PHYSICS

BOOKS - U-LIKE PHYSICS (HINGLISH)

ELECTROSTATIC POTENTIAL AND CAPACITANCE

N C E R T Textbook Exercises

1. Two charges 5×10^{-8} and -3×10^{-8}C are located 16 cm apart. At what points (s) on

the line joining the two charges is the electric potential zero? Take the potential at infinity to be zero.

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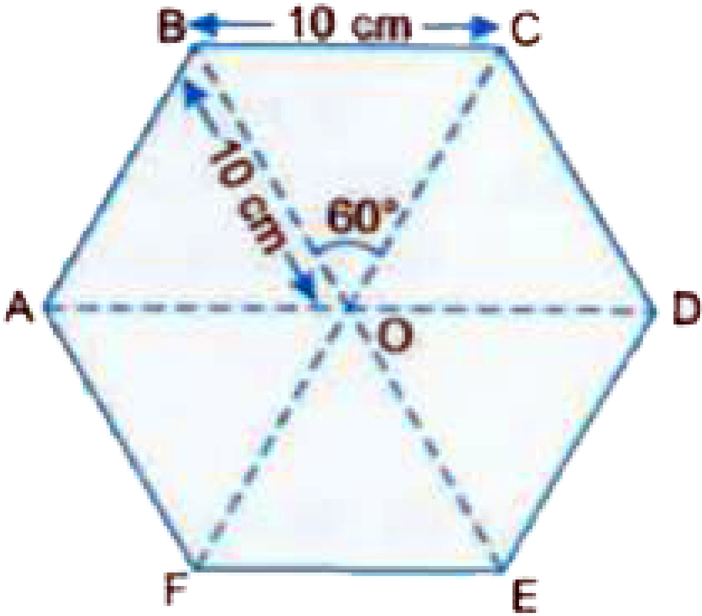
2. A regular hexagon of side 10 cm has a charge $5\mu C$ at each of its vertices. Calculate the potential at the centre of the hexagon.



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3. Two charges $2\mu C$ and $-2\mu C$ are placed at points A and B 6 cmapart.

(a) Identify an equipotential surface of the system.

(b) What is the direction of the electric field at every point on this surface ?

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4. A spherical conductor of radius 12 cm has charge of 1.6×10^{-7}C distributed uniformly on its surface. What is the electric field

(a) inside the sphere (b) just outside the sphere (c) at a point 18 cm from the centre of the spere ?

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5. A parallel plate capacitor with air between the plates has a capacitance of 8pF ($1pF = 10^{-12}F$). What will be the capacitance if the distance between the plates is reduced by half, and the space between them is filled with a substance of dielectric constant 6 ?

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6. Three capacitors each of capacitance 9 pF are connected in series.

(a) What is the total capacitance of the combination ?

(b) What is the potential difference across each capacitor if the combination is connected to a 120 V supply ?

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7. Three capacitors of capacitances 2 pF, 3 pF and 4 pF are connected in parallel.

(a) What is the total capacitance of the combination ?

(b) Determine the charge on each capacitor if the combination is connected to a 100 V supply.

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8. In a parallel palte capacitor with air between the plates, each plate has an area of $6 \times 10^{-3} m^2$ and the distacne between the plates is 3 mm. Calculate te capacitance of the capacitor. If this capacitor is connected to a 100 V supply, what is the each plate of the capacitor ?

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9. Explain what would happen if in the capacitor given in Question 2.8, a 3 mm thick mica sheet (of dielectric constant =6) were inserted between the plates,

(a) while the voltage supply remained connected.

(b) after the supply was disconnected.

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10. A 12 pF capacitor is connected to a 50 V battery. How much electrostatic energy is stored in the capacitor ?

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11. A 600 pF capacitor is charged by a 200 V supply. It is then disconnected from the supply and is connected to another uncharged 600 pF capacitor. How much electrostatic energy is lost in the process ?

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Additional Exercises

1. A charge of 8 mC is located at the origin. Calculate the work done in taking a small charge of $-2 \times 10^{-9} C$ from a point P(0,0,3 cm) to a point Q10,4 cm, 0) via a point R(0,6 cm, 9 cm).

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2. A cube of side b has a charge g at each of its vertices. Determine the potential and electric field due to this charge array at the centre of the cube.

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3. Two tiny spheres carrying charges $1.5\mu C$ and $2.5\mu C$ are located 30 cm apart. Find the potential and electric field:

(a) at the mid-point of the line joining the two charges, and

(b) at a point 10 cm from this mid-point in a plane normal to the line and passing through the mid point.

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4. A spherical conducting shell of inner radius r_1 and outer radius r_2 has a charge Q.

(a) A charge q is placed at the centre of the shell. What is the surface charge density on the inner and outer surfaces of the shell ?

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5. A spherical conducting shell of inner radius r_1 and outer radius r_2 has a charge Q.

Is the electric field inside a cavity (with no charge) zero, even if the shell is not spherical, but has any irregular shape ? Explain.

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6. Show that the normal component of electrostatic field has a discontinuity from one side of a charged surface to another given by

$$\left(\overrightarrow{E}_2 - \overrightarrow{E}_1\right). H \tan = \frac{\sigma}{\varepsilon_0}$$

where $\widehat{n}$ is a unit vector normal to the surface at a point and o is the surface charge density at that point. (The direction of în is from side 1 to side 2). Hence, show that just outside a conductor, the electric field is $\frac{\sigma}{\varepsilon_0}\widehat{n}$.

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7. Show that the tangential component of electrostatic field is continuous from one side of a charged surface to another.

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8. A long charged cylinder of linear charged density à is surrounded by a hollow co-axial conducting cylinder. What is the electric field in the space between the two cylinders ?

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9. In a hydrogen atom, the electron and proton are bound at a distance of about 0.53 Å :

(a) Estimate the potential energy of the system in eV, taking the zero of the potential energy at infinite separation of the electron from proton.

(b) What is the minimum work required to free the electron, given that its kinetic energy in the orbit is half the magnitude of potential energy obtained in (a)?

(c) What are the answers to (a) and (b) above if the zero of potential energy is taken at 1.06 Å separation ?

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10. If one of the two electrons of a H_2 molecule is removed, we get a hydrogen molecular ion H_2^+ .In the ground state of an H_2^+, the two protons are separated by roughly 1.5 Å, and the electron is roughly 1 Å from each proton. Determine the potential energy of the system. Specify your choice of the zero of potential energy.

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11. Two charged conducting spheres of radii a and b are connected to each other by a wire. What is the ratio of electric fields at the surfaces of the two spheres ? Use the result obtained to explain why charge density on the sharp and pointed ends of a conductor is higher than on its flatter portions.

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12. Two charges - q and +q are located at points (0, 0, - a) and (0,0, a), respectively. What is the electrostatic potential at the points (0, 0, z) and (x, y,0) ?

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13. Two charges - q and +q are located at points (0, 0, - a) and (0,0, a), respectively. Obtain the dependence of potential on the distance r of a point from the origin when $\frac{r}{a} >> 1$.

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14. Two charges - q and +q are located at points (0, 0, - a) and (0,0, a), respectively. How much work is done in moving a small test charge from the point (5, 0, 0) to (-7,0,0) along the x-axis ? Does the answer change if the path of the test charge between the same points is not along the x-axis ?

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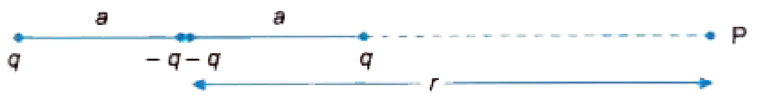
15. Figure shows a charge array known as an 'electric quadrupole'. For a point on the axis of the quadrupole, obtain the dependence of potential on r for $\frac{r}{a} > > 1$, and contrast your results with that due to an electric dipole, and an electric monopole (i.e., a single charge).



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16. An electrical technician requires a capacitance of 2 uF in a circuit across a potential difference of 1 kV. A large number of 1 uF capacitors are available to him each of which can withstand a potential difference of not more than 400 V. Suggest a possible arrangement that requires the minimum number of capacitors.

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17. What is the area of the plates of a 2 F parallel plate capacitor, given that the separation between the plates is 0.5 cm ? [You will realise from your answer why ordinary capacitors are in the range of uF or less. However, electrolytic capacitors do have a much larger capacitance (0.1 F) because of very minute seperation between the conductors.]

