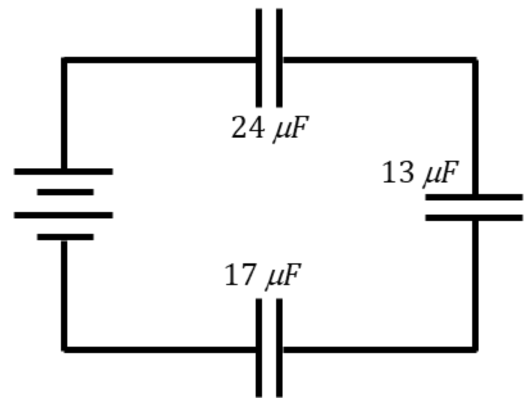
APPC, E & M: Unit B HW 2

Name: ____________________
Hr: ___ Due at beg of hr on: __________

UB, HW2, P1
Reference Video: "Capacitors in Parallel"
YouTube, lasseviren1, CAPACITANCE playlist



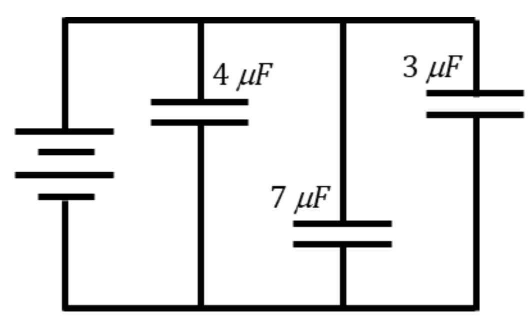
A. First, refer back to your work in HW Set 1, Problem 5 to help you determine the equivalent capacitance of the circuit show at right.

B. Now, write the equation for finding the equivalent capacitance C_{eq} for when two capacitors C_1 and C_2 are wired in parallel.

C. What is true of the potential difference V across two or more capacitors that are in parallel with each other?

D. If Q_{tot} is the total charge moved in a circuit containing capacitors C_1 and C_2 in parallel with a battery of voltage V, write a simple equation that relates Q_{tot} with the amounts of charge (Q_1 and Q_2) on the capacitors.

E. Use your Part B answer to determine the equivalent capacitance of the circuit show at right.



UB, HW2, P2
Reference Video: "Review of Unit on Capacitance (Part I)"
YouTube, lasseviren1, CAPACITANCE playlist

Here, you will walk through a line of reasoning about what happens when we add a dielectric in between the plates of a capacitor (after first charging it when a vacuum is between the plates). The video uses a dielectric constant of $\kappa = 2$; here, we will insert a dielectric of $\kappa = 3$. We will let the original quantities (when the capacitor is charged with the vacuum between plates) be C_o, V_o, Q_o, E_o, and U_o. You will also need to reference several equations as justification for your answers. (There might be more than one possible answer.)

I. $C = \frac{Q}{V}$

II. $C = \frac{k\varepsilon_0 A}{d}$

III. $V = Ed$

IV. $U = \frac{Q^2}{2C}$

V. $U = \frac{1}{2}QV$

VI. $U = \frac{1}{2}CV^2$

Here we go…

A. Let us charge the capacitor with nothing between the plates. Then, with the battery still connected into the circuit, we insert between the plates a dielectric having $\kappa = 3$.

How the new quantities compare to the original	Equation (AND/OR explanation) that justifies your answer
C_{new} = ____ C_o	
V_{new} = ____ V_o	
Q_{new} = ____ Q_o	
E_{new} = ____ E_o	
U_{new} = ____ U_o	

B. We now charge the capacitor again, with nothing between the plates. Then, we disconnect the battery from the circuit, and then insert between the plates a dielectric having $\kappa = 3$.

How the new quantities compare to the original	Equation (AND/OR explanation) that justifies your answer
C_{new} = ____ C_o	
Q_{new} = ____ Q_o	
V_{new} = ____ V_o	
E_{new} = ____ E_o	
U_{new} = ____ U_o	

UB, HW2, P3
Reference Video: "Review of Unit on Capacitance (Part II)"
YouTube, lasseviren1, CAPACITANCE playlist

Use any of these equations to help you determine the various quantities for the circuits shown.

