^6 \quad \text{or} \quad 91 \Omega \]
6) The main thing here is to find the time constant.

\[ C = \frac{1}{60} + \frac{1}{60} \]

\[ C = \frac{1}{60} + \frac{1}{60} \]

So, equivalent = 50 μF

\[ \frac{1}{R} = \frac{1}{30Ω} + \frac{1}{20Ω} \]

\[ R_{11} = 12Ω \]

\[ R_{11} = \frac{12}{\frac{1}{30Ω} + \frac{1}{20Ω}} \]

\[ R = 48Ω \]

Requiv = 20Ω

So, R = 120Ω 1.0 ms

\[ I = I_0 e^{-t/RC} \]

Need: time when \( \frac{I}{I_0} = \frac{1}{2} \)

\[ t = 0.79 ms \]

\[ \frac{I}{I_0} = \frac{1}{2} = e^{-t/1x10^{-3}} \]

\[ -0.693 = -\frac{t}{1x10^{-3}} \]

\[ t = 0.693 ms \]
As capacitor is fully charged, \( I_3 = 0 \)

1. Using loop rule for the 1st loop

\[
\Delta V_b = I_1 (60\Omega) - I_2 (40\Omega)
\]

2. Junction Rule

\[
I_1 = I_2 + I_3
\]

\[
I_3 = I_2
\]

3. \( \Delta V_b = 100 \times I_1 \)

\[
I_1 = 1A
\]

4. \( \Delta V_{AB} = I_1 (40\Omega) = 40V \)

\[
\Delta V_c = \Delta V_{AB} \quad (No \ voltage \ drop \ across \ 10\Omega)
\]

5. \( Q = C \Delta V_c \\
   = (2.0 \text{ mF})(40V) \)

\[
Q = 80 \text{ mC}
\]

6. \( RC \times t = (50\Omega)(2.0 \text{ mF}) \\
   = 100 \times 10^{-6}s \\
   = 0.1ms \)

\[
\frac{Q}{Q_0} = 0.1 = e^{-t/\tau} \\
- \tau \ln(0.1) = t \\
\]

\[
t = 0.23 ms
\]