Physics 2220
Spring 2003
George A. Williams

THIRD MIDTERM

3

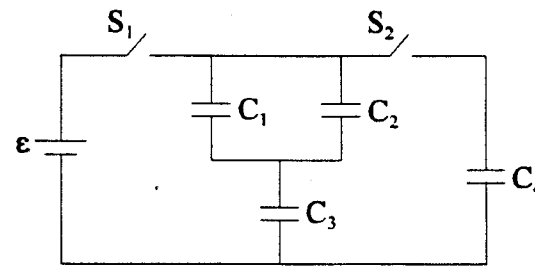
Name:_____

Discussion Instructor (circle): Billeter Blake Herring Young

Discussion Section # _____ Student ID #:_____

SHOW ALL WORK!!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

Initially S_1 is closed and S_2 is open.



(a) *[5 pts.]* Calculate the effective capacitance for C_1, C_2, C_3.
(b) *[5 pts,]* Calculate the electric charge and potential on C_3.
(c) *[7 pts.]* Calculate the electric charge and potential on C_2.

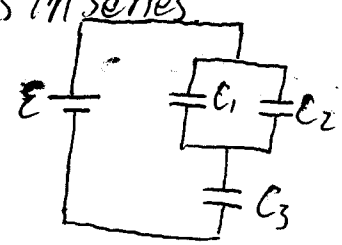
Now S_1 is opened and then S_2 is closed.

(d) *[8 pts.]* Calculate the charge and potential on C_4.

ε = 150 V; C_1 = 2.0 μF; C_2 = 4.0 μF; C_3 = 5.0 μF; C_4 = 2.5 μF

Solution:

(a) Initially S_1 is closed and S_2 is open. We can simplify the figure like this
Obviously, C_1 and C_2 is parallel. C_3 and C_1, C_2 is in series.



$C_{12} = C_1 + C_2$

$C_{effective} = \left(\frac{1}{C_{12}} + \frac{1}{C_3}\right)^{-1} = \left(\frac{1}{C_1+C_2} + \frac{1}{C_3}\right)^{-1}$

$= \frac{C_3(C_1+C_2)}{C_1+C_2+C_3}$

$= \frac{5.0\mu F(2.0\mu F + 4.0\mu F)}{2.0\mu F + 4.0\mu F + 5.0\mu F} = \frac{30}{11}\mu F = \boxed{2.73\mu F}$

(b) $Q_{effective} = C_{effective} \cdot \varepsilon = \frac{30}{11}\mu F \cdot 150V = 4.09 \times 10^{-4} C$

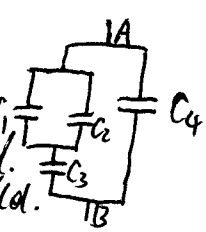
Because C_3 is in series. $Q_3 = Q_{effective} = \boxed{4.09 \times 10^{-4} C}$

$V_3 = \frac{Q_3}{C_3} = \frac{4.09 \times 10^{-4} C}{5.0 \times 10^{-6} F} = \boxed{81.8 V}$

(c) $V_2 = V_{12} = \varepsilon - V_3 = 150V - 81.8V = \boxed{68.2V}$

$Q_2 = C_2 V_2 = 4.0\mu F \cdot 68.2V = \boxed{2.73 \times 10^{-4} C}$

(d) Now S_1 is opened and S_2 is closed. We can simplify it.



C_4 is charged. But total charge in the circuit is conserved.

$Q_{total} = Q_{effective} = 4.09 \times 10^{-4} C$. C_4 and $C_{effective}$ is parallel.

$C_{total} = C_{effective} + C_4 = 5.23\mu F$ $V_4 = V_{total} = \frac{Q_{total}}{C_{total}} = \boxed{78.2V}$

$Q_4 = C_4 V_4 = \boxed{1.96 \times 10^{-4} C}$

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Problem 3. Grading Scale:

For all the question, if you have a wrong significant figure. Subtract one point.

For part a, Write correct effective capacitance formula, plus three points. After correct calculation, get the final answer, plus 2 points.

For part b, Write the formula $Q_3 = C_{effective} \cdot \mathcal{E}$, plus 2 points.
Get correct electric charge Q_3, plus 1 points.
Write the voltage $V_3 = \frac{Q_3}{C_3}$ and then get correct answer plus 2 points.

For part c, Write $V_2 = \mathcal{E} - V_3$ or other similar formula and then get the correct answer, plus 4 points.
Write $Q_2 = C_2 V_2$ and Get the correct answer, plus 3 points

For part d, Write total charge in the circuit is conserved or other similar description, plus 3 points.
Write effective capacitance $C_{effective}$ and C_4 is in parallel, plus 3 points.
Get correct voltage on C_4, plus 1 points.
Get correct charge on C_4, plus 1 points.