PHYSICS

BOOKS - HC VERMA

CAPACITORS

Examples

1. A capacitor gets a charge of $60\mu C$ when it is connected to a battery of emf 12 V. Calculate the capacitance of the capacitor.

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2. Show that the SI unit of ε_0 may be written as farad $meter^{-1}$.

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3. Calculate the capacitance of a parallel-plate capacitor having 20 cm xx 20 cm square plates separated by a distance of 1.0 mm.

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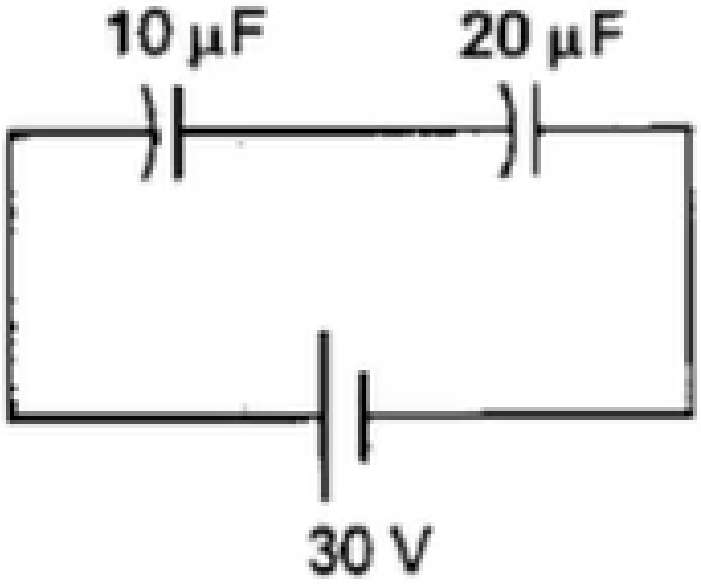
4. Calcuate the charge on each capacitor shown in figure



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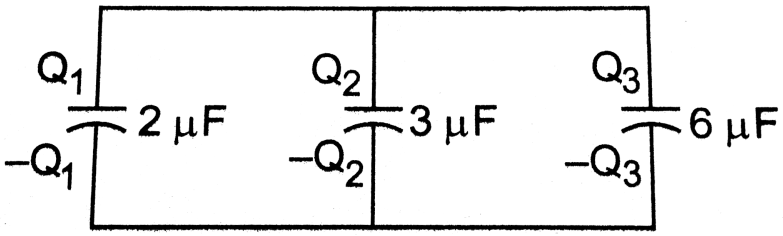
5. Find the equivalent capacitance of the combination shown in figure between the points P and N.



A. 11 uF

B. 3uF

C. 4uF

D. 7uF

Answer: A

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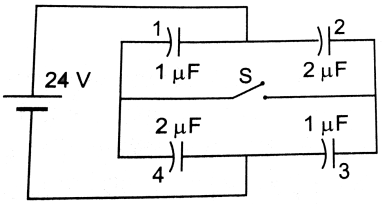
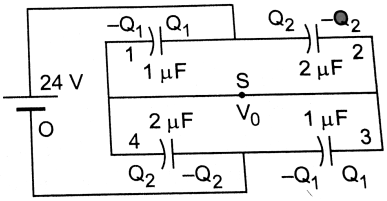
6. Find the equivalent capacitance of the combination shown in figure (31.11a) between the point P and N.

through the switch if it is closed ?



(a)



(b)

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7. Find the energy stored in a capacitor of capacitance $100\mu F$ when it is charged to a potential difference of 20 V.

A. $0.02J$

B. $0.04J$

C. $0.01J$

D. $0.05J$

Answer: A

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8. Two parallel plate capacitors, each of capacitance $40\mu F$ are connected is series. The space between the plates of one capacitor is filled with a dielectric material of dielectric constant K =4. Find the equivalent capacitance of the system.

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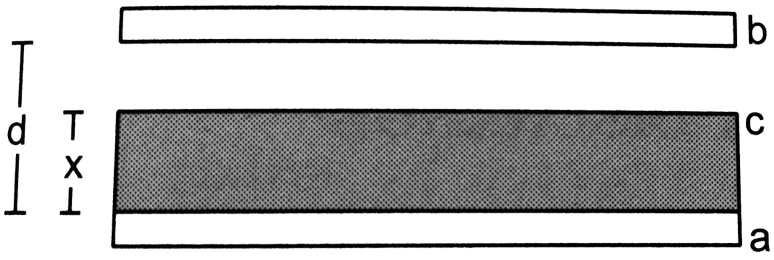
9. A parallel plate capacitor has plate area A and plate separation d. The space betwwen the plates is filled up to a thickness x (ltd) with a dielectric constant K. Calculate the capacitance of the system.



A. $\frac{2K\varepsilon lion_A}{Kd - x(K-1)}$

B. $\frac{K\varepsilon lion_A}{K2d - x(K-1)}$

C. $\frac{K\varepsilon lion_A}{K - x(K-1)}$

D. $\frac{K\varepsilon lion_A}{Kd - x(K-1)}$

Answer: D

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Worked Out Examples

1. A parallel plate capacitor has plates of area $200cm^2$ and separation between the plates 1.00 mm. What potential difference will be developed if a charge of 1.00 nC)(i.e., $1.00 \times 10^{-9}C$) is given to the capacitor? If the plate separation is now increased to 2.00 mm, what will be the new potential difference?

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2. An isolated sphere has a capacitance of 50 pF. (a) Calculate its radius. (b) how much charge should be placed on it to raise its potential ot 10^4V

?

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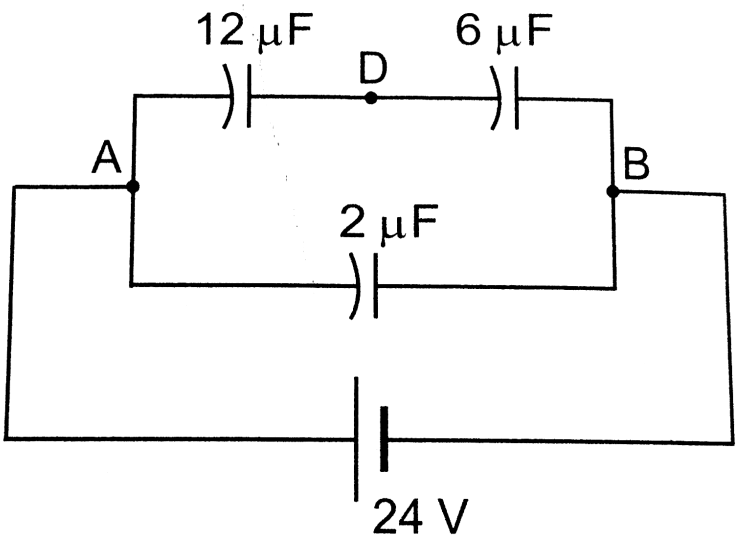
3. Consider the connections shown in (a) Find the capacitance between the points A and B. (b) find the charge on the three capacitors. (c) Taking the potential at the point B to be zero, find the potential at the point D.



A. $(12\mu F)$, $48\mu C$ & 96 micro coulomb $16V$

B. $(6\mu F)$, 48 micro coulomb & 96 micro coulomb , $16V$

C. $(6\mu F)$, 48 micro coulomb & 96 micro coulomb, $12V$

D. $(6\mu F)$ 48 micro coulomb & 96 micro coulomb, $10V$

Answer: B

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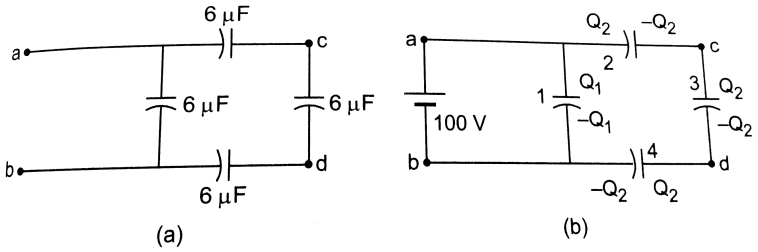
4. If 100 volts of potential difference is applied between a and b in the circuit of , find the potential difference between c and d.



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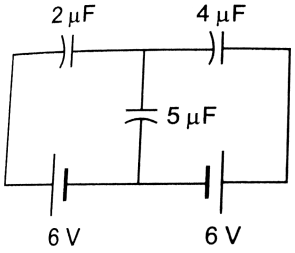
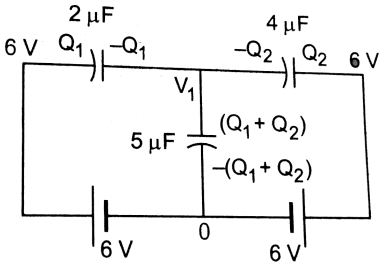
5. Find the charges on the three capacitors shown in figure



(a)



(b)

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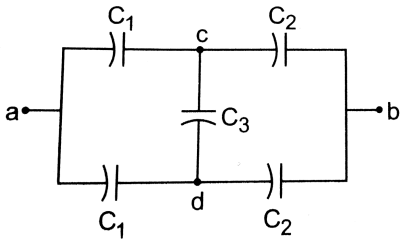
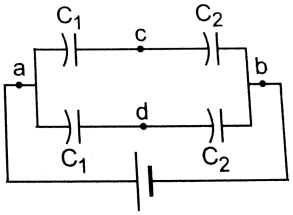
6. Find the equivalent capacitance of the system shown in figure between the points a and b.



