Consider the circuit shown in the diagram.

(a) What is the equivalent capacitance if the four capacitors are to be replaced with a single capacitance?

\[
\left[ \frac{1}{C_1} + \frac{1}{C_2} \right]^{-1} = 10 \mu F \quad \Rightarrow \quad C_\text{eq} = 20 \mu F
\]

(b) What is the voltage across the 20 \( \mu F \) capacitor?

The total voltage across the top 3 capacitors = 40 V (in parallel with the bottom one).

Total charge on the top 3 capacitors \( Q \) = \( C_3 V_3 = 10 \mu F \times 40 V = 400 \mu C \)

Charge on the 20 \( \mu F \) capacitor = charge on the 2 \( 10 \mu F \) capacitors = \( Q \)

Voltage on 20 \( \mu F \) capacitor \( \Rightarrow V_{20} = \frac{Q}{C_2} = \frac{400 \mu C}{20 \mu F} = 20 V \)

or by symmetry \( V_3 = V_{20} + V_{2,10} \Rightarrow V_{20} = V_{2,10} \Rightarrow V_{20} = \frac{V_3}{2} = \frac{40 V}{2} = 20 V \)

(c) How much energy is stored in the lowest 10 \( \mu F \) capacitor?

\[
U = \frac{1}{2} CV^2 = \frac{1}{2} \left( 10 \mu F \right) (40 V)^2 = \frac{4000 \mu J}{2} = 2000 \mu J
\]

(d) What is the magnitude of the charge on the top 10 \( \mu F \) capacitor?

By symmetry \( q_1 + q_2 = q_3 = q_2 \) and \( q_1 = q_2 \) \( \text{(since } C_1 = C_3 \text{ and } V_1 = V_3) \Rightarrow q_1 = \frac{q_3}{2} \)

\[
V_1 = V_3 = \frac{q_3}{20 \mu F} = \frac{400 \mu C}{20 \mu F} = 20 V \quad \Rightarrow \quad V_{20} + V_1 = 40 V \Rightarrow V_1 = 20 V
\]

\[
q_1 = 10 \mu F (20 V) = 200 \mu C = \frac{400 \mu C}{2} = 200 \mu C
\]