Physics 172
Summer Quarter 1983
August 15, 1983
George Williams

Av = 9.6

LAST EXAM

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Name: Williams

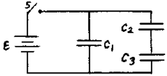
Discussion Instructor (CIRCLE ONE): Arnold Campbell Schoenborn

Discussion Section #______

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

In the diagram shown the switch is closed for a long time, and then opened. Now a dielectric of $\kappa = 4.00$ is inserted into C_3.

(a) Find the new voltage across C_1.
(b) Find the new voltage across C_2.
(c) Find the charge that flows, and the direction it flows when the dielectric is inserted.



$\varepsilon = 12.0$ V

$C_1 = 155$ pF

$C_2 = 125$ pF

$C_3 = 250$ pF

This problem was not well done.

(1) Calculate the situation before the dielectric is inserted.

C_2 and C_3 are in series; C_1 is in parallel with the combination of C_2 and C_3.

$$C_{eff} = C_1 + C_{23} = C_1 + \frac{C_2 C_3}{C_1 + C_2} = 238.3 \text{ pF}$$

$$Q_{initial}^{T} : CV = (238.3)(12.0) = 2860 \times 10^{-12} \text{ C}$$

$$Q_1 = 1860 \times 10^{-12} \text{ C}$$

$$Q_{23} = 1000 \times 10^{-12} \text{ C} = Q_2 = Q_3$$

(2). Insert the dielectric; since the switch is open Q is conserved, but redistributed.

$$C'_{eff} = C_1 + C'_{23} = 155 + 111 \text{ pF} = 266 \text{ pF}$$

$C_3' = \kappa C_3 = 1000$ pF

Calc $C_{23}' = \frac{C_2 C_3'}{C_2 + C_3} = \frac{125(1000)}{125 + 1000}$ pF

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Name: Page 2

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(3) Now calculate the redistributed charge. $q = q\left(1 - \frac{1}{\kappa}\right)$ Does not work, calculates the wrong thing.

$Q_{TOT} = 2860 \times 10^{-12}$

$V_1' = V_{23}'$

$C_1 Q_1' = C_{23}' Q_2'$

$\frac{Q_{23}'}{Q_1'} = \frac{C_{23}'}{C_1} = \frac{111}{155} = 0.719 \qquad Q_{23}' = .719\,Q_1'$

$2860 \times 10^{-12}\,C = .719\,Q_1 + Q_1' = 1.719\,Q_1'$

$Q_1' = 1665 \times 10^{-12}$

$Q_{23}' = 1198 \times 10^{-12}$

Therefore $V_1' = \frac{Q_1'}{C_1} = \frac{1665 \times 10^{-12}}{155 \times 10^{-12}} = 10.75\,V$

Since $Q_2' = Q_3' = Q_{23}'$ $\quad V_2 = \frac{Q_2'}{C_2} = \frac{1198 \times 10^{-12}}{125 \times 10^{-12}} = 9.55\,V$

(4) The charge that moves is the change in charge on C_1

$Q_1 = 1860 \times 10^{-12}$
$Q_1' = 1665 \times 10^{-12}$
$195 \times 10^{-12}\,C$

$\Delta Q = 195 \times 10^{-12}\,C$ from C_1 to C_{23}'

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