PHYSICS

BOOKS - RESNICK AND HALLIDAY PHYSICS (HINGLISH)

CAPACITANCE

Sample Question

1. In Fig. 25-7a switch S is closed to connect the uncharged capacitor of capacitance C $=0.25\mu F$ to the battery of potential difference V=12V. The lower capacitor plate has thickness L=0.50 cm and face area A$=2.0 \times 10^{-4} m^2$ and it consists of copper in which the density of conduction electrons is $n = 8.49 \times 10^{25}$ electrons/m^3. From what depth d within the plate (Fig.25-7b) must electrons move to the plate face as the capacitor becomes charged?

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2. Find the equivalent capacitance for the combination of capacitances shown in fig.25-10a, across which potential difference V is applied . Assume

(a) $C_1 = 12.0\mu F, C_2 = 5.30\mu F \text{ and } C_3 = 4.50\mu F$

(b) The potential difference applied to the input terminals in fig.25-10a is V=12.5V What is the charge on C_1?

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3. A capacitor C_1 is charged to a p.d.V. The charging battery is then removed and the capacitor is connected to an uncharged capacitor C_2. The final p.d. across the combination is

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4. AN isolated conducting sphere whose radius R is 6.85 cm has a charge q=1.25 nC

(a) How much potential energy is stored in the electric field of this charged conductor?

(b) What is the energy density at the surface of the sphere?

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5. A capacitor of capacitance C is charged by connecting it to a battery of emf epsilon. The capacitor is now disconnected and reconnected to the battery with the polarity reversed. Calculate the heat developed in the connecting wires.

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6. A parallel plate capacitor whose capacitance C is $13.5pF$ is charged by a battery to a potential difference V=12.5V between its plates. The charging battery is now disconnected, and a porcelain slab (k=6.50) is slipped between the plates.

(a) What is the potential energy of the capacitor before the slab is inserted?

(b) What is the potential energy of the capacitor slab device after the slab is inserted?

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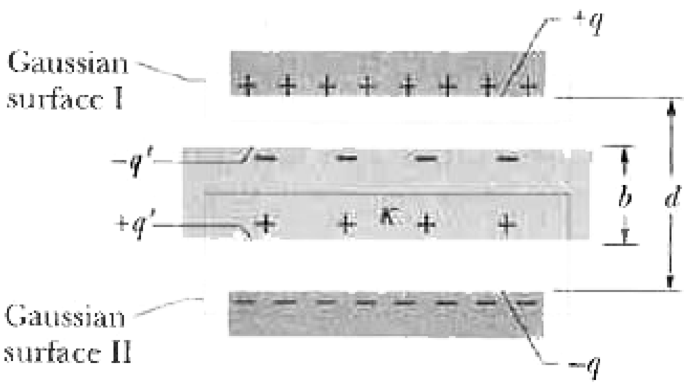
7. Figure 25-22 shows a parallel plate capacitor of plate area A and plate separation d. A potential difference V_0 is applied between the plates by connecting a battery between them. The battery is then disconnected and a dielectric slab of thickness b and dielectric constant k is placed between the plates as shown.

Assume

$A = 115cm^2, d = 1.2cm, V_0 = 85.5V, b = 0.780cm$ and $k = 2.61$

What is the capacitance C_0 before the dielectric slab is inserted?

(b) What free charge appears on the plates?



(c) What is the electrci field E_0 in the gaps between the plates and teh dielectric slab?

(d) What is the electric field E_1 in the dielectric slab?

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Checkpoints

1. Does the capacitance C of a capacitor increase , decrease or remain the same (a) when the charge q on it is doubled and (b) when the potential difference V across it is tripled?

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2. For capacitors charged by the same battery, does the charge stored by the capacitor increase , decrease or remain the same in each of the following situations? (a) the plate separation of a parallel plate capacitor is increased b) the radius of the inner cylinder capacitor is increased (c) the radius of the outer spherical shell of a capacitor is increased.

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3. A battery of potential V stores charge q on a combination of two identical capacitors. What are the potential difference across the end the charge or either capacitors if the capacitors are (a) in parallel and (b) in series?

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4. In a cylindrical capacitor , if the potential difference is too great, dielectric breakdown will occur. Will such breakdown begin near the inner or the outer conductor why?

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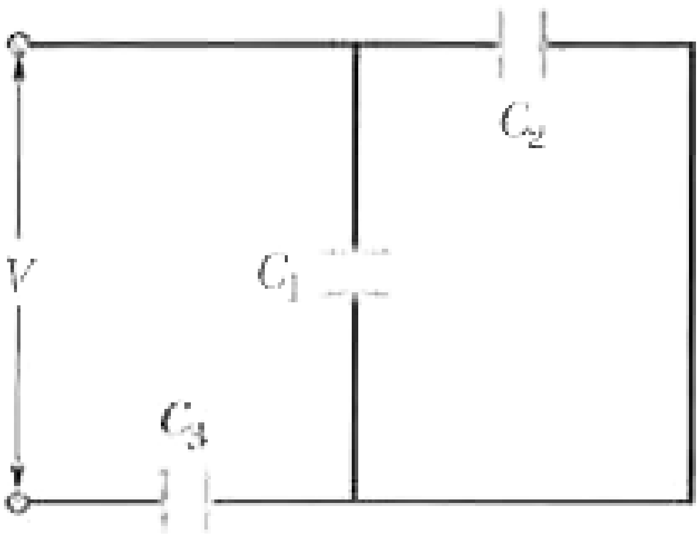
Problems

1. In Fig. 25-25 $C_1 = 10.0\mu F, C_2 = 5.0\mu F$ and $C_3 = 4.0\mu F$ What is the change in their equivalent capacitance if (a) capacitors 1 and 2 are interchanged and (separately) (B) capacitors 1 and 3 are interchanged?



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2. In Fig. 25-25 a potential difference V=75.0 V is applied across a capacitor arrangement with capacitances

$C_1 = 10.0 \mu F, C_2 = 5.00 \mu F,$ and $C_3 = 15.0 \mu F$. What are (a) charge q_3 (b) potential difference V_3 and (c) stored energy U_3 for capacitor 3, (d) q_1 (e) V_1 and $(f) U_1$ for capacitor 1, and (g) $q_2 (h) V_2$ and (i) U_2 for capacitor 2?

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3. In fig.25-25 a potential arrangement with capacitances applied across a capacitor arrangement with capacitances $C_1 = 10.0 \mu F, C_2 = 5.00 \mu F,$ and $C_3 = 4.00 \mu F$. IF capacitor 3 undergoes electrical breakdown so that is becomes equivalent to conducting wire, then for capacitor 1 what are the increase in (a) charge, (b) potential difference, and (c) stored energy

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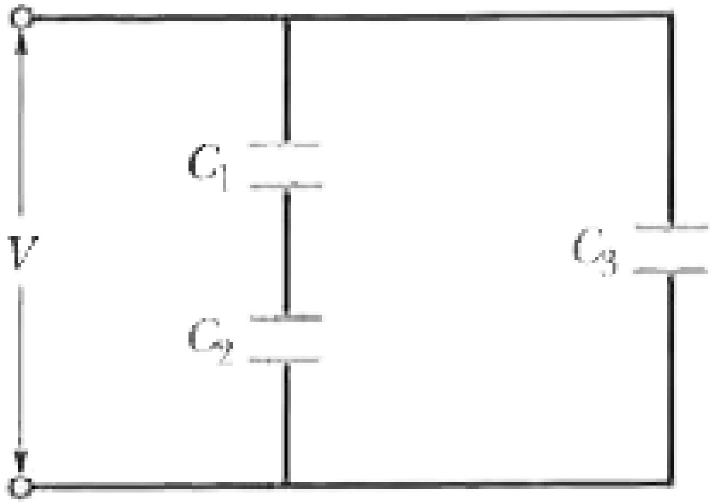
4. In Fig, 25-26 , find the equivalent capacitance of the combination. C_1 is $10.0\mu F$, C_2 is $8.00\mu F$, and C_3 is $4.00\mu F$



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5. What capacitance is required to store an energy of 10kW.h at a potential difference of 1700V?

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6. In Fig.25-25 a potentila difference V=100V is applied across a capacitor arragnement with capacitances $C_1 = 10.0\mu F, C_2 = 5.00\mu F$ and $C_3 = 2.00\mu F$ What are (a) charge q_3, (B) potential difference V_3 and (c) stored energy U_3 for capacitor 3 (d) q_1 (v) v_1 and (f) U_2 for capacitor 1, and (g) $q_3(h)V_2$ and (i) U_2 for capacitor 2?

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7. A parallel plate capacitor has plates of area $0.080m^2$ and a separation of 1.2 cm . A battery charges the plates to a potential difference of 120V and is then disconnected . A dielectric slap of thickness 4.0mm and dielectric constant 4.8 is then placed symmetrically between the plates (a) What is the capacitance with the slab in place ? What is the free charge q (c) before and (d) after the slap is inserted ? What is the magnitude of the electric field (e) in the space between the plates and dielectric and (f) in the electric itself? (g) with the slab in place, what is the potential difference across teh plates (h) How much external work is involved in inserting the slab?

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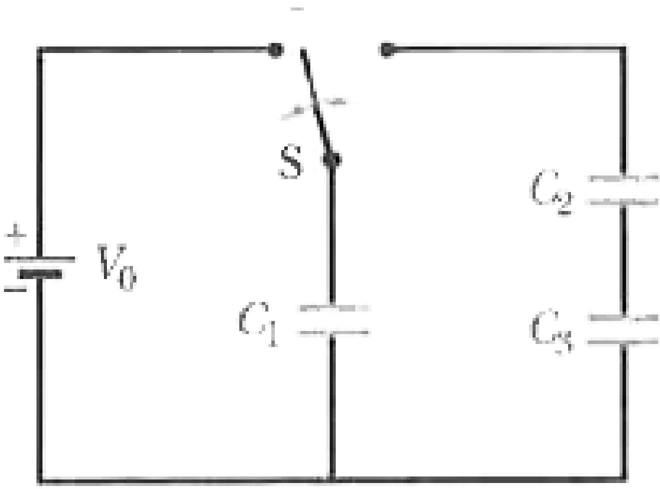
8. Figure 25-27 displays a 16.0 V battery and 3 uncharged capacitors of capacitances $C_1 = 4.00\mu F, C_2 = 6.00\mu F$ and $C_3 = 3.00\mu F$ The switch is thrown to the left side until capacitor 1 is fully charged. Then the switch is thrown to the right. What is the final charge on (a) capacitor 1, (b) capacitor 2 and (c) capacitor 3?



