Solution of assignment

24. (a) Find the equivalent capacitance of the capacitors in Figure. (b) Find the charge on each capacitor and the potential difference across it.

Solution

\[ C_1 = 4 \ \mu F, \quad C_2 = 2 \ \mu F, \quad C_3 = 3 \ \mu F \]

\[ C = C_1 + C_2 = 4.0 + 2.0 = 6.0 \ \mu F \]

\[ C_{eq} = \frac{CC_3}{C + C_3} = \frac{6 \times 3}{6 + 3} = 2 \mu F \]

The charge across the capacitor \( C, C_3, C_{eq} \) are equals, then the charge in \( C_{eq} \) given by

\[ Q_{eq} = C_{eq} \Delta V = 2 \times 12 = 24 \mu C \]

\[ \Delta V_3 = \frac{Q_3}{C_3} = \frac{24 \mu C}{3 \mu F} = 8 \ \text{Volt} \]

The potential difference across 6 \( \mu \text{F} \) capacitor is given by

\[ \Delta V_3 = \frac{24 \mu C}{6 \mu F} = 4 \ \text{Volt} \]

The tow capacitor \( C_1 \) and \( C_2 \) are connected in parallel so, the potential difference across \( C_1, C_2 \) and \( C \) is equal 4 volt, then

\[ Q_1 = C_1 \Delta V = 4 \times 4 = 16 \mu C \]

\[ Q_2 = C_2 \Delta V = 2 \times 4 = 8 \mu C \]

25. Two capacitors give an equivalent capacitance of 9.0 \( \text{pF} \) when connected in parallel and an equivalent capacitance of 2.00 \( \text{pF} \) when connected in series. What is the capacitance of each capacitor?

Solution

Parallel connection

\[ C_1 + C_2 = 9 \ \text{pf} \quad \text{then } C_1 = 9 \text{pf} - C_2 \]
Series connection

\[ \frac{C_1 C_2}{C_1 + C_2} = 2 \text{ \text{\text{pf}}} \]

Substituted the value of \( C_1 + C_2 \) and the value of \( C_1 \)

\[ \frac{(9 - C_2)C_2}{9pf} = 2 \text{ \text{\text{pf}}} \]

\[ C_2^2 - 9C_2 + 18 = 0 \]

\[ C_2 = 3pf \quad \text{or} \quad C_2 = 6pf \]

and Then \( C_1 = 6pf \quad \text{or} \quad C_1 = 3pf \)

26. Four capacitors are connected as shown in Figure. (a)

Find the equivalent capacitance between points a and b.

(b) Calculate the charge on each capacitor if a 15.0 V battery is connected across points a and b.

Solution

The charge across the capacitor 20, 8.5, \( C_{eq} = 5.96 \mu C \) are equals because they connected in series, the charge on the equivalent capacitor \( C_{eq} \) given by

\[ Q_{eq} = C_{eq} \Delta V = 5.96 \times 15 = 89.4 \mu C \]

The potential difference across 20 \( \mu F \) capacitor is given by

\[ \Delta V = \frac{89.4 \mu C}{20 \mu F} = 4.47 \text{ \text{\text{Volt}}} \]

The potential difference across 8.5 \( \mu F \) capacitor is given by

\[ \Delta V = \frac{89.4 \mu C}{8.5 \mu F} = 10.517 \text{ \text{\text{Volt}}} \]
The two capacitors 2.5 µF and 6 µF are connected in parallel so, the potential difference across \( C_1, C_2 \) and \( C \) is equal 10.51 volt, then

\[
Q_{2.5} = C \Delta V = 2.5 \times 10.517 = 26.3 \mu C
\]

\[
Q_6 = C \Delta V = 6 \times 10.517 = 63.1 \mu C
\]

The charge across the capacitor 15, 3, \( C_{eq} = 2.5 \mu F \) are equal because they connected in series, equal 16.3 µC.

The potential difference across 15 µF capacitor is given by

\[
\Delta V = \frac{26.3 \mu C}{15 \mu F} = 1.7533 \text{ Volt}
\]

The potential difference across 3 µF capacitor is given by

\[
\Delta V = \frac{26.3 \mu C}{3 \mu F} = 8.77 \text{ Volt}
\]

27. Consider the combination of capacitors in Figure. (a) What is the equivalent capacitance of the group? (b) Determine the charge on each capacitor.

Solution

The capacitors 4 µF, 2 µF and 6 µF are connected in parallel so; the potential difference across them is equal 36.0 volt, then

\[
Q_4 = C \Delta V = 4 \times 36 = 144 \mu C
\]

\[
Q_2 = C \Delta V = 2 \times 36 = 72 \mu C
\]

\[
Q_6 = C \Delta V = 6 \times 36 = 216 \mu C
\]
The charge across the capacitor $24, 8, C_{eq} = 6 \, \mu F$ are equals because they connected in series, equal $216 \, \mu C$

28. To repair a power supply for a stereo amplifier, an electronics technician needs a $100 \, \mu F$ capacitor capable of withstanding a potential difference of $90 \, V$ between its plates. The only available supply is a box of five $100 \, \mu F$ capacitors, each having a maximum voltage capability of $50 \, V$. Can the technician substitute a combination of these capacitors that has the proper electrical characteristics, and if so, what will be the maximum voltage across any of the capacitors used?

Solution

![Diagram of capacitors](image)

The maximum voltage across any capacitor is $45 \, volt$