

Practice Questions: Topic 4– Capacitors

1. Capacitor is a device that stores ____.

- A. electric charge only
- B. electric potential energy only
- C. electric potential
- D. charge and electric potential energy

2. Which of the following is a unit of capacitance?

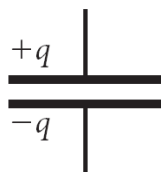
- A. Coulomb *Charge*
- B. Farad
- C. Volt *potential difference*
- D. Joule *Battery*

3. Which of the following is a circuit symbol for a capacitor?

- A.  *Resistor*
- B. 
- C.  *Inductor*
- D.  *Battery*

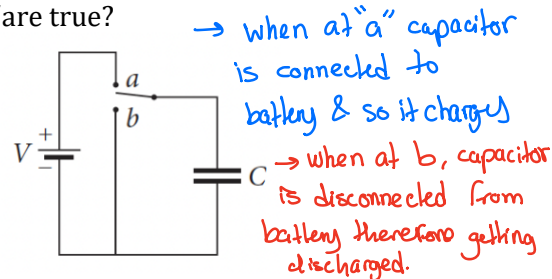
4. The figure shows a charged capacitor. What is the net charge on the capacitor?

- A. $(+q) + (-q) = 0$
- B. $|+q| + |-q| = 0$
- C. $|+q| + |-q| = 2q$
- D. q



** Add the charges on the individual plates*

5. Simple circuit used for charging and discharging a capacitor. Which of the following statements is/are true?



- I. The capacitor charges when switch is at a
- II. The capacitor charges when switch is at b
- III. The capacitor discharges when switch is at a
- IV. The capacitor discharges when switch is at b

A. I and III

B. I and IV

C. II and III

D. II and IV

6. What is the voltage across the plates of a capacitor if the capacitance is $10 \mu\text{F}$ and the charge stored is $30 \mu\text{C}$?

A. 0.33 V

B. 3.0 V

C. 300 V

D. 600 V

$$C = \frac{Q}{V} \rightarrow V = \frac{Q}{C}$$

$$V = \frac{30 \mu\text{C}}{10 \mu\text{F}} = 3 \text{ V}$$

7. A parallel-plate capacitor stores 240 nC when fully charged by the application of a 12 V potential difference across its plates. What is its capacitance?

A. $5.0 \times 10^{-11} \text{ F}$

B. $1.7 \times 10^{-9} \text{ F}$

C. $2.0 \times 10^{-8} \text{ F}$

D. $2.9 \times 10^{-6} \text{ F}$

$$C = \frac{Q}{V} = \frac{240 \times 10^{-9}}{12} = 2 \times 10^{-8} \text{ F}$$

8. A capacitor stores charge Q at a potential difference ΔV . What happens if the voltage applied to the capacitor by a battery is doubled to $2\Delta V$?

* Capacitance Independent of charge & voltage

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

- A. The capacitance falls to half its initial value, and the charge remains the same
 B. The capacitance and the charge both fall to half their initial values
 C. The capacitance and the charge both double
 D. The capacitance remains the same, and the charge doubles

$$Q = CV$$

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

$$Q \propto V$$

9. A parallel plate capacitor has a capacitance equal to C . What would be its capacitance if the area of each of the two plates doubled and their separation distance quadrupled?

- A. $C/4$
 B. $C/2$
 C. $2C$
 D. $4C$

$$C = \frac{\epsilon_0 A}{d}$$

$$C = \frac{\epsilon_0 (2A)}{4d}$$

$$C = \frac{1}{2} \left(\frac{\epsilon_0 A}{d} \right)$$

10. The capacitance of a charged parallel plate capacitor can be increased by ____.

- A. increasing the charge *Not effected*
 B. decreasing the charge *Not effected*
 C. increasing the plate separation *Decreased*
 D. decreasing the plate separation

11. Which of the following is (are) proportional to the capacitance of a parallel plate capacitor?

- A. the charge stored on each conducting plate
 B. the potential difference between the two plates
 C. the separation distance between the two plates
 D. the area of each plate

$$C \propto A \quad C \propto \frac{1}{d}$$

12. Suppose you charge a parallel plate capacitor using a battery and then remove the battery, isolating the capacitor and leaving it charged. You then move the plates of the capacitor farther apart. The potential difference between the plates will ____.

* Case where battery is disconnected

ΔV : change Q : constant

$$C \propto \frac{1}{d} \text{ so if } \uparrow d = \downarrow C$$

- A. increase
 B. decrease
 C. stay the same
 D. not be determinable

$$\text{since } C = \frac{Q}{V} \text{ if } \downarrow C = \uparrow V$$

13. Suppose you have a parallel plate capacitor with area A and plate separation d , but space constraints on a circuit board force you to reduce the area of the capacitor by a factor of 2. What do you have to do to compensate and retain the same value of the capacitance?