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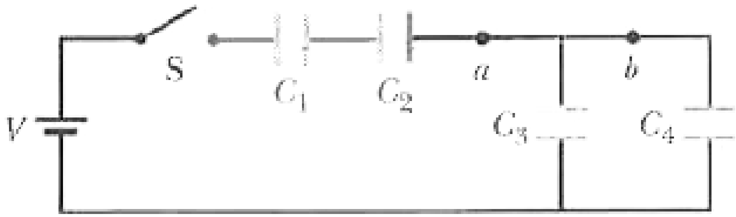
9. In fig 25-28, the battery has potential difference V=14.0 V $C_2 = 3.00 \mu F, C_4 = 4.00 \mu F$ and all the capacitors are initially uncharged, when switch S s closed, a total charge of $12 \mu C$ passes through point a and a total change of $8.0 \mu C$ passes through point b. What are (a) C_1 and (b) C_3?



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10. A parallel plate air filled capacitor having area $40cm^2$ and plate spacing 1.0 mm is charged to a potential difference of 500V. Find (a) the capacitance, (b) the magnitude of the charge on each plate (c) the stored energy, (d) the electric field between the plates and (e) the energy density between the plates.

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11. A dielectric material is to fill the space in a capacitor Initially, with only air in place, the capacitance is $8.0\mu F$ With the dielectric material in place, the capacitor should store $3.2\mu J$ at a maximum potential difference of 350.8V. (a) What dielectric constant is required? (b) Of the materials in Table 25-1, which material should be used?

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12. AN air filled parallel plate capacitor has a capacitance of 2.1 pF. The separation of the plates is doubled, and wax is inserted between them . The new capacitance is $2.6pF$ Find the dielectric constant of the wax.

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13. A $2.0\mu F$ capacitor and a $4.0\mu F$, capacitor are connected in parallel across in 300V potential difference (a) What is the total energy stored by them? (b) They are next connected in series across that potential difference. What is the ratio of the total energy stored by them in the parallel arrangement to that in the series arrangement?

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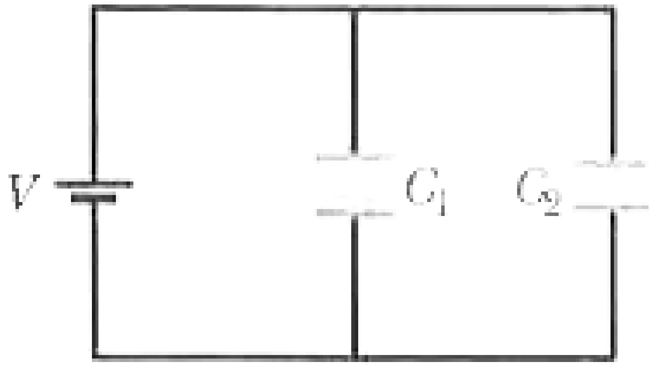
14. In fig25-29, how much charge is stored on the parallel-plate capacitors by the 10.0 V battery? One is the filled with air, and the other the filled with a dielectric for which k=3.00,both capacitors have a plate area of $5.00 \times 10^{-3} m^2$ and a plate separation of 2.00 mm.



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15. Assume that a stationary electron is a point of charge . What is the energy density u of its electric field at radial distances (a) r=1.00 mm, (b) r=1.00 μm (c) r=1.00 nm (d) r=1.00 pm, and (e) r=1.00 fm (f) What is the u in the limit as $r \to 0$?

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16. You are asked to construct a capacitor having a capacitance near 1 n F and a breakdown potential in excess of 10,000 V. You think of using the sides of a tail pyrex drinking glass as a dielectric lining the inside and outside curved surfaces with aluminium foil to act as the plates. The glass is 10cm tall with an inner radius of 3.6 cm and an outer radius of 3.8 cm What are the (a) capacitance and (b) breakdown potential of this capacitor?

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17. The parallel plates in a capacitor, with a plate area of $8.50 cm^2$ and an air filled separation of 8.00 mm are charged by a 16.0 battery . Then are then disconnected from the battery and pushed together (without discharge) to a separation of 3.00 mm. Neglecting fringing the (a) the potential difference between the plates (b) the initial stored energy (c) the final stored energy and (d) the (negative) work is pushing them together.

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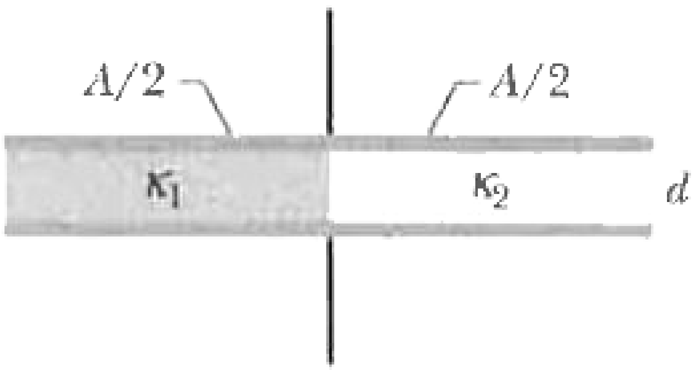
18. Figure 25-30 shows a parallel plate capacitor with a plate area $A = 5.56 cm^2$ separation d=5.56 mm. The left half of the gap is filled with material of dielectric constant $k_1 = 7.00$, the right half is filled with material of dielectric constant $k_2 = 10.0$ what is the capacitance?



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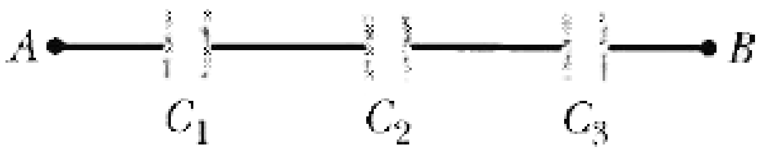
19. In fig 25-31 $C_1 = 10.0\mu F$, $C_2 = 20.0\mu F$ and $C_3 = 5.00\mu F$ If no capacitor can withstand a potential difference of more than 100V without failure , what are (a) the magnitude of the maximum potential difference that can exist between points A and B and (b) the maximum energy that can be stored in the three capacitor arrangement?



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20. A coaxial cable used in transmission line has an inner radius of 0.10 mm and an outer radius of 0.40mm. Calculate the capacitance per meter for the cable. Assume that the space between the conductors is filled with epoxy resin with dielectric constant 3.6.

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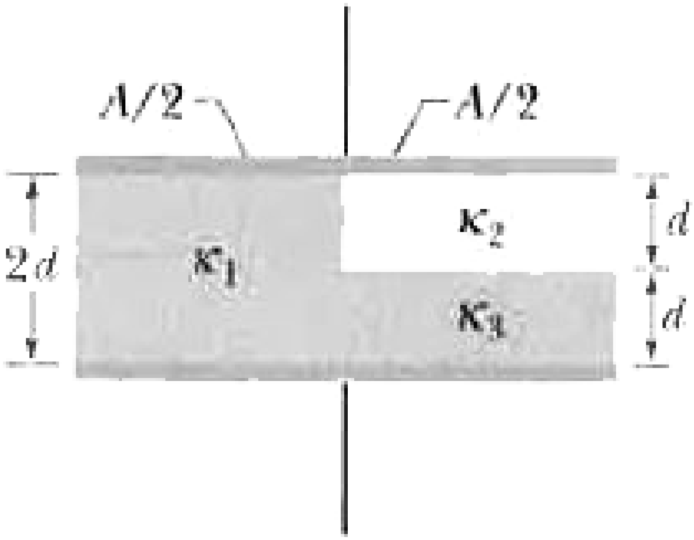
21. Figure 25-32 shows a parallel plate capacitor of plate area $A = 12.5 cm^2$ and plate separation 2d=7.12mm. The left half of the gap is filled with material of dielectric constant $k_1 = 21.0$ the top of the right half is filled with material of dielectric constant $k_2 = 42.0$ the bottom of the right half is filled with material of dielectric constant $k_3 = 58.0$ What is the capacitance?



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22. A parallel plate capacitor has square plates with ege length 8.20 cm and 1.30 mm separation. (a) Calculate the capacitance. (b) Find the charge for a potential difference of 120V.

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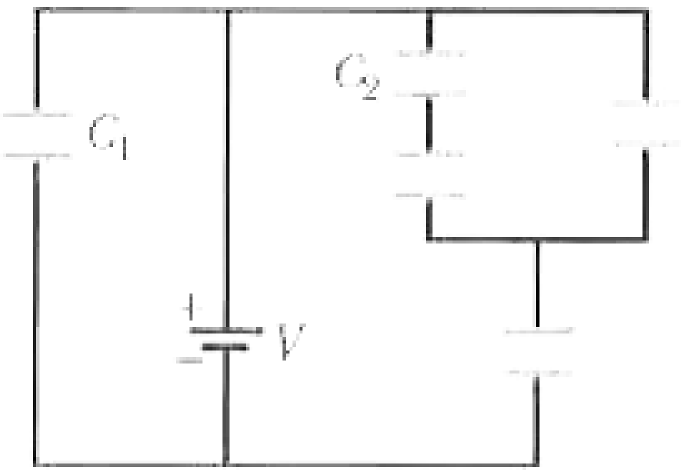
23. In Fig 25-33 the battery has a potential difference of V=12.0 V and the five capacitors each have a capacitance each have a capacitance of $10.0\mu F$ What is the charge on (a) capacitor 1 and (b) capacitor 2?



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24. A parallel plate air filled capacitor has a capacitance of 50 pF. (a) IF each of its plates has an area of $0.30m^2$ What is the separation (b) IF the region between the plates is now filled with material having $k = 5.6$ What is the capacitance.