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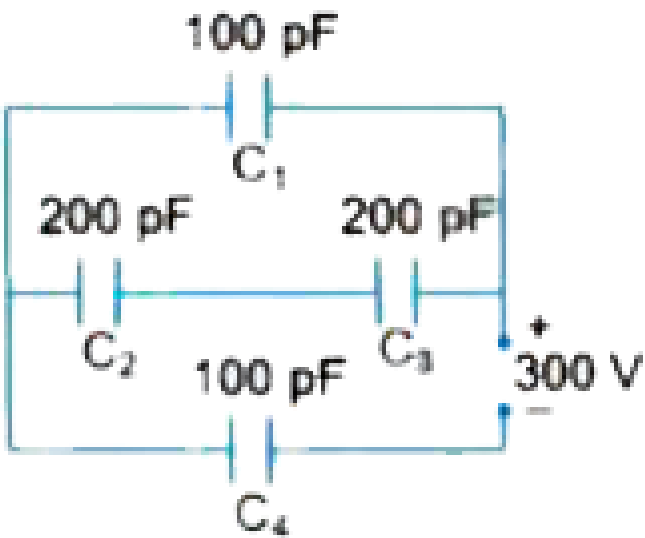
18. Obtain the equivalent capacitance of the network in Fig. For a 300 V supply, determine the charge and voltage across each 100 pF capacitor.



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19. The plates of a parallel plate capacitor have an area of $90cm^2$? each and are separated by 2.5 mm. The capacitor is charged by connecting it to a 400 V supply.

How much electrostatic energy is stored by the capacitor ?

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20. The plates of a parallel plate capacitor have an area of $90cm^2$? each and are separated by 2.5 mm. The capacitor is charged by connecting it to a 400 V supply.

View this energy as stored in the electrostatic field between the plates and obtain the energy per unit volume u. Hence arrive at a relation between u and the magnitude of electric field E between the plates.

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21. A 4 μF capacitor is charged by a 200 V supply. It is then disconnected from the supply, and is connected to another uncharged $2\mu F$ capacitor. How much electrostatic energy of the first capacitor is lost in the form of heat and electromagnetic radiation ?

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22. Show that the force on each plate of a parallel plate capacitor has a magnitude equal to $\frac{1}{2}QE$, where Q is the charge on the capacitor, and E is the magnitude of electric field between the plates. Explain the origin of the factor $\frac{1}{2}$.

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23. Two large conducting spheres carrying charges Q_1 and Q_2 are brought close to each other. Is the magnitude of electrostatic force between them exactly given by $Q_1 Q_2 / 4\pi\varepsilon_0 r^2$, where r is the distance between their centres ?

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24. If Coulomb's law involved $1/r^3$ dependence (instead of $1/r^2$), would Gauss's law be still true ?

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25. A small test charge is released at rest at a point in an electrostatic field configuration. Will it travel along the field line passing through that point ?

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26. What is the work done by the field of a nucleus in a complete circular orbit of the electron ? What if the orbit is elliptical ?

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27. We know that electric field is discontinuous across the surface of a charged conductor. Is electric potential also discontinuous there?

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28. What meaning would you give to the capacitance of a single conductor ?

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29. Guess a possible reason why water has a much greater dielectric constant (= 80) than say, mica (= 6).

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30. A parallel plate capacitor is to be designed with a voltage rating 1 kV, using a material of dielectric constant 3 and dielectric strength about $10^7 Vm^{-1}$. (Dielectric strength is the maximum electric field a material can tolerate without breakdown, i.e., without starting to conduct electricity through partial ionisation). For safety, we should like the field never to exceed, say 10% of the dielectric strength. What minimum area of the plates is required to have a capacitance of 50 pF ?

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31. Describe schematically the equipotential surfaces corresponding to

(a) a constant electric field in the z-direction,

(b) a field that uniformly increases in magnitude but remains in a constant (say, z) direction,

(c) a single positive charge at the origin, and

(d) a uniform grid consisting of long equally spaced parallel charged wires in a plane.

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32. A small sphere of radius r_1 and charge q_1 is enclosed by a spherical shell of radius r_2 and charge q_2. Show that if q_1 is positive, charge will necessarily flow from the sphere to the shell (when the two are connected by a wire) no matter what the charge q_2 on the shell is.

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33. The top of the atmosphere is at about 400 kV with respect to the surface of the earth, corresponding to an electric field that decreases with altitude. Near the surface of the earth, the field is about 100 Vm^{-7}. Why then do we not get an electric shock as we step out of our house into the open ? (Assume the house to be a steel cage so there is no field inside)

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34. A man fixes outside his house one evening a two metre high insulating slab carrying on its top a large aluminium sheet of area $1m^2$. Will he get an electric shock if he touches the metal sheet next morning?

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35. The discharging current in the atmosphere due to the small conductivity of air is known to be 1800 A on an average over the globe. Why then does the atmosphere not discharge itself completely in due course and become electrically neutral ? In other words, what keeps the atmosphere charged ?

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36. What are the forms of energy into which the electrical energy of the atmosphere is dissipated during a lightning ?

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Case Based Source Based Integrated Questions

1. On the basis of your understanding of the following paragraph and the related studied concepts.

An electric dipole is a pair of equal and opposite point charges q and -9 separated by a distance '2a'. The total charge of the electric dipole is obviously zero but the field of the electric dipole at a point is non-zero because electric fields due to + qand - q charges at the point do not exactly cancel out. Electric field of a dipole, at large distances, depends on the product 'qa'. So we define a term dipole moment vector $\overrightarrow{p}$ of an electric dipole as $\overrightarrow{p} = q(2a)$ and its direction is along the line from q to + q charge. The dipole field at large distances fall off as $\frac{1}{r^3}$. Further, the magnitude and direction of the dipole field depends not only on the distance r but also on the angle between the position vector $\overrightarrow{r}$ and the dipole moment $\overrightarrow{p}$.

Concept of electric dipoles is very significant for different materials. In most molecules, the centres of positive charges and of negative charges exactly coincide and their dipole moment is zero. However they develop a dipole moment when an electric field as applied. Such molecules are termed non-polar molecules. But in some molecules, the centres of positive charges do not exactly coincide with that of negative charges and the molecules has a permanent dipole moment even in the absence of an electric field. Such molecules are called polar molecules. Various materials give rise to interesting properties and important applications in the presence or absence of electric field.

Is the electric field due to a charge configuration with total charge zero necessarily zero ? Give an illustration in support of your answer.

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2. On the basis of your understanding of the following paragraph and the related studied concepts.

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In which direction is the magnitude of electric field due to a short dipole (i) maximum, (ii) minimum ? Write expression for the same.

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Distinguish between polar and non-polar molecules. Give examples too.

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What do you mean by polarisation of a dielectric ?

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Define polarisation vector and give its SI unit.

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6. On the basis of your understanding of the following paragraph and the related studied concepts.

An equipotential surface is a surface with a constant value of electric potential at all points on the surface. The component of electric field parallel to an equipotential surface is zero, as the potential does not change in this direction. Thus, the electric field is perpendicular to the equipotential surface at each point of the surface. Further, say the direction of electric field electrical potential gradually fall with distance.

Draw equipotential surfaces around an isolated positive point charge + q. Mark direction of electric field $\vec{E}$ also.

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7. On the basis of your understanding of the following paragraph and the related studied concepts.

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A uniform electric field $\overrightarrow{E} = 1000\hat{i} Vm^{-1}$ exists in space at a given place. What is the shape of equipotential surfaces there ?

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8. On the basis of your understanding of the following paragraph and the related studied concepts.

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If electric potential at origin point O be 100 V, then for electric field specified in part (b), draw equipotential surfaces corresponding to potentials 80 V, 60 V and 40 V respectively.

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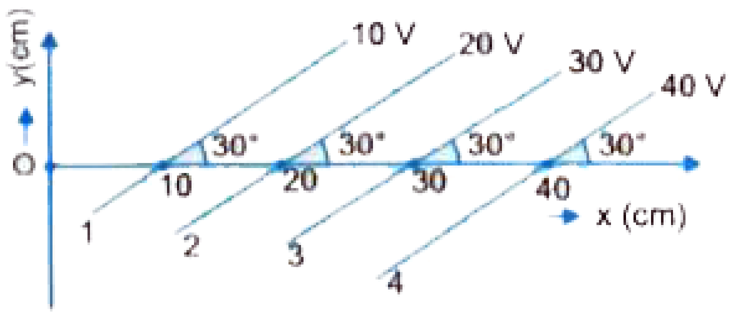
9. On the basis of your understanding of the following paragraph and the related studied concepts.

An equipotential surface is a surface with a constant value of electric potential at all points on the surface. The component of electric field parallel to an equipotential surface is zero, as the potential does not change in this direction. Thus, the electric field is perpendicular to the equipotential surface at each point of the surface. Further, say the direction of electric field electrical potential gradually fall with distance.

Four equipotential surfaces are shown in the adjoining figure. Find the magnitude and direaction of the electric field.



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If a charge of 2 nC is taken from equipotential surface number 2 to 3, what is the amount of work done ?