- A. reduce d by a factor of 2
 B. increase d by a factor of 2
 C. reduce d by a factor of 4
 D. increase d by a factor of 4

$$C = \frac{\epsilon_0 \left(\frac{A}{2} \right)}{d}$$

$$C = \frac{\epsilon_0 A}{2d}$$

if we divided by 2: $C = \frac{\epsilon_0 A}{d}$

14. A parallel plate capacitor is connected to a battery for charging. After some time, while the battery is still connected to the capacitor, the distance between the capacitor plates is doubled. Which of the following is (are) true?

- A. The electric field between the plates is halved
 B. The potential difference of the battery is halved
 C. The capacitance doubles
 D. The potential difference across the plates does not change

* Battery still connected: V is same

$$E = \frac{\Delta V}{d} \rightarrow E = \frac{\Delta V}{2d}$$

Therefore E is halved

$$Q = CV$$

$$V = \frac{Q}{C} \downarrow$$

$$\frac{Q}{C}$$

15. The distance between the plates of a parallel plate capacitor is reduced by half and the area of the plates is doubled. What happens to the capacitance?

- A. It remains unchanged
- B. It doubles
- C. It quadruples
- D. It is reduced by half

$$C = \frac{\epsilon_0 A}{d}$$

$$C = \frac{\epsilon_0 (2A)}{\frac{d}{2}}$$

$$C = 4 \frac{\epsilon_0 A}{d}$$

16. A parallel plate capacitor of capacitance C has plates of area A with distance d between them. When the capacitor is connected to a battery supplying potential difference V , it has a charge of magnitude Q on its plates. While the capacitor is connected to the battery, the distance between the plates is decreased by a factor of 3. The magnitude of the charge on the plates and the capacitance will then be ____.

- A. $\frac{1}{3}Q$ and $\frac{1}{3}C$
- B. $\frac{1}{3}Q$ and $3C$
- C. $3Q$ and $3C$
- D. $3Q$ and $\frac{1}{3}C$

$$C = \frac{\epsilon_0 A}{\frac{d}{3}}$$

$$C = 3 \frac{\epsilon_0 A}{d} \rightarrow 3C$$

$$C = \frac{Q}{V} \rightarrow Q = CV$$

$$Q = 3CV = 3Q$$

17. The potential drop for a circuit with three capacitors of different individual capacitances in series connection is

$$V = V_1 + V_2 + V_3$$

- A. the same across each capacitor and has the same value as the potential difference supplied by the battery
- B. the same across each capacitor and has the same value as the potential difference supplied by the battery
- C. largest across the capacitor with the smallest capacitance
- D. largest across the capacitor with the largest capacitance

$$C = \frac{Q}{V} \rightarrow V = \frac{Q}{C}$$

less capacitance = more voltage

larger capacitance = smaller voltage

18. Capacitors connected in series always have the same ____?

- A. capacitance
- B. charge
- C. potential difference
- D. dielectric strength

$$C_{total} = \left[\frac{1}{C_1} + \frac{1}{C_2} \right]^{-1}$$

$$Q = Q_1 = Q_2$$

$$V = V_1 + V_2 + V_3$$

19. Capacitors connected in parallel always have the same ____?

- A. capacitance
- B. charge
- C. potential difference
- D. dielectric strength

$$C = C_1 + C_2 + C_3$$

$$Q = Q_1 + Q_2 + Q_3$$

20. N identical capacitors are connected in ~~series~~. The capacitance of one of them is equal to C . What is the equivalent capacitance of all N capacitors?

- A. C/N
- B. N/C
- C. C
- D. NC

$$C_{total} = \left[N \left(\frac{1}{C} \right) \right]^{-1}$$

$$= \left[\frac{N}{C} \right]^{-1}$$

$$= \frac{C}{N}$$

21. N identical capacitors are connected in parallel. The capacitance of one of them is equal to C . What is the equivalent capacitance of all N capacitors?

- A. C/N
- B. N/C
- C. C
- D. NC

$$C_{total} = NC$$

Remember the rules: $C = \frac{Q}{V}$, $Q = CV$, $V = \frac{Q}{C}$

22. The total capacitance of two capacitors connected in series is _____ the lowest value capacitor.

- A. equal to
- B. greater than
- C. less than
- D. opposite

* Since they're added this way:

$$C_{\text{Total}} = \left[\frac{1}{C_1} + \frac{1}{C_2} \right]^{-1}$$

$$C_{\text{Total}} < C_{\text{least}}$$

23. Three capacitors, each with capacitance C , are connected as shown in the figure. What is the equivalent capacitance for this arrangement of capacitors?