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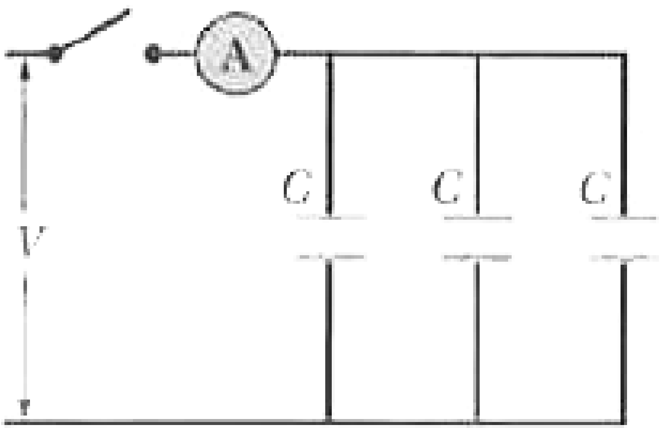
25. Each of the uncharged capacitors in Fig 25-34 has a capacitance of $25.0 \mu F$. A potential difference of V=750 V is established when the switch is closed . How many coulombs of charge then pass through meter A?



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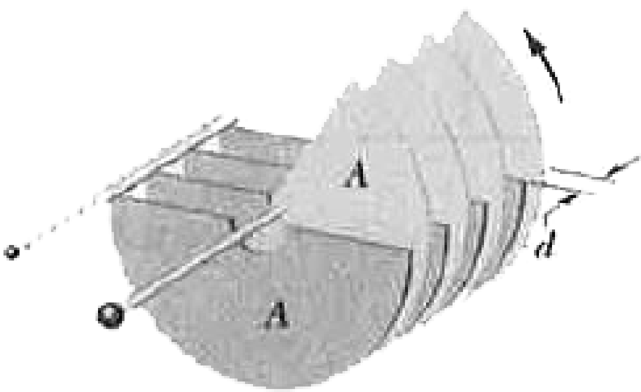
26. Figure 25-35 shows a variable "air gap" capacitor for manual training Alternate plates are connected together, one group of plates is fixed in position, and the other group is capable is rotation. Consider a capacitor of n=8 plates of alternating polarity, each plate having area $A = 1.50cm^2$ and separated from adjacent plates by distance d=3.40mm. What is the maximum capacitance of the device?



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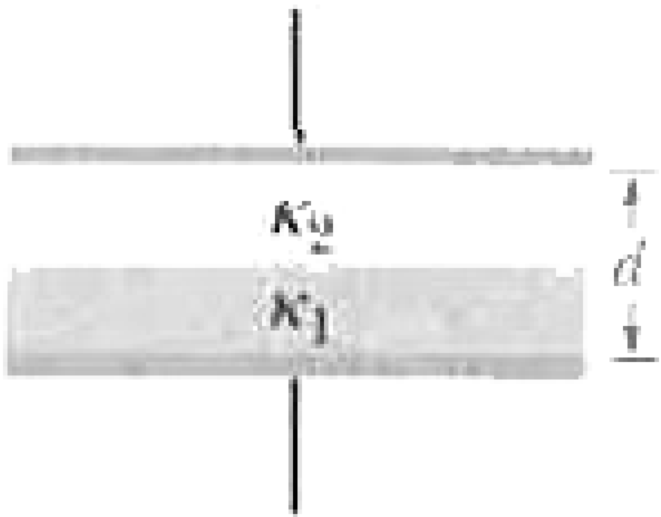
27. Figure 25-36 shows a parallel plate capacitor with a plate area $A = 789cm^2$ and plate separation d=4.62 mm. The top half of the gap is filled with material of dielectric constant $k_1 = 11.0$, the bottom half is filled with material of dielectric constant $k_2 = 4.0$ What is the capacitance?



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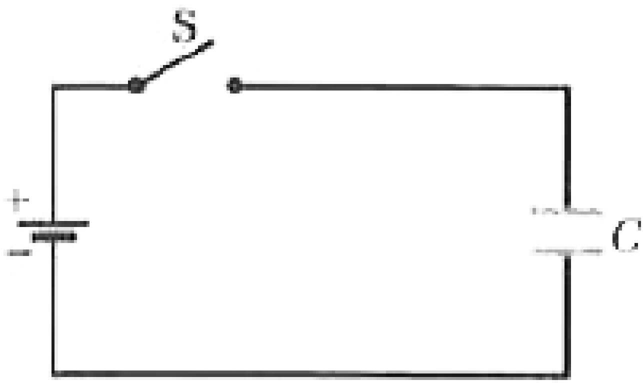
28. Two capacitor in Fig 25-37 has a capacitance of $30\mu F$ and is initially uncharged. The battery provides a potential difference of 120 V. After switch S is closed, how much charge will pass through it?



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29. Two parallel plate capacitors $8.0\mu F$ each , are connected in parallel to a 10V battery. One of the capacitors is then squeezed so that its plate separation is 50.0% of its initial value. Because of the squeezing, (a) how much additional charge is transferred to the capacitors by the battery and (b) what is the increase in the total charge stored on the capacitors?

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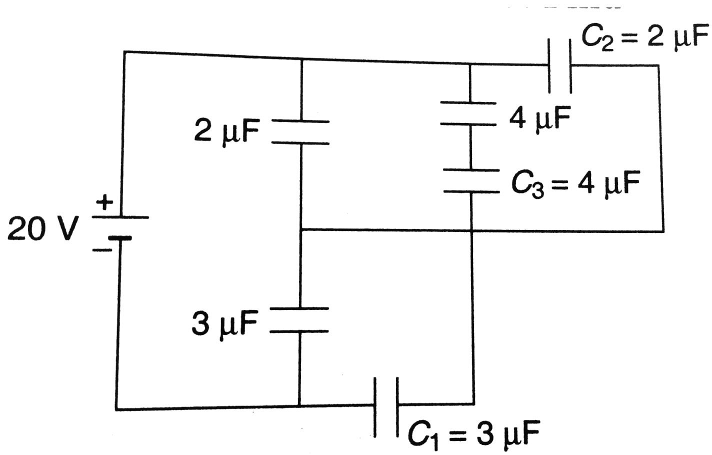
30. In figure the battery has a potential difference of $20V$. Find



(a) the equivalent capacitance of all the capacitors across the battery and

(b) the charge stored on that, equivalent capacitance. Find the charge on

(c) capacitor 1,

(d) capacitor 2, and

(e) capacitor 3.

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31. A certan substance has a dielectric constant of 5.6 and a dielectric strength of $18mV/m$. IF it is used as the dielectric material in a parallel plate capacitor. What minium area should the plates of the capacitor have to obtain a capacitance of $3.9 \times 10^{-2} \mu F$ and to ensure that the capacitor will be able to withstand a potential difference of 4.0 kV?

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32. For the arrangement of Fig 25-22 suppose, that the battery remains connected while the dielectric slab is being introduced.

Calculate (a) the capacitance (b) the charge on the capacitors plates (c) the electric field in the gap and (d) the electric field in the slab after the slab is in place.

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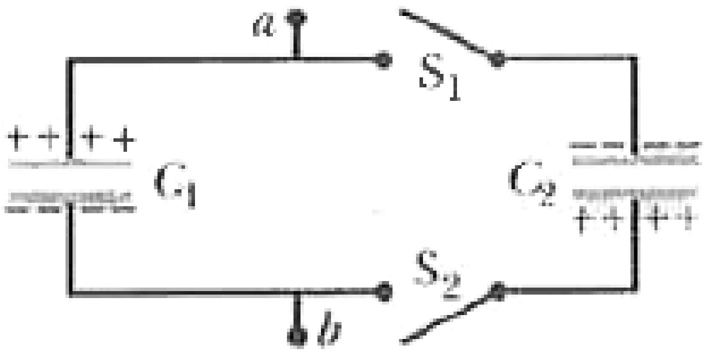
33. In fig 25-39 the capacitances are $C_1 = 1.0\mu F$ and $C_2 = 3.0\mu F$ and both capacitors are charged to a potential difference of V=200V but with opposite polarity as shown. Switches S_1 and S_2 are now closed. (a) What is the now the potential difference between points a and b? What now is the charge on capacitor (b) 1 and (c) 2?



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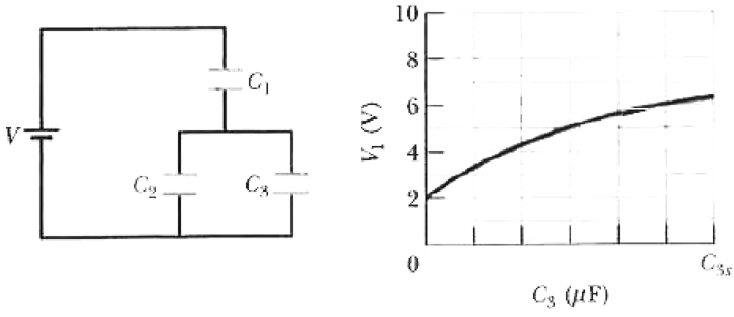
34. Capacitor 3 in Fig. 25-40a is a variable capacitor (its capacitance C_3 can be varied) Figure 25-40b gives the electric potential V_1 across capacitor 1 versus C_3 The horizontal scale is set by $C_3s = 12.0 \mu F$ Electric potential V_1 approaches as asymptote of 8.0 V as $C_3 \to \infty$ What are (a) the electric potential V across the battery , (b) C_1 and (c) C_2?



(a) (b)

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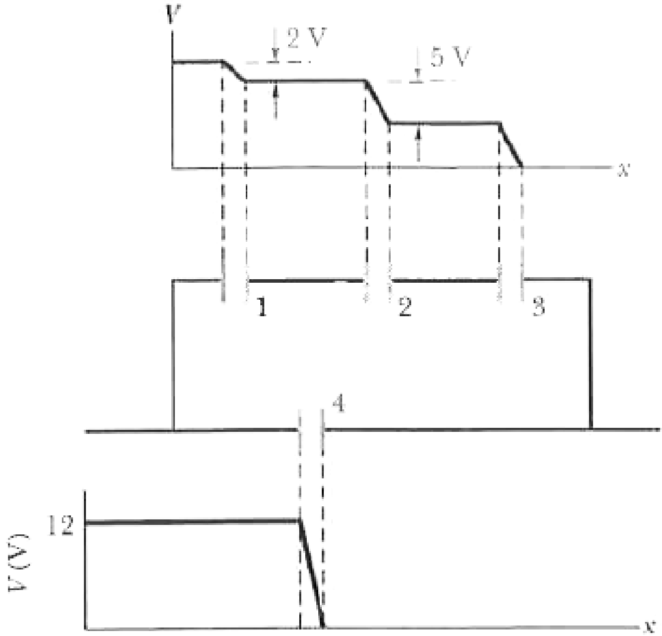
35. Figure 25-41 shows a circuit section of four air filled capacitors that is connected to a larger circuit. The graph below the section shows the electrin potential V(x) as a function of position x along the lower part of the section, through capacitor 4. Similarly the graph above the section shows the electric potential V(x) as a function of position x along the upper part of the section, through capacitors 1,2 and 3 capacitors 3 has a capacitance of $1.60\mu F$ What are the capacitances of (a) capacitor 1 and (b) capacitor 2?