(a)



(b)

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7. Find the equivalent capacitance between the point A and B in figure .

equivalent capacitance of the given system is

$$2C = \frac{2\,C_1C_2}{C_1 + C_2}\,.$$

7. *Find the equivalent capacitance between the point A and B in figure (31-W5a).*

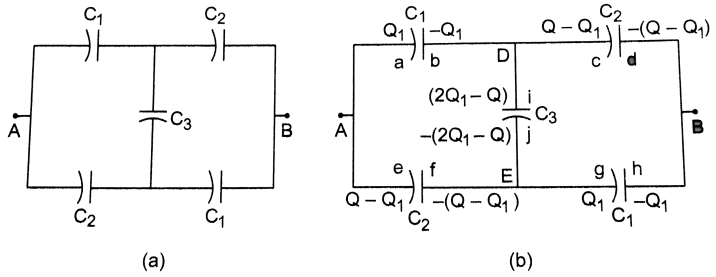

Figure 31-W5

Solution : Let us connect a battery between the points *A* and *B*. The charge distribution is shown in figure (31-W5b). Suppose the positive terminal of the battery supplies a charge $+Q$ and the negative terminal a charge $-Q$. The charge Q is divided between plates *a* and *e*. A charge Q_1 goes to the plate *a* and the rest $Q - Q_1$ goes to the plate *e*. The charge Q supplied by the

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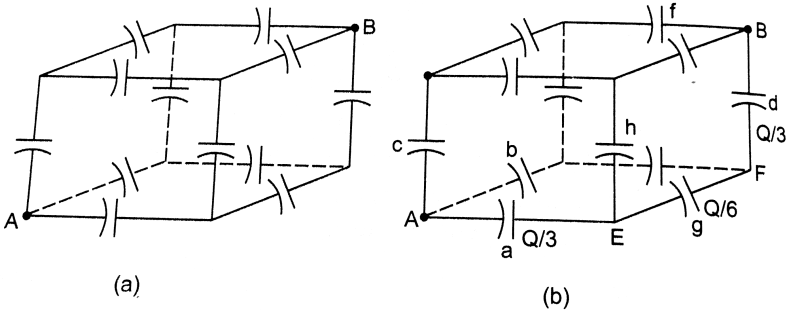
8. Twelve capacitors, each having a capacitance C, are connected to form a cube. Find the equivalent capacitance between the diagonally opposite

corners such as A and B.



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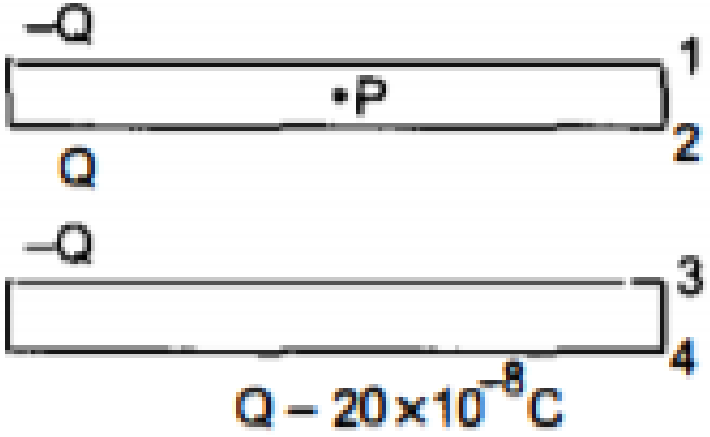
9. The negative plate of a parallel plate capacitor is given a charge of $-20X10^{-8}C$. Find the charges appearing on the four surface of the capacitor plates.



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10. Three capacitors of capacitances $2\mu F, 3\mu F$ and $6\mu F$ are connected in series with a 12 V battery. All the connecting wire are disconnected, the three positive plates are connected together and the three negative plates are connected together. Find the charges on the three capacitors after the reconnection.

A. $Q_1 = \frac{7}{11}\mu C, Q_2 = \frac{10}{11}\mu C$ and $Q_3 = \frac{21}{11}\mu C$

B. $Q_1 = \frac{72}{11}\mu C, Q_2 = \frac{18}{11}\mu C$ and $Q_3 = \frac{216}{11}\mu C$

C. $Q_1 = \frac{72}{11}\mu C, Q_2 = \frac{108}{11}\mu C$ and $Q_3 = \frac{216}{11}\mu C$

D. $Q_1 = \frac{2}{11}\mu C, Q_2 = \frac{108}{11}\mu C$ and $Q_3 = \frac{216}{11}\mu C$

Answer: C

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11. The connnections shown in figure are established with the swithc S open. How much charge will flow through the switch if it is closed?

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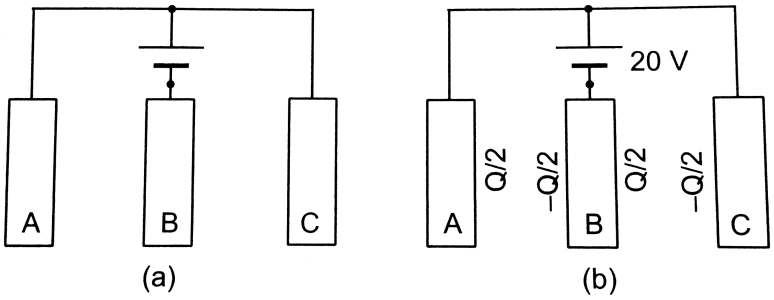
12. Each of the three plates shown in figure has an area of 200 cm^2 on one side and the gap between the adjacent plates is 0.2 mm. The emf of the battery is 20V. Find the distribution of charge on various surfaces of the plates. What is the equivalent capacitance of the system between the terminal points?



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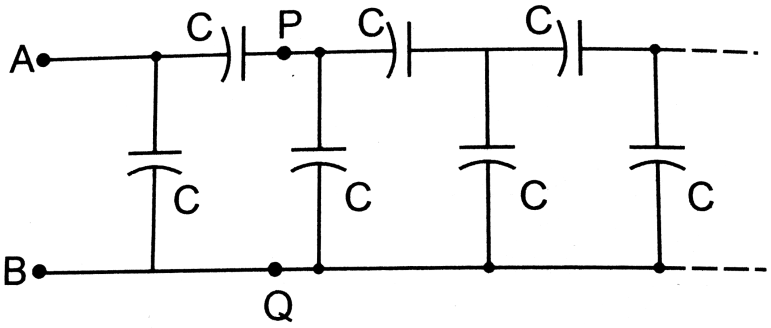
13. Find the capacitance of the infinite ladder shown in figure.



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14. Find the energy stored in the electirc field produced by a metal sphere of radius R containing a charge Q.

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15. 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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16. An uncharged capacitor is connected to a battery. Show that half the energy supplied by the battery is lost as heat while charging the capacitor.

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17. A parallel-plate capacitor having plate are $100cm^2$ and separation 1.0 mm holds a charge of $0.12\mu C$ when connected to a 120 V battery. Find the dielectric constant of the material filling the gap.

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18. A parallel plate capacitor is formed by two plates, each of area $100cm^2$, separated by a distance of 1 mm. A dielectric of dielectric constant 5.0 and dielectric strength $1.9 \times 10^7 Vm^{-1}$ is filled between the plates. Find

the maximum charge that can be stored on the capacitor without causing any dielectric breakdown.

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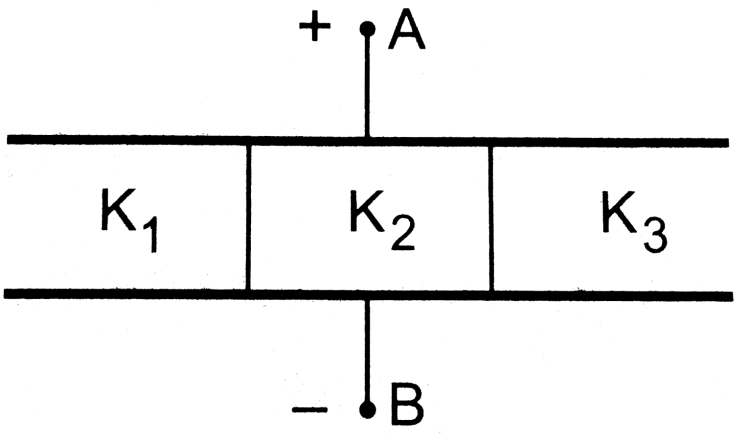
19. The space between the plates of a parallel plate capacitor of capacitance C is filled with three dielectric slabs of identical siza as shown in figure. If the dielectric constants of the three slabs are K_1, K_2 and K_3 find the new capacitance.



A. $C_eq = (K_1 + K_2 + K_3)\frac{C}{3}$

B. $C_eq = (K_1 - K_2 + K_3)\frac{C}{3}$

C. $C_eq = (K_1 + K_2 - K_3)\frac{C}{3}$

D. $C_eq = (K_1 - K_2 - K_3)\frac{C}{3}$

Answer: A

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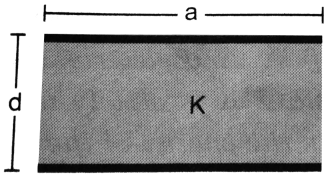
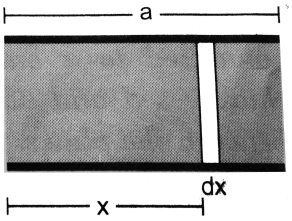
20. Figure shown a parallel-plate capacitor having square plates of edge a and plate-separation d. The gap between the plates is filled with a dielectric of dielectric constant K which varies parallel to an edge as $K = K_0 + \alpha x$, where K and α are constants and x is the distance from the left end. Calculate the capacitance.