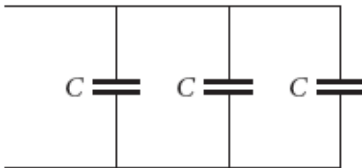
* Series connection

- A. $C/9$
- B. $C/3$
- C. $3C$
- D. $9C$

$$C_{\text{Total}} = \left[\frac{1}{C} + \frac{1}{C} + \frac{1}{C} \right]^{-1}$$

$$= \left[\frac{3}{C} \right]^{-1} = \frac{C}{3}$$

24. Three capacitors, each with capacitance C , are connected as shown in the figure. What is the equivalent capacitance for this arrangement of capacitors?



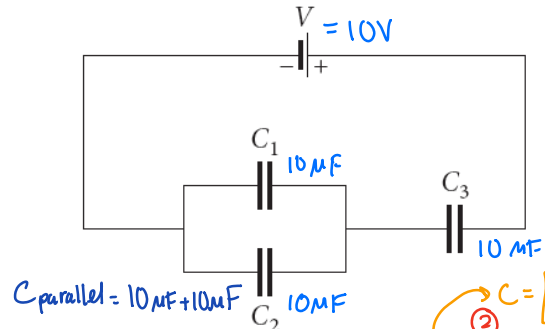
* parallel connection: each one has its own path

- A. $C/9$
- B. $C/3$
- C. $3C$
- D. $9C$

$$C_{\text{Total}} = C + C + C$$

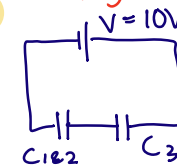
$$= 3C$$

25. Three capacitors are connected to a battery as shown in the figure. If $C_1 = C_2 = C_3 = 10.0 \mu\text{F}$ and $V = 10.0 \text{ V}$, what is the charge on capacitor C_3 ?



- A. $66.7 \mu\text{C}$
- B. $100 \mu\text{C}$
- C. $150 \mu\text{C}$
- D. $457 \mu\text{C}$

① Simplify circuit



* $Q_{\text{Total}} = Q_1 = Q_2$
* $V_{\text{Total}} = V_1 + V_2 + V_3$

$$C = \left[\frac{1}{10} + \frac{1}{10} \right]^{-1}$$

$$= \frac{20}{3} \mu\text{F}$$

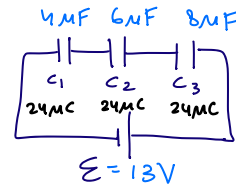
$$Q_3 = Q_{\text{Total}}$$

$$Q_{\text{Total}} = C_{\text{Total}} V_{\text{Total}}$$

$$= \frac{20}{3} \times 10$$

$$\approx 66.7 \mu\text{C}$$

26. Three capacitors of capacity $4 \mu\text{F}$, $6 \mu\text{F}$, and $8 \mu\text{F}$ are connected in series with a battery of 13 V . What is the potential difference across the $6 \mu\text{F}$ capacitor?



- A. 4 V
- B. 6 V
- C. 8 V
- D. 9 V

① Find Q_{Total}

$Q = C_{\text{Total}} V_{\text{Total}}$

$$= \left[\frac{1}{4} + \frac{1}{6} + \frac{1}{8} \right]^{-1} (13) = 24 \mu\text{C}$$

$$Q_{\text{Total}} = Q_1 = Q_2 = Q_3$$

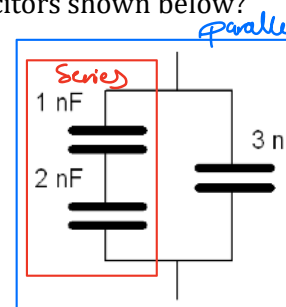
$$V_{\text{Total}} = V_1 + V_2 + V_3$$

$$V_2 = \frac{Q}{C_2}$$

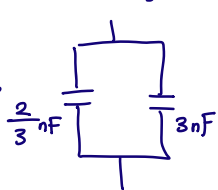
$$= \frac{24 \mu\text{C}}{6 \mu\text{F}}$$

