

# LESSON 8

BOOK CHAPTER 25

CAPACITANCE

## Capacitors in series combination:

Potential difference of each actual capacitor:

$$V_1 = \frac{q}{C_1} \quad V_2 = \frac{q}{C_2} \quad \text{And} \quad V_3 = \frac{q}{C_3}$$

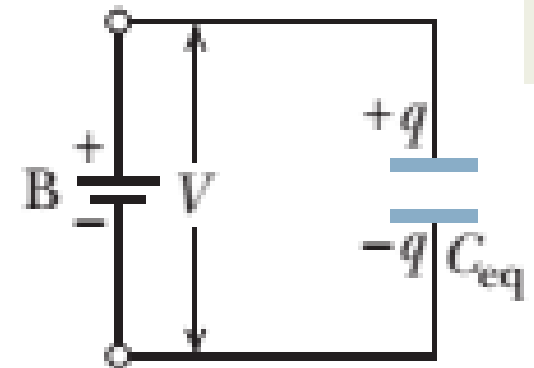
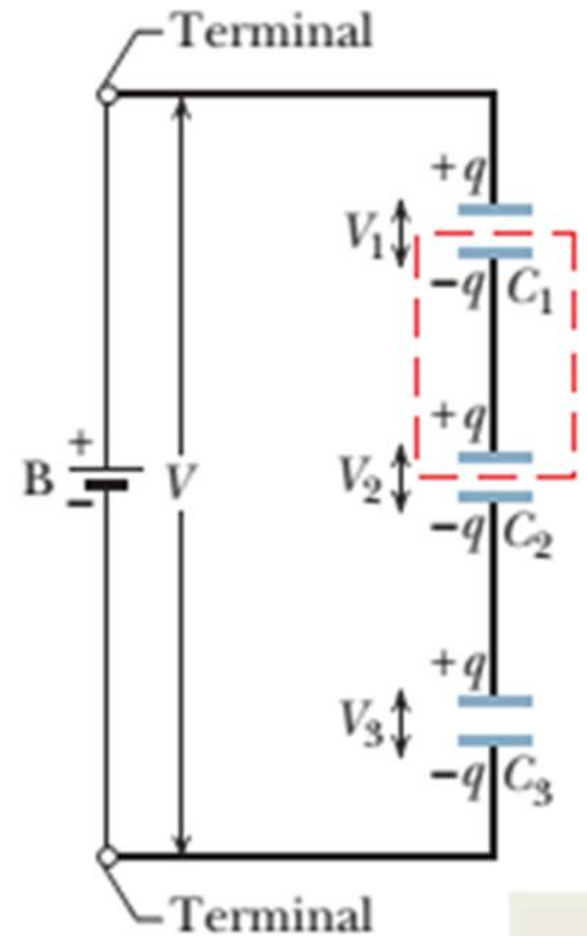
The total potential difference  $V$  due to the battery is the sum of these three potential differences. Thus,

$$V = V_1 + V_2 + V_3 = q \left( \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \right)$$

The equivalent capacitance is then

$$C_{eq} = \frac{q}{V} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$$

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$



### Problem 10 (Book chapter 25):

In the adjacent Figure, find the equivalent capacitance of the combination. Assume that  $C_1$  is  $10.00 \mu F$ ,  $C_2$  is  $5.00 \mu F$ , and  $C_3$  is  $4.00 \mu F$ .

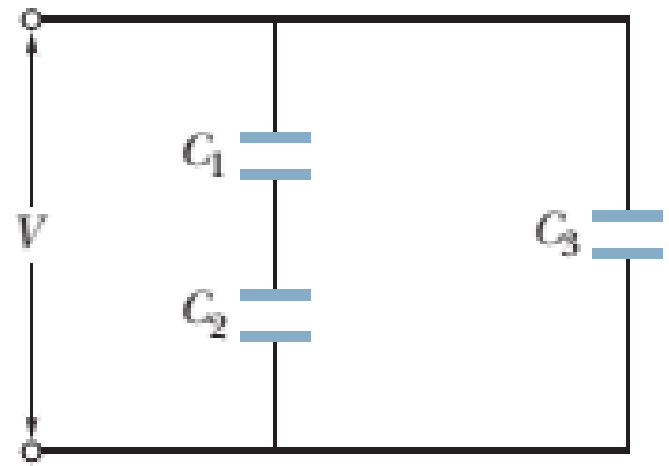
**Answer:** **Step1:**  $C_1$  and  $C_2$  are in series

