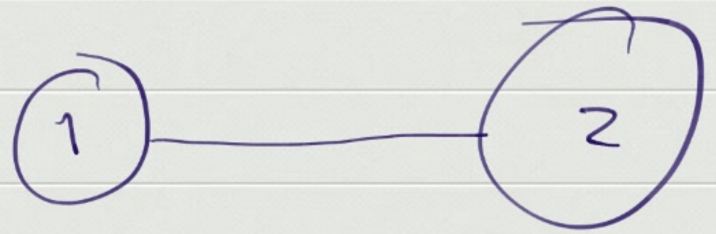
Solution to HW Problems
Chapter 26

104 Phys

Prof. *Nasser S. Alzayed*

5. Two conducting spheres with diameters of 0.400 m and 1.00 m are separated by a distance that is large compared with the diameters. The spheres are connected by a thin wire and are charged to 7.00 μC. (a) How is this total charge shared between the spheres? (Ignore any charge on the wire.) (b) What is the potential of the system of spheres when the reference potential is taken to be $V = 0$ at $r = \infty$?

Problem #5/Ch 26:



(A) $\because Q \propto R$

$\therefore Q_1 \propto R_1$

$Q_2 \propto R_2$

$\rightarrow \frac{Q_1}{Q_2} = \frac{R_1}{R_2} \rightarrow Q_1 = Q_2 \frac{R_1}{R_2}$ --- (1)

$\because Q_1 + Q_2 = 7 \mu C$ ------- (2)

$\therefore Q_1 = 7 - Q_2$

$\rightarrow 7 - Q_2 = Q_2 \frac{R_1}{R_2} = Q_2 \frac{0.2}{0.5} \Rightarrow 7 = \left(1 + \frac{0.2}{0.5}\right) Q_2$

$\therefore Q_2 = 7/1.4 = 5 \mu C$

$\therefore Q_1 = 7 - 5 = 2 \mu C$ #

(b): ∵ $V = k\frac{q}{r}$

∴ $V = 9\times10^{9} \times \frac{5\times10^{-6}}{0.5} = 90\ kV$

or $= 9\times10^{9} \times \frac{2\times10^{-6}}{0.2} = 90\ kV$

this proves that $V_1 = V_2$ #

27. Find the equivalent capacitance between points a and b for the group of capacitors connected as shown in Figure P26.27. Take $C_1 = 5.00\ \mu F$, $C_2 = 10.0\ \mu F$, and $C_3 = 2.00\ \mu F$.

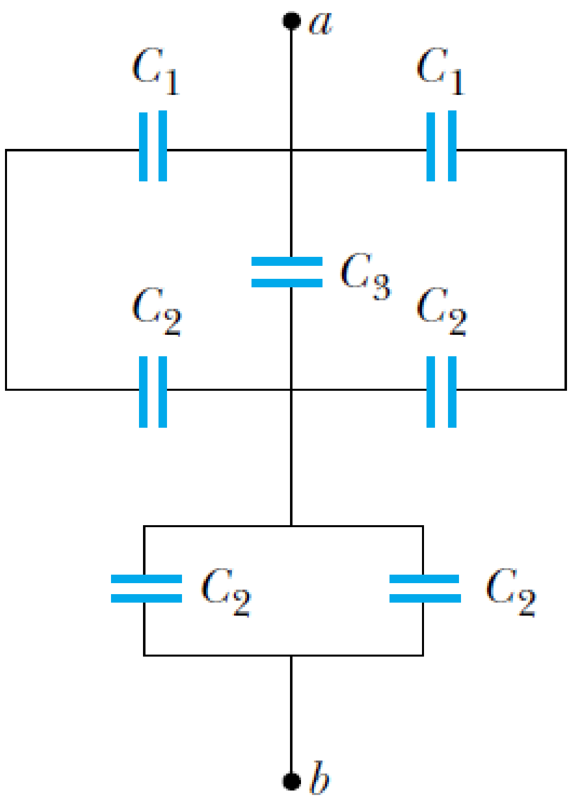


Figure P26.27 Problems 27 and 28.

