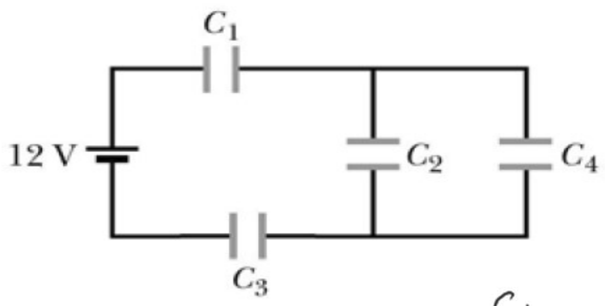
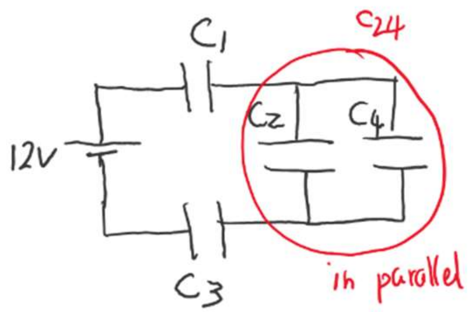
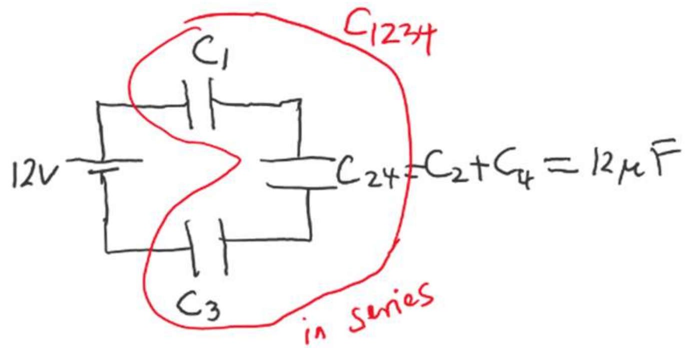
Q1 M2-112-17

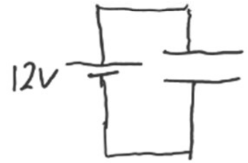
The figure shows a combination of four capacitors $C_1 = C_3 = 8.0$ μF and $C_2 = C_4 = 6.0$ μF connected to a 12-V battery. Calculate the charge on capacitor C_1.

A) 36 μC
B) 18 μC
C) 12 μC
D) 24 μC
E) 30 μC









$$C_{1234} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_3} + \frac{1}{C_{24}}} = \frac{1}{\frac{1}{8} + \frac{1}{8} + \frac{1}{12}}\,\mu F = 3\,\mu F$$

$$\Rightarrow q_{1234} = C_{1234} V = 36\,\mu C$$

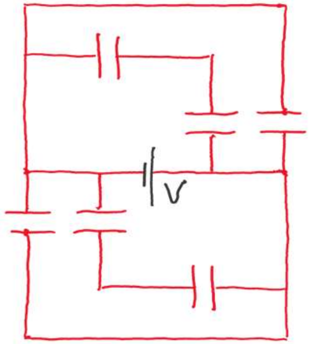
The charge on C_1 is the same as that on C_{1234}

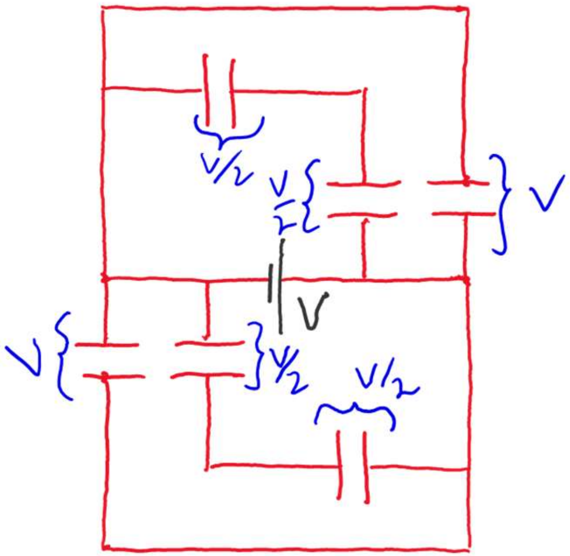
$$\Rightarrow q_1 = 36\,\mu C$$

Q2 M2-122-18

Consider the circuit of identical capacitors shown in the figure. A potential difference of 2.0×10^{2} V is applied by the battery V. Calculate the energy stored in the system if the capacitance of each capacitor is 50 μF.

A) 3.0 J
B) 4.0 J
C) 6.0 J
D) 1.0 J
E) 7.0 J





The electric potential across 4 capacitors is V/2 and across 2 capacitors is V.

$$U = 4\left[\frac{1}{2}C\left(\frac{V}{2}\right)^2\right] + 2\left[\frac{1}{2}CV^2\right]$$

$$U = \frac{3}{2}CV^2 = \frac{3}{2}(50\times10^{-6})(200)^2$$

$$U = 3.0\ \text{J}$$

Q3 M2-142-16

An air-filled parallel plate capacitor has a capacitance of 5.0 μF and a plate area of 60 cm^2. What is the energy density stored, in J/m^3, between the plates if the potential difference across them is 8.0 V?