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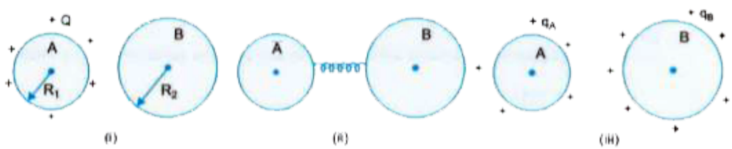
11. See the figure here. We have two hollow thin spherical shells A and B of radii R, and R, respectively. Initially as shown in Fig. (i) shell B has a charge + Q which is uniformly distributed over its outer surface but shell B has no charge. At a particular instant the two spherical shells are connected by a thin copper wire as shown in Fig. (ii). After a couple of minutes two spherical shells A and B are disconnected again as shown in Fig. (iii).



Now answer the following questions :

What is the ratio of capacitances of shell A and shell B ?

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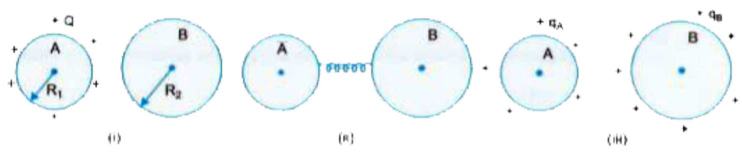
12. See the figure here. We have two hollow thin spherical shells A and B of radii R, and R, respectively. Initially as shown in Fig. (i) shell B has a charge + Q which is uniformly distributed over its outer surface but shell B has no charge. At a particular instant the two spherical shells are connected by a thin copper wire as shown in Fig. (ii). After a couple of minutes two spherical shells A and B are disconnected again as shown in Fig. (iii).



Now answer the following questions :

What is the ratio of final electric potentials of shell A and shell B ?

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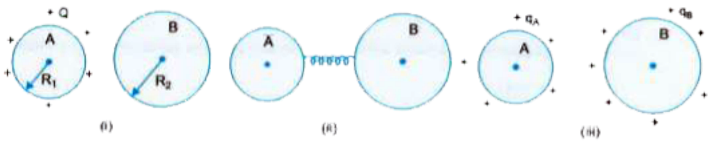

Now answer the following questions :

Find the ratio of surface charge densities of shell A and shell B.

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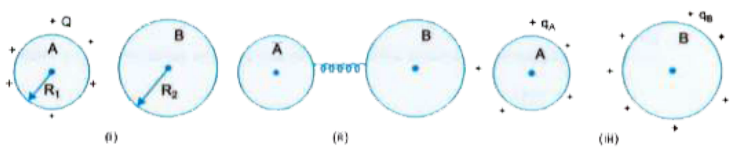
14. See the figure here. We have two hollow thin spherical shells A and B of radii R, and R, respectively. Initially as shown in Fig. (i) shell B has a charge + Q which is uniformly distributed over its outer surface but shell B has no charge. At a particular instant the two spherical shells are connected by a thin copper wire as shown in Fig. (ii). After a couple of minutes two spherical shells A and B are disconnected again as shown in Fig. (iii).



Now answer the following questions :

Find the ratio of electric field on the surfaces of shell A and B.

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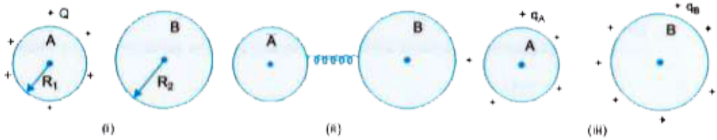
15. See the figure here. We have two hollow thin spherical shells A and B of radii R, and R, respectively. Initially as shown in Fig. (i) shell B has a charge + Q which is uniformly distributed over its outer surface but shell B has no charge. At a particular instant the two spherical shells are connected by a thin copper wire as shown in Fig. (ii). After a couple of minutes two spherical shells A and B are disconnected again as shown in Fig. (iii).



Now answer the following questions :

Compare the final electrostatic energy stored in shell A with that in shell B.

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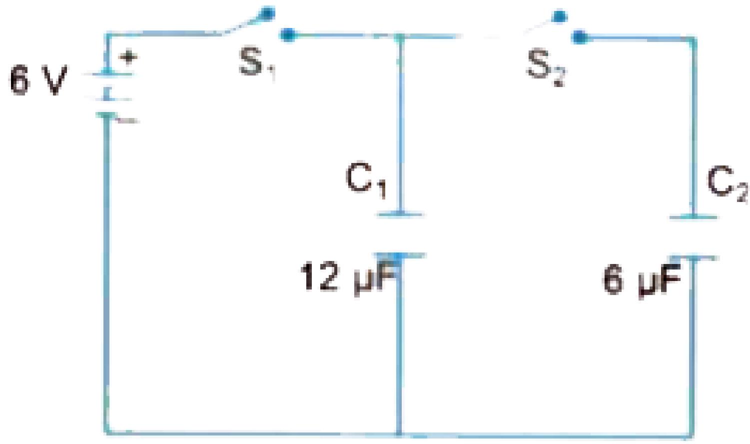
16. We have two capacitors C_1 and C_2 of capacitance $12\mu F$ and $6\mu F$ respectively. As shown in the given circuit arrangement the two capacitors are joined to a power supply of 6 volts. Initially the switch S_1 is closed but switch S_2 is open. After some time, the switch S_1 is opened and simultaneously switch S_2 is closed.

Now answer the following questions :

The final value of potential of capacitor C_1 is



A. 6 V

B. 4V

C. 2 V

D. 12 V

Answer: B

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17. We have two capacitors C_1 and C_2 of capacitance $12\mu F$ and $6\mu F$ respectively. As shown in the given circuit arrangement the two capacitors are joined to a power supply of 6 volts. Initially the switch S_1 is closed but switch S_2 is open. After some time, the switch S_1 is opened and simultaneously switch S_2 is closed.

Now answer the following questions :

The final value of charge on capacitor C_2 is

A. $24\mu C$

B. $48\mu C$

C. $72\mu C$

D. $12\mu C$

Answer: A

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18. We have two capacitors C_1 and C_2 of capacitance $12\mu F$ and $6\mu F$ respectively. As shown in the given circuit arrangement the two capacitors are joined to a power supply of 6 volts. Initially the switch S_1 is closed but switch S_2 is open. After some time, the switch S_1 is opened and simultaneously switch S_2 is closed.

Now answer the following questions :

The fractional loss in electrostatic energy of the arrangement after closing the switch S_2 is

A. $\frac{1}{4}$

B. $\frac{1}{2}$

C. $\frac{1}{3}$

D. $\frac{3}{4}$

Answer: C

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Multiple Choice Questions

1. A hollow metallic sphere of radius 5 cm is charged so that the potential on its surface is 10 V. Thepotential at the centre of the sphere is

A. 0 V

B. 10 V

C. same as at a point 5 cm away from the surface.

D. same as at a point 25 cm away from the surface.

Answer: B

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2. If a unit positive charge is taken from one point to another over an equipotential surface, then

A. work is done on the charge.

B. work is done by the charge

C. work done is constant.

D. no work is done.

Answer: D

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3. On rotating a point charge g around a charge Q in a circle of radius r, the work done is

A. $q. 2\pi r$

B. $\frac{q. 2\pi O}{r}$

C. zero

D. $\frac{Q}{2\varepsilon_0 r}$

Answer: C

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4. Electric charges of $+10\mu C, \ +5\mu C, \ -3\mu C$ and $+8\mu C$ are placed at the corners of a square of side $\sqrt{2}m$.

The potential at the centre of the square is

A. $1.8V$

B. $1.8 \times 10^6 V$

C. $1.8 \times 10^5 V$

D. $1.8 \times 10^4 V$

Answer: C

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5. An electric dipole has the magnitude of its charge as q and its dipole moment is p. It is placed in a uniform electric field E. If its dipole moment is along the direction of the field, the force on it and its potential energy are respectively

A. 2qE and minimum.

B. qE and pE.

C. zero and minimum.

D. qE and maximum.

Answer: C

View Text Solution

6. An electric charge $10^{-3}\mu C$ is placed at the origin (0,0) of x-y coordinate system. Two points A and B are situated at $(\sqrt{2}, \sqrt{2})$ and (2,0) respectively. The potential difference between the points A and B will be

A. zero

B. 9V

C. 4.5 V

D. 2V

Answer: A

View Text Solution

7. The capacitance of a capacitor is $4\mu F$ and its potential is 100 V. The energy released on discharging it fully will be

A. 0.02 J

B. 0.04 J

C. 0.025 J

D. 0.05 J

Answer: A

View Text Solution

8. If the charge on a capacitor is doubled, the value of its capacitance will be

A. doubled.

B. halved.

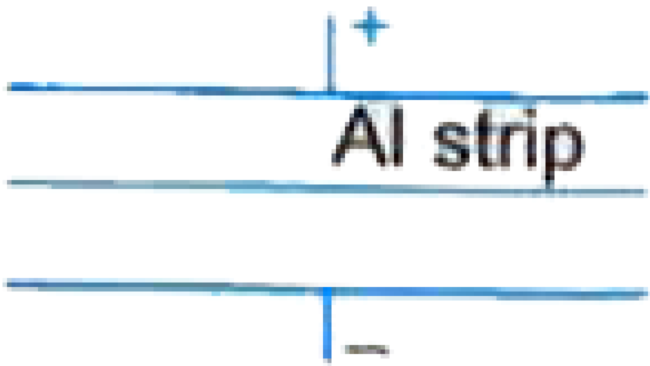
C. remain the same.