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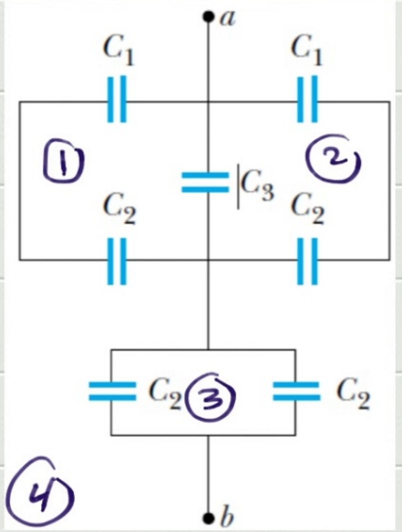
in ① C_1 ad C_2 are is series.

$$\therefore \frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{5} + \frac{1}{10} = \frac{15}{50}$$

$$\therefore C_{eq} = \frac{50}{15} = 3.33 \ \mu F \ \text{--} \ ①$$



in ② C_1 ad C_2 are in series

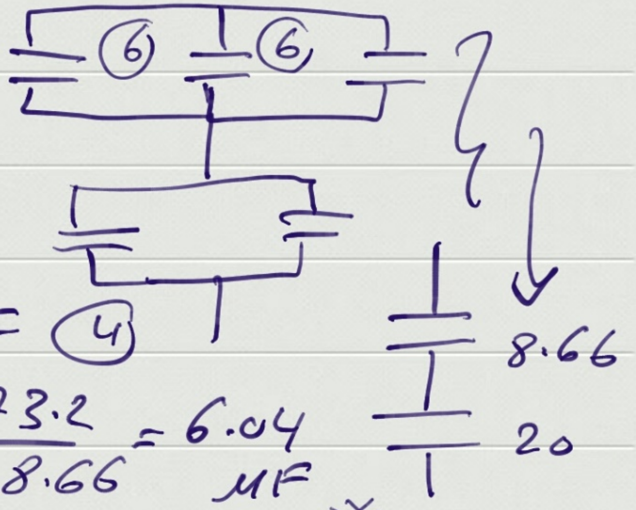
$$\rightarrow C_{eq} = 3.33 \ \mu F \ — \ ②$$

in ⑥ all in parallel

$$\therefore C_6 = 3.33 + 3.33 + 2 = 8.66 \ \mu F \ \text{-} \ ③$$

in ③ C_2 ad C_2 in // $\rightarrow C_{eq} = 2 \times 10 = 20 \ \mu F$ ④

$$\therefore \frac{1}{C_{Final}} = \frac{1}{8.66} + \frac{1}{20} = \frac{28.66}{20 \times 8.66} \rightarrow C_{Final} = \frac{173.2}{28.66} = 6.04 \ \mu F$$