$C = \frac{Q}{V} = \frac{k\varepsilon_o A}{d}$ $V = Ed$ $U = \frac{Q^2}{2C} = \frac{1}{2}CV^2 = \frac{1}{2}QV$ $C_p = \sum C_i$ $\frac{1}{C_s} = \sum \frac{1}{C_i}$

A. C_{eq} =

Q_{tot} =

Q_1 =

Q_2 =

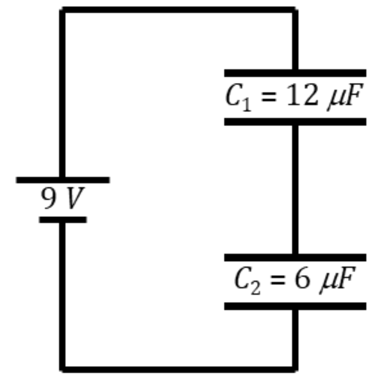
V_1 =

V_2 =

U_1 =

U_2 =

U_{tot} =



Circuit for Part A

B. C_{eq} =

Q_{tot} =

Q_1 =

Q_2 =

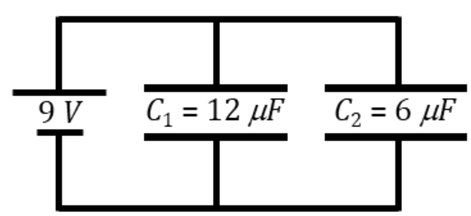
V_1 =

V_2 =

U_1 =

U_2 =

U_{tot} =



Circuit for Part B

UB, HW2, P4

Reference Video: "Review of Unit on Capacitance (Part III)"
YouTube, lasseviren1, CAPACITANCE playlist

Here, we will go through a line of reasoning that will allow you to determine the capacitance when various fractions of the region between capacitor plates have been filled with dielectrics of varying dielectric constant κ. The problem associated with Figure 1 is very similar to what is shown on the video, while the problem associated with Figure 2 is somewhat different.

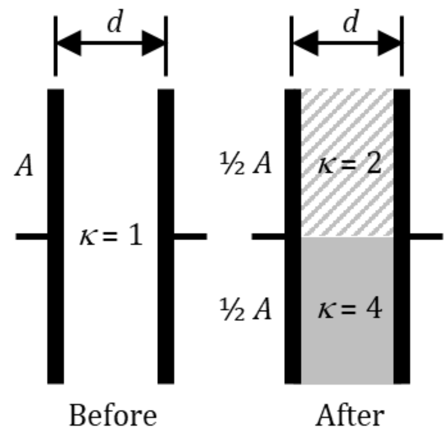


Figure 1

Consider Figure 1. A capacitor with a vacuum between its plates ($\kappa = 1$) has plate area A and plate separation d. These values, used in the equation $C = \frac{k\varepsilon_o A}{d}$, give us a capacitor having an original capacitance of C_o.

We then add two dielectrics in between the plates. The top half of the region (i.e., ½ of A) has a dielectric of $\kappa = 2$, while the bottom half (i.e., the other ½ of A) has a dielectric of $\kappa = 4$. The plate separation remains at d.

A. In terms of C_o, determine the capacitance of the $\kappa = 2$ portion. $C_{\kappa=2} =$

B. In terms of C_o, determine the capacitance of the $\kappa = 4$ portion. $C_{\kappa=4} =$

C. Circle your answer… The $C_{\kappa=2}$ and $C_{\kappa=4}$ capacitors are in: SERIES PARALLEL

D. Choose the correct equation for finding equivalent capacitance, then use that equation in conjunction with your answers above to find the equivalent capacitance C_{eq} for the "After" capacitor of Figure 1.

Refer now to Figure 2. We again start with a vacuum between the plates ($\kappa = 1$), with plate area A, and with plate separation d. Again, this results in a capacitor with a capacitance of C_o.

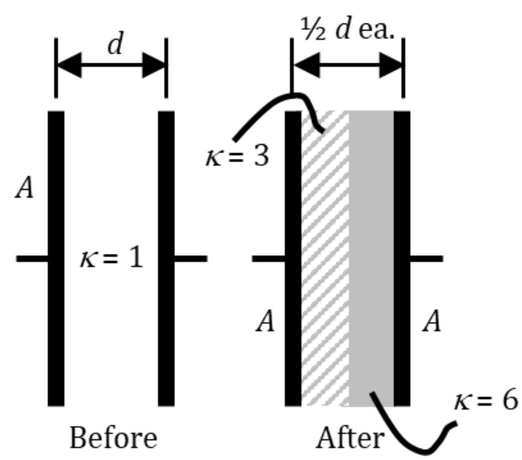


Figure 2

When we add dielectrics this time, however, the left half of the region has a dielectric of $\kappa = 3$, while the right half has a dielectric of $\kappa = 6$. The plate separation, in effect, becomes ½ d for each of these regions, while the area for each of these regions remains A.