D. none of these.

Answer: C

View Text Solution

9. As shown in Fig., a very very thin sheet of aluminium is placed in between the plates of the capacitor. Then the capacitance



A. will increase.

B. will decrease.

C. remains unchanged.

D. may increase or decrease.

Answer: C

View Text Solution

10. The dielectric constant of dielectric cannot be

A. 3

B. 6

C. 8

D. ∞

Answer: D

View Text Solution

11. Two points P and Q are maintained at the potentials of 10 V and - 4 V respectively. The work done in moving 100 electrons from P to Q is

A. $9.60 \times 10^{-17} J$

B. $-2.24 \times 10^{-16} J$

C. $2.24 \times 10^{-16} J$

D. $-9.60 \times 10^{-17} J$

Answer: C

View Text Solution

12. The capacity of a parallel plate capacitor is $10\mu F$, when the distance between its plates is 8 cm. If the distance between the plates is reduced to 4 cm, the new capacity of the parallel plate capacitor will be

A. $5\mu F$

B. $10\mu F$

C. $20\mu F$

D. $40\mu F$

Answer: C

View Text Solution

13. A parallel plate capacitor with air between the plates has a capacitance of 9 pF. The separation between its plates is 'd'. The space between the plates is now filled with two dielectrics. One of the dielectrics has dielectric constant $K_1 = 3$ and thickness $\frac{d}{3}$ while the other one has dielectric constant $K_2 = 6$ and thickness $\frac{2}{3}d$. Capacitance of the capacitor is now

A. $1.8pF$

B. $45pF$

C. $40.5pF$

D. $20.25pF$

Answer: C

View Text Solution

14. A parallel plate capacitor has a uniform electric field E in the space between the plates. If the distance between the plates is ‘d and area of each plate is ‘A’, the energy stored in the capacitor is

A. $\frac{1}{2}\varepsilon_0 E^2 Ad$

B. $\frac{E^2 Ad}{\varepsilon_0}$

C. $\frac{1}{2}\varepsilon_0 E^2$

D. $\varepsilon_0 E.\ Ad$

Answer: A

View Text Solution

15. A positively charged particle is released from rest in an uniform electric field. The electric potential energy of the charge

A. remains a constant because the electric field is uniform.

B. increases because the charge moves along the electric field.

C. decreases because the charge moves along the electric field.

D. decreases because the charge moves opposite to the electric field.

Answer: C

View Text Solution

16. Equipotentials at a great distance from a collection of charges, whose total sum is not zero, are approximaltey

A. spheres

B. planes

C. paraboloids

D. ellipsoids

Answer: A

View Text Solution

17. The electric potential V at a point on the axis of an electric dipole depends on the distance 'r of the point from the dipole as

A. $V \propto \frac{1}{r}$

B. $V \propto \frac{1}{r^2}$

C. $V \propto \frac{1}{r^3}$

D. $V \propto r$

Answer: B

View Text Solution

18. A capacitor of capacitance $50\mu F$ is charged to 100 volts. Its energy is equal to

A. $25 \times 10^{-2} J$

B. $25 \times 10^{-3} J$

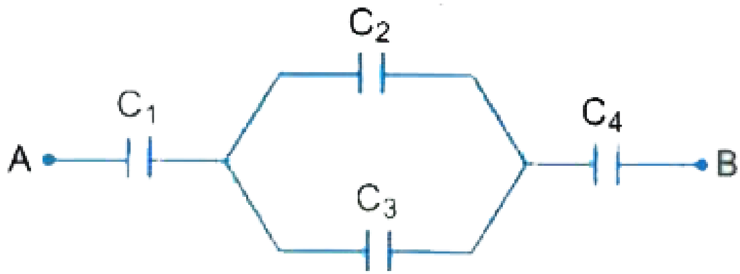
C. $25 \times 10^{-4} J$

D. $25 \times 10^{-6} J$

Answer: A

View Text Solution

19. Four capacitors, each of capacitance $4 \mu F$, are connected as shown here. The equivalent capacitance between the points A and B will be



A. $16\mu F$

B. $10\mu F$

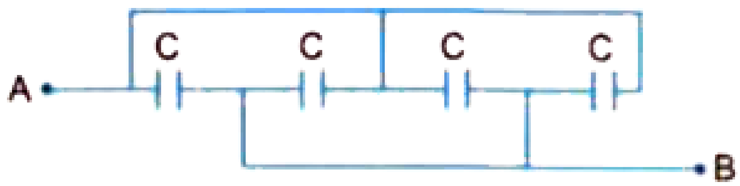
C. $1.6\mu F$

D. $4\mu F$

Answer: C

View Text Solution

20. Four capacitors, each of $1\mu F$, are joined as shown in Fig.The equivalent capacitance between the points A and B is



A. $1\mu F$

B. $0.25\mu F$

C. $2\mu F$

D. $4\mu F$

Answer: D

View Text Solution

21. Energy density in an electrostatic field E is

A. $\frac{1}{2}CV^2$

B. $\frac{1}{2}\varepsilon_0 E^2$

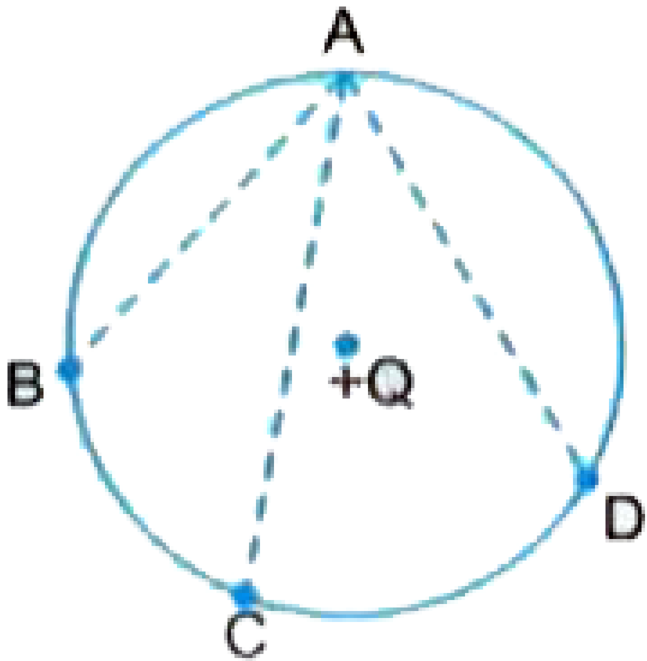
C. $\frac{2E^2}{\varepsilon_0}$

D. $\varepsilon_0 E^2$

Answer: B

View Text Solution

22. In the electric field of a point charge Q placed at the centre of a circle, as shown in fingure, a certain test charge q_0 is carried from point A to B, C B and D. Then the work done



A. is least along the path AB.

B. is least along the path AC.

C. is same along all the three paths AB, AC

as well as AD and has a finite value.

D. is zero for all the three paths.

Answer: D

View Text Solution

23. At a certain distance from a point charge the electric field is $500 V m^{-1}$ and the potential is 3000 V. The distance is

A. 6 m

B. 12 m

C. 36 m

D. 144 m

Answer: A

View Text Solution

24. An alpha particle is accelerated through a potential difference of 100 volts. Its kinetic energy will be

A. 1 MeV

B. 2 MeV

C. 4 MeV

D. 8 MeV

Answer: B

View Text Solution

25. If 8 identical charges of -g each are placed at the eight corners of a cube of side b, then electrostatic potential energy of a charge $+q_0$ placed at the centre of the cube will be

A. $\frac{8\sqrt{2}qq_0}{4\pi\varepsilon_0 b}$

B. $-\frac{8\sqrt{2}qq_0}{4\pi\varepsilon_0 b}$

C. $+\frac{4qq_0}{\sqrt{3}\pi\varepsilon_0 b}$

D. $-\frac{4qq_0}{\sqrt{3}\pi\varepsilon_0 b}$

Answer: D

View Text Solution

26. An electric dipole of dipole moment p is placed in a uniform electric field E. Initially the dipole is aligned parallel to the field. The dipole is now rotated so that it becomes antiparallel to the field. Work required to be done on the dipole by an external agency is

A. – 2pE

B. – pE

C. pE

D. 2pE

Answer: D

View Text Solution

27. A capacitor of capacitance $50\mu F$ is charged to 10 V. Its electrostatic potential energy is

A. $2.5 \times 10^{-3} J$

B. $2.5 \times 10^{-4} J$

C. $5 \times 10^{-2} J$

D. $1.2 \times 10^{-5} J$

Answer: A

View Text Solution

28. A parallel plate capacitor with a sheet of paper (dielectric constant K) between the plates has a capacitance C. If the sheet is removed then capacitance of the capacitor becomes