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36. A charged isolated metal sphere of diameter 15cm has a potential of 6500V relative to V=0 at infinity. (a) calculate the energy density in the electric field near the surface of the sphere. (b) IF the diameter is decreased, does the energy density near the surface increase, decrease or remain the same?

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37. Two parallel plates of area $100cm^2$ are given charges of equal magnitudes of8.4×10^{-7} C but opposite signs. The electric field within the dielectric material filling the space between the space is $1.4 \times 10^6 V/m$ (a) Calculate the dielectric constant of the material. (b) Determine the magnitude of the charge induced on each dielectric surface.

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38. What is the capacitance of a drop that results when two mercury spheres, each of radius R=3.00 mm merge?

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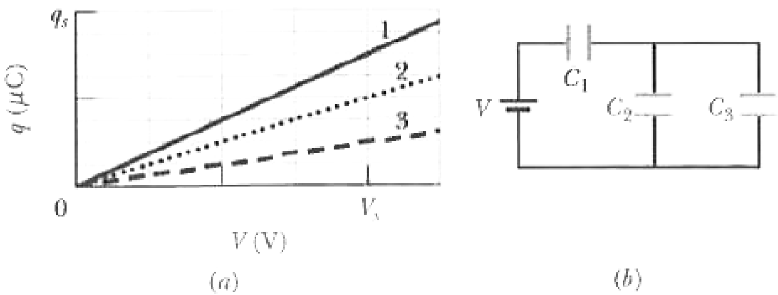
39. Plot 1 in fig25-42a gives the charge q that can be stored on capacitor 1 versus the electric potential V set up across it. The vertical scale is set by $q_s = 16.0 \mu F$ and the horizontal scale is set by $V_S = 2.0 V$ Plots 2 and 3 are similar plots for capacitors 2 and 3 respectively. FIgure 25-42b shows a circuit that whose three capacitors and a 10.0V battery.What is the charge stored on capacitor 2 in that circuit?



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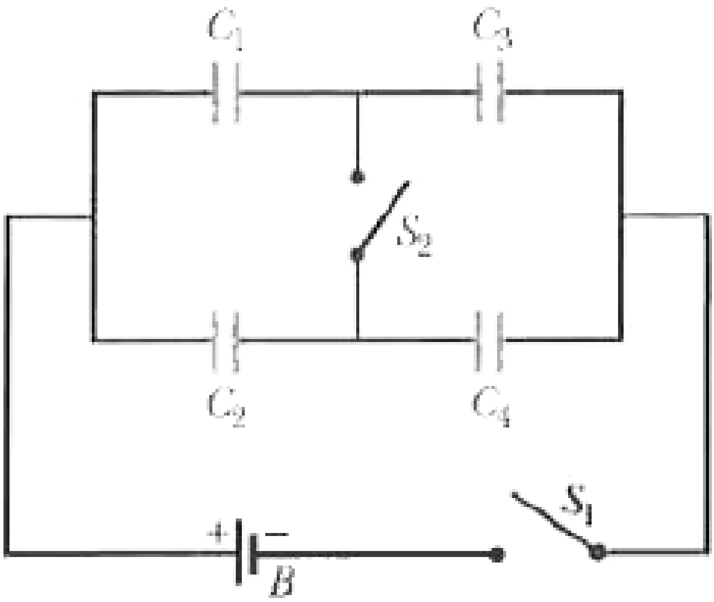
40. Figure 25-43 shows a 24.0 V battery and four uncharged capacitors of capacitances

$C_1 = 1.00 \mu F, C_2 = 2.00 \mu F C_3 = 3.00 \mu F$ and $C_4 = 4.00 \mu F$

IF only switch S_1 is closed, what is the charge, on (a) capacitor 1 (b) capacitor 2 (c) capacitor 3 and (d) capacitor 4? IF both switches are enclosed , what is the charge on (e) capacitors1.(f) capacitor 2, (g) capacitor 3, and (h) capacitor 4?



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41. How many $12.5 \mu F$ capacitors must be connected in parallel to store a charge of 33.0m C with a potential of 110V across the capacitors?

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42. The space between two concentric conducting spherical shells of radii b=1.70 cm and a=1.20 cm is filled with a substance of dielectric constant k=6.91 A. A potential difference V=73.0 V is applied across the inner and outer shells Determine (a) the capacitance of the device (b) the free charge q on the inner shell, and (c) the charge q induced along the surface of the inner shell?

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43. You have two flat metal plates, each of area $1.00m^2$ with which to construct a parallel plate capacitor (a) If the capacitance of the device is to be 2.00F what must be the separation between the plates? (b) could this capacitor actually be constructed?

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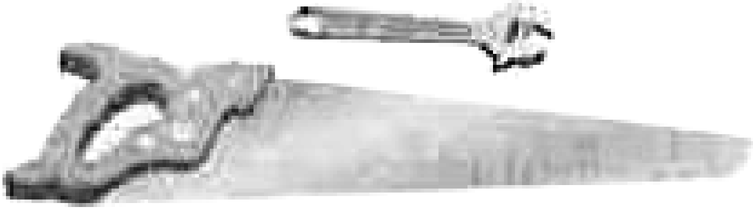
44. The two metals objects in Fig 25-44 have net charges of +70pC and -70pC which result in a 35V potential difference between them (a) What is the capacitance of the system? (b) If the charges are changed to +200pC and -200pC, what does the capacitance become ? (c) what does the potential difference become?



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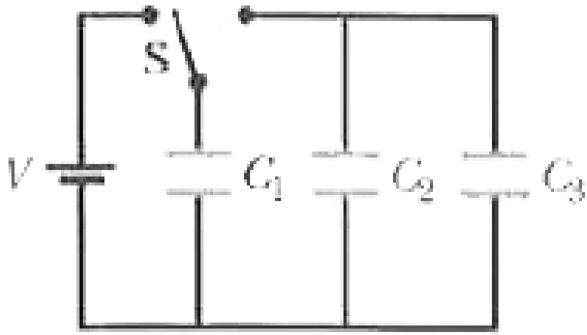
45. In fig.25-45 V=12V $C_1 = 10\mu F$ and $C_2 = C_3 = 20\mu F$ Switch S in first thrown to the left side until capacitor 1 reaches equilibrium. Then the switch is thrown to the right when equilibrium is again reached, how must charge is on capacitor 1?



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46. A 100pF capacitor is charged to a potential difference of 80.0V and the charging battery is disconnected. The capacitor is then connected in parallel with a second capacitor. If the potential difference across the first capacitor drops to 35.0 V what is the capacitance of this second capacitor?

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47. The plates of a spherical capacitor havi radii 37.0mm and 40.00 mm (a) calculate the capacitance. (b) What must be the plate area of a parallel plate capacitor with the same plate separation and capacitance?

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48. In fig.25-46 two parallel plate capacitors (with air between the plates) are connected to a battery. Capacitor 1 has a plate area of $1.5cm^2$ and an electric field of magnitude $3500V/m$. Capacitor 2 has a plate area of $0.70cm^2$ and an electric field of magnitude $1500V/m$ (a) What is the total charge on the two capacitors? (b) If the first plate area is cut in half does the total charge increase, decrease, on remain the same?

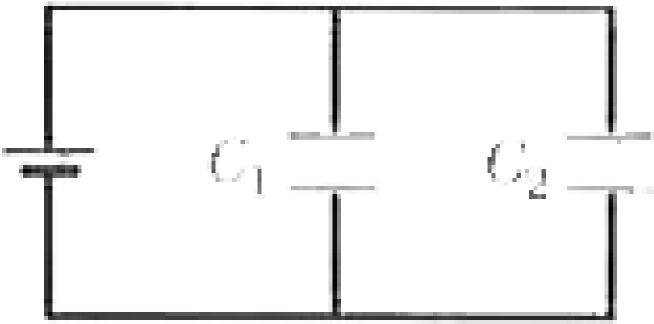

Figure 25-45
Problem 48.