$$\frac{1}{C_{12}} = \frac{1}{C_1} + \frac{1}{C_2} \quad \text{or} \quad C_{12} = \frac{C_1 C_2}{C_2 + C_1}$$

$$C_{12} = \frac{(10)(5)}{5 + 10} = \frac{50}{15} = 3.33 \mu F$$

**Step2:**  $C_{12}$  and  $C_3$  are in parallel

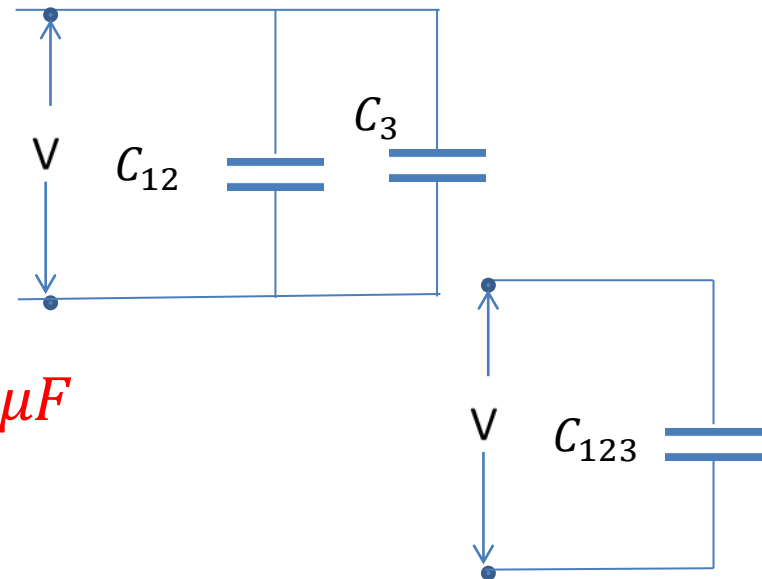
$$C_{123} = C_{12} + C_3 = 3.33 + 4 = 7.33 \mu F$$



Given

$$C_1 = 10 \mu F \quad C_2 = 5 \mu F$$

$$C_3 = 4 \mu F$$



### Problem 11 (Book chapter 25):

In the adjacent Figure, find the equivalent capacitance of the combination. Assume that  $C_1$  is  $10.00 \mu F$ ,  $C_2$  is  $5.00 \mu F$ , and  $C_3$  is  $4.00 \mu F$ .

**Answer:**

**Step1:**  $C_1$  and  $C_2$  are in parallel

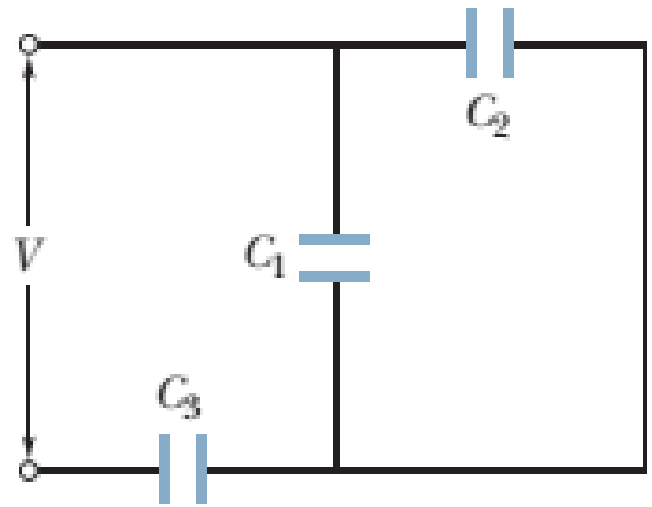
$$C_{12} = C_1 + C_2 = 10 + 5 = 15 \mu F$$

