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← Phys 232, section 001, Fall 2023

Chapter 25 Capacitance (Homework)

INSTRUCTOR
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Liberty University

Current Score

QUESTION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
POINTS	0/3	–/6	–/4	–/3	–/3	–/5	–/5	–/4	0/10	–/4	–/9	–/6	–/2	–/1	–/2	–/4	–/7

TOTAL SCORE

0/78	0.0%

Due Date

SUN, NOV 19, 2023
12:00 AM EST

Request Extension

Assignment Submission & Scoring

Assignment Submission

For this assignment, you submit answers by question parts. The number of submissions remaining for each question part only changes if you submit or change the answer.

Alt+A

Assignment Scoring

Your last submission is used for your score.

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1. **[0/3 Points]** DETAILS PREVIOUS ANSWERS **SERPSE10 25.2.OP.002.MI.**

MY NOTES ASK YOUR TEACHER PRACTICE ANOTHER

An air-filled spherical capacitor is constructed with an inner-shell radius of 6.60 cm and an outer-shell radius of 12.0 cm.

(a) Calculate the capacitance of the device.

.163325 ✖

What is the formula for the capacitance of a spherical capacitor? How does it depend on the inner radius and outer radius of a spherical shell? Be sure to convert the radii from units of centimeters to meters in your calculation, Also, be sure to convert the final answer from farads to picofarads, where "pico" (metric prefix p) means 1×10^{-12}. pF

(b) What potential difference between the spheres results in a 4.00 μC charge on the capacitor?

kV

(c) **What If?** What would be the length (in cm) of a cylindrical air-filled capacitor with the same inner and outer radii as the spherical capacitor if it were to have the same capacitance as the spherical capacitor?

cm

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2. **[–/6 Points]** DETAILS **SERPSE10 25.2.OP.003.MI.SA.**

MY NOTES ASK YOUR TEACHER PRACTICE ANOTHER

This question has several parts that must be completed sequentially. If you skip a part of the question, you will not receive any points for the skipped part, and you will not be able to come back to the skipped part.

Tutorial Exercise

A 48.0-m length of coaxial cable has an inner conductor that has a diameter of 2.58 mm and carries a charge of 8.10 μC. The surrounding conductor has an inner diameter of 7.27 mm and a charge of −8.10 μC.

(a) What is the capacitance of this cable?

(b) What is the potential difference between the two conductors? Assume the region between the conductors is air.

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3. [–/4 Points] DETAILS SERPSE10 25.2.OP.005.MI.

MY NOTES ASK YOUR TEACHER PRACTICE ANOTHER

An air-filled capacitor consists of two parallel plates, each with an area of 7.60 cm^2, separated by a distance of 2.10 mm. A 19.0-V potential difference is applied to these plates.

(a) Calculate the electric field between the plates.

[ ] kV/m

(b) Calculate the surface charge density.

[ ] nC/m^2

(c) Calculate the capacitance.

[ ] pF

(d) Calculate the charge on each plate.

[ ] pC

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4. [–/3 Points] DETAILS SERPSE10 25.2.OP.006.

MY NOTES ASK YOUR TEACHER PRACTICE ANOTHER

An isolated charged conducting sphere has a radius R = 13.0 cm. At a distance of r = 18.0 cm from the center of the sphere the electric field due to the sphere has a magnitude of $E = 4.90 \times 10^4$ N/C.

(a) What is its surface charge density (in $\mu C/m^2$)?

[ ] $\mu C/m^2$

(b) What is its capacitance (in pF)?

[ ] pF

(c) **What If?** A larger sphere of radius 25.0 cm is now added so as to be concentric with the first sphere. What is the capacitance (in pF) of the two-sphere system?

[ ] pF

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5. **[–/3 Points]** DETAILS **SERPSE10 25.2.P.004.**

MY NOTES | ASK YOUR TEACHER | PRACTICE ANOTHER

An air-filled parallel-plate capacitor has plates of area 2.60 cm^2 separated by 1.00 mm. The capacitor is connected to a 3.0-V battery.

