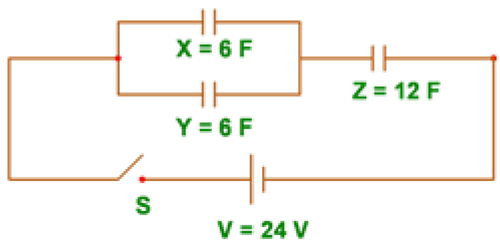
UCONN Physics 1202Q: Name: ____________________

Date: ___________ Per:_____

Directions: Solve for each of the below questions.

Problem 1

Given a circuit contents a combination of three capacitors X, Y and Z , see the figure below.



If the switch S is ON, find:

a) circuit equivalent capacitance (equivalent capacitor)

b) electric charge stored in the circuit

c) electric charge stored in capacitor Z, use series principle

d) potential difference across capacitor Z

e) potential difference across capacitor X

f) potential difference across capacitor Y

g) electric charge stored in capacitor X

h) electric charge stored in capacitor Y

i) electric charge stored in capacitor Z

j) energy stored in the circuit

k) energy stored in capacitor X

l) energy stored in capacitor Y

m) energy stored in capacitor Z

Problem 2

Given a parallel-plate capacitor in vacuum. The plates of capacitor are 2 cm apart and 50 cm^2 in area of each plate. A potential difference of 120 volt is applied acroos capacitor. When ε_o is 8,85 x 10^{-12} C^2 $N^{-1\,-2}$ calculate :

a) capacitor capacitance

b) charge stored in capacitor

c) the magnitude of electric charge in space between the two plates of capacitor

Problem 3

A plate-capacitor of capacitance C in vacuum. If then a material with its dielectric constant K = 2 is inserted between capacitor plates, find the new capacitance of capacitor!

Problem 4

Given a parallel plate-capacitor of 1200 μF in vacuum. If the area of capacitor plates are doubled and the separation between two plates is 1.5 times the original, find the new capacitance of the capacitor!

Answer Key:

Problem 1 : Discussion

a) First replace X and Y parallel combination by its equivalent capacitance, named C_{xy} :

$$C_{xy} = C_x + C_y$$
$$C_{xy} = 6 + 6 = 12\ F$$

Replacing the two capacitors gives us the equivalent circuit in series combination, then find the equivalent for C_{xy} and C_z , the two are in series, called C_{eq} or C_{tot} :

$$\frac{1}{C_{tot}} = \frac{1}{C_{xy}} + \frac{1}{C_z}$$
$$\frac{1}{C_{tot}} = \frac{1}{12} + \frac{1}{12} = \frac{2}{12}$$
$$C_{tot} = \frac{12}{2} = 6\ F$$

b) Charge stored in the circuit or the charge in the equivalent capacitance; Q_{tot} , C_{tot} multipled by V_{tot}

$$Q_{tot} = C_{tot} V_{tot} = 6(24) = 144\ C$$

c) Charge stored in capacitor Z; Q_z

For series combination, the charge is the same on all capacitors, it's the same as the charge on the equivalent capacitor :

$$Q_{xy} = Q_z = Q_{tot}$$
$$Q_z = 144\ C$$

d) potential difference across capacitor Z; named V_z

$$V_z = \frac{Q_z}{C_z} = \frac{144}{12} = 12\ Volt$$

e) potential difference across capacitors X and Z are the same cause of parallel combination

$$V_x = V_{xy} = \frac{Q_{xy}}{C_{xy}} = \frac{144}{12} = 12\ Volt$$

f) potential difference across Y is the same as potential difference across X

$$V_y = V_x = 12\ Volt$$

g) charge in capacitor X, be careful, it's not the same as charge in equivalent capacitor

$$Q_x = C_x V_x = 6(12) = 72\ C$$

h) charge in capacitor Y

$$Q_y = C_y V_y = 6(12) = 72\ C$$

i) charge in capacitor Z

$$Q_z = C_z V_z = 12(12) = 144\ C$$

j) energy stored in the circuit
Use one of these three formula to get the energy stored

$$W = \frac{1}{2}CV^2$$
$$W = \frac{1}{2}\frac{Q^2}{C}$$
$$W = \frac{1}{2}QV$$

So then

$$W_{tot} = \frac{1}{2}C_{tot}V_{tot}^2 = \frac{1}{2}(6)(24)^2 = 1728\ joule$$

k) energy stored in capacitor X

$$W_x = \frac{1}{2}C_x V_x^2 = \frac{1}{2}(6)(12)^2 = 432\ joule$$

l) energy stored in capacitor Y

$$W_y = \frac{1}{2}C_y V_y^2 = \frac{1}{2}(6)(12)^2 = 432\ joule$$

m) energy stored in capacitor Z

$$W_z = \frac{1}{2}C_z V_z^2 = \frac{1}{2}(12)(12)^2 = 864\ joule$$

Problem 2: Answer

a) capacitor capacitance

$$C = \frac{kA\epsilon_o}{d}$$
$$C = \frac{(1)(50 \times 10^{-4})(8,85 \times 10^{-12})}{2 \times 10^{-2}} = 2,2 \times 10^{-12} = 2,2\ pF$$

b) charge stored in capacitor

$$Q = CV$$
$$Q = (2\times,2 \times 10^{-12})(120) = 264 \times 10^{-12} = 264\ pC$$

c) the magnitude of electric charge in space between the two plates of capacitor

$$E = \frac{V}{d}$$
$$E = \frac{120}{2 \times 10^{-2}} = 6000\ V/m$$

Problem 3: Answer

There are no changing in area and plates separation distance of capacitor, so then the new capacitance is

$$\frac{C_2}{C_1} = \frac{k_2}{k_1}$$
$$\frac{C_2}{C} = \frac{2}{1}$$
$$C_2 = 2C$$

Problem 4: Answer

$$C = \frac{kA\epsilon_o}{d}$$
$$\frac{C_2}{C_1} = \frac{A_2}{A_1} \times \frac{d_1}{d_2}$$
$$\frac{C_2}{1200} = \frac{(2)(1)}{(1)(1,5)}$$
$$C_2 = \frac{2}{1,5} \times 1200 = 1600\ \mu F$$