**Step2:**  $C_{12}$  and  $C_3$  are in series

$$\frac{1}{C_{123}} = \frac{1}{C_{12}} + \frac{1}{C_3} = \frac{C_3 + C_{12}}{(C_{12})(C_3)}$$

$$C_{123} = \frac{(C_{12})(C_3)}{C_3 + C_{12}}$$

$$C_{123} = \frac{(15)(4)}{4 + 15} = \frac{60}{19} = 3.158 \mu F$$



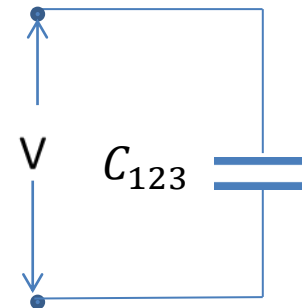
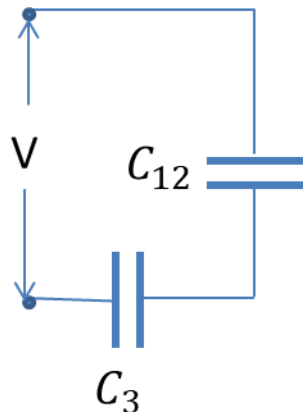
Given

$$C_1 = 10 \mu F$$

$$C_2 = 5 \mu F$$

$$C_3 = 4 \mu F$$

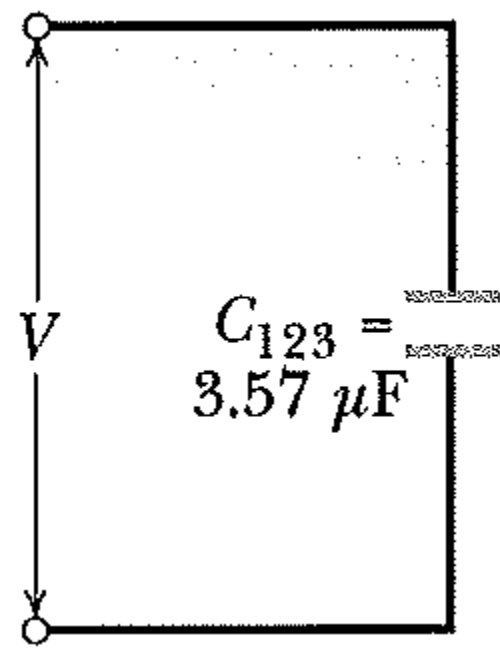
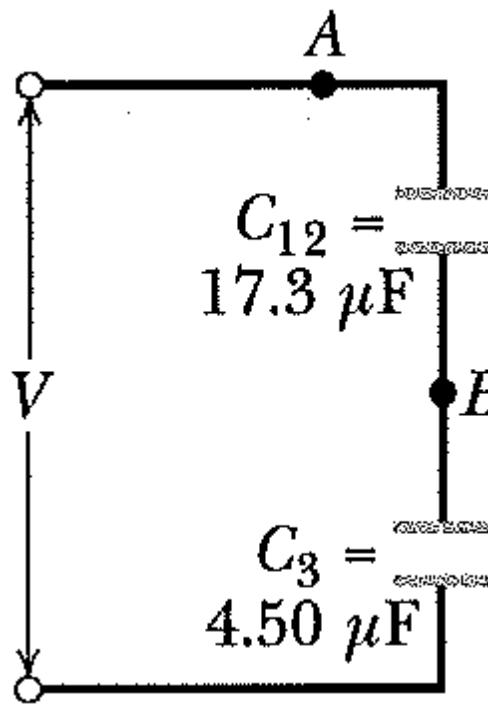
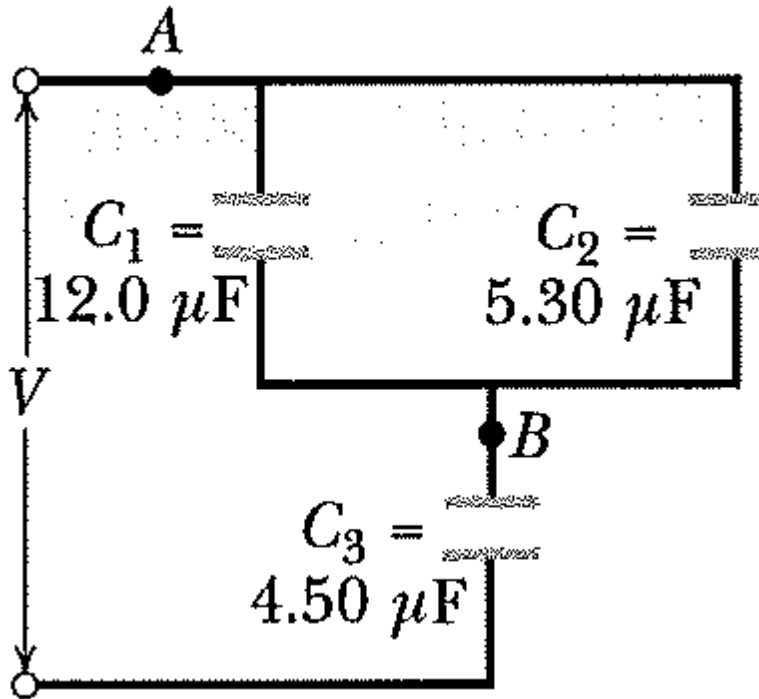
$$C_{123} = ?$$