E. In terms of C_o, determine the capacitance of the $\kappa = 3$ portion. $C_{\kappa=3} =$

F. In terms of C_o, determine the capacitance of the $\kappa = 6$ portion. $C_{\kappa=6} =$

G. Circle your answer… The $C_{\kappa=3}$ and $C_{\kappa=6}$ capacitors are in: SERIES PARALLEL

H. Choose the correct equation for finding equivalent capacitance, then use that equation in conjunction with your answers above to find the equivalent capacitance C_{eq} for the "After" capacitor of Figure 2.

UB, HW2, P5
Reference Video: "Review of Unit on Capacitance (Part IV)"
YouTube, lasseviren1, CAPACITANCE playlist

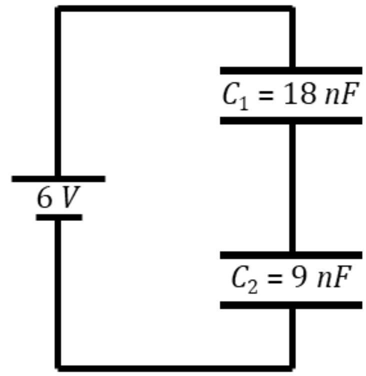


Figure 1

A. In Figure 1, which capacitor, if either… (circle your answer)

i. …stores more charge Q? C_1 C_2 it's a tie

ii. …has a larger potential V across it? C_1 C_2 it's a tie

B. For Figure 1, calculate the following quantities. Include the correct units.

Figure 1 Quantities	V_1 =
C_{eq} =	V_2 =
Q_{tot} =	U_1 =
Q_1 =	U_2 =
Q_2 =	U_{tot} =

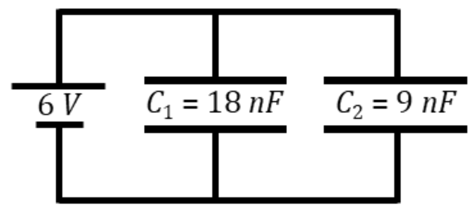


Figure 2

C. In Figure 2, which capacitor, if either… (circle your answer)

i. …stores more charge Q? C_1 C_2 it's a tie

ii. …has a larger potential V across it? C_1 C_2 it's a tie

D. For Figure 2, calculate the following quantities. Include the correct units.

Figure 2 Quantities	Q_1 =
C_{eq} =	Q_2 =
Q_{tot} =	U_1 =
V_1 =	U_2 =
V_2 =	U_{tot} =

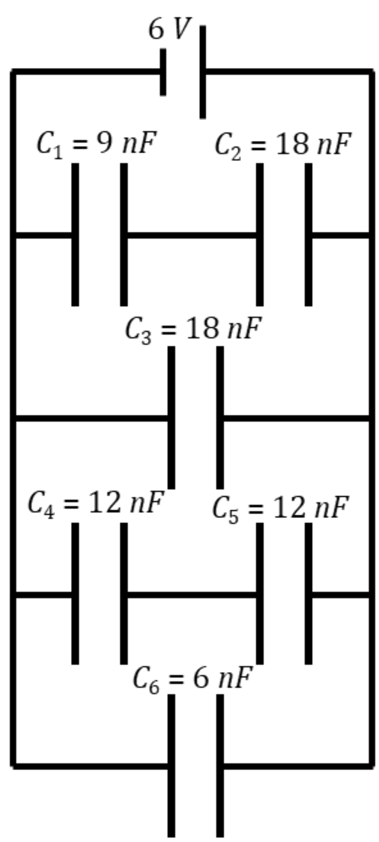


Figure 3

E. For Figure 3, calculate the following quantities. Include the correct units.

Figure 3 Quantities	Q_3 =
	V_3 =
C_{eq} =	Q_4 =
Q_{tot} =	V_4 =
Q_1 =	Q_5 =
V_1 =	V_5 =
Q_2 =	Q_6 =
V_2 =	V_6 =

F. Determine the total energy U_{tot} stored in the system of Figure 3.