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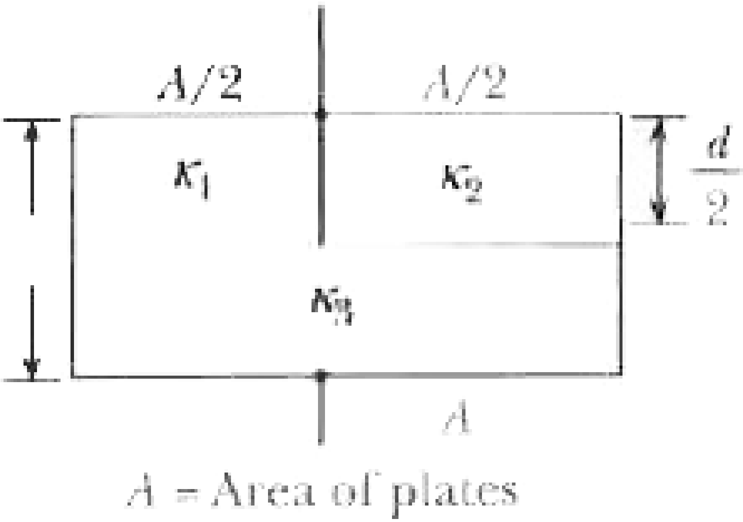
Practice Questions Single Correct Choice Type

1. A parallel plate capacitor of area A, plate separation d and capacitance C is filled with three different dielectric materials having dielectric constants $k_1 k_2$ and k_3 as shown in the following figure. If a single dielectric material is to be used to have the same capacitance C in this capacitor then its dielectric constant k is given by



A. $\frac{1}{k}=\frac{1}{k_1}+\frac{1}{k_2}+\frac{1}{2k_3}$

B. $\frac{1}{k}=\frac{1}{k_1+k_2}+\frac{1}{2k_3}$

C. $k=\frac{k_1k_2}{k_1+k_2}+2k_3$

D. $k=\frac{k_1k_3}{k_1+k_3}+\frac{k_2k_3}{k_2+k_1}$

Answer: B

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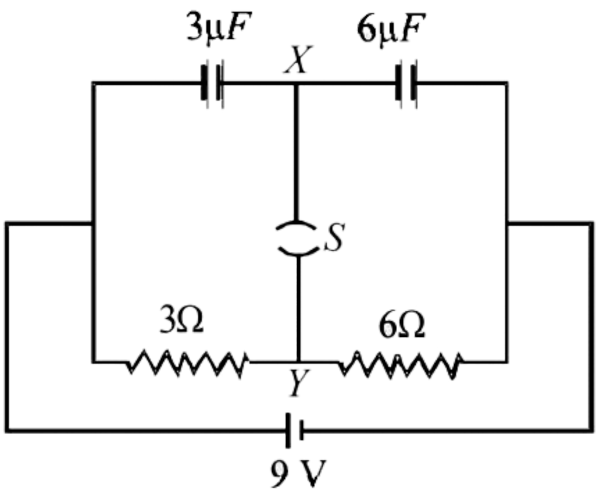
2. A circuit is connected as shown in the figure with the switch S open. When the switch is closed, the total amount of charge that flows from Y to X is



A. 0

B. $54\mu C$

C. $27\mu C$

D. $81\mu C$

Answer: C

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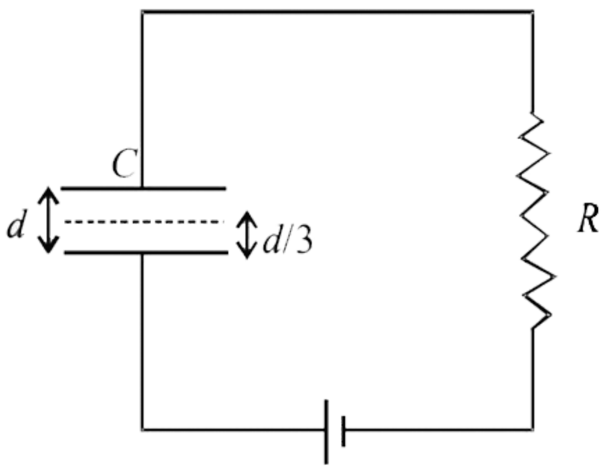
3. A parallel plate capacitor C with plates of unit area and separation d is filled with a liquid of dielectric constant $K = 2$. The level of liquid is $d/3$ initially. Suppose the liquid level decreases at a constant speed v, the time constant as a function of time t is-



A. $\frac{6\varepsilon R}{5d + 3vt}$

B. $\dfrac{(15d+9vt)\varepsilon_0 R}{2d^2-3dvt-9v^2t^2}$

C. $\dfrac{6\varepsilon_0 R}{5d-3vt}$

D. $\dfrac{(15d-9vt)\varepsilon_0 R}{2d^2-3dvt-9v^2t^2}$

Answer: A

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4. What is the capacitance of a spherical conductor with radius 1 m?

A. 1.1×10^{-10}

B. 10^{-6}

C. 9×10^{-9}

D. 10^{-3}

Answer: A

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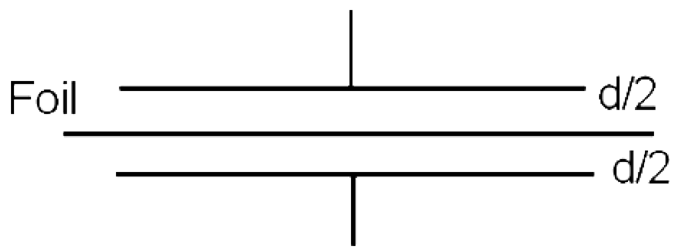
5. A sheet of aluminium foil of negligible thickness is placed between the plates of a capacitor of capacitance C as shown in the figure then capacitance of capacitor becomes



A. Decreases

B. Remains unchanged

C. Becomes infinite

D. Increases

Answer: B

Watch Video Solution

6. The plate areas and plate separation of five parallel plate capacitors are

Capacitor 1: Area A_0, separation d_0

Capacitor 2: Area $2A_0$, separation d_0

Capacitor 3: Area $2A_0$, separation $d_0/2$

Capacitor 4: Area $A_0/2$ separation $2d_0$

Capacitor 5: Area A_0, separation $d_0/2$

Rank these according to their capacitances, least to greatest

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7. Electric potential difference between the positive plate and halfway point between the two parallel plates of a fully charged capacitor is

A. Zero

B. One half of the total potential difference between the two plates

C. One quarter of the total potential difference between the two plates

D. None of the above

Answer: B

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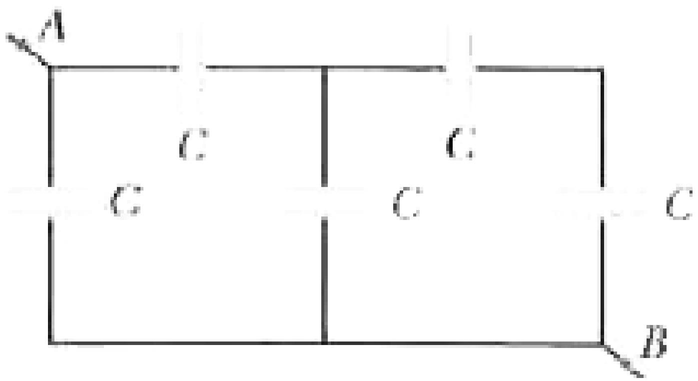
8. What is the equivalent capacitance of the system of capacitors between A and B as shown in the following figure.



A. 1C

B. 1.6C

C. C

D. None of these

Answer: B

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9. How many different capacitances can you produce using three capacitors if you have all three connected in the circuit each time?

A. 5

B. 6

C. 7

D. 8

Answer: D

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10. Two capacitors with C_A greater than C_B and are connected in series with a battery. Which of the following is true?

A. There is move charge stored on C_A

B. There is more charge stored on C_B

C. There is the same charge stored on each capacitor

D. There is the same potential difference across both capacitors

Answer: C

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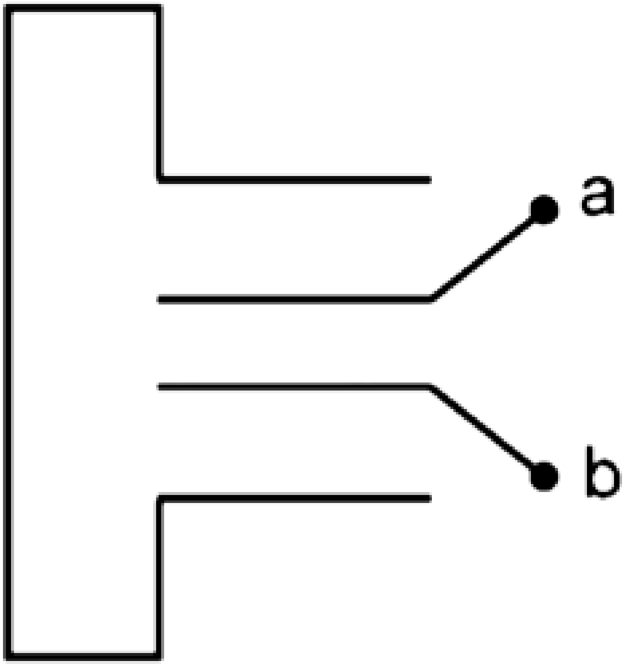
11. Four metallic plates each with a surface area A of one side and placed at a distance d from each other. the plates are connected as shown in the fig. Then the capacitance of the system between a and b is -



A. $\frac{\varepsilon_0 A}{d}$

B. $\frac{2\varepsilon_0 A}{d}$

C. $\frac{3\varepsilon_0 A}{d}$

D. $\frac{4\varepsilon_0 A}{d}$

Answer: B

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12. Two capacitors of capacitances $2\mu F$ and a $1\mu F$ are connected in series and charged from a battery. They store charges P and Q respectively. When disconnected and charged separately using the same battery, they have charges R and S respectively, then

A. $R > S > Q = P$

B. $P > Q > R = S$

C. $R > P = Q > S$

D. $R = P > S = Q$

Answer: A

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13. You have five capacitors To store maximum amount of energy when using a source with terminal voltage V.

A. You need to connect them all in series

B. You need to connect them all in parallel

C. You need to connect three capacitors in parallel and the rest in series with that combination

D. You need to connect two capacitors in parallel and the rest in series with that combination

Answer: B

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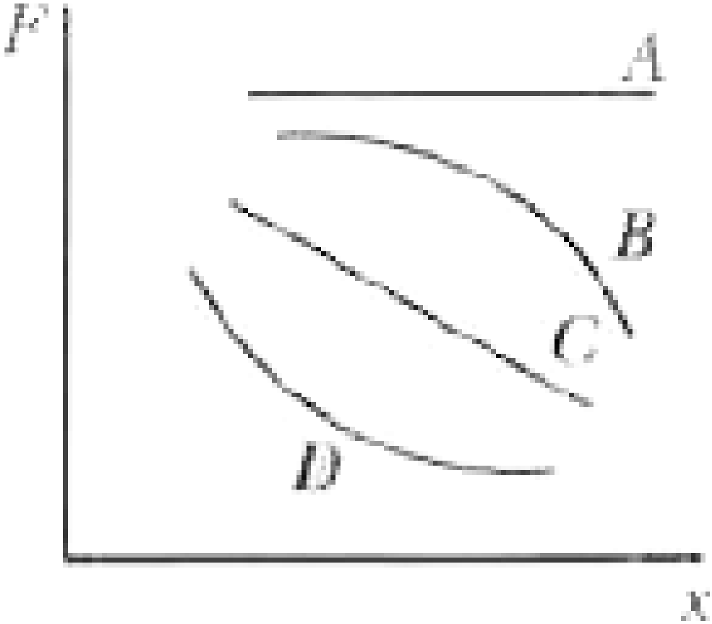
14. Which of the following graph in the following figure correctly represents the force between plates of an isolated charged parallel plate capacitor with distance x between them.



