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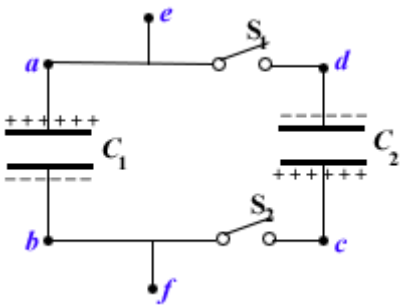
Problem 31.23 (RHK)

In the figure two capacitors $C_1 = 1.16\ \mu\text{F}$ *and* $C_2 = 3.22\ \mu\text{F}$ *have been shown. Each is charged to a potential* $V = 96.6\ \text{V}$ *but with opposite polarity, so that points a and c are on the side of the respective positive plates of* C_1 *and* C_2*, and points b and d are on the side of the respective negative plates. Switches* S_1 *and* S_2 *are now closed. We have to find* (a) *the potential difference between points e and f;* (b) *the charge on* C_1 *and* (c) *the charge on* C_2.



Solution:

(a)

In the circuit shown in the figure the capacitors

$C_1 = 1.16\ \mu$F and $C_2 = 3.22\ \mu$F each have been charged to potential $V = 96.6$ V and the switches S_1 and S_2 are open.

Therefore, the magnitude of the charge on C_1 will be

$q_1 = 1.16 \times 10^{-6} \times 96.6$ C $= 112.0 \times 10^{-6}$ C $= 112.0\ \mu$C.,

and the magnitude of the charge on C_2 will be

$q_2 = 3.22 \times 10^{-6} \times 96.6$ C $= 311.0 \times 10^{-6}$ C $= 311.0\ \mu$C.

After the switches S_1 and S_2 are closed an amount of charge $q\ \mu$C will flow from C_2 to C_1 till both the capacitors have the same potential across their plates. That is the potential difference between points e and f will be the potential difference across each of the two capacitors.

This implies that

$$\frac{(311.0 - q)}{3.22 \times 10^{-6}} = \frac{(q - 112.0)}{1.16 \times 10^{-6}}.$$

Solving this equation, we find

$q = 164.75\ \mu$C.

We calculate the potential difference across the capacitor C_1. It will also be equal to the potential difference

between *e* and *f* after the two switches have been closed.

We have

$$V' = \frac{(164.7 - 112.0)}{1.16}\ \text{V} = 45.4\ \text{V}.$$

(b)

Charge on C_1 will be

$$q_1' = (164.7 - 112.0)\ \mu\text{C} = 52.7\ \mu\text{C},$$

(c)

And charge on C_2 will be

$$q_2' = (311 - 164.7)\ \mu\text{C} = 146.3\ \mu\text{C}.$$