$$= 4 \text{ V}$$

27. What is the equivalent capacitance for the three capacitors shown below?



Simplify



- A. 0.27 nF
- B. 1.50 nF
- C. 3.67 nF
- D. 6.00 nF

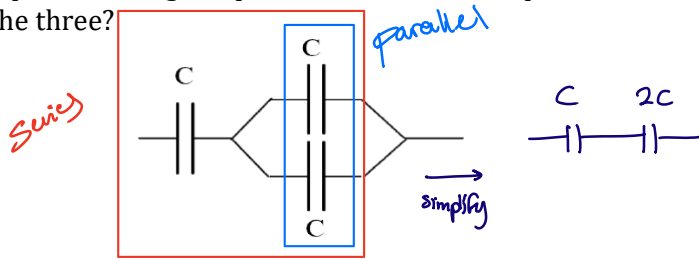
$$C_{\text{Series}} = \left[\frac{1}{1 \text{ nF}} + \frac{1}{2 \text{ nF}} \right]^{-1} = \frac{2}{3} \text{ nF}$$

$$C_{\text{Parallel}} = \frac{2}{3} \text{ nF} + 3 \text{ nF}$$

$$= \frac{11}{3} \text{ nF}$$

$$\approx 3.67 \text{ nF}$$

28. In the circuit shown, what would be the equivalent single capacitor which would replace the three?



A. $C/3$

B. $2C/3$

C. $4C/3$

D. $2C$

$C_{\text{parallel}} = C + C = 2C$

$C_{\text{series}} = \left[\frac{1}{C} + \frac{1}{2C} \right]^{-1}$
 $= \frac{2}{3}C \text{ or } \frac{2C}{3}$

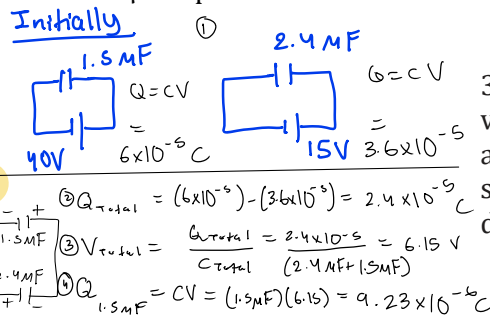
29. A $1.50 \mu\text{F}$ capacitor charged to 40.0 V and a $2.40 \mu\text{F}$ capacitor charged to 15.0 V are connected to each other, with the positive plate of each connected to the negative plate of the other. What is the final charge on the $1.50 \mu\text{F}$ capacitor?

A. $1.82 \mu\text{C}$

B. $5.74 \mu\text{C}$

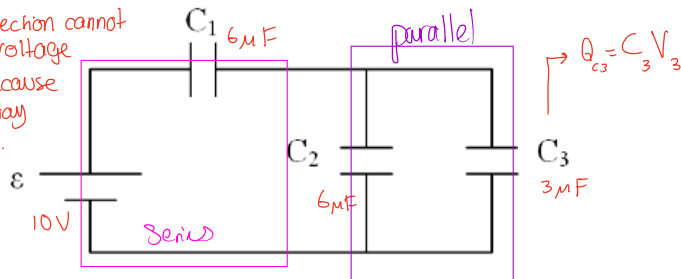
C. $9.23 \mu\text{C}$

D. $15.8 \mu\text{C}$



30. In circuit shown, calculate the charge on C_3 , where $\mathcal{E} = 10 \text{ V}$, $C_1 = C_2 = 6 \mu\text{F}$ and $C_3 = 3 \mu\text{F}$.

* parallel connection cannot have same voltage as battery because C_1 takes away some voltage.



A. $9 \mu\text{C}$

B. $12 \mu\text{C}$

C. $24 \mu\text{C}$

D. $36 \mu\text{C}$

① Simplify the Circuit (Add C_2 & C_3)



② In Series $V_{\text{total}} = V_1 + V_{23}$ where V_{23} will be the same for capacitors 2 and 3 since they're in parallel

$V_{23} = \frac{Q}{C_{23}}$ * In series, $Q_{\text{total}} = Q_1 = Q_{23}$
 $Q_{\text{total}} = V_{\text{total}} \times C_{\text{total}}$
 $Q_{\text{total}} = 10 \times 3.6 \mu\text{F} = 36 \mu\text{C}$

$V_{23} = \frac{Q}{C_{23}} = \frac{36 \mu\text{C}}{9 \mu\text{F}} = 4 \text{ V}$

$Q_3 = C_3 V_3 = (3 \mu\text{F})(4) = 12 \mu\text{C}$

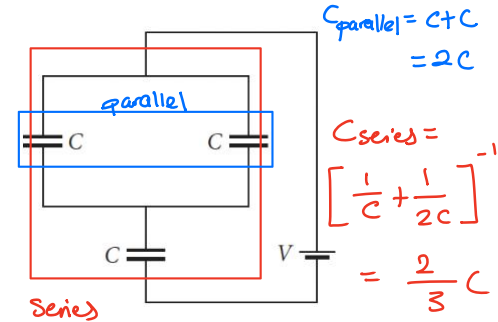
31. In the circuit shown in the figure, the capacitance for each capacitor is C . What is the equivalent capacitance for these three capacitors?