(a) Find the value of its capacitance.

[ ] pF

(b) What is the charge on the capacitor?

[ ] pC

(c) What is the magnitude of the uniform electric field between the plates?

[ ] V/m

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6. **[–/5 Points]** DETAILS **SERPSE10 25.3.OP.007.**

MY NOTES | ASK YOUR TEACHER | PRACTICE ANOTHER

Two capacitors, C_1 = 6.00 μF and C_2 = 13.0 μF, are connected in parallel, and the resulting combination is connected to a 9.00-V battery.

(a) Find the equivalent capacitance of the combination.

[ ] μF

(b) Find the potential difference across each capacitor.

V_1 = [ ] V

V_2 = [ ] V

(c) Find the charge stored on each capacitor.

Q_1 = [ ] μC

Q_2 = [ ] μC

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7. **[–/5 Points]** DETAILS **SERPSE10 25.3.OP.008.**

MY NOTES | ASK YOUR TEACHER | PRACTICE ANOTHER

Two capacitors (C_1 = 8.00 μF and C_2 = 11.0 μF) are now connected in series and to a 9.00-V battery.

(a) Find the equivalent capacitance of the combination.

[ ] μF

(b) Find the potential difference across each capacitor.

V_1 = [ ] V

V_2 = [ ] V

(c) Find the charge on each capacitor.

Q_1 = [ ] μC

Q_2 = [ ] μC

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8. **[–/4 Points]** DETAILS **SERPSE10 25.3.OP.009.**

MY NOTES | ASK YOUR TEACHER | PRACTICE ANOTHER

A student is working with a 3.00-μF capacitor, a 4.50-μF capacitor, and a 4.60-V battery. What is the the charge (in μC) on each capacitor if the student connects the capacitors in the following ways.

(a) in series across the battery

3.00-μF capacitor [ ] μC

4.50-μF capacitor [ ] μC

(b) in parallel across the battery

3.00-μF capacitor [ ] μC

4.50-μF capacitor [ ] μC

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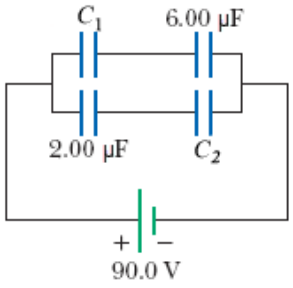
9. [0/10 Points] DETAILS PREVIOUS ANSWERS SERPSE10 25.3.OP.010.

MY NOTES ASK YOUR TEACHER PRACTICE ANOTHER

Consider the circuit shown in the figure, with C_1 = 4.22 μF and C_2 = 8.04 μF.



(a) Find the equivalent capacitance (in μF) of the system.

8 ✖

Note that for the upper and lower branches, the capacitors are in series. These two equivalent resistances are in parallel. Review how to add capacitors in series and parallel. μF

(b) Find the charge (in μC) on each capacitor.

4.22 μF capacitor ____ μC

6.00 μF capacitor ____ μC

8.04 μF capacitor ____ μC

2.00 μF capacitor ____ μC

(c) Find the potential difference (in V) on each capacitor.

4.22 μF capacitor ____ V

6.00 μF capacitor ____ V

8.04 μF capacitor ____ V

2.00 μF capacitor ____ V

(d) Find the total energy (in mJ) stored by the group.

____ mJ

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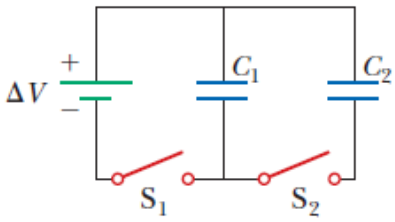
10. [–/4 Points] DETAILS SERPSE10 25.3.OP.011.MI.