29. Find the equivalent capacitance between points *a* and *b* in the combination of capacitors shown in Figure P26.29.

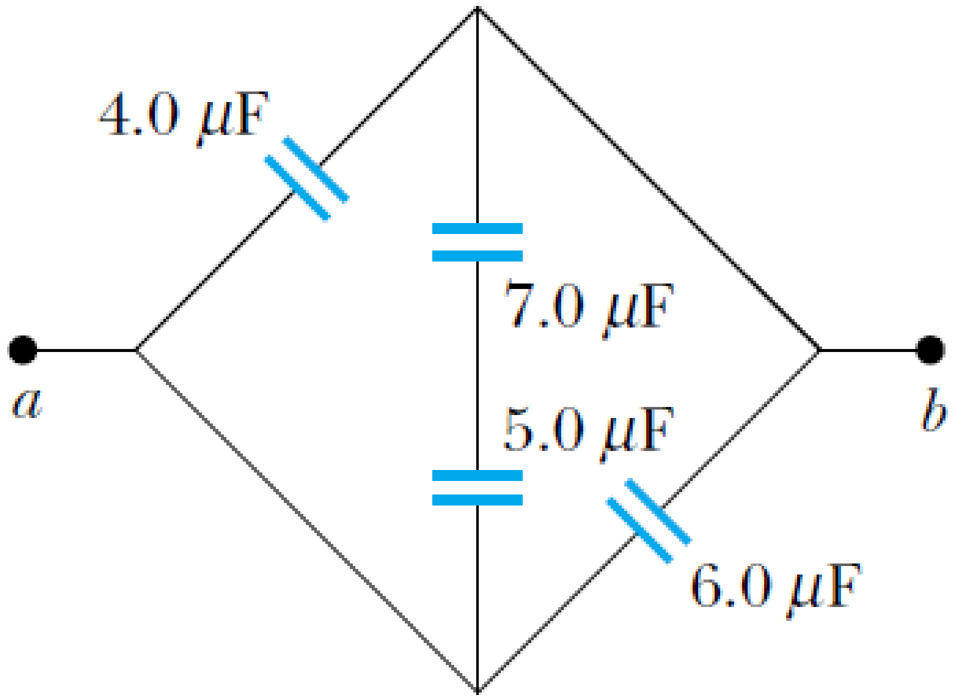


Figure P26.29

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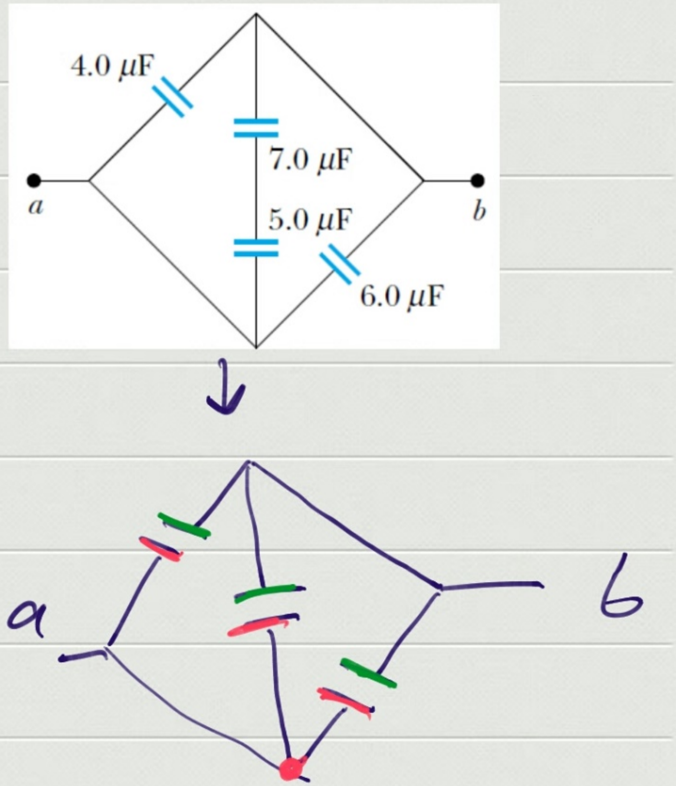
7 μF and 5 μF in series

$\therefore \frac{1}{C_{57}} = \frac{1}{5} + \frac{1}{7} = \frac{5+7}{35} = \frac{12}{35}$

$\therefore C_{57} = \frac{35}{12} = 2.92\ \mu F$ (1)



Now: all Red are connected to a

all Green " " " b

$\therefore$ all C's are in //

$\therefore C_{eq} = 4 + 6 + 2.92 = 12.92\ \mu F$ #

31. (a) A 3.00-μF capacitor is connected to a 12.0-V battery. How much energy is stored in the capacitor? (b) If the capacitor had been connected to a 6.00-V battery, how much energy would have been stored?

P3 26:

$C = 3\,\mu F \qquad V = 12\,V$

a) find $U = ?$

$\because U = \frac{1}{2}CV^2 = \frac{1}{2} \times 3 \times 10^{-6} \times 12^2 = 216 \times 10^{-6}\,J$

$\div 4 = \left(\frac{1}{2}\right)^2$

b) if $V \to 6V$ find U ?

$\because U = \frac{1}{2}CV^2 = \frac{1}{2} \times 3 \times 10^{-6} \times 6^2 = 54 \times 10^{-6}\,J$

43. Determine (a) the capacitance and (b) the maximum potential difference that can be applied to a Teflon-filled parallel-plate capacitor having a plate area of 1.75 cm^2 and plate separation of 0.040 0 mm.

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$d = 0.04\ mm$

a) find $C = ?$

$\therefore C = \epsilon_0 \frac{A}{d}$

$A = 1.75\ cm^2$

but with $K \longrightarrow C = K \epsilon_0 \frac{A}{d} = \frac{2.10 \times 8.85 \times 10^{-12} \times 1.75 \times 10^{-4}}{4 \times 10^{-5}\ m}$

$\therefore C = 8.13 \times 10^{-11}\ F = 81.3\ pF$ #

note: $K = 2.10$ for Teflon. ← from table 26.1

b) V_{max} ?

$\because V = Ed \rightarrow V_{max} = E_{max} d = 60 \times 0.04 \times 10^{-3} = 2.4\ kV$

49. Each capacitor in the combination shown in Figure P26.49 has a breakdown voltage of 15.0 V. What is the breakdown voltage of the combination?