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21. A parallel plate capacitor of capacitance $100\mu F$ is connected a power supply of $200V$. A dielectric slab of dielectric constant 5 is now inserted into the gap between the plates. (a) Find the extra charge flown through the power supply and the work done by the supply. (b) Find the change in the electrostatic energy of the electric field in the capacitor.

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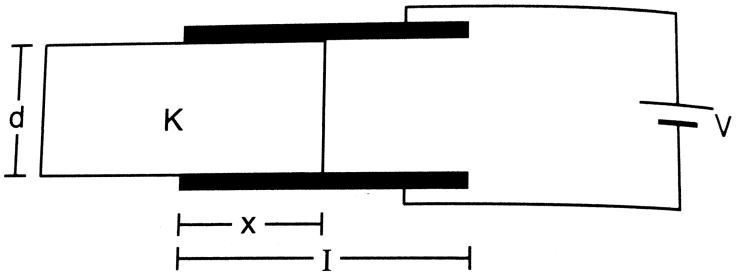
22. Shown a parallel plate capacitor with plates of width b and length l. The separation between the platesis d. The plates are rigidly clamped and connected to a battery of emf V. A dielectric slab of thickness d and dielectric constant K is slowly inserted between the plates. (a) Calculate the energy of the system when a length x of the slab is introduced into the capacitor. (b) what force should be applied on teh slab to ensure that

is goes slowly into the capacitor? Neglect any effect of friction or gravity.



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23. A parallel-plate capacitor is placed in such a way that its plates are horizontal and the lower plate is dipped into a liquid of dielectric constant K and density ρ. Each plate has an area A. The plates are now connected to a battery which supplies a positive charge of magnitude Q to the upper plate. Find the rise in the level of the liquid in the space between the plates. (figure)

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Short Answer

1. Suppose a charge $+Q_1$ is given to the positive plates and a charge $-Q_2$ to the negative plate of a capacitor. What is the "charge on the capacitor"?

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2. As $C = \left(\frac{1}{V}\right)Q$, can you say that the capacitor C is proportion to the charge Q?

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3. A solid and a hollow metal spheres are given equal charges, which one will have higher electric potential.

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4. The plates of a parallel-plate capacior are given equal positive charges .What will be the potential difference between the plates ? What will be the charges on the facing surfaces and on the outer surfaces ?

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5. A capacitor has capacitance C. Is this information sufficient to know what maximum charge the capacitor can contain? If yes,what is this charge? If no what other information is needed?

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6. The dielectric containt decreases if the temperature is increased .Explain this in term of polarization of the material.

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7. A dielectric slab is inserted between the plates of an isolated capacitor. The force between the plates will

A. increase

B. decrease

C. remain unchanged

D. become zero

Answer:

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Objective 1

1. A capacitor of capacitance C is charged to a potential V. The flux of the electric field through a closed surface enclosing the capacitor is

A. $\frac{CV}{\varepsilon}$

B. $\frac{2CV}{\varepsilon_0}$

C. $\frac{CV}{2\varepsilon_0}$

D. zero

Answer: D

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2. Two capacitor each having capacitance $C$and breakdown voltage $V$are joind in series .The capacitance and the breakdown voltage of the combination will be

A. $2C$ and $2V$

B. $\frac{C}{2}$ and $\frac{V}{2}$

C. $2C$ and $\frac{V}{2}$

D. $\frac{C}{2}$ and $2V$

Answer: D

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3. If the capacitors in the previous question are joined in parallel,the capacitance and the breakdown voltage of the combination will be

A. $2C$ and $2V$

B. C and $2V$

C. $2C$ and V

D. C and V

Answer: C

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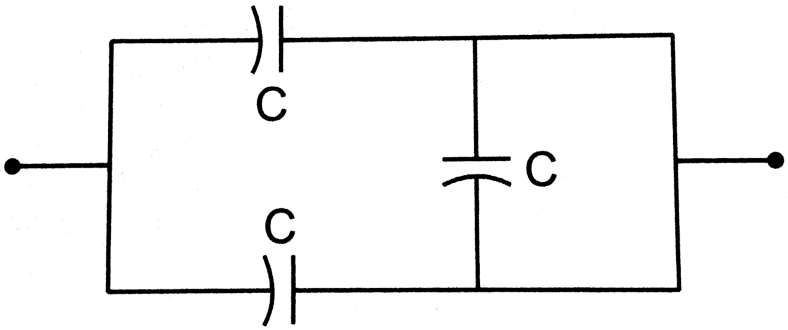
4. The equivalent capacitance of the combination show in figure is



A. C

B. $2C$

C. $\left(\frac{C}{2}\right)$

D. none of these

Answer: B

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5. When a dielectric slab is gradually inserted between the plates of an isolated parallel-plate capacitor , the energy of the system

decreases.What can you conclude about the force on the slab exerted by the electric field?

A. increase

B. decrease

C. remain unchanged

D. become zero

Answer: C

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6. The energy density in the electric field created by a point charge falls off with the distance from the point charge as

A. $\left(\frac{1}{r}\right)$

B. $\left(\frac{1}{r^2}\right)$

C. $\left(\frac{1}{r^3}\right)$

D. $\left(\frac{1}{r^4}\right)$

Answer: D

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7. A parallel-plate capacitor haas plates of unequal area . The large r plates is connected to the positive terminal of the brttery and the smaller plate to its nagative terminal. Let Q, and Q be the charges appearing on the positive and negative appearing on the

A. $Q_+ > Q-$

B. $Q+ = Q-$

C. $Q_+ < Q-$

D. The information is not sufficient to decide the ralation between Q_+ and Q.

Answer: B

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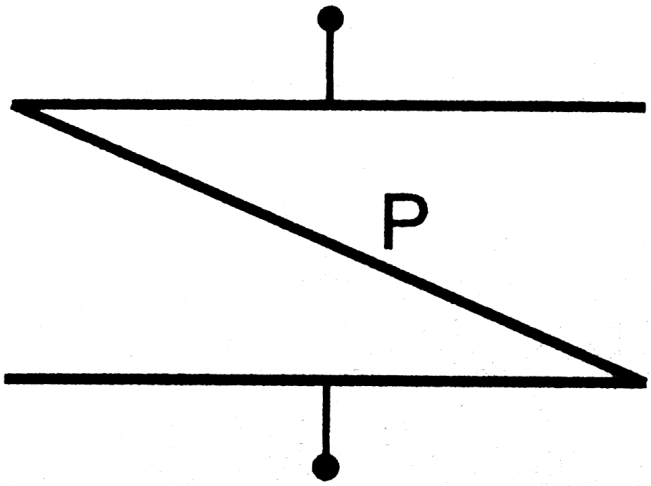
8. A thin metal plate P is inserted between the plates of a parallel-plate capacitor of capacitance$C$in such a way that its edges touch the two plates (figure 31-Q2).The capacitance now becomes.



A. $\left(\frac{C}{2}\right)$

B. $2C$

C. 0

D. indeterminated

Answer: D

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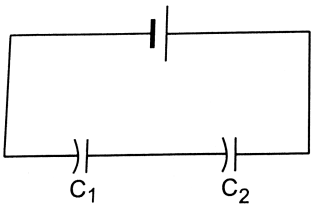
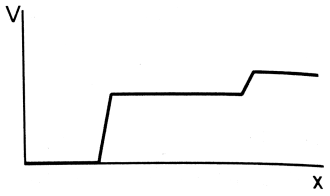
9. Figure show two capacitors connected in series and joind to a bettery. The graph shows the variation in potential as one movies from right to left on the branch containing the capacitors.





A. $C_1 > C_2$

B. $C_1 = C_2$

C. $C_1 < C_2$

D. The information is not sufficient to decide the ralation between Q_+ and Q_-.

Answer: C

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10. Two metal plates having charges $Q, -Q$ face each other at some separation and are dipped into an oil tank .If the oil is pumped out, the eletric field between the plates will

A. increase

B. decrease

C. remain unchangeed

D. become zero

Answer: A

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11. Two metal spheres of capacitances C_1 and C_2carry some charges . They are put in contact and then seperated.The final charges Q_1 and Q_2 on them will satisfy

A. $\frac{Q_1}{Q_2} < \frac{C_1}{C_2}$

B. $\frac{Q_1}{Q_2} = \frac{C_1}{C_2}$

C. $\frac{Q_1}{Q_2} > \frac{C_1}{C_2}$

D. $\frac{Q_1}{Q_2} = \frac{C_2}{C_1}$

Answer: B

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12. Three capacitors of capacitances $6\mu F$ each are available.The minimum and maximam capacitances,which be obtained are

A. $6\mu F, 18\mu F$

B. $3\mu F, 12\mu F$

C. $2\mu F, 12\mu F$

D. $2\mu F, 18\mu F$

Answer: D

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Objective 2

1. The capacitance of a capacitor does not depend on

A. the shape of the plates

B. the size of the plates

C. the charges on the plates

D. the separation between the plates

Answer: C

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2. A dielectric slab is inserted between the plates of an isolatted charged capacitor. Which of the following quantities will remain the same?