A. KC

B. $\frac{C}{K}$

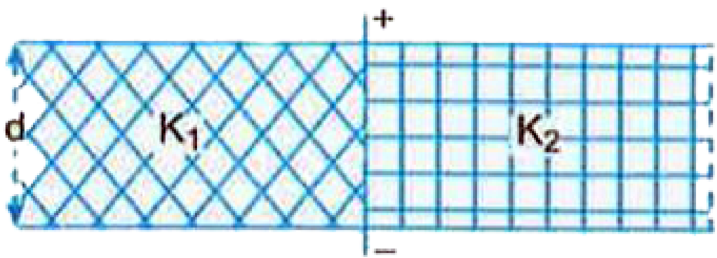
C. $\sqrt{K}C$

D. $\frac{C}{\sqrt{K}}$

Answer: B

View Text Solution

29. The area A of a parallel plate capacitor is divided into two equal, halves and filled with two media of dielectric constants K_1 and K_2 respectively. The capacitance of the capacitor will be



A. $\frac{\varepsilon_0 A(K_1 + K_2)}{d}$

B. $\frac{\varepsilon_0 A}{d}\left(\frac{K_1+K_2}{2}\right)$

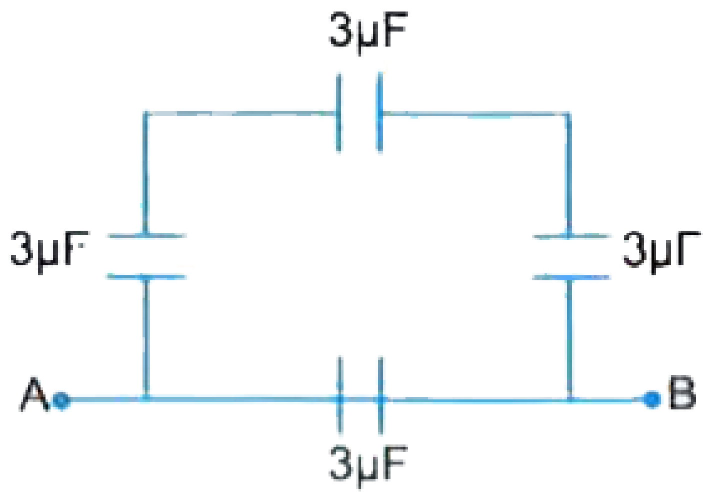
C. $\frac{\varepsilon_0 A}{d}\cdot\frac{K_1 K_2}{(K_1+K_2)}$

D. $\frac{\varepsilon_0 A}{2d}\cdot\frac{K_1 K_2}{(K_1+K_2)}$

Answer: B

View Text Solution

30. Four capacitors are connected as shown in Fig. The equivalent capacitance between the points A and B is



A. $12 \mu F$

B. $2.25 \mu F$

C. $4 \mu F$

D. $0.75 \mu F$

Answer: C

View Text Solution

31. Three capacitors of $3\mu F, 10\mu F$ and $15\mu F$ are connected in series to a voltage supply of 100 V. The charge on $15\mu F$ capacitor is

A. $50\mu C$

B. $100\mu C$

C. $200\mu C$

D. $0.75\mu F$

Answer: C

View Text Solution

32. Three capacitors of $2\mu F, 3\mu F$ and $6\mu F$ are joined in series and the combination is charged by means of a 24 V battery. The potential difference between the plates of the $6\mu F$ capacitor is

A. 4V

B. 6 V

C. 8V

D. 10 V

Answer: A

View Text Solution

33. Two identical capacitors when joined in series have an effective capacitance of $3\mu F$. When connected in parallel, the effective capacitance becomes $12\mu F$. What is the capacitance of each capacitor ?

A. $6\mu F$

B. $3\mu F$

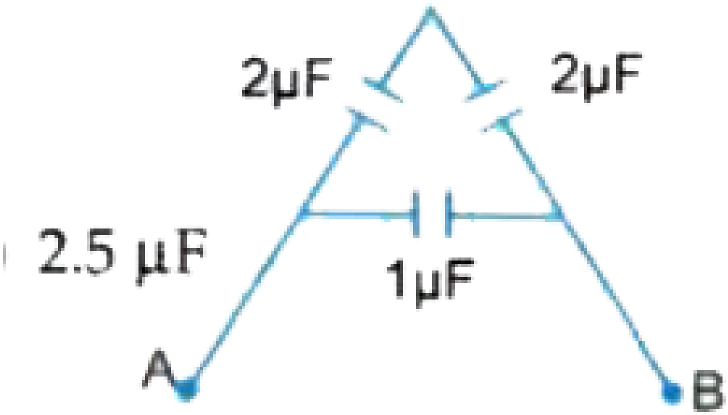
C. $12\mu F$

D. $9\mu F$

Answer: A

View Text Solution

34. What is the effective capacitance between A and B in the arrangement shown here?



A. $1\mu F$

B. $2\mu F$

C. $1.5\mu F$

D. $2.5\mu F$

Answer: B

View Text Solution

35. A capacitor of capacitance $10\mu F$ is charged to 100 V. It is now connected to uncharged capacitor in parallel so that the common potential becomes 40 V. The capacitance of the second capacitor is

A. $10\mu F$

B. $5\mu F$

C. $15\mu F$

D. $25\mu F$

Answer: C

View Text Solution

Fill In The Blanks

1. A small sphere A of radius r and carrying a charge q is enclosed by a concentric spherical shell B of radius 2r carrying a charge 29. When A and B are connected by a conducting wire, the charge will flow from ________ to ________ .

View Text Solution

2. Capacitance of a spherical conductor of radius r is given as___________ .

View Text Solution

3. Electric potential at the centre of a spherical shell of radius r and having charge g is given as __________ .

View Text Solution

4. Potential energy of an electric dipole in a uniform electric field is ________in stable equilibrium position and ________ in its unstable equilibrium position.

View Text Solution

5. The electric potential V at any point x, y, z in space is given by $V = 4x^2 V$. The electric field at the point (1, 0, 2) is________ V m^{-1}.

View Text Solution

6. Two spheres A and B have their radii R and 2R respectively and charge on sphere A is Q. On connecting A and B by a metallic wire no charge will flow from A to B or vice versa if charge on sphere B is ____________ .

View Text Solution

7. When two capacitors C_1 and C_3 are connected in series, the ratio of charges and potential differences across two capacitors are

________ and _________ respectively.

View Text Solution

8. When two capacitors C_1 and C_2 are connected in parallel, the ratio of charges and potential differences across two capacitors are

___________ and __________ respectively.

View Text Solution

9. The plates of a charged parallel plate capacitor attract each other by a force F= ___________, where q = charge on each plate and A = area of each plates.

View Text Solution

10. A $5\mu F$ capacitor is charged to a potential of 100 V and then disconnected from the power supply. Now it is connected in parallel to another capacitor of $20\mu F$. The common potential of the capacitors will be ____________ .

View Text Solution

11. Two capacitors of a capacitance $3\mu F$ and $6\mu F$ respectively are connected in series across a 100 V power supply. Charge on each capacitor is ____________ .

View Text Solution

12. Five identical capacitor plates, each of surface area 'A', are arranged such that adjacent plates are at distance 'd' apart. The alternate plates are joined together as shown in Fig. The capacitance of the arrangement is __________ .

View Text Solution

13. The capacitance of a conductor ___________ when an earthed conductor is brought near it.

View Text Solution

14. A capacitor of capacitance $8\mu F$ is connected across a 200 V power supply. The energy gained by the capacitor is __________ .

View Text Solution

15. Electric field is always directed __________ to an equipotential surface.

View Text Solution

16. SI unit of capacitance is __________ .

View Text Solution

17. A parallel plate capacitor has a capacitance of $6\mu F$. If the separation between the plates is reduced to one half of its original separation and a dielectric of dielectric constant 3 is introduced between the plates of capacitor, its new capacitance will be ________ .

View Text Solution

18. We have a charged conductor having a cavity. Electric field inside the cavity is ________ and the electric potential inside the cavity is ________ .