A. A

B. B

C. C

D. D

Answer: A

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15. Consider an isolated capacitor made of two parallel metallic plate separated by a distance d. the top plate has a surface change density of $-\sigma$. A slab of metal of thickness $l < d$ is inserted between the plates. Not touching either plates. Upon insertion of the metal slab, the potential different between the plates

A. Increase

B. Decreases

C. Remains the same

D. Become zero

Answer: B

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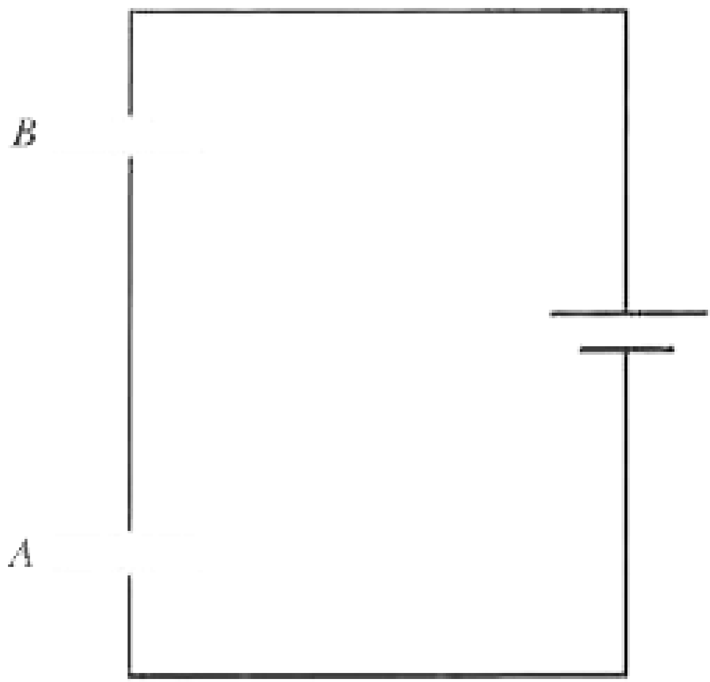
16. Two identical capacitors are connected as shown in the following figure. If a dielectric slab is inserted in B, choose correct statement



A. Energy of both capacitors will increase

B. Energy of both capacitors will decrease

C. Energy of A will increase but B will decrease

D. Energy of B will increase but A will decrease

Answer: C

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17. A parallel plate capacitor is charged completely and then disconnected from the battery. IF the separation between the plates is reduced by 50% and the space between the plates if filled with a dielectric slab of dielectric constant 10, then the potential difference between the plates

A. Decrease by 95%

B. Increase by 95%

C. Decrease by 50%

D. Increases by 50%

Answer: A

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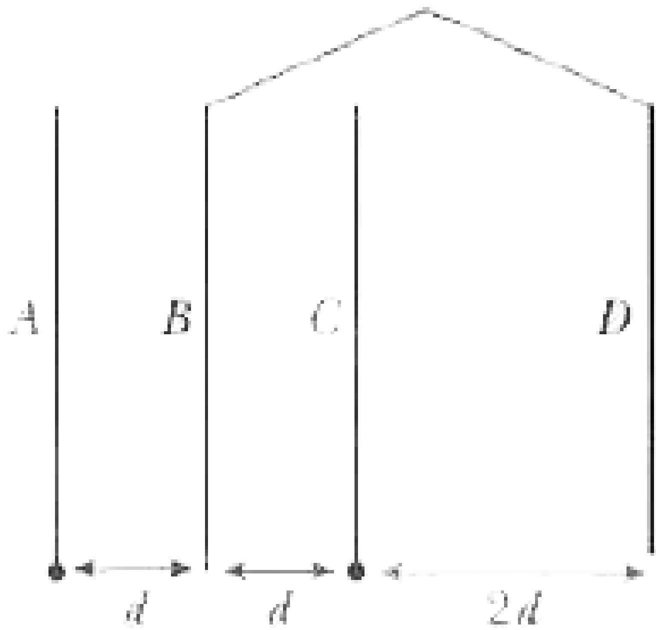
18. Four square plates, each with edge length a, are arranged as shown in the following figure. The equivalent capacitance between A and C is



A. $\dfrac{3\varepsilon_0 a^2}{5d}$

B. $\dfrac{3\varepsilon_0 a^2}{2d}$

C. $\dfrac{2\varepsilon_0 a^2}{3d}$

D. $\dfrac{5\varepsilon_0 a^2}{3d}$

Answer: A

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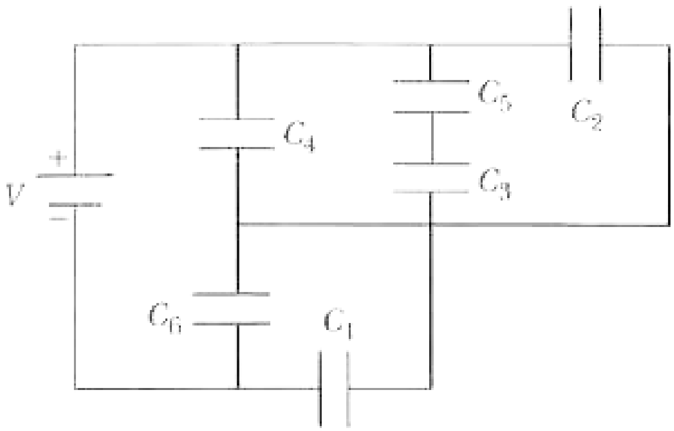
19. What is the equivalent capacitance of the capacitors in the following figure?

Given that

$C_1 = C_6 = 3\mu F$ and $C_3 = C_5 = 2C_2 = 2C_4 = 4\mu F$



A. $4.5\mu F$

B. $1.5\mu F$

C. $2\mu F$

D. $3\mu F$

Answer: D

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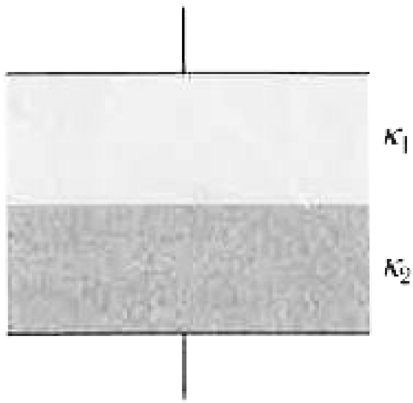
20. A parallel plate capacitor of plate area $2.00 \times 10^{-2} m^2$ is filled with two dielectric slabs, each with thickness 2.00mm. One slab has dielectric consant 3.00, and the other,4.00 as shown in the figure.



How much charge does the capacitor store when charged by a 7.00 battery?

A. 1.08nC

B. 2.16nC

C. 0.84nC

D. 1.68nC

Answer: A

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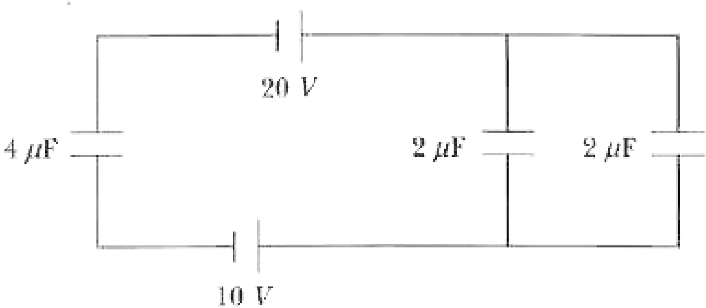
21. Charge store in $4\mu F$ capacitor in the circuit shown in following figure is:



A. $20\mu C$

B. $40\mu C$

C. $10\mu C$

D. $120\mu C$

Answer: A

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22. The plates of a parallel plate capacitor are charged to 100V. Then a 4mm thick dielectric slab is inserted between the plates and then to obtain the original potential difference , the distance between the system plates is increased by 2.00 mm. the dielectric constant of the slab is

A. 5.4

B. 2.2

C. 2.0

D. 2.6

Answer: C

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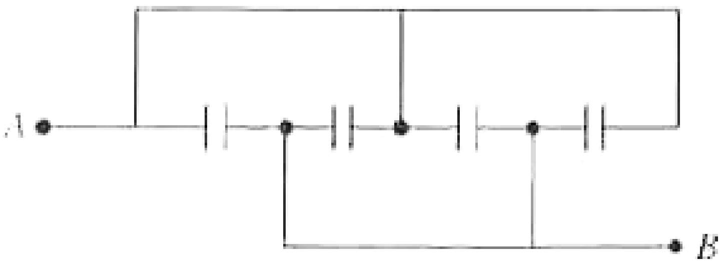
23. Four capacitors each of $8\mu F$, are joined as shown in the figure. The equivalent capacitance between the points A and B is



A. $32\mu F$

B. $2\mu F$

C. $8\mu F$

D. $16\mu F$

Answer: A

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Practice Questions More Than One Correct Choice Type

1. A dielectric slab of thickness d is inserted in a parallel plate capacitor whose negative plate is at $x = 0$ and positive plate is at $x = 3d$. The slab is equidistant from the plates. The capacitor is given some charge. As one goes from 0 to $3d(1998)$.

A. The magnitude of the electric field remains the same

B. the direction of the electric field remains the same

C. The electrical potential increases continuously

D. The electric potential increases at first, then decreases and again increases

Answer: B::C

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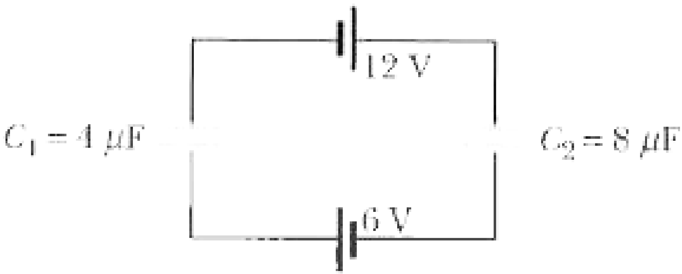
2. Consider the circuit shown in the following figure.