A. $C/3$

B. $2C/3$

C. $2C/5$

D. $3C/5$



32. The capacitance of a capacitor is $47 \mu\text{F}$, and the voltage difference across the capacitor is 6.0 V . What is the energy stored in the capacitor?

A. $0.001 \mu\text{J}$

B. $7.83 \mu\text{J}$

C. $282 \mu\text{J}$

D. $846 \mu\text{J}$

$C = 47 \mu\text{F}, V = 6 \text{ V}$

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

$U = \frac{1}{2} (47 \times 10^{-6}) (6)^2$

$\text{same} \rightarrow 8.46 \times 10^{-4} \text{ J}$

33. When a capacitor has a charge of absolute value $80 \mu\text{C}$ on each plate the potential difference across the plates is 10 V . How much energy is stored in this capacitor when the potential difference across its plates is 120 V ?

A. 0.48 mJ

B. 58 mJ

C. 0.36 J

D. 0.12 J

$Q = 80 \mu\text{C}, V = 10 \text{ V}$ changed Q as well

$U = ?$ When $V = 120 \text{ V}$ * cannot use equation with 2 varying variables

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

$C = \frac{Q}{V} = \frac{80 \mu\text{C}}{10 \text{ V}} = 8 \mu\text{F}$ $C = \frac{1}{2} (6 \mu\text{F}) (10)^2$

34. How much energy is stored in the $180 \mu\text{F}$ capacitor of a camera flash unit charged to 300.0 V ?

A. 1.22 J

B. 8.10 J

C. 45.0 J

D. 115 J

$C = 180 \mu\text{F}, V = 300 \text{ V}$

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

$U = \frac{1}{2} (180 \times 10^{-6}) (300)^2$
 $= 8.1 \text{ J}$

35. A capacitor stores energy U_1 when it holds charge Q . The same capacitor stores energy U_2 when it holds charge $16Q$. What is the ratio U_2/U_1 ?

- A. 16
- B. 64
- C. 128
- D. 256

$$U = \frac{Q^2}{2C} \leftarrow \text{Ignore (constant)}$$

$$\frac{U_2}{U_1} = \frac{Q_2^2}{Q_1^2} = \frac{256Q^2}{Q^2} = 256$$

36. Two capacitors are identical. They can be connected in series or in parallel to a circuit. How should they be connected to get the smallest equivalent capacitance or the maximum possible energy stored when connected to a battery?

	Smallest Equivalent Capacitance	Maximum Energy
A. Series	$C_{\text{total}} < C_{\text{least}}$	Series
B. Series		Parallel
C. Parallel		Series
D. Parallel		Parallel

$$C_{\text{total}} > C_{\text{largest}} \text{ so } U = \frac{1}{2} CV^2$$

37. A capacitor is created out of two metal plates and an insulating material called a ____.

- A. inductor
- B. resistor
- C. dielectric
- D. variable resistor

38. The advantage of using a dielectric in a capacitor is that it ____.

- A. increases the capacitance of the capacitor
- B. increases the conductivity of the capacitor
- C. decreases the charging time of the capacitor
- D. makes the capacitor dissipate less power

39. How does the capacitance of a parallel-plate capacitor affected by filling the space between the plates with an insulator $\epsilon_r > 1$?

- A. increases
- B. decreases
- C. remains the same
- D. fluctuates

40. When a dielectric is placed between the plates of a charged, isolated capacitor, what happens to the electric field inside the capacitor?

- A. increases
- B. decreases
- C. stays the same
- D. increases if the charge on the plates is positive

$$\downarrow E = \frac{q}{\epsilon \epsilon_0 A} = \frac{q}{\uparrow \epsilon A}$$

41. The space between the plates of an isolated parallel plate capacitor is filled with a slab of dielectric material. The magnitude of the charge Q on each plate is kept constant. If the dielectric material is removed the energy stored in the capacitor.

- A. increases
- B. decreases
- C. stays the same
- D. may increase or decrease

$$\downarrow C = \frac{\epsilon_0 A}{d} \quad \uparrow U = \frac{Q^2}{2C} \quad \leftarrow \text{must pick formula with constant}$$

42. What is the capacitance of two parallel plates 0.9 mm apart with an area of 12 cm² if the space between the plates is filled with a material with dielectric constant of 3.7?