View Text Solution

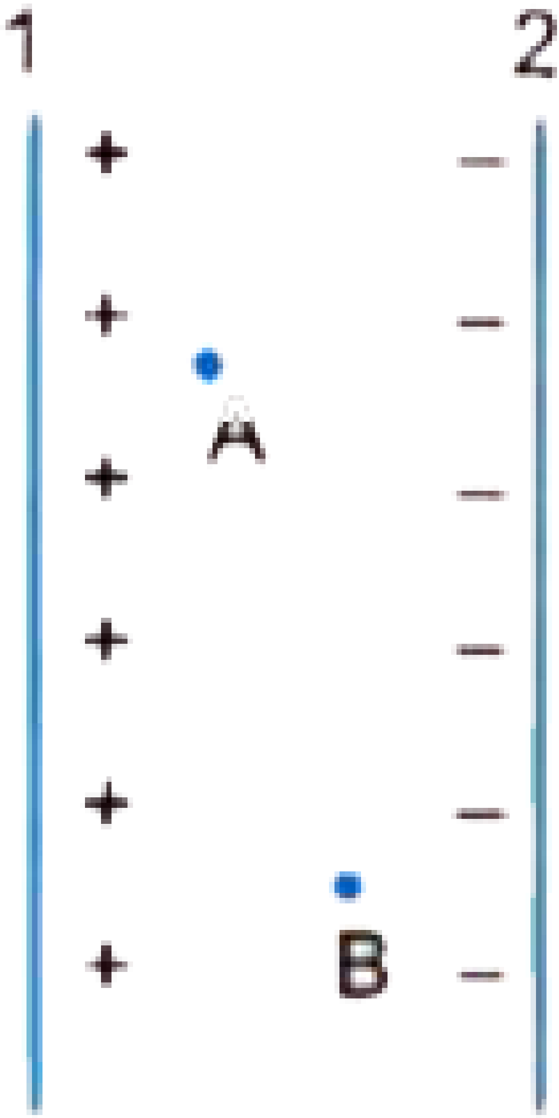
True Or False

1. A solid conducting sphere holds more charge than a hollow sphere of the same radius when they are at same potential.

View Text Solution

2. Two protons A and B are placed in between the two plates of a parallel plate capacitor charged to a potential difference Vas shown in

Fig. The force on the two protons are exactly the same.



View Text Solution

3. The capacitance of parallel plate capacitor depends on the metal used to make the plates of capacitor.

View Text Solution

4. When a dielectric is introduced between the plates of a capacitor, which is connected to a battery of voltage V, the charge on the plates remains unchanged.

View Text Solution

5. The distance between the plates of a parallel plate capacitor is 'd'. The capacitance of the capacitor gets doubled when a metal plate of thickness $\frac{d}{2}$ is placed between the plates.

View Text Solution

6. $A 10 \mu F$ capacitor is charged to 200 V and is isolated. It is then connected to another $10 \mu F$ uncharged capacitor. The total electrostatic energy of the capacitor remains conserved.

View Text Solution

7. We are provided 10 capacitors each of $1 \mu F$ capacitance. We can employ them so as to have a minimum capacitance of $0.1 \mu F$ and maximum capacitance of $10 \mu F$.

View Text Solution

Assertion Reason Type Questions

1. Assertion (A): The surface of spherical conductor can be considered as an equipotential surface.

Reason (R) : In a conductor charges can easily flow till potential is same at the entire surface.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer:

View Text Solution

2. Assertion (A): A bird perches on an electric power line but nothing happens to the bird.

Reason (R) : The level of bird on the power line is quite high above the ground.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer:

View Text Solution

3. Assertion (A): If the distance between plates of a parallel plate capacitor is halved and the intervening space is filled with a dielectric of dielectric constant 3, the capacitance of capacitor becomes 6 times of its original capacitance.

Reason (R) : The capacitance of a capacitor does not depend on the material of the metal plates.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer:

View Text Solution

4. Assertion (A): Two equipotential surfaces can never intersect.

Reason (R) : Potential at all points of an equipotentialsurface is uniform.

A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

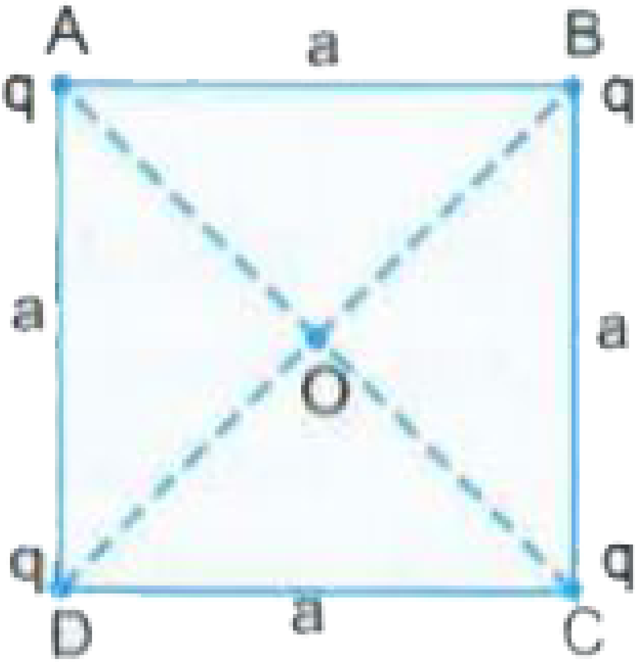
D. If the assertion is false but reason is true.

Answer:

View Text Solution

5. Assertion (A): For identical charges of magnitude g each are placed at the vertices of a square of side'a'. The electric field at the centre point O is zero but electric potential is non-zero and finite. Reason

(R) : Electric field is a vector quantity but electric potential is a D scalar.



A. If both assertion and reason are true and the reason is the correct explanation of the assertion.

B. If both assertion and reason are true but reason is not the correct explanation of the assertion.

C. If assertion is true but reason is false.

D. If the assertion is false but reason is true.

Answer:

View Text Solution

Very Short Answer Questions

1. Name the physical quantity whose SI unit is JC. Is it a scalar or vector quantity ?

View Text Solution

2. Can there be a potential difference between two adjacent conductors carrying the same charge ?

View Text Solution

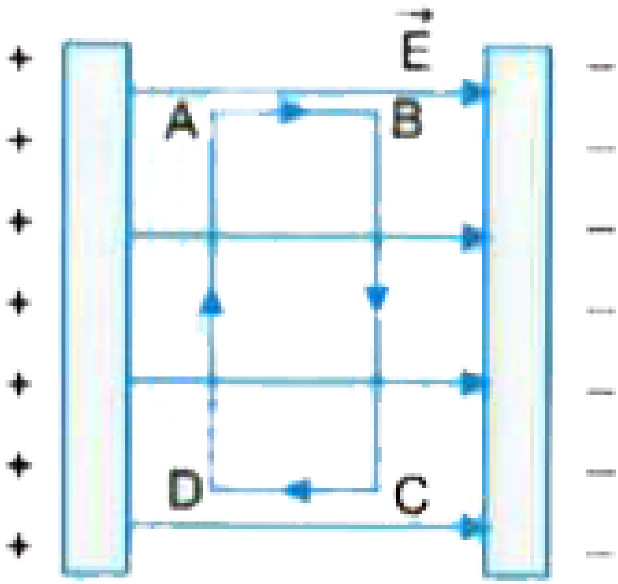
3. Is electrostatic potential necessarily zero at a point where electric field is zero ? Illustrate your answer.

View Text Solution

4. A point charge Q is placed at point O as shown in the figure. Is the potential difference $V_A - V_B$ positive, negative or zero, if Q is (i) positive (ii) negative ?

View Text Solution

5. The electric field inside a parallel plate capacitor is E. What would be the work done in moving a charge q along the closed rectangular path ABCDA ?



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6. What is the amount of work done in moving a point charge q_0 around a circular arc of radius 'r' at the centre of which another point charge q is located ?

View Text Solution

7. Why should electrostatic field be zero inside a conductor ?

View Text Solution

8. Why is electrostatic potential constant throughout the volume of the conductor and has the same value (as inside) on its surface ?

View Text Solution

9. A hollow metal sphere of radius 5 cm is charged such that the potential on its surface is 10 V. What is the potential at the centre of the sphere?

View Text Solution

10. Can the potential function have a maximum or minimum in free space ?

View Text Solution

11. Draw equipotential surfaces for a uniform electric field along z-axis.

View Text Solution

12. Draw equipotential surfaces for a single point charge O>0.

View Text Solution

13. Why must electrostatic field be normal to the surface at every point of a charged conductor ?

View Text Solution

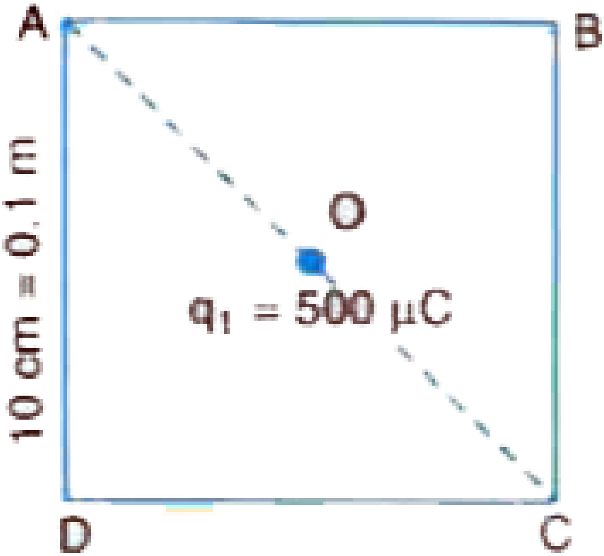
14. What is the direction of the electric field at the surface of a charged conductor having charge density $\sigma < 0$?