A. The charge on C_2 is greater than on C_1

B. The charge on C_1 and C_2 are the same

C. The potential drops across C_1 and C_2 are the same

D. The potential drops across C_1 is greater than that across C_2

Answer: B::D

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3. You charge a parallel capacitor, remove it from the battery and prevent the wires connected to the plates from touching each other. When you pull the plates further apart, which one of the following quantities increases?

A. Electric field between the plates

B. Capacitance

C. Voltage between the plates

D. Energ stored in the capacitor

Answer: C::D

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4. When two identical capacitors are charged individually to different potentials & then connected in parallel, after disconnecting from the source then

A. Net charge is less than the sum of initial individual charges

B. Net charge equals the sum of initial charge

C. The net potential difference across them is different from the sum of the individual initial potential difference

D. The net energy stored in the two capacitors is less than the sum of the initial individual energies

Answer: B::C::D

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5. The top plate of a charged plane capacitor is fixed, whereas the bottom one is kept in equilibrium by the gravitational and electrostatic forces.

A. When the capacitor is isolated, the plate is in stable equilibrium

B. When the capacitor is connected to a battery, the plate is In unstable equilibrium

C. When the capacitor is isolated, the plate is in neutral equilibrium

D. When a capacitor is connected to a battery, the plate is in neutral equilibrium.

Answer: B::C

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6. A parallel plate capacitor is charged by a battery. The battery is removed and a thick glass slab is inserted between the plates. Now,

A. The capacity of the capacitor is increased

B. The electrical energy stored in the capacitor is decreased

C. The potential across the plate is decreased

D. The electric field between the plates is decreased.

Answer: A::B::C::D

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7. A parallel plate capacitor has a parallel slab of copper inserted between and parallel to the two plates without touching the plates. The capacitor after the introduction of the copper sheet is

A. Minimum when the copper sheet touches one of the plates

B. Maximum when the copper sheet is midway between the two plates

C. Invariant for all positions of the sheet between the plates

D. Greater than that before introducing the sheet

Answer: C::D

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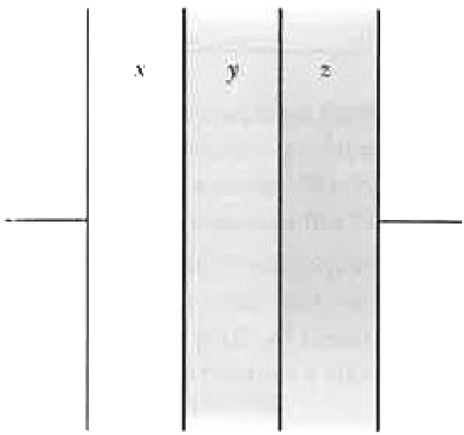
8. In the given figure a capacitor having three layers between the plates. Layer x in vaccum, y is conductor, and z is a diselectric. Which of the following charge will result in increase in capacitance?



A. Replace x by conductor

B. Replace y by dielectric

C. Replace z by conductor

D. Replace x by dielectric

Answer: A::C::D

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9. A parallel plate capacitor is charged from a cell and then isolated from it. The separation between the plates is now increased

A. The force of attraction between the plates will decrease

B. The field in the region between the plates will not change

C. The energy stored in the capacitor will increase

D. The potential difference between the plates will decrease

Answer: B::C

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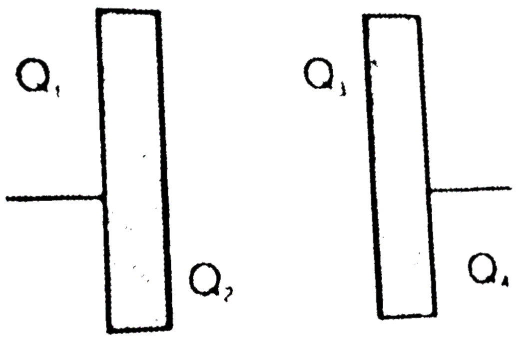
10. In an isolated parallel plate capacitor of capacitance C the four surfaces have charges Q_1, Q_2, Q_3 and Q_4 as shown in the figure. The potential difference between the plates is :



A. $\frac{Q_1 + Q_2}{C}$

B. $\left|\frac{Q_2}{C}\right|$

C. $\left|\frac{Q_3}{C}\right|$

D. $\frac{1}{C}[(Q_1+Q_2)-(Q_3-Q_4)]$

Answer: B::C

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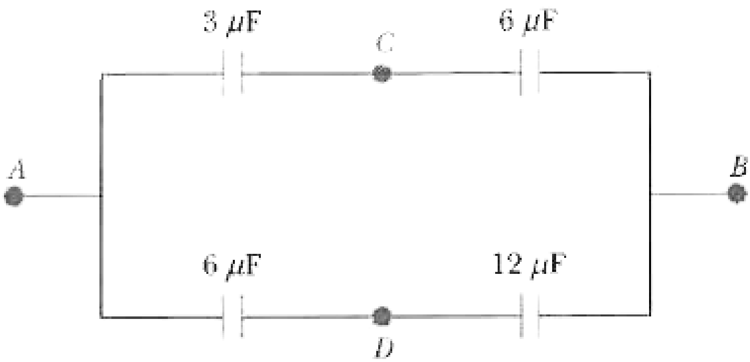
11. In the circuit shown in the following figure some potential difference is applied between A and B . IF C is joined to D,



A. No charge will flow between C and D

B. Some charge will flow between C and D

C. The equivalent capacitance between C and D will not change

D. the equivalent capacitance between C and D will change.

Answer: A::C

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12. The capacitance of a parallel plate capacitor is C when the region between the plate has air. This region is now filled with a dielectric slab of dielectric constant k. The capacitor is connected to a cell of $emf E$, and the slab is taken out

A. Charge $\varepsilon C_0(k-1)$ flows through the cell

B. Energy $\varepsilon^2 C_0(k-1)$ is absorbed by the cell

C. The energy stored in the capacitor is reduced by $\varepsilon^2 C_0(k-1)$

D. The external agent has to do $(1/2)\varepsilon^2 C_0(k-1)$ amount of work to take the slab out

Answer: A::B::D

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Practice Questions Linked Comprehension

1. Consider a parallel plate capacitor originally with a charge q_0 capacitance C_0 and potential difference ΔV_0 There is an electrostatic force of magnitude F_0 between the plates and the capacitor has a stored energy U_0. The terminals of the capacitor are connected to another capacitor of same capacitance and charge.

A dielectric slab with $k_e > 1$ is inserted between the plates of the first capacitor . Which quantity decreases?

A. q

B. C

C. ΔV

D. F

Answer: C

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2. Consider a parallel plate capacitor originally with a charge q_0 capacitance C_0 and potential difference ΔV_0 There is an electrostatic force of magnitude F_0 between the plates and the capacitor has a stored energy U_0. The terminals of the capacitor are connected to another capacitor of same capacitance and charge.

What is the direction of the electrostatic force on the dielectric slab while it is being increased?

A. The force pulls the slab into the capacitor

B. The force pushes the slab out of the capacitor

C. There is no electrostatic force of the slab

D. Can't be said

Answer: A

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3. Consider a parallel plate capacitor originally with a charge q_0 capacitance C_0 and potential difference ΔV_0 There is an electrostatic force of magnitude F_0 between the plates and the capacitor has a stored energy U_0. The terminals of the capacitor are connected to another capacitor of same capacitance and charge.

Later the dielectric slab is removed. WHile the slab is being removed.

A. Charge on second capacitor increases

B. Charge on second capacitor decreases

C. Charge on second capacitor is constant

D. Can't be said

Answer: A

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4. Two parallel plate condenser A and B having capacitances of $1\mu F$ and $5\mu F$ are charged separately to the same potential of 100V. Now the positive plate of A is connected to the negative plate of B and the negative plate of A to the positive plate of B. Common potential is

A. $\frac{200}{5}V$

B. $\frac{200}{3}V$

C. $\frac{200}{4}V$

D. $\frac{200}{7}V$

Answer: B

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5. Two parallel plate condenser A and B having capacitances of $1\mu F$ and $5\mu F$ are charged separately to the same potential of 100V. Now the positive plate of A is connected to the negative plate of B and the negative plate of A to the positive plate of B. Energy stored in capacitor is

A. $2 \times 10^{-2} J$

B. $3 \times 10^{-2} J$

C. $4 \times 10^{-4} J$

D. $5 \times 10^{-5} J$

Answer: B

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6. Two parallel plates capacitors A and B having capacitance of $1\mu F$ and $5\mu F$ are charged separately to the same potential of 100 V. Now, the positive plate of A is connected to the negative plate of B and the negative plate of A to the positive plate of B. Find the final charges on each capacitors.

A. $111\mu F$

B. $222\mu F$

C. $444\mu F$

D. $333\mu F$

Answer: D

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7. Two parallel plates capacitors A and B having capacitance of $1\mu F$ and $5\mu F$ are charged separately to the same potential of 100 V. Now, the positive plate of A is connected to the negative plate of B and the negative plate of A to the positive plate of B. Find the final charges on each capacitors.

A. $76.67\mu C$

B. 84.43

C. 66.67

D. $37.74\mu C$

Answer: C

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8. Two parallel plate condenser A and B having capacitances of $1\mu F$ and $5\mu F$ are charged separately to the same potential of 100V. Now the positive plate of A is connected to the negative plate of B and the negative plate of A to the positive plate of B. Final energy stored in capacitor is

A. $1.67J$

B. $6.71J$

C. $1.2J$

D. $1.33J$

Answer: D

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Practice Question Matrix Match

1. Match the following

Column I	Column II
(a) $(1/4\pi\varepsilon_0)q_1q_2/r^2$, where q_1 and q_2 are charges and r is distance	(p) (kilogram) (meter) $(\text{second})^{-2}$
(b) qE, q is charge and E is electric field	(q) newton
(c) $(1/2)CV^2$, where C is capacitance and V is voltage	(r) (newton) $(\text{meter})^2$ $(\text{coulomb})^{-1}$
(d) q/ε_0, q is charge and ε_0 is absolute permittivity of free space	(s) joule

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Column I	Column II
(a) A parallel-plate capacitor is connected to a battery. A dielectric of dielectric constant κ is introduced in the capacitor	**(p)** charge on each plate remains the same.
(b) A parallel-plate capacitor is connected to a battery. Now, battery is disconnected and a dielectric of dielectric constant κ is introduced in the capacitor	**(q)** charge on each plate increases by κ.
(c) A conducting slab completely fills the space between the plate of a capacitor	**(r)** potential difference between the plates of the capacitor becomes infinite.
(d) The distance between the plates of a parallel-plate capacitor is increased	**(s)** the capacitance of the capacitor becomes infinite.