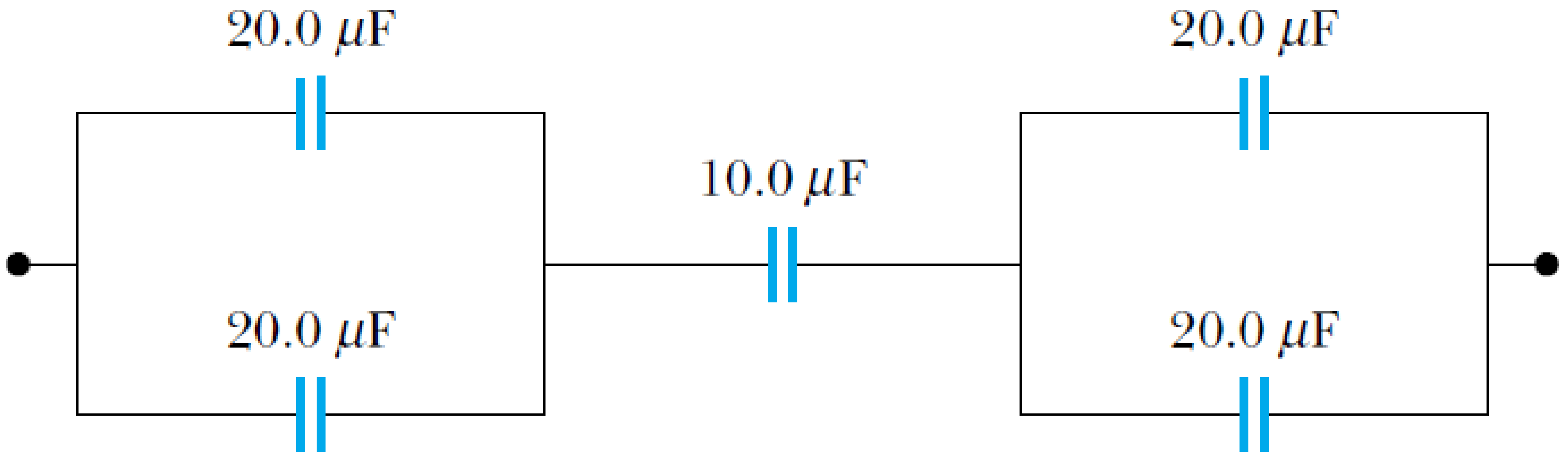

Figure P26.49

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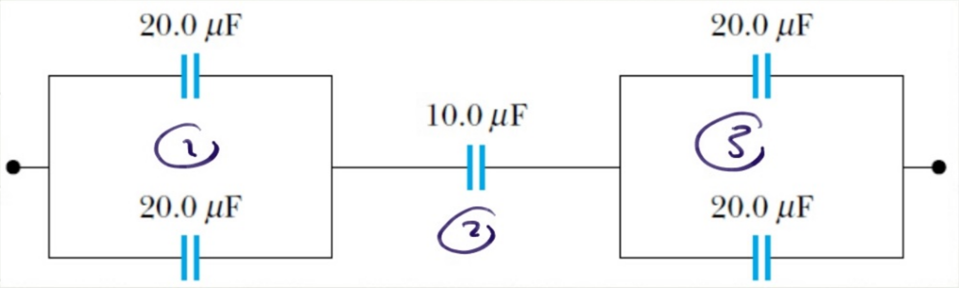
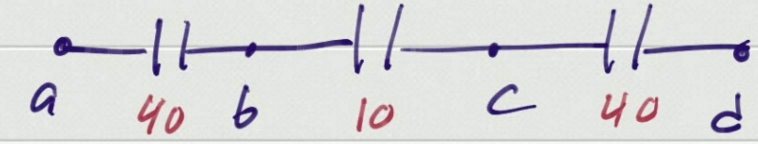
① → $C = 20 + 20 = 40\ \mu F$

② → $C = 10\ \mu F$

③ → $C = 40\ \mu F$



→ 

all have same Q but different V

∴ $Q = 40 V_{ab} = 10 V_{bc} = 40 V_{cd}$ OR $4 V_{ab} = 4 V_{cd} = V_{bc}$

when the $V_{bc} = 15$ → $10\ \mu F$ will breakdown.

∴ let $V_{bc} = 15\ V$

∴ $V_{ab} = V_{cd} = \frac{15}{4} = 3.75\ V$

∴ total voltage that will Breakdown all capacitors

$= 3.75 + 15 + 3.75 = 22.5\ V$ # $\equiv V_{ad}$