- A. 3.7 μF
- B. 44 pF
- C. 76 F
- D. 130 μF

$$C = \frac{\epsilon_0 A}{d} \quad C_{\text{other}} = \frac{\epsilon \epsilon_0 A}{d} = \frac{3.7(8.85 \times 10^{-12})(0.12)}{0.0009} \approx 4.4 \times 10^{-9} = 44 \times 10^{-10}$$

Explanations

a. $\downarrow C \propto \frac{1}{d} \uparrow$

b. $\uparrow \Delta V = \frac{Q}{C} \downarrow$
 $E = \frac{\Delta V}{d} \uparrow$ E stays same

c. $\downarrow d = \uparrow C$
 $\uparrow C = \downarrow V$
 $Q = \uparrow C \downarrow V$ cannot tell

d. $\uparrow C = \downarrow V$
 Q doesn't change

Free Response:

$\uparrow u = \frac{Q^2}{2C} \downarrow$

1. State whether each of the following statements about an isolated parallel plate capacitor is true or false.

↳ Disconnected from battery (V: changing, Q: constant)

- When the distance between the plates of the capacitor is doubled, the energy stored in the capacitor doubles. **True**
- Increasing the distance between the plates increases the electric field between the plates. **False**
- When the distance between the plates is halved, the charge on the plates stays the same. **True**
- Inserting a dielectric between the plates increases the charge on the plates. **False**
- Inserting a dielectric between the plates decreases the energy stored in the capacitor. **False**

(Increases) Inserting dielectric = more capacitance

2. Suppose a thundercloud with a width of 2.0 km and a length of 3.0 km hovers at an altitude of 0.50 km over a flat area. The cloud carries a charge of 160 C, and the ground has no charge. Approximate the cloud-ground system as a parallel plate capacitor.

- What is the capacitance of the cloud-ground system capacitor?

$$C = \frac{\epsilon_0 A}{d} = \frac{(8.85 \times 10^{-12})(2000 \times 3000)}{500} = 1.062 \times 10^{-7} \approx 1.1 \times 10^{-7} \text{ F}$$

- What is the potential difference between the cloud and the ground?

* The total charge 160 C will distribute itself between the cloud & ground.
 Considering $160 \text{ C} = 2Q$ then one plate will have $+Q$ & the other $-Q$ (80 C).

$$C = \frac{Q}{\Delta V} \rightarrow \Delta V = \frac{Q}{C} = \frac{80}{1.1 \times 10^{-7}} \approx 7.3 \times 10^8 \text{ V}$$

3. Two conductors having net charges of $+10.0 \mu\text{C}$ and $-10.0 \mu\text{C}$ have a potential difference of 10.0 V between them.

- Determine the capacitance of the system.

$$C = \left| \frac{Q}{V} \right| = \frac{10 \mu\text{C}}{10 \text{ V}} = 1 \mu\text{F}$$

- What is the potential difference between the two conductors if the charges on each are increased to $+100 \mu\text{C}$ and $-100 \mu\text{C}$?

$$V = \frac{Q}{C} = \frac{100 \mu\text{C}}{1 \mu\text{F}} = 100 \text{ V}$$

4.

- How much charge is on each plate of a $4.00 \mu\text{F}$ capacitor when it is connected to a 12.0 V battery?

$$Q = CV = (4 \mu\text{F})(12) = 48 \mu\text{C}$$

- If this same capacitor is connected to a 1.50 V battery, what charge is stored?

$$Q = CV = (4 \mu\text{F})(1.5) = 6 \mu\text{C}$$

5. An air-filled parallel-plate capacitor has plates of area 2.30 cm^2 separated by 1.50 mm .

a. Find the value of its capacitance. The capacitor is connected to a 12.0-V battery.

$$C = \frac{\epsilon \cdot A}{d} = \frac{(8.85 \times 10^{-12})(2.3 \times 10^{-4})}{1.5 \times 10^{-3}} \approx 1.36 \times 10^{-12} \text{ F} \text{ or } 1.36 \text{ pF}$$

b. What is the charge on the capacitor?

$$Q = CV = (1.36 \times 10^{-12})(12) \approx 1.63 \times 10^{-11}$$

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

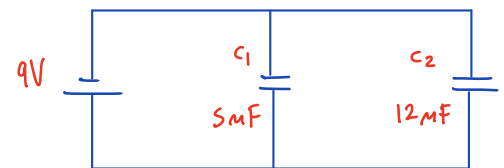
$$E = \frac{\Delta V}{d} = \frac{12}{1.5 \times 10^{-3}} = 8000 \text{ V/m}$$

6. Two capacitors, $C_1 = 5.00 \mu\text{F}$ and $C_2 = 12.0 \mu\text{F}$, are connected to a 9.00 V battery.

a. If the two capacitors are connected to the battery in parallel, find:

i. the equivalent capacitance of the combination.