A) 2.5×10^{6}
B) 5.0×10^{5}
C) 1.2×10^{6}
D) 1.6×10^{6}
E) 8.9×10^{5}

$$U = \frac{1}{2} C V^2$$

$$\text{Volume} = A d = \frac{\varepsilon_0 A^2}{C}$$

$$C = \frac{\varepsilon_0 A}{d} \Rightarrow d = \frac{\varepsilon_0 A}{C}$$

$$u = \frac{U}{\text{Volume}} = \frac{1}{2} \frac{C^2 V^2}{\varepsilon_0 A^2} = \frac{1}{2} \frac{(5.0\times10^{-6})^2 (8)^2}{8.85\times10^{-12} (60\times10^{-4})^2}$$

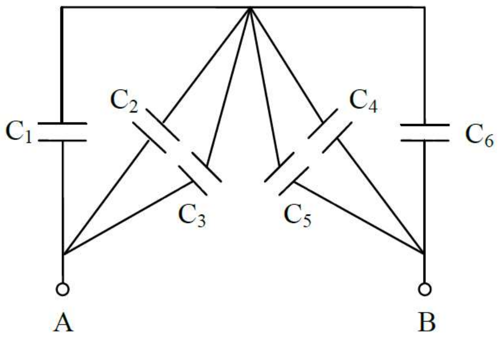
$$u = 2.5\times10^{6} \frac{J}{m^3}$$

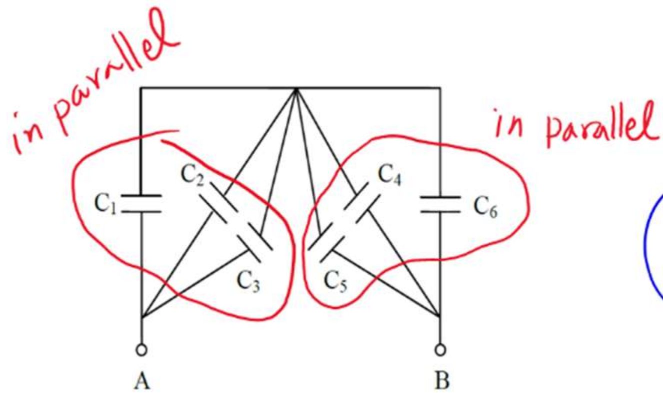
Q4

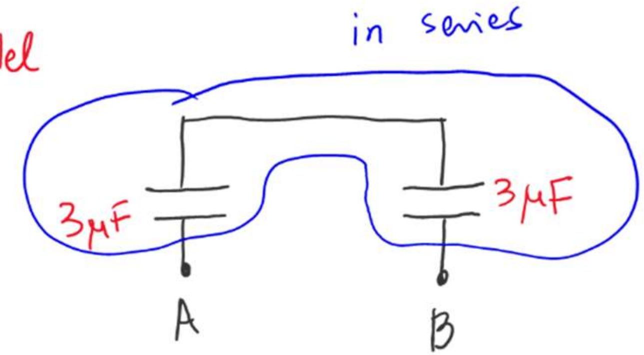
M2-142-15

The figure shows 6 identical capacitors, each with a capacitance of 1.0 μF. Find the equivalent capacitance C_{eq} between points A and B.

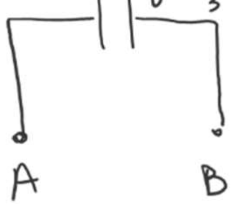
A) 1.5 μF
B) 4.0 μF
C) 3.0 μF
D) 2.5 μF
E) 9.0 μF







$$C_{eq} = \frac{1}{\frac{1}{3}+\frac{1}{3}} \mu F = 1.5 \mu F$$



Q5 M2-112-20

A 2.0-nF parallel plate capacitor is charged using a 12-V battery. The battery is removed and a dielectric of dielectric constant κ = 3.5 is inserted, filling completely the space between the plates of the capacitor. What is the energy stored in the capacitor after inserting the dielectric?

A) 4.1×10^{-8} J
B) 5.0×10^{-5} J
C) 1.4×10^{-7} J
D) 2.4×10^{-8} J
E) 1.0×10^{-6} J

$$q = CV = 2\times10^{-9} \times 12 = 24\ nC$$

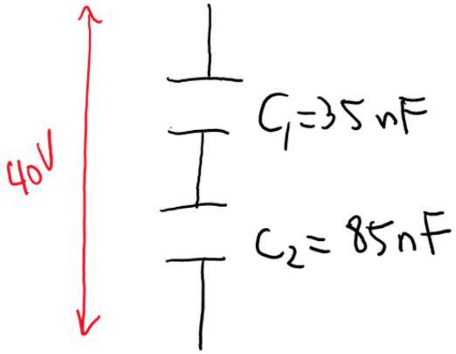
When the battery is removed, the charge on the capacitor does not change

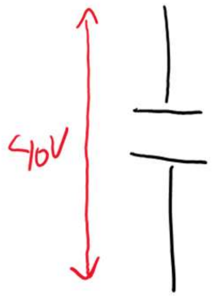
$$U = \frac{q^2}{2\kappa C} = \frac{(24\times10^{-9})^2}{2(3.5)\,2\times10^{-9}} = 4.1\times10^{-8}\ J$$

Q6 M2-142-14

Two capacitors, C_1 and, C_2 are connected in series to a 40 V power supply. If the capacitance C_1 = 35 nF, and of C_2 = 85 nF, find the voltage across C_1.

A) 28 V
B) 12 V
C) 16 V
D) 40 V
E) 24 V





$$C_{eq} = \frac{1}{\frac{1}{C_1}+\frac{1}{C_2}} = \frac{35\times 85}{35+85}\ nF = 24.79\ nF$$

The charge on C_{eq} is the same as the charge on C_1.

$$q = CV = 24.79\times10^{-9} \times 40 = 991.7\ nC$$

The voltage across C_1 is $V_1 = \frac{q_1}{C_1} = \frac{q}{C_1} = \frac{991.7}{35} = 28.3\ V$