A. The electric field in the capacitor

B. The charge on the capacitor

C. The cpotential difference between the plates

D. The stored energy in the capacitor

Answer: B

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3. A dielectric slab is inserted between the plates of a capacitor. The charge on the capacitor is Q and the magnitude of the induced charge on each surface of the dielectric is Q'.

A. Q' may be larger than Q.

B. Q' must be larger than Q.

C. Q' must be equal to Q.

D. Q'must be smaller than Q.

Answer: D

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4. Each plate of a parallel plate capacitor has a charge q on it. The capacitor is now connected to a battery. Now,

A. the facing surfaces of the capacitor have equal and opposite charges

B. the two plates of the capacitor have equal and opposite charges

C. the battery supplies equal and opposite charges to the two plates

D. the outer surfaces of the plates have equal charges

Answer: A::C::D

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5. The separation between the plates of a charged parallel-plate capacitor is increased. Which of the following quantities will change?

A. Charge on the capacitor

B. potential difference across the capacitor

C. Energy of the capacitor

D. Energy density between the plates

Answer: B::C

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6. A parallel-plate capacitor is connected to a battery. A metal sheet of negligible thickness is placed between the plates. The sheet remains parallel to the plates of the capacitor.

A. The battery will supply more charge.

B. The capacitance will increase.

C. The potential difference between the plates will increase.

D. Equal and opposite charges will appear on the two faces of the metal plate.

Answer: D

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7. Following operations can be performed on a capacitor: X - connect the capacitor to a battery of $emf\varepsilon$. Y - disconnect the battery. Z - reconnect the battery with polarity reversed. W - insert a dielectric slab in the capacitor.

A. In XYZ (perform X, then Y, then Z). The stored electric energy remains unchanged and no thermal energy is developed.

B. The charge appearing on the capacitor is greater after the action XWY than after the action XYW.

C. The electric energy stored in the capacitor is greater after the action WXY than after the action XYW.

D. The electric field in the capacitor after the action XW is the same as that after WX.

Answer: B::C::D

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Exercises

1. When 1.0×10^{12}electronns aare transferred from one conductor to another, a potential difference of $20V$. What will be capacitance of the the -conductor system .

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2. Suppose ,one wishes to construct a1.0farad capacitor using circular discs. If the separaton between the discs be kept at 1.0mm, what would be the rradius of the discs?

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3. A parallel -plate capacitor having plate area $25cm^2$ and separation 1.00 mm is connected to a battery of $6.0V$. Calculate the charge flown through the battery . How much work has been done by the battery during the process ?

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4. A parallel -plate capacitor having plate area 25.0cm^ and a separation 2.00mm between the plates .the capacitor is connected to a bettery of 12.0V.(a)find the charge on the capacitor .(b) the plate separation is decrerased to 1.00mm. Find the extra charge given by the bettery to the positive plate.

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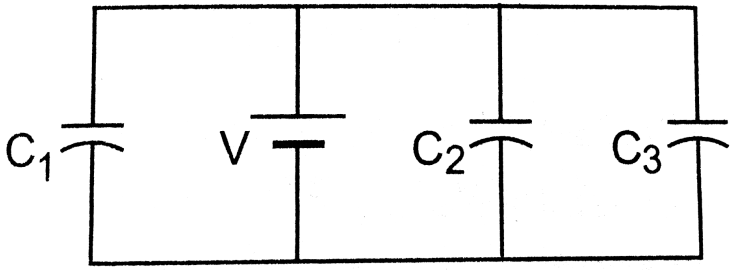
5. Find the charges on the three capacitors connected to a battery as shown in figure . Take $C_1 = 2.0\mu F, C_2 = 4.0\mu f, C_3 = 6.0\mu F$ and $V = 12v.$



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6. Three capacitors having capanctances $20\mu F, 30\mu F$ and $40\mu F$ are conneceted in series with a 12V battary. Find the charge on each of the capacitors. How much work has been done by the battery in charging the capacitors?

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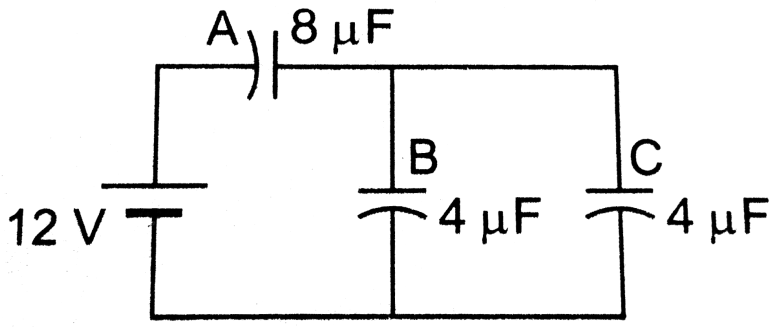
7. Find the charges on the three capacitors connected to a battery as shown in figure.



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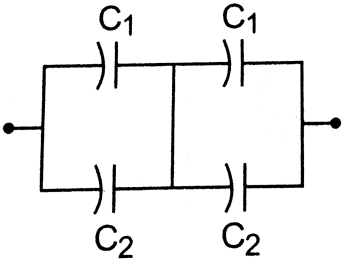
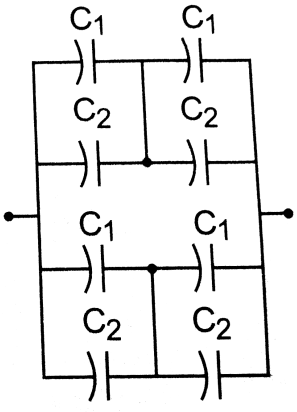
8. Take $C_1 = 4.0\mu F$ and $C_1 = 6.0\mu F$ in figure. Calculate the equivalent capacitance of the combination between the point s indicated.



(a)



(b)

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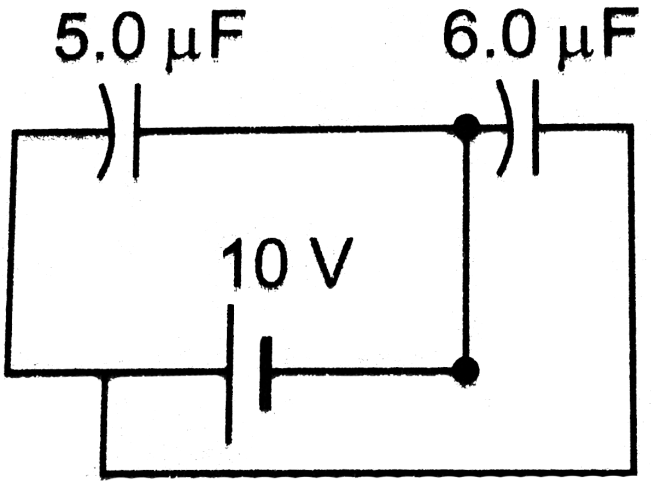
9. Find charge supplied by the battery in the arrangement shown in figure.



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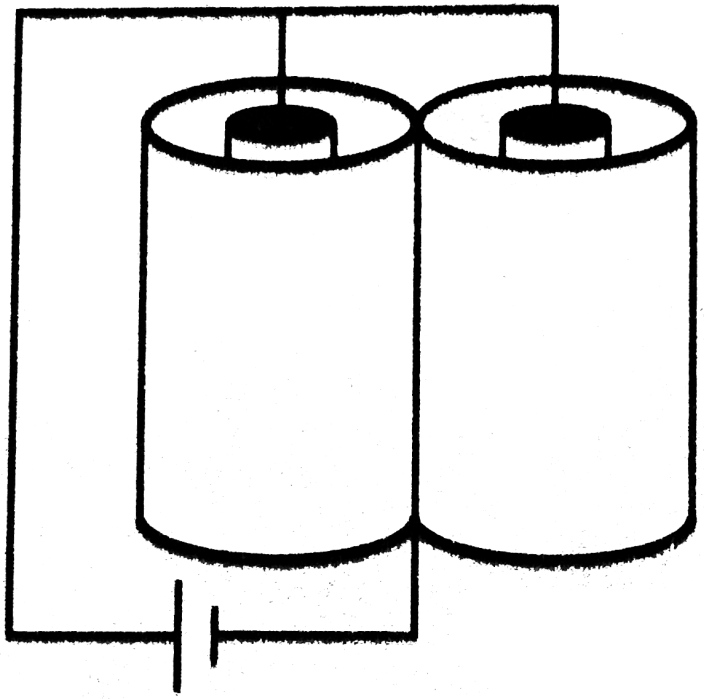
10. The outer cyliunders of two cylindrical capacitors of capacitance 2.2 mu F each , are keot in contact and the inner cylinders are connected through a wire .A bettery of end 10V is connected as shown in figure. Find the totatl charge supplied by the bettery to the inner cylioders.



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11. Two conducting spberes of radii R_1 and R_2 are kept widely separated from each other . What are their individual capacitances? If the spheres are connected by a meral wire , what will be the capacitances of the combination ? Think in terms of seies-parallel connections.