2.

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3.

Column 1	Column 2	Column 3
(I) $C = \frac{4\pi\varepsilon_0 ba}{(b-a)}$	(i) $E = \frac{\lambda}{2\pi\varepsilon_0 r}$	(J) $V = \frac{Q\ln(b/a)}{2\pi\varepsilon_0 L}$

Column 1	Column 2	Column 3
(II) $C = \frac{2\pi\varepsilon_0 L}{\ln\left(\frac{r_b}{r_a}\right)}$	(ii) $E = \frac{Q}{\varepsilon_0 A}$	(K) $V = \frac{Q(b-a)}{4\pi\varepsilon_0 ba}$
(III) $C = \frac{\varepsilon_0 A}{d}$	(iii) $E = \frac{Q}{2\pi\varepsilon_0 r^2}$	(L) $V_a - V_b = \int E \cdot dr$
(IV) $C = \frac{Q}{V}$	(iv) $E = \frac{\sigma}{\varepsilon_0}$	(M) $V = \frac{Qd}{\varepsilon_0 A}$

1. What are the equations for C,E and V of a cylindrical plate capacitor

A. (III) (II) (L)

B. (II) (I) (J)

C. (III) (III) (J)

D. (I) (I) (M)

Answer: A::B::C::D

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4.

Column 1	Column 2	Column 3
(I) $C = \frac{4\pi\varepsilon_0 ba}{(b-a)}$	(i) $E = \frac{\lambda}{2\pi\varepsilon_0 r}$	(J) $V = \frac{Q\ln(b/a)}{2\pi\varepsilon_0 L}$

Column 1	Column 2	Column 3
(II) $C = \frac{2\pi\varepsilon_0 L}{\ln\left(\frac{r_b}{r_a}\right)}$	(ii) $E = \frac{Q}{\varepsilon_0 A}$	(K) $V = \frac{Q(b-a)}{4\pi\varepsilon_0 ba}$
(III) $C = \frac{\varepsilon_0 A}{d}$	(iii) $E = \frac{Q}{2\pi\varepsilon_0 r^2}$	(L) $V_a - V_b = \int E \cdot dr$
(IV) $C = \frac{Q}{V}$	(iv) $E = \frac{\sigma}{\varepsilon_0}$	(M) $V = \frac{Qd}{\varepsilon_0 A}$

2. Give te General formulas of C, E and V of capacitor?

A. (II) (II) (L)

B. (II) (III) (L)

C. (IV) (IV) (L)

D. (I) (I) (K)

Answer: A::B::C::D

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5.

Column 1	Column 2	Column 3
(I) $C=\frac{4\pi\varepsilon_0 ba}{(b-a)}$	(i) $E=\frac{\lambda}{2\pi\varepsilon_0 r}$	(J) $V=\frac{Q\ln(b/a)}{2\pi\varepsilon_0 L}$

Column 1	Column 2	Column 3
(II) $C=\frac{2\pi\varepsilon_0 L}{\ln\left(\frac{r_b}{r_a}\right)}$	(ii) $E=\frac{Q}{\varepsilon_0 A}$	(K) $V=\frac{Q(b-a)}{4\pi\varepsilon_0 ba}$
(III) $C=\frac{\varepsilon_0 A}{d}$	(iii) $E=\frac{Q}{2\pi\varepsilon_0 r^2}$	(L) $V_a-V_b=\int E\cdot dr$
(IV) $C=\frac{Q}{V}$	(iv) $E=\frac{\sigma}{\varepsilon_0}$	(M) $V=\frac{Qd}{\varepsilon_0 A}$

What are the equations for C,E and V of a spherical plate capacitor?

A. (I) (I) (J)

B. (I) (I) (M)

C. (III) (III) (J)

D. (I) (III) (K)

Answer: A::B::C::D

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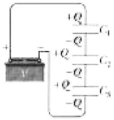
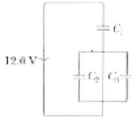
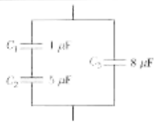
6.

Column 1	Column 2	Column 3
(I) All have the same voltage V across their plates.	(i) 	(J) Each capacitor may store a different charge.
(II) Voltage may vary across their plates.	(ii) 	(K) Each of the capacitors acquires an identical charge Q.
(III) In mixed combination the series capacitors have different voltages and parallel capacitors have same voltages.	(iii) 	(L) Each capacitor may store a different charge in first parallel connection, then each of the capacitors acquires an identical charge Q in series connection.

Column 1	Column 2	Column 3
(IV) In mixed combination the series capacitors have same voltages and parallel capacitors have same voltages.	(iv) 	(M) Each of the capacitors acquires an identical charge Q in first parallel connection, then each capacitor may store a different charge in series connection.

What are the conditions when capacitor is in the parallel network?

A. (I) (II) (J)

B. (IV) (II) (M)

C. (II) (II) (J)

D. (I) (IV) (K)

Answer: A::B::C

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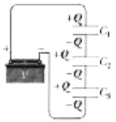
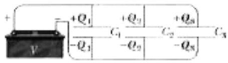
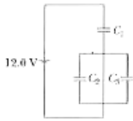
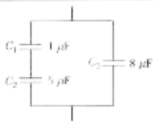
7.

Column 1	Column 2	Column 3
(I) All have the same voltage V across their plates.	(i) 	(J) Each capacitor may store a different charge.
(II) Voltage may vary across their plates.	(ii) 	(K) Each of the capacitors acquires an identical charge Q.
(III) In mixed combination the series capacitors have different voltages and parallel capacitors have same voltages.	(iii) 	(L) Each capacitor may store a different charge in first parallel connection, then each of the capacitors acquires an identical charge Q in series connection.

Column 1	Column 2	Column 3
(IV) In mixed combination the series capacitors have same voltages and parallel capacitors have same voltages.	(iv) 	(M) Each of the capacitors acquires an identical charge Q in first parallel connection, then each capacitor may store a different charge in series connection.

What are the conditions when capacitors is in mixed combination, that is parallel and series combination respectively?

A. (III) (IV) (K)

B. (IV) (I) (M)

C. (III) (III) (L)

D. (I) (I) (M)

Answer: A::B::C

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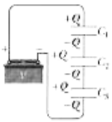
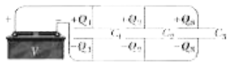
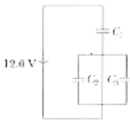
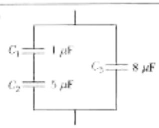
8.

Column 1	Column 2	Column 3
(I) All have the same voltage V across their plates.	(i) 	(J) Each capacitor may store a different charge.
(II) Voltage may vary across their plates.	(ii) 	(K) Each of the capacitors acquires an identical charge Q.
(III) In mixed combination the series capacitors have different voltages and parallel capacitors have same voltages.	(iii) 	(L) Each capacitor may store a different charge in first parallel connection, then each of the capacitors acquires an identical charge Q in series connection.

Column 1	Column 2	Column 3
(IV) In mixed combination the series capacitors have same voltages and parallel capacitors have same voltages.	(iv) 	(M) Each of the capacitors acquires an identical charge Q in first parallel connection, then each capacitor may store a different charge in series connection.

What are the conditions when capacitor is in th series network?

A. (III) (I) (L)

B. (IV) (I) (J)

C. (II) (I) (K)

D. (II) (III) (M)

Answer: A::B::C

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Practice Question Integer Type

1. P and Q are two capacitors with capacitance $10\mu F$ and $20\mu F$ respectively which are connected in series with a battery of value 12V. Find the ratio between the charges and P and Q.

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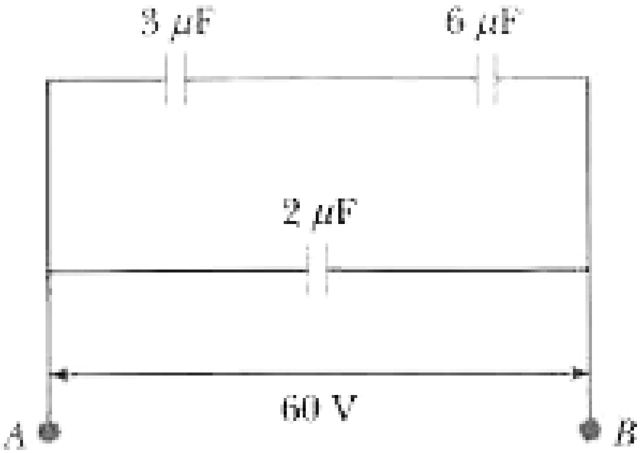
2. In the circuit shown in the following the potential difference across the $3\mu F$ capacitor is



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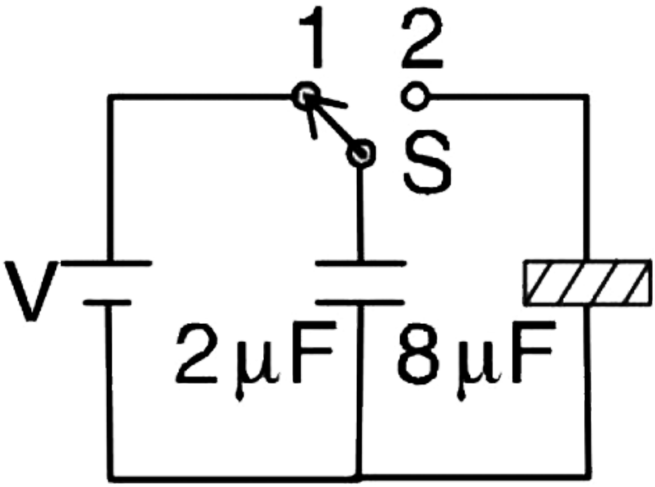
3. A $2\mu F$ capacitor is charged as shown in the figure. The percentage of its stored energy disisipated after the switch S is turned to poistion 2 is



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