Answer on Question 58074, Physics, Electric Circuits

Question:

The capacitances of the four capacitors shown in the figure are given in terms of a certain quantity *C*. If $C = 37 \ \mu F$, what is the equivalent capacitance (a) between points *A* and *B* and (b) between points *A* and *D*?

Solution:



a) Let's look at the picture above and let's find the equivalent capacitance between points A and B step-by-step. Here the capacitors 4C and 6C are in series, then the equivalent capacitance will be:

$$C_{eq1} = \frac{C_1 C_2}{(C_1 + C_2)} = \frac{4C \cdot 6C}{(4C + 6C)} = \frac{24C^2}{10C} = \frac{12C}{5}.$$

The combination of these two capacitors is in parallel to capacitor 2C, then the equivalent capacitance will be:

$$C_{eq2} = C_1 + C_2 = C_{eq1} + 2C = \frac{12C}{5} + 2C = \frac{22C}{5}$$

Finally, that combination of capacitors is in series with capacitor 1C, then the equivalent capacitance will be:

$$C_{eq(AB)} = \frac{C_1 C_2}{(C_1 + C_2)} = \frac{\frac{22C}{5} \cdot 1C}{\left(\frac{22C}{5} + 1C\right)} = \frac{\frac{22}{5}C^2}{\frac{27C}{5}} = \frac{22C}{27},$$
$$C_{eq(AB)} = \frac{22C}{27} = \frac{22 \cdot 37 \cdot 10^{-6}F}{27} = 30.15 \ \mu F.$$

b) Let's look at the picture above and let's find the equivalent capacitance between points A and D step-by-step. Here the capacitors 2C and 6C are in series, then the equivalent capacitance will be:

$$C_{eq1} = \frac{C_1 C_2}{(C_1 + C_2)} = \frac{2C \cdot 6C}{(2C + 6C)} = \frac{12C^2}{8C} = \frac{3C}{2}.$$

The combination of these two capacitors is in parallel to capacitor 4C, then the equivalent capacitance will be:

$$C_{eq2} = C_1 + C_2 = C_{eq1} + 4C = \frac{3C}{2} + 4C = \frac{11C}{2}.$$

Finally, that combination of capacitors is in series with capacitor 1C, then the equivalent capacitance will be:

$$C_{eq(AD)} = \frac{C_1 C_2}{(C_1 + C_2)} = \frac{\frac{11C}{2} \cdot 1C}{\left(\frac{11C}{2} + 1C\right)} = \frac{\frac{11}{2}C^2}{\frac{13C}{2}} = \frac{11C}{13},$$
$$C_{eq(AD)} = \frac{11C}{13} = \frac{11 \cdot 37 \cdot 10^{-6}F}{13} = 31.31 \,\mu F.$$

Answer:

a)
$$C_{eq(AB)} = 30.15 \, \mu F.$$

b) $C_{eq(AD)} = 31.31 \, \mu F.$

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