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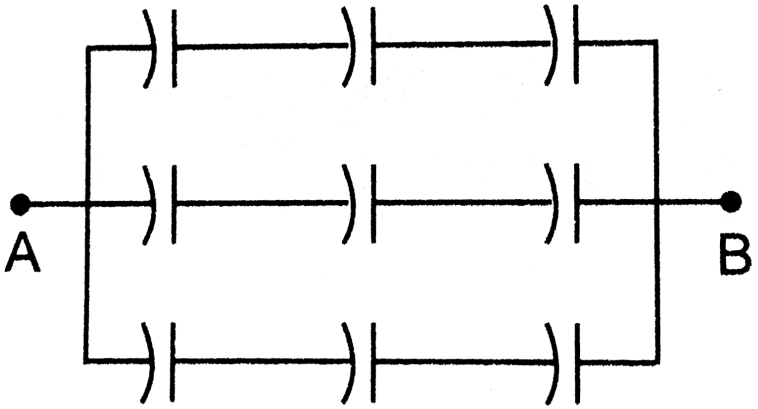
12. Each of the capacitors shown n figure has a capacitance of 2 mu F . Find the equivalent capacitance of the assembly between the points A and B . Suppose ,a battery of end of emf 60 volts is is connected between A and B .Find the potential difference appearing on the individual capacitors .



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13. It is required to consttruct a 10 mu F capacitor which can be connected across a 200V bettery . Capacitance 10 mu F are available but they can withstand only 50V ,Degin a combination which can yield the desired result .

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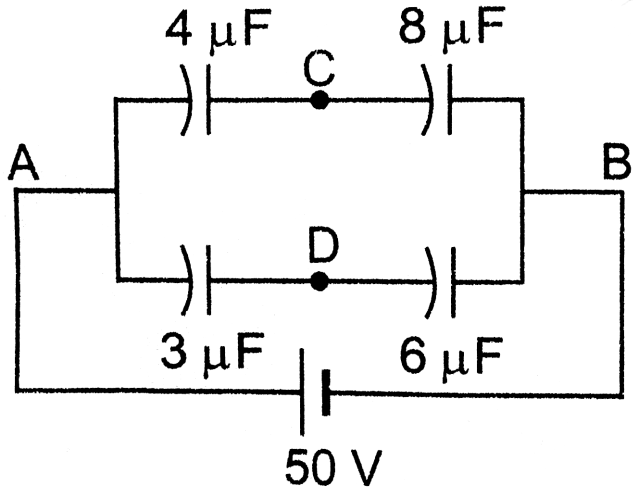
14. Take the potential of the point B in figure to be zero . (a) Find the potentials at the points C and D ,(b)If a capacitor is connected between C

and D , what charge will appear on the capacitor ?



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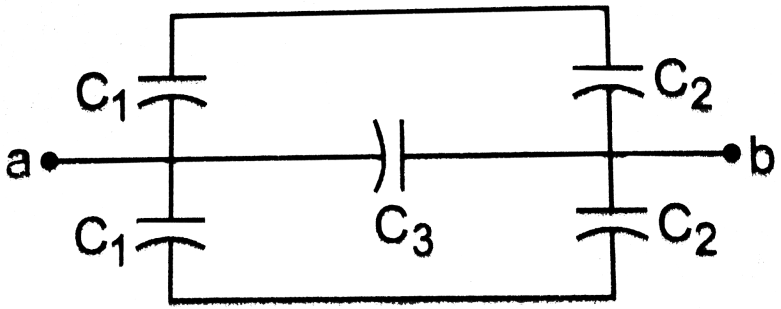
15. Find the equivalent capacitance of the system shown in figure between the popins a and b .



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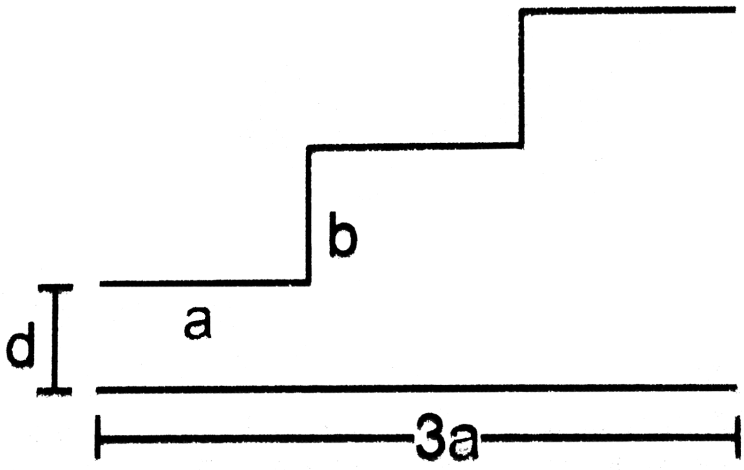
16. A capacitor is made of a flat plate of area A and B second plate having a stair -like structure as shown in figure (31-E9). The width of each stair is a and the height is b . Find the capacitance of the assembly.



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17. A cylindrical capacitor is constructed using two coaxial cylinders of the same length 10cm of redii 2mm and for mm. (a) calculate the capacitance

(b) another capacitor of the same length is constructed with cylinders of rqadii 4mm and 8mm. Calculate the capacitance .

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18. A$100pF$ capacitor is charged o a potential difference of$24V$. It is connected to an uncharged capacitor of capaciance$20pF$What will be the new polential diffeernce across the 100 pF capacitor?

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19. Each capacitor shown in figure has a capacitance of 5.0n mu F , The emf of the bettery is 50 V , How much charge will flow though AB if the swich S is closed ?

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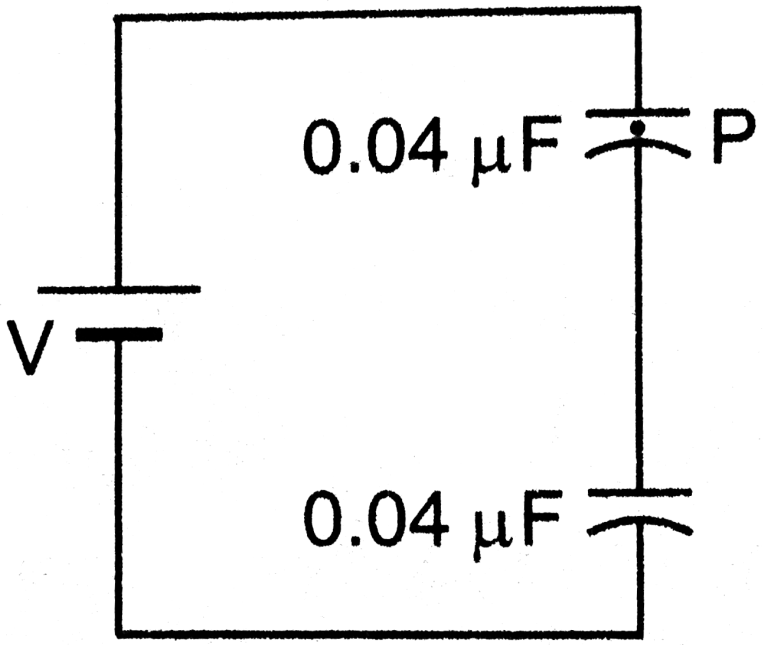
20. The particle P shown in figure has a mass of 10mg and a charge of -0.01μC. Each plate has a surface area 100cm2 on one side. What potential difference V should be applied to the combination to hold the particle P in equilibrium?



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21. The plate of a capacitor are 2.00cm apert . An electron -prodon pair is released somewhere in the gap between the plates and it is found that the prolon reeaches the negative plate . At what distance from the negative plate was the pair released?

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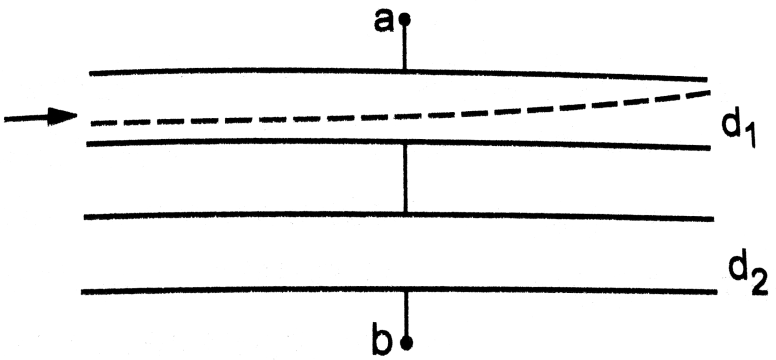
22. Convince yourself that parts (a) ,(b) and (c) of figure are identical . Find the capaciance between the point A and B of the assembly .