$$C_{\text{total}} = C_1 + C_2 = 5 \text{ mF} + 12 \text{ mF} = 17 \text{ mF}$$



ii. the potential difference across each capacitor.

$$V_{\text{total}} = V_1 = V_2 = 9 \text{ V}$$

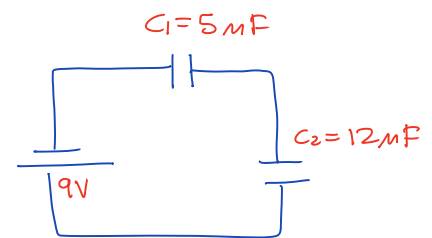
iii. the charge stored on each capacitor.

$$Q_1 = C_1 V = 5 \text{ mF} \times 9 = 45 \text{ mC}, \quad Q_2 = C_2 V = 12 \text{ mF} \times 9 = 108 \text{ mC}$$

b. If the two capacitors are connected to the battery in series, find:

i. the equivalent capacitance of the combination.

$$C_{\text{total}} = \left[\frac{1}{5 \text{ mF}} + \frac{1}{12 \text{ mF}} \right]^{-1} = \frac{60}{17} \approx 3.53 \text{ mF}$$



ii. the charge on each capacitor.

$$Q_1 = Q_2 = Q_{\text{total}}, \quad Q_{\text{total}} = C_{\text{total}} V_{\text{total}} = (3.53 \times 10^{-6})(9) \approx 31.8 \text{ mC}$$

iii. the potential difference across each capacitor. The potential difference across each is:

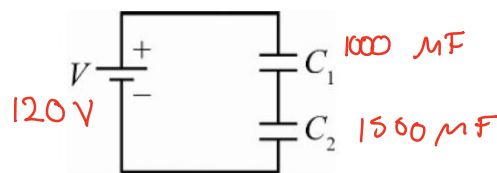
$$V_1 = \frac{Q}{C_1} = \frac{31.8 \text{ mC}}{5 \text{ mF}} = 6.36 \text{ V}, \quad V_2 = \frac{Q}{C_2} = \frac{31.8 \text{ mC}}{12 \text{ mF}} = 2.65 \text{ V}$$

* To convert from cm^2 to m^2 divide by 10,000 OR multiply by 10^{-4}

7. The potential difference across two capacitors in series is 120 V. The capacitances are $C_1 = 1.00 \times 10^3 \mu F$, and $C_2 = 1.50 \times 10^3 \mu F$.

a. What is the total capacitance of this pair of capacitors?

$$C_{\text{total}} = \left[\frac{1}{1000 \mu F} + \frac{1}{1500 \mu F} \right]^{-1} = 600 \mu F$$



b. What is the charge on each capacitor?

$$Q_{\text{total}} = Q_1 = Q_2$$

$$Q_{\text{total}} = C_{\text{total}} V_{\text{total}} = (600 \mu F)(120V) = 72000 \mu C$$

c. What is the potential difference across each capacitor?

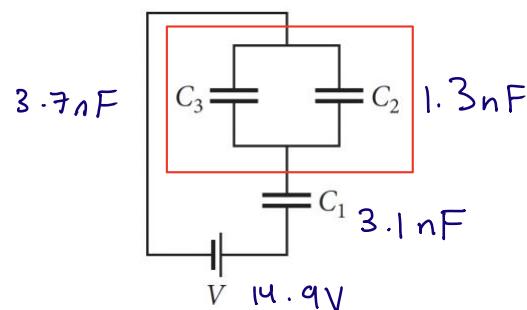
$$V_1 = \frac{Q_1}{C_1} = \frac{72000 \mu C}{1000 \mu F} = 72 V$$

$$V_2 = \frac{Q_2}{C_2} = \frac{72000 \mu C}{1500 \mu F} = 48 V$$

8. What is the total energy stored by the capacitors? Three capacitors with capacitances $C_1 = 3.10 \text{ nF}$, $C_2 = 1.30 \text{ nF}$ and $C_3 = 3.70 \text{ nF}$ are wired to a battery with $V = 14.9 \text{ V}$, as shown in the figure.

a. What is the total capacitance in the circuit?

$$C_{\text{Total}} = \left[\frac{1}{5 \text{ nF}} + \frac{1}{3.1 \text{ nF}} \right]^{-1} = 1.91 \text{ nF}$$



↓
simplify the circuit

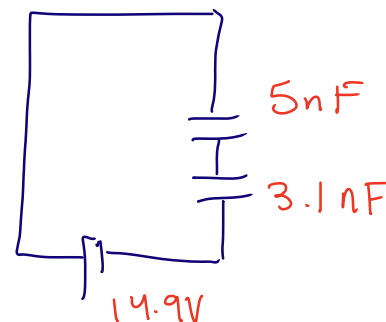
b. What is the total charge supplied?

$$Q_{\text{total}} = C_{\text{total}} V_{\text{total}} = (1.9 \text{ nF})(14.9) = 28.5 \text{ nC}$$

c. What is the potential drop across capacitor C_2 ?

$$V_{\text{total}} = \frac{Q_{\text{total}}}{C_{\text{total}}} = \frac{28.5 \text{ nC}}{5 \text{ nF}} = 5.7 \text{ Volts}$$

for parallel



* Both capacitors in parallel will have the same "V".

