This problem concerns resistors and capacitors in a circuit. The capacitor $C_1$ below has a charge of 1 $\mu$C, with the sign as indicated.

\[ R_1=100 \text{ K}\Omega \]
\[ C_1=1 \text{ } \mu\text{F} \]

a) What is the potential difference between points A and B? (The circuit is as drawn, with A and B the ends of the wires).

The voltage across the capacitor is $V = \frac{Q}{C} = \frac{1\mu\text{C}}{1\mu\text{F}} = 1V$. Since there is no current through $R_1$, there is no voltage drop across it. The potential between A and B is then 1V.

b) Now a 9V battery is connected to the circuit, the + terminal to A and the – terminal to B. What is the current through $R_1$ immediately after connecting the battery?

The drop across $R_1$ is 8V, since the battery is 9V and the drop across the capacitor is 1V. The current through the resistor is then $8\text{V}/10^5 \text{\Omega} = 80\mu\text{A}$.

c) After a very long time, with the battery still connected, what is the total amount of charge that has flowed from the battery through $R_1$?

After a very long time, the capacitor has charged up to 9V. This means that it has charge $Q = CV = (10^{-6} \text{F})(9\text{V}) = 9\mu\text{C}$. Since it originally had 1$\mu$C, a total of 8$\mu$C flowed through the resistor.

d) After this very long time, the battery is disconnected, with terminals A and B open again. How much energy is stored in the capacitor?

The capacitor voltage is 9V, so its stored energy is

\[ U = \frac{1}{2}CV^2 = \frac{1}{2}(10^{-6}\text{C})(9\text{V})^2 = 40.5 \times 10^{-6} \text{J} = 40.5\mu\text{J}. \]
With the capacitor charged as in d) above, a 50kΩ resistor is connected between A and B as shown.

![Diagram of RC circuit with R₁=100 KΩ, R₂=50 KΩ, and C₁=1 µF]  

**e)** Immediately after connecting $R₂$, what is the current flowing through $R₁$?

*The voltage across $C₁$ is 9V, so the current through $R₁$ is $\frac{9V}{150 \times 10^3 \Omega} = 0.06mA = 60\mu A$*

**f)** What is the time constant for the decay of the current through $R₁$?

*After connecting $R₂$, the capacitor discharges as in a normal RC circuit. The time constant is $\tau = RC = (150 \times 10^3 \Omega)(10^{-6} F) = 0.15s$*

**g)** What is the total energy dissipated by both resistors during the discharge?

*All the energy that was stored in the capacitor was dissipated by the resistors, since the energy is not in the circuit after the discharge. This was found in d) to be 40.5µJ.*