View Text Solution

15. A metal sphere with a charge Q is surrounded by an uncharged concentric thin spherical shell. The potential difference between them is V. If the shell is now given an additional charge Q, what is the new potential difference between them?

View Text Solution

16. $A 500 \mu C$ charge is at the centre of a square of side 10 cm. Find the work done in moving a charge of $10 \mu C$ between two diagonally opposite points on the square.



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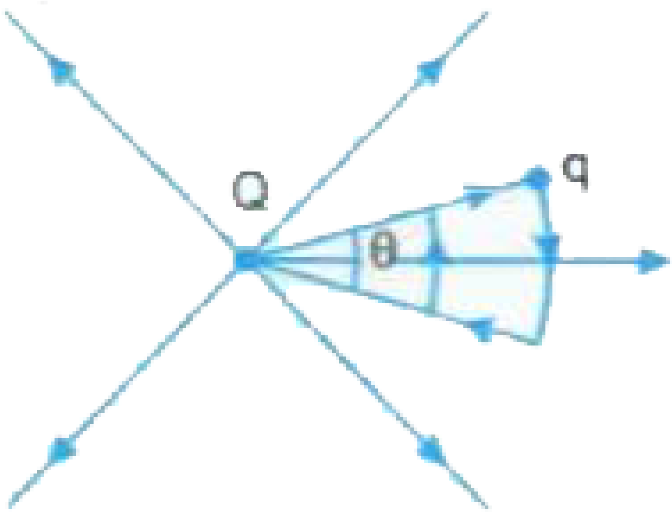
17. A test charge q is made to move in the electric field of a point charge +Q along a closed path as shown in figure. What is the

work done ?



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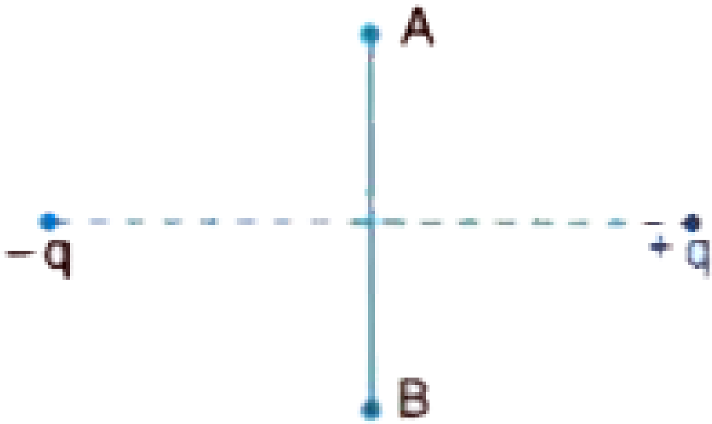
18. Do free electrons travel to region of higher potential or lower potential ?

View Text Solution

19. Can two equipotential surfaces intersect each other ? Justify your answer.

View Text Solution

20. A charge q_0 is moved from a point A above a dipole of dipole moment p to a point B below the dipole at equatorial plane without acceleration. Find the work done in the process.



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21. What is the work done in moving a test charge q through a distance of 1 cm along the equatorial axis of an electric dipole ?

View Text Solution

22. Show on a plot the nature of variation of the (i) electric field (E), and (ii) potential (V) of a small electric dipole with the distance (r) of the field point from the centre of the dipole.

View Text Solution

23. For any charge configuration equipotential surface through a point is normal to the electric field. Justify.

View Text Solution

24. In which orientation, a dipole placed in a uniform electric field is in (i) stable (ii) unstable equilibrium ?

View Text Solution

25. Draw an equipotential surface for a system, consisting of two charges Q,-Q separated by a distance 'r' in air.

View Text Solution

26. Draw equipotential surfaces for an electric dipole.

View Text Solution

27. Write the expressiond for the work done on an electric dipole of dipole moment p in turning it from its position of stable equilibrium to a position of unstable equilibrium in a uniform electric field $\vec{E}$.

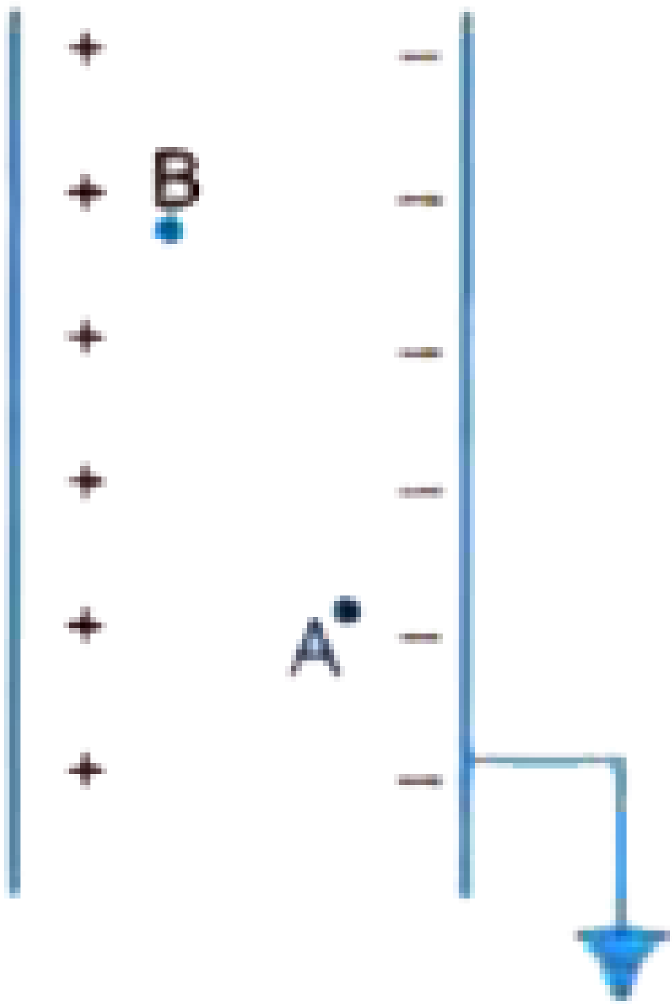
View Text Solution

28. Define the term 'potential energy' of charge 'q' at a distance 'y in an external electric field.

View Text Solution

29. In a parallel plate capacitor the potential difference of 100 V is manitianed between the plates. If distance between the plates be 5mm, what will be the electric field at points A and B

?



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30. Define capacitance of a capacitor.

View Text Solution

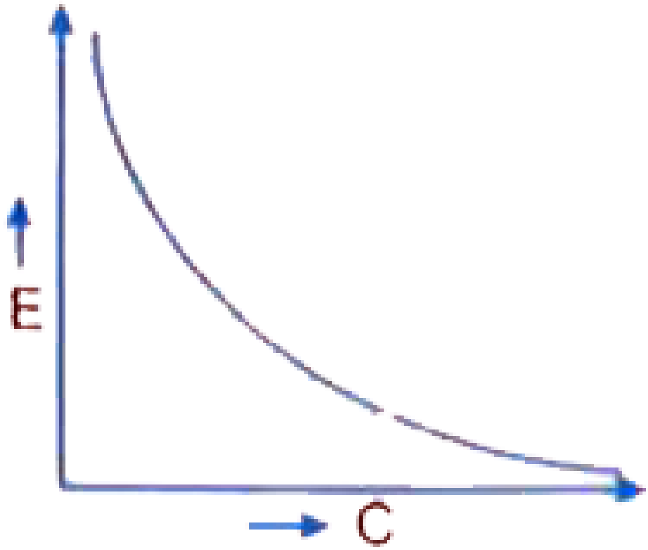
31. Define the term 'dielectric constant of a medium in terms of capacitance.

View Text Solution

32. Why does the electric field inside a dielectric decrease when it is placed in an external electric field ?

View Text Solution

33. The graph shown here figure, shows the variation of the total energy (E) stored in a capacitor against the value of the capacitance (C) itself. Which of the two - the charge on the capacitor or the potential used to 4 charge it is kept constant for this graph ?



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34. Name the physical quantity whose SI unit is Fm^{-1} (farad/metre).