9. Referring to the figure, decide which of the equations in the table below is (are) true. Assume that all of the capacitors have different capacitances.

The potential difference across capacitor C_1 is V_1 .

The potential difference across capacitor C_2 is V_2 .

The potential difference across capacitor C_3 is V_3 .

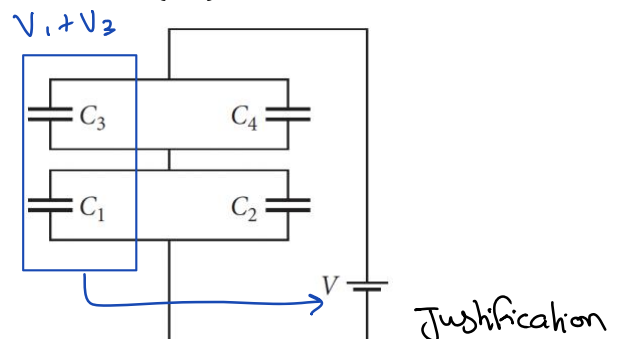
The potential difference across capacitor C_4 is V_4 .

The charge stored in capacitor C_1 is q_1 .

The charge stored in capacitor C_2 is q_2 .

The charge stored in capacitor C_3 is q_3 .

The charge stored in capacitor C_4 is q_4 .



* If you're unsure,
plug some numbers
in & check.

Equations	True/ False
$q_1 = q_3$	False
$V_1 + V_2 = V$ V_{12} in series	False
$q_1 + q_2 = q_3 + q_4$	True
$V_1 + V_2 = V_3 + V_4$	False
$V_1 + V_3 = V$	True

$q = CV$ — different — different
 V_{12} becomes a series component & capacitors in series don't have same V as battery
 In series $q_{total} = q_{12} = q_{34}$
 & q_{12} and q_{34} become series components
 They have different capacitances, therefore the voltage $V_{12} \neq V_{34}$ but
 $V_{12} + V_{34} = V_{battery}$
 $V_1 = V_2$ and $V_3 = V_4$
 So even $V_1 + V_4 = V$

10. The figure shows a circuit with $V = 12.0 \text{ V}$, $C_1 = 500 \text{ pF}$ and $C_2 = 500 \text{ pF}$.

a. The switch is closed, to A, and the capacitor, C_1 is fully charged. Find,

i. The charge delivered to the capacitor.

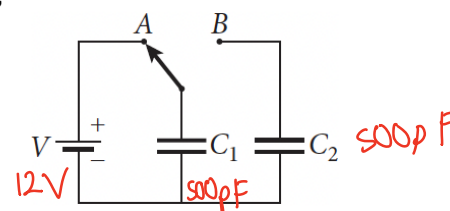
$$Q = CV = 500(12) = 600 \text{ pC}$$

ii. the energy delivered by the battery

$$u = q\Delta V = (600 \text{ pC})(12) = 7200 \text{ pJ}$$

iii. the energy stored in C_1 .

$$u = \frac{1}{2} CV^2 = \frac{1}{2} (500 \text{ pF})(12)^2 = 36000 \text{ pJ}$$



b. Then the switch is thrown to B and the circuit is allowed to reach equilibrium. Which of the statements below are true? Tick the appropriate box.

☒ The potential difference across C_1 is equal to the potential difference across C_2

☐ The potential difference across C_1 is more than the potential difference across C_2

☐ The potential difference across C_1 is less than the potential difference across C_2

Q

11. When a capacitor has a charge of magnitude $60.0 \mu\text{C}$ on each plate, the potential difference across the plates is 12.0 V .

✓

a. What is the capacitance of the capacitor?

$$C = \frac{Q}{V} = \frac{60 \times 10^{-6}}{12} = 5 \times 10^{-6} \text{ F or } 5 \mu\text{F}$$

b. How much energy is stored in this capacitor when the potential difference across its plates is 120 V ?

$$U = \frac{1}{2} CV^2 = \frac{1}{2} (5 \times 10^{-6}) (120)^2 = 0.036 \text{ J}$$