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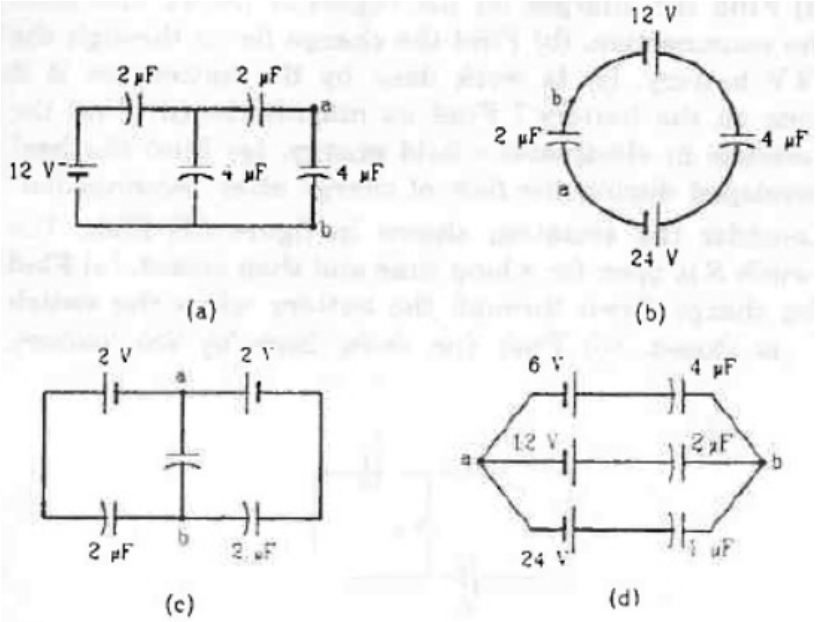
23. Find the potential difference $V_a - V_b$ between the points a and b shown in each part of the figure.



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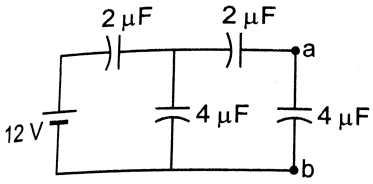
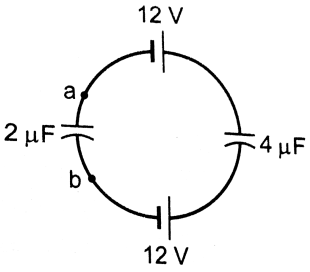
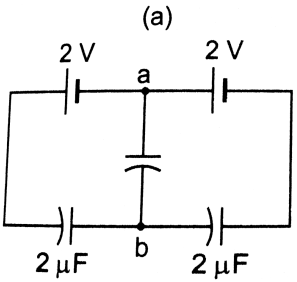
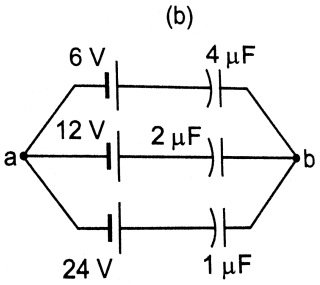
24. Find the equivalent capacitances of the combinations shown in figure between the indicated points.









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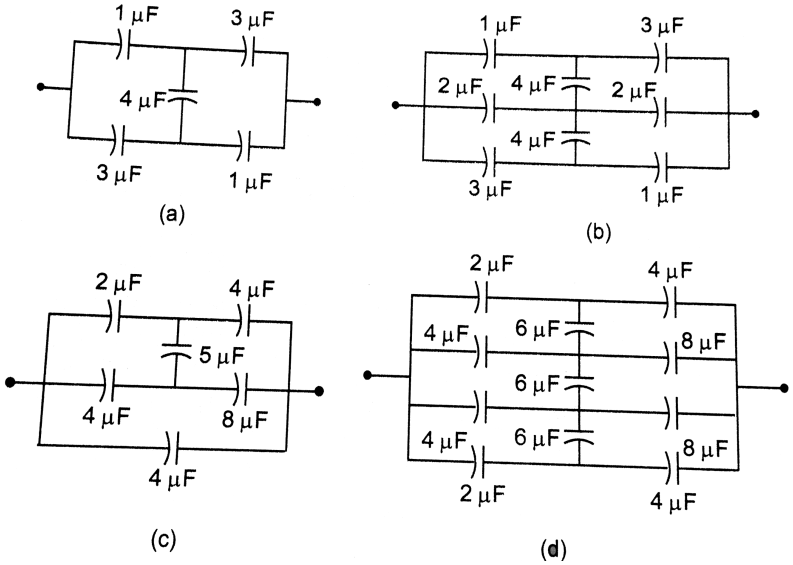
25. Find the capacitance of the combination shown in figure between A and B .

between the indicated points.



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26. Find the equivalent capacitance of the point A and B .

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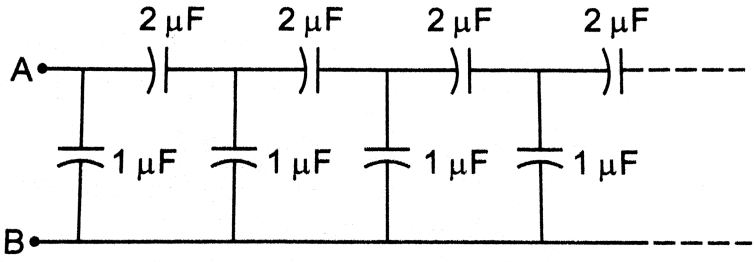
27. A infinite ladder is constructed by connecting several sections of $2\mu F, 1\mu F$ capacitor combinations as shown in figure . It is terminated by a capacitor of capacitance C . What value should be chosen for C, such

that the equivalent capacitance of the number of sections in between ?



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28. A charge of $+2.0 \times 10^{-8} C$ is placed on the positive place and a charge of - $1.0 \times 10^{-8} Conthe \neg ativeplateofaparal \leq l - plate \cap aci \rightarrow rof \cap aci$ tar 1.2 xx (10^-3) mu F. Calculate the potential difference developed between the plates.

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29. A charge of $20 \mu C$ is placed on the positive plante of on isolated parailel - plate capacitor of capacitance $10 \mu F$ calculate the potential

difference developed between the plates .

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30. A charge of $1\mu C$ is given to one plate of a parailel - plate capacitor of capacitance $0.1\mu F$ and a charge of $2\mu C$ is given to the other plate . Find the potential difference developed between the plate .

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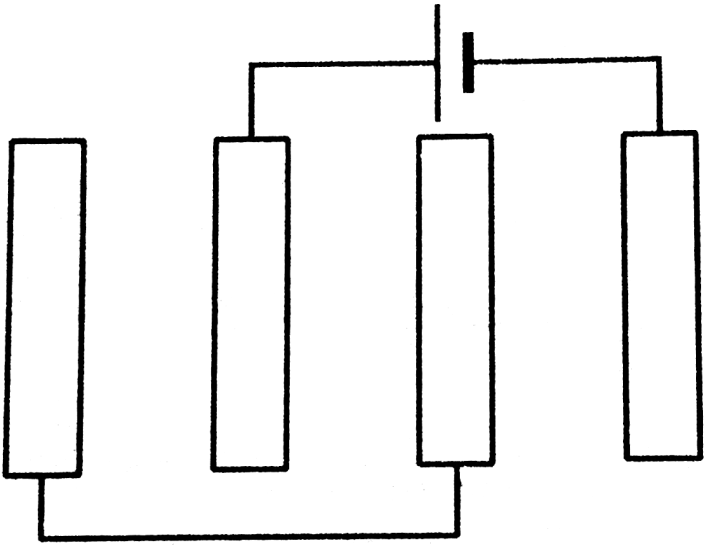
31. Each of the plates shown in figure (31- E19) haas serface area $\left(\frac{96}{\varepsilon_0}\right) \times 10^{-12}$Fm on one side and the seperation between the consecutive plates is 4.0 mm. The emf of the bettery connected is `10 volts . Find the magnitude of the charge supplied by the bettery to each of the

plates connected to it .



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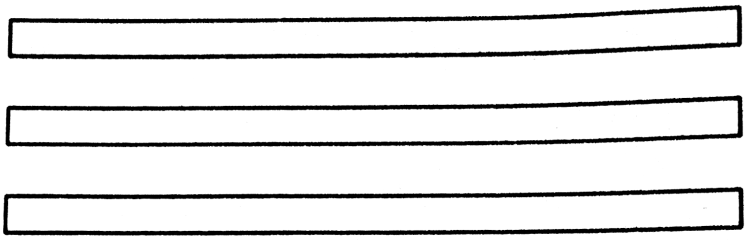
32. The capacitance between the adjacent plates shown in figure (31-E20) is $50nF$. A charge of $1.0\mu C$is placed on the middle plate (a)What will be the charge on the outer surface pf the upper plate ? (b) Find the

potential difference developed between the upper and the middle plates .



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33. Consider the situation of the previous . If $1.0\mu C$ is placed on the upper plate instead of the middle , what will be the potential difference between (a) the upper and middle plates and (b) the middle and the lower plate?

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34. Two capacitors of capacitances $20.0pF$ and $50.0pF$ are connected in series with a $6.00V$ battery . Find (a)the potential difference across each capacitor and (b) the energy stored in each capacitor .

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35. Two capacitor of capacitance $4.0\mu F$ and $6.0\mu F$ are connected in series with a battery of $20V$. Find the energy supplied by the battery .

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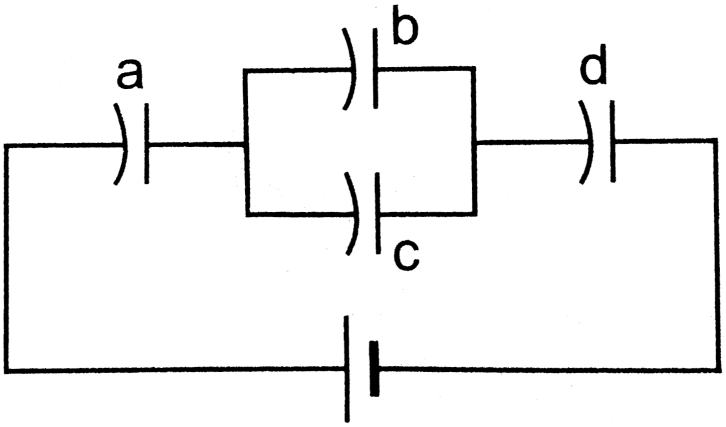
36. Each capacitor in figure has a capacitance of $10\mu F$. The emf of the battery is $100V$. Find the energy stored in each the four capacitors.



