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Discussion Instructor (CIRCLE ONE):

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Discussion Section # _____

Spanning Stimpson Stone Wiseman

Report all numbers to three significant figures!
Use the conversion constants given on the front page.

- (a) Calculate the equivalent capacitance of the series combination of 3 capacitors: $C_1 = 40.0$ pf, $C_2 = 60.0$ pf, $C_3 = 45.0$ pf

$C_f = 15.7$ pf

- (b) A 25.0 pf capacitor is charged to 100.0 volts. The battery is then disconnected. A second capacitor, uncharged, of capacitance 60.0 pf is connected in parallel with the first. Find the new potential across the combination.

$V_f = 29.4$ (Volts)

- (c) A parallel plate capacitor has an area of 3.50 m², and a separation of 0.145 mm. The dielectric material has a dielectric constant of 4.25. Calculate its capacitance in picofarads. (Be sure to get units right.)

$C = 9.08 \times 10^5$ (pf)

- (d) A dielectric material has a dielectric strength of 12,500 V/mm. If it is used in a capacitor at a thickness of 0.130 mm, find the breakdown voltage for that capacitor.

$V_m = 1.63 \times 10^3$ (Volts)

- (e) A potential is given by $V = Ax^2y$, where A is constant, and x and y are the coordinates, find the x component of the electric field.

$E_x = -2Axy$ V/m

Solution of Problem 1.

$$\begin{aligned} a) \quad \frac{1}{C_T} &= \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \\ &= \frac{1}{40.0} + \frac{1}{60.0} + \frac{1}{45.0} \\ &\approx 6.39 \times 10^{-2} (\text{pf})^{-1} \end{aligned}$$

$$\Rightarrow C_T = 15.7 \text{ pf}$$

b) The total charge after disconnected from battery

$$Q = C_1 V = 25.0 \times 100.0 = 2.50 \times 10^3 \text{ (picocoulombs)}$$

$$C_T = C_1 + C_2 = 25.0 + 60.0 = 85.0 \text{ pf}$$

$$V_f = \frac{Q}{C_T} = \frac{2.50 \times 10^3}{85.0} \approx 29.4 \text{ (V)}$$

$$\begin{aligned} c) \quad C &= \frac{\kappa \epsilon_0 A}{d} = \frac{4.25 \times 3.50 \times 8.85 \times 10^{-12}}{1.45 \times 10^{-4}} \\ &\approx 9.08 \times 10^5 \text{ (pf)} \end{aligned}$$

$$d) \quad V_m = E_m \cdot d = 1.25 \times 10^4 \times 0.130 \approx 1.63 \times 10^3 \text{ (V)}$$

$$e) \quad E_x = - \frac{\partial V}{\partial x} = - \frac{\partial A x^2 y}{\partial x} = -2Ax y$$