View Text Solution

35. Define dielectric strength of a dielectric.

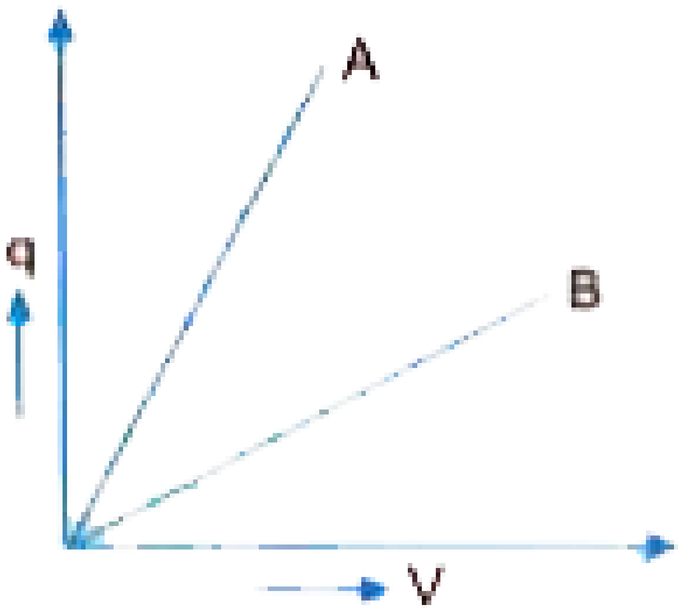
View Text Solution

36. The distance between the plates of a parallel plate capacitor is d. A metal plate of thickness d/2 is placed between the plates, without touching either of the two plates. What will be the new capacity ?

View Text Solution

37. The given graph [Figure] shows variation of charge 'q' versus potential difference V for two capacitors C_1 and C_2. Both the capacitors have same plate separation but plate area of C_2 is greater then that of C_1. Which line (A or

B) corresponds to C_1 and why ?



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38. Write two properties by which electric potential is related to the electric field.

View Text Solution

39. Where does the energy of a capacitor reside ?

View Text Solution

40. Two insulated metal spheres of different capacitances charged to different potentials are joined together by a wire so as to share their charges. What happens to the total electrical energy of the system?

View Text Solution

Short Answer Questions

1. Find an expression for the potential at a point due to a point charge Q.

View Text Solution

2. How does electric potential vary from point to point due to a thin charged spherical shell ?

Draw a graph showing variation of potential with distance.

View Text Solution

3. Two spherical conductors of radii R, and R2 (R2 > Ri) are charged. If they are connected by a conducting wire, find out the ratio of the surface charge densities on them.

View Text Solution

4. Draw a plot showing the variation of (i) electric field E, and (ii) electric potential V with distance 'r' due to a point charge Q.

View Text Solution

5. Derive an expression for the electric potential at any point along the axial line of an electric dipole.

View Text Solution

6. Deduce an expression for the electric potential due to an electric dipole at any point on its axis. Mention one contrasting feature of electric potential at a point due to dipole as compared to that due to a single charge.

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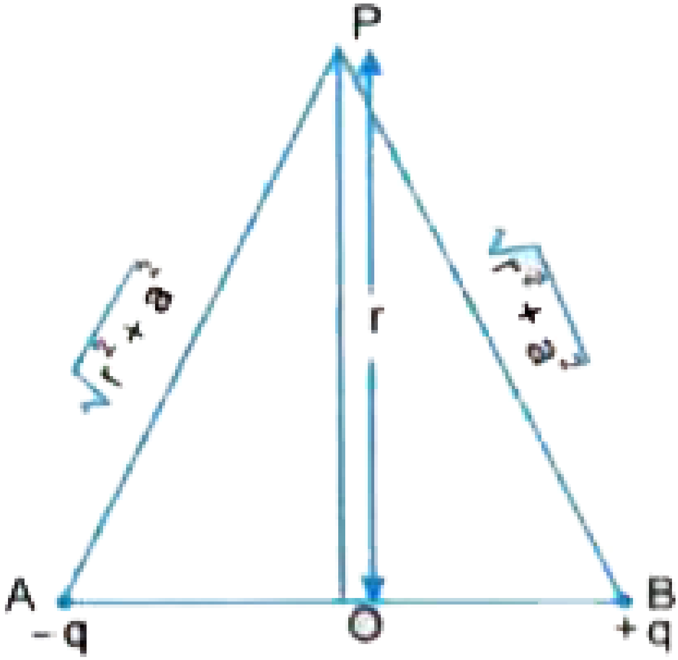
7. Show mathematically that the potential at a point on the equatorial line of an electric dipole is zero.



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8. Derive an expression for the work done in rotating an electric dipole of dipole moment 'p' in a uniform electric field 'E' from an orientation θ_1 to θ_2.

View Text Solution

9. A dipole is present in an electrostatic field of magnitude $10^6 NC^{-1}$. If the work done in rotating it from its position of stable equilibrium to its positionof unatable equilibriumequals $2 \times 10^{-23} J$,find the magnitude of the dipole moment of this dipole.

View Text Solution

10. Calculate the amount of work done in turing an electric dipole of dipole moment $2 \times 10^{-8} C - m$ from its position of unstable eqquilibrium to its position of stable equilibrium, in a uniform electric field of 10^{3} N C^{1}.

View Text Solution

11. The electric field and electric potential at any point due to a point charge kept in air si $20NC^{-1}$ and $10JC^{-1}$ respectively. Compute the magnitude of this charge.

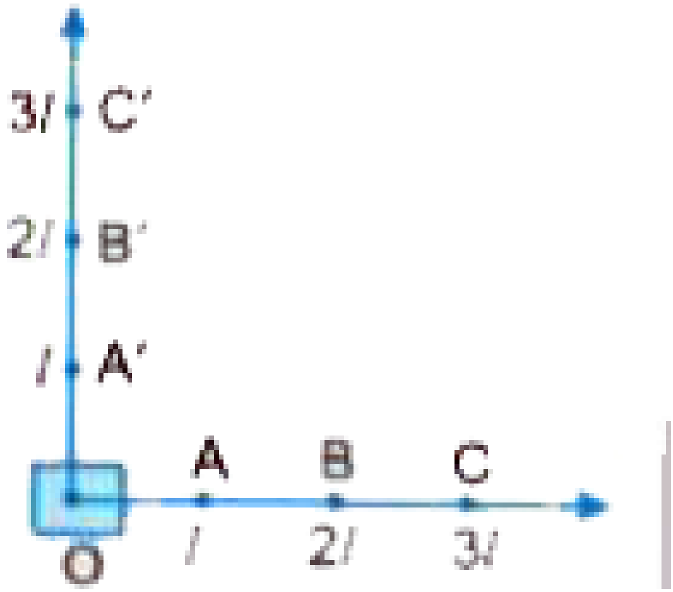
View Text Solution

12. Calculate the electric potetial at the surface of a gold nucles. Given, the radius of nucleus $= 6.6 \times 10^{-15}$ m and atomic number of gold = 79.

View Text Solution

13. The following data was obtained for the dependence of the magnitude of the electric field, with distance,form a refernce point O, within the chargedistribution in the shaded region figure.

Field point	A	B	C	A'	B'	C'
Magnitude of electric field	E	$\frac{E}{8}$	$\frac{E}{27}$	$\frac{E}{2}$	$\frac{E}{16}$	$\frac{E}{54}$

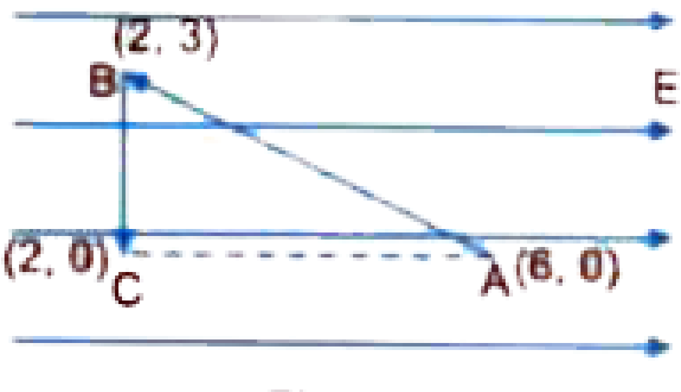


(i) Identify the charge distribution and justify your answer.

(ii) If the potential due to this charge distribution, has a value V at the point A, what is its value at the point A'?

View Text Solution

14. A test charge 'q' is moved without acceleration from A to C along the path from A to B and then from B to C in electric field E as shows in the figure. (i) Calculate the potential difference between A and C. (ii) At which point (of the two) is the electric potential more and why ?



View Text Solution

15. An electric dipole is held in a uniform electric field.

Show that the net force acting on it is zero.

View Text Solution

16. An electric dipole is held in a uniform electric field.

The dipole is aligned parallel to the field.Find the work done is rotating it through the angle of 180°.

View Text Solution

17. What is an equipotential surface ? Show that the electric field at a point on the surface of a charged conductor or just outside it is perpendicular to the surface ?

View Text Solution

18. State main characteristics of an equipotential surface.

View Text Solution

19. Can two equipotential surfaces intersect each other? Give reasons.

View Text Solution

20. Two charges - q and + q are located at points A(0, 0, -a) and B(0, 0, +a) respectively. How much work is done in moving a test charge from point P(7,0,0) to Q(-3,0,0) ?

View Text Solution

21. Draw 3 equipotential surfaces corresponding to a field that uniformly increases in magnitude but remains constant along Z-direction. How are these surfaces different from that of a constant electric field along Z-direction ?

View Text Solution

22