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37. A capacitor with stored energy $4.0J$ is connected with an identical capacitor with no electric fileld in between . Find the total energy stored in the two capactors .

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38. A capacitor of capacitor of capacitance $2.0\mu F$ is charge to a potential diffrence of $12V$ It is then connected of uncharged capacitor of capacitance $4.0\mu F$ as shown in figure . Find (a) the charge on each of the two capacitors after the connection, (b) the electrostatic energy stored in each of the two capacitors and (c) the best produced during the charge transfer from one capacitor to the other .

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39. A point charge Q is placed at the origin . Find the electrostatic energy stored outside the sphere of radius R centred at the origen.

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40. A metal sphere of radius R is charged to a pontital V . (a) Find the electtrostatic energy stored in the electric field within a concentric sphere of radius 2 R . (b)Show that the electrostatic field energy stored outside the sphere of radius 2R equals that stored within it .

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41. A large conducting plane has a surface charge density $1.0 \times 10^{-4} cm^{-2}$. Find the electrostatic energy stored in a cubical volume of edge 1.0cm in front of the plane .

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42. A parellel - plate capacitor having plate area $20cm^2$ and seperation between the plates 1.00mm is connected to a bettery of $12.0V$. The plates are pulled apart to incrase the separation to $2.0mm$. (a) calculate the charge flown through the circuit during the process . (b) How much energy is absorbed by the bettery during the process ? (c) calculate the stored energy in the electric field before and after the process . (d) Using the expression for the force between the plates , find the work done by the person polling the plates apart . (e) Show and justify that no heat is producted during this transfer of charge as the separation is increased.

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43. A capacitor having a capacitance of $100\mu F$ is chargeed to a potential difference of 24V . The charging bettery is disonnected and the capacitor is connected to another bettery of emf $12V$ with the positive plate of the capacitor joined with the positive terminal of the bettery . (a) Find the charges on the capacitor before and after the reconnection . (b) Find the charge flown through the 12V bettery . (c) Is work done by the bettery or is it done on the bettery ? find its magnitude . (d) Find the decrease is

electrostatic field energy . (e) Find the best developed during the flow of charge after reconnection.

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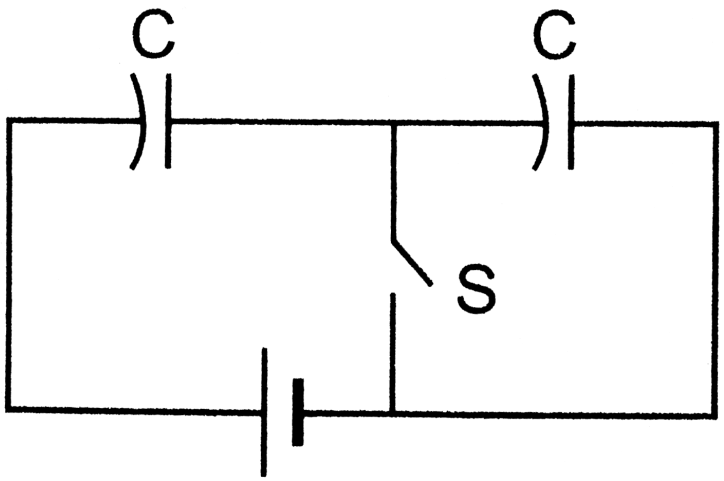
44. Consider the situation shown in figure (31-E23) . The switch S is open for a long time and then closed . (a) Find the charge flown through the battery when the switch S is closed (b)Find the work done by the battery .



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45. 47-A capacitor of capacitor $5.00\mu F$ is charged to$24.0V$ and another capacitor of capacitance $6.0\mu F$ is charged to $12.0V$ (a) Find the energy stored in each capacitor .(b)The positive plates of the first capcitor is now connnected to the negative plate of the second and vice versa . Find the new charges on the capacitors .(c)Find the loss of electrostatic energy during the process .(d)Where does this energy go?

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46. A $5.0\mu F$ capacitor is charged to $12V$. The positive plate of this capacitor is now connected to the negative terminal of a $12V$bettery and vide versa . Calculate the head developed in the connecting wires.

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47. The two square faces of a rectangular dielectric slab (dielectric constant 4.0) of dimensions 20cm x20cm x 1.0mm are metal -coated. Find the capacitance between the coated surfaces.

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48. If the above capacitor is connected across a $6.0V$ bettery , find (a)the charge supplied by the bettery , (b)the induced charge on the dielectric and (c)the net charge appearing on one of the coated surfaces.

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49. The separation between the plates of a parallel-plate capacitor is 0.500 cm and its plate area is $100cm^2$. A 0.400cm thick metal plate is inserted into the gap with its faces parallel to the plates .Show that the capacitance of the assombly is independent of the position of the metal plate within the gap and find its value.

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50. A capacitor stores $50\mu c$charge when connected across a battery . When the gap between the plates is filled with a dielectric , a charge of

$100\mu c$ flows through the battery .Find the dielectric constand of the material inserted.

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51. A parallel-plate of capacitor of capacitance $5\mu F$ is connected in a battery of emf $6V$. The separation between the plate is 2mm.(a) Find the charge on the positive plate.(b) find the eletric field between the plate.(c) A dielectric slab of thickness 1 mm and dielectric constant 5 is inserted into the gap to occupy the lower half of it.Find the capacitance of the new combination .(d)How much charge has flow n through the battery after the slab is inserted?

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52. A paller- plate capacitor has plate area $100cm^2$ and plate separation 1.0cm.A glass plate (dielectric constant 4.0)are inserted one over the other the fill the space between the plate of the capacitor.Find the new capacitance.

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53. A parallel -plate capacitor having plate area $400cm^2$ and separation between the plate 1.0mm is connected to a power supply of $100V$. A dielectric slab of thickness1.0mm and dielectric constant 5.0 is inserted into the gap .(a)Find the increase in electrostatic energy .(b) If the power supply is now disconnected and the dielectric slab is taken out , find the further increase in energy. (c) Why does the energy increase in inserting the slab as well as in taking it out?

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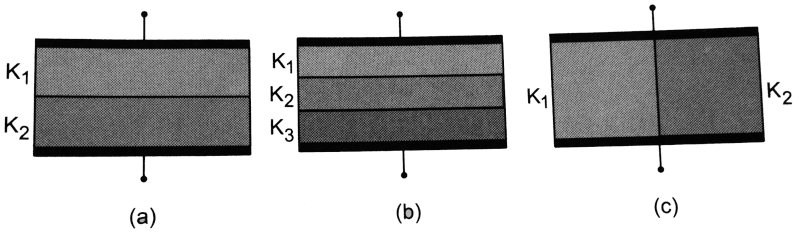
54. Find the capacitances of the capacitance of the capacitors shown In figure .The plate area is A and the separation between the plate is d. Different dielectric slab in a particular part of the figure area of the same thickness and the entire gap between the plate is filled with the dielectric

slabs.



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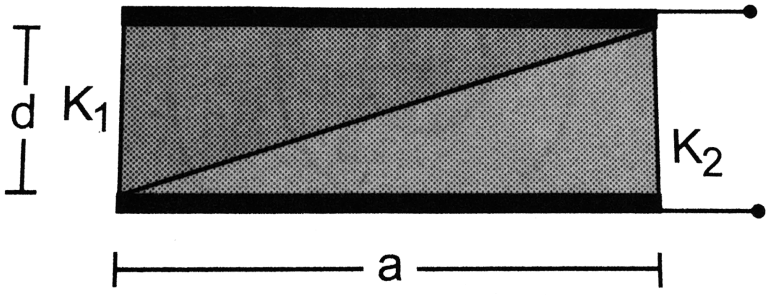
55. A capacitor is formed by two square metal plate of edge a,separated by a distance d.Dielectric constants K_1 and K_2 are filled in the gap as shown in figure(31-E25).Find the capacitance.



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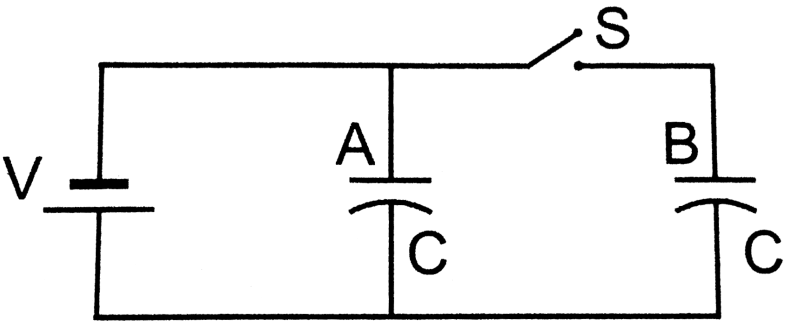
56. Figure shows two indentical pallel plate capacitors connected to a switch S. Initially ,the switch is closed so that the capacitors are completely charged .The switch is now opened and the free space between the plates of the capacitors is filled with a dielectric of dielectric constant 3. Find the ratio of the initial total energy stored in the capacitors to the final total energy stored.



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57. A parallel - plate capacitor of plate area $A$and plate separation d is charged to a potential difference V and then the battery is disconnected . A slab of dielectric constant K is then inserted between the plate of the

capacitor so as to fill the space between the plate .Find the work done on the system in the process of inserting the slab.

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58. A capacitor having a capacitance of $100\mu f$ is changed to a potential difference of $50V$. (a) What is the magnitude of the charge on each plate? (b)The charging battery is disconnected and a dielectric of dielectric constant 2.5 is inserted . Calculate the new potential difference between the plate .(c) What charge would have producted this potential difference in absence of the dielectric slab.(d) Find the charge induced at a surface of the dielectric slab.

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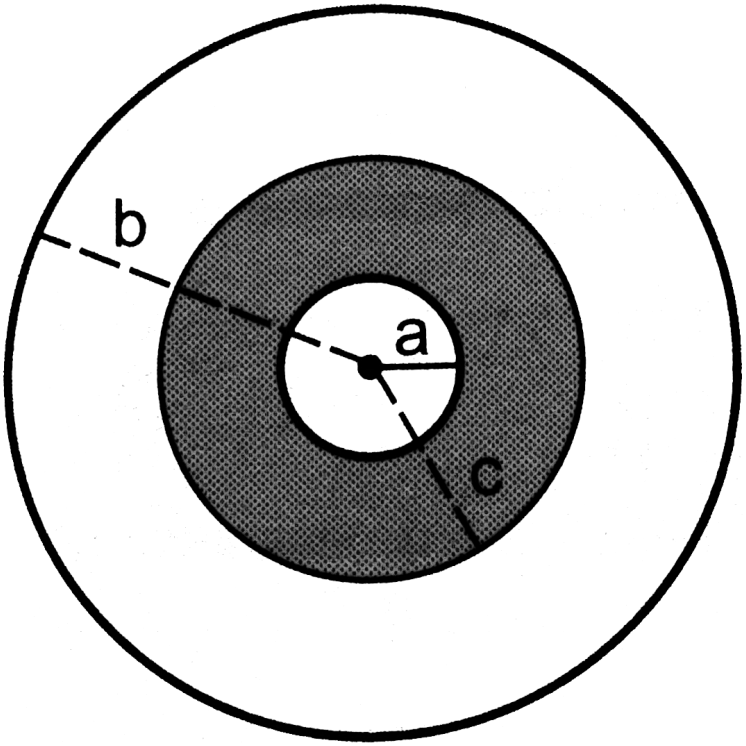
59. A sphercial capacitor is made of two conducting spherical shells of radii a and b.The space between the shells is filled with a dielectric

constant Kup to a radius c as shown in figure. Calculate the capacitance .



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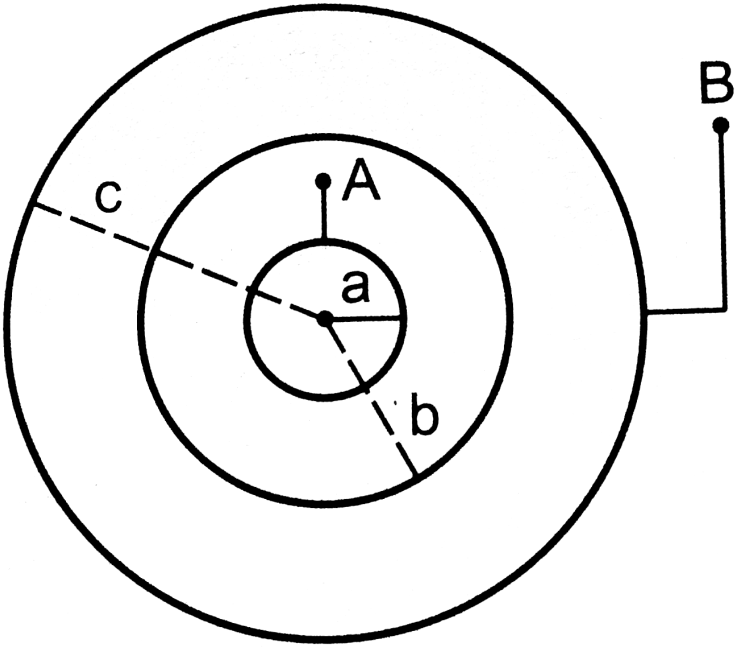
60. Suppose the space between the two inner shells of the previous problum is filled with a dielectric constant .K. Find the capacitance of the

system between A and B.



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61. An air -filled parallel-plate capacitor is to be constructed which can store$12\mu C$ of charge when operated at $1200V$. What can be the minimum plate area of the capacitor?The dielectric strength air is $3 \times 10^6 Vm^{-1}$.

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62. A pallel -plate capacitor whith the plate area $100cm^2$ and the separation between the plate 1.0cm is connected across a battery of emf 24 volts .Find the force of attraction between the plates.

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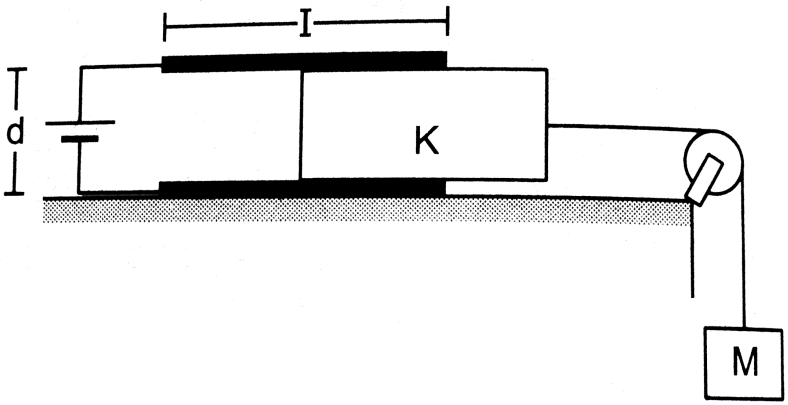
63. Concider the situation shown in figure .The width of each plate is b.The capacitor plates are rigidly clamped in the laboratory and connected to be a battery of emf ε All surfaces are frictionless .Calculate the value of$M$ for which the dielectric slab will stay in equilibrium.



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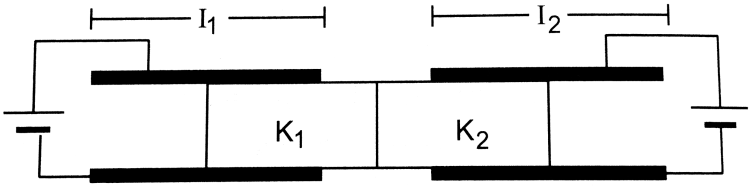
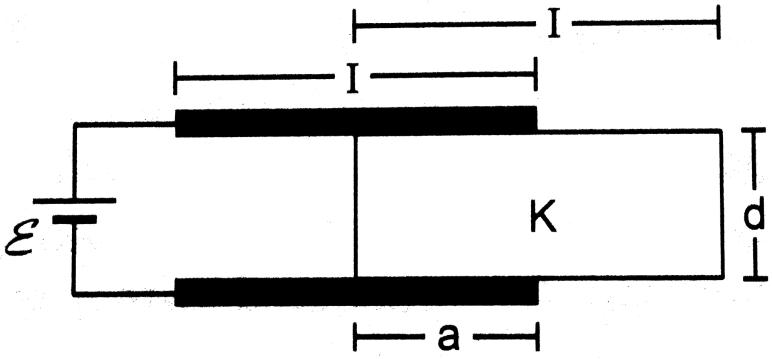
64. Consider the situation shown in figure .The plates of the capacitor have plate area A and are clapmed in the laborstory . The dielectric slab is released from rest with a length a inside the capacitor. Neglecting any effect of friction or gravity, show that slab will execute periodie motion and find its time period.





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Exercise

1. The plates of a paraller-plate capacitor are made of circular discs of radii5.0cm each .If the separation between the plates is 1.0mm,What is the capacitance?

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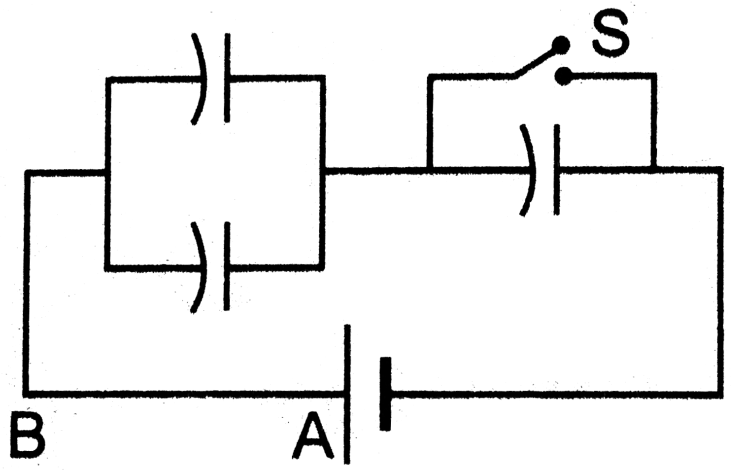
2. The particle P shown has amass of 10mg and a charge $of -0.01\mu C.$ Each plate has a surface area



View Text Solution