MY NOTES ASK YOUR TEACHER PRACTICE ANOTHER

Consider the circuit shown in the figure below, where C_1 = 8.00 μF, C_2 = 6.00 μF, and ΔV = 22.0 V. Capacitor C_1 is first charged by closing switch S_1. Switch S_1 is then opened, and the charged capacitor is connected to the uncharged capacitor by closing S_2.



(a) Calculate the initial charge (in μC) acquired by C_1. (Round your answer to at least one decimal place.)

[ ] μC

(b) Calculate the final charge (in μC) on each capacitor. (Round your answers to at least the nearest integer.)

Q_1 = [ ] μC

Q_2 = [ ] μC

(c) **What If?** After a very long time, switch S_1 is also closed. By what amount does the charge on the second capacitor change after S_1 has been closed for a very long time? (Give your answer in μC.)

[ ] μC

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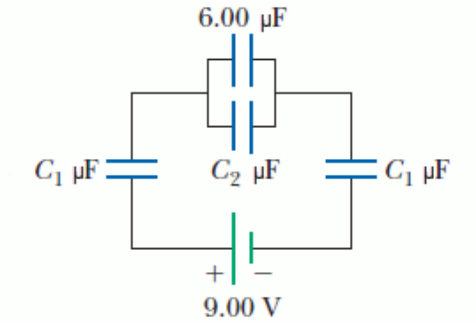
11. [–/9 Points] DETAILS SERPSE10 25.3.OP.012.

MY NOTES ASK YOUR TEACHER PRACTICE ANOTHER

A lab tech builds a circuit as shown in the figure. Find the following. (Assume C_1 = 32.0 μF and C_2 = 2.93 μF.)



(a) the equivalent capacitance (in μF)

[ ] μF

(b) the charge on each capacitor (in μC)

C_1 (left) [ ] μC

C_1 (right) [ ] μC

C_2 [ ] μC

6.00 μF capacitor [ ] μC

(c) the potential difference across each capacitor (in V)

C_1 (left) [ ] V

C_1 (right) [ ] V

C_2 [ ] V

6.00 μF capacitor [ ] V

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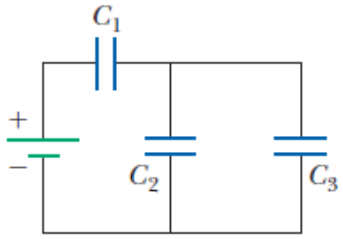
12. **[–/6 Points]** DETAILS **SERPSE10 25.3.P.010.** MY NOTES ASK YOUR TEACHER

Three capacitors are connected to a battery as shown in the figure below. Their capacitances are $C_1 = 3C$, $C_2 = C$, and $C_3 = 5C$.



(a) What is the equivalent capacitance of this set of capacitors? (Use the following as necessary: C.)

C_{eq} =

(b) State the ranking of the capacitors according to the charge they store from largest to smallest.

---Select--- > ---Select--- > ---Select---

(c) Rank the capacitors according to the potential differences across them from largest to smallest.

- ○ $\Delta V_1 > \Delta V_2 > \Delta V_3$
- ○ $\Delta V_2 > \Delta V_3 > \Delta V_1$
- ○ $\Delta V_1 = \Delta V_2 < \Delta V_3$
- ○ $\Delta V_1 > \Delta V_2 = \Delta V_3$

(d) Assume C_3 is increased. Explain what happens to the charge stored by each capacitor.

- ○ Q_3, Q_1, and Q_2 increase.
- ○ Q_3 and Q_1 increase; Q_2 decreases.
- ○ All charges stay the same.
- ○ Q_3 and Q_2 increase; Q_1 decreases.

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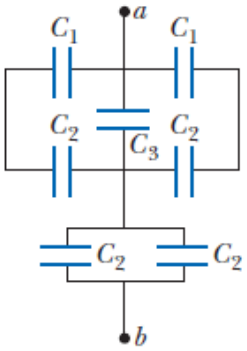
13. [–/2 Points] DETAILS SERPSE10 25.3.P.012.