*Sample Problem 25.02(a) (page 726):* Find the equivalent capacitance for the combination of capacitances shown in Figure, across which potential difference  $V$  is applied.

Assume  $C_1 = 12.0 \mu F$ ,  $C_2 = 5.30 \mu F$ , and  $C_3 = 4.5 \mu F$ .

Home Task

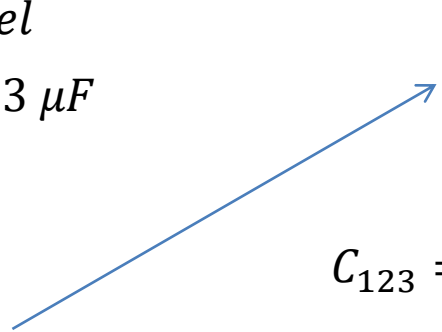


**Step1:**  $C_1$  and  $C_2$  are in parallel

$$C_{12} = C_1 + C_2 = 12 + 5.3 = 17.3 \mu F$$

**Step2:**  $C_{12}$  and  $C_3$  are in series

$$\frac{1}{C_{123}} = \frac{1}{C_{12}} + \frac{1}{C_3} = \frac{C_3 + C_{12}}{(C_{12})(C_3)}$$



$$C_{123} = \frac{(C_{12})(C_3)}{C_3 + C_{12}}$$

$$C_{123} = \frac{(17.3)(4.5)}{4.5 + 17.3} = \frac{77.85}{21.8} = 3.57 \mu F$$

## Energy Stored in an Electric Field:

Suppose that, at a given instant, a charge  $q'$  has been transferred from one plate of a capacitor to the other. The potential difference  $V'$  between the plates at that instant will be  $\frac{q'}{C}$ . If an extra increment of charge  $dq'$  is then transferred, the increment of work required will be,

$$dW = V' dq' = \frac{q'}{C} dq'$$

The work required to bring the total capacitor charge up to a final value  $q$  is

$$W = \int_{q'=0}^{q'=q} dW = \frac{1}{C} \int_0^q q' dq' = \frac{q^2}{2C}$$

This work is stored as potential energy  $U$  in the capacitor, so

$$U = W = \frac{q^2}{2C} = \frac{(CV)^2}{2C} = \frac{1}{2} CV^2$$

Finally,

$$U = \frac{q^2}{2C}$$

OR

$$U = \frac{1}{2} CV^2$$

Thank You