MY NOTES ASK YOUR TEACHER PRACTICE ANOTHER

Consider the following figure.



(a) Find the equivalent capacitance between points *a* and *b* for the group of capacitors connected as shown in the figure above. Take C_1 = 6.00 μF, C_2 = 13.0 μF, and C_3 = 1.00 μF.

[ ] μF

(b) What charge is stored on C_3 if the potential difference between points *a* and *b* is 60.0 V?

[ ] μC

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14. [–/1 Points] DETAILS SERPSE10 25.4.OP.014.

MY NOTES ASK YOUR TEACHER PRACTICE ANOTHER

A professor connects an 18.0 V battery to a capacitor of unknown capacitance. The result is that 41.2 μC of charge is stored on the capacitor. How much energy (in J) is stored in the capacitor?

[ ] J

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15. [–/2 Points] DETAILS SERPSE10 25.4.P.017.

MY NOTES ASK YOUR TEACHER PRACTICE ANOTHER

(a) A 6.00-μF capacitor is connected to a 15.0-V battery. How much energy is stored in the capacitor?

[ ] μJ

(b) Had the capacitor been connected to a 6.00-V battery, how much energy would have been stored?

[ ] μJ

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16. [–/4 Points] DETAILS SERPSE10 25.4.P.019.

MY NOTES ASK YOUR TEACHER PRACTICE ANOTHER

Two identical parallel-plate capacitors, each with capacitance 20.0 μF, are charged to potential difference 45.5 V and then disconnected from the battery. They are then connected to each other in parallel with plates of like sign connected. Finally, the plate separation in one of the capacitors is doubled.

(a) Find the total energy of the system of two capacitors *before* the plate separation is doubled.

[ ] J

(b) Find the potential difference across each capacitor *after* the plate separation is doubled.

[ ] V

(c) Find the total energy of the system *after* the plate separation is doubled.

[ ] J

(d) Reconcile the difference in the answers to parts (a) and (c) with the law of conservation of energy.

- ○ Positive work is done by the agent pulling the plates apart.
- ○ Negative work is done by the agent pulling the plates apart.
- ○ No work is done by pulling the agent pulling the plates apart.

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17. [–/7 Points] DETAILS SERPSE10 25.4.P.023. MY NOTES ASK YOUR TEACHER

Consider two conducting spheres with radii R_1 and R_2 separated by a distance much greater than either radius. A total charge Q is shared between the spheres. We wish to show that when the electric potential energy of the system has a minimum value, the potential difference between the spheres is zero. The total charge Q is equal to $q_1 + q_2$, where q_1 represents the charge on the first sphere and q_2 the charge on the second. Because the spheres are very far apart, you can assume the charge of each is uniformly distributed over its surface.

(a) Show that the energy associated with a single conducting sphere of radius R and charge q surrounded by a vacuum is $U = \frac{k_e q^2}{2R}$. (Submit a file with a maximum size of 1 MB.)

Choose File No file chosen

This answer has not been graded yet.

(b) Find the total energy of the system of two spheres in terms of q_1, the total charge Q, and the radii R_1 and R_2. (Use the following as necessary: R_1, R_2, Q, q_1, q_2, and k_e.)

$U =$

(c) To minimize the energy, differentiate the result to part (b) with respect to q_1 and set the derivative equal to zero. Solve for q_1 in terms of Q and the radii. (Use the following as necessary: R_1, R_2, Q, and k_e.)

$q_1 =$

(d) From the result to part (c), find the charge q_2. (Use the following as necessary: R_1, R_2, Q, and k_e.)

$q_2 =$

(e) Find the potential of each sphere. (Use the following as necessary: R_1, R_2, Q, and k_e.)

$V_1 =$

V_2 =

(f) What is the potential difference between the spheres? (Use the following as necessary: R_1, R_2, Q, and k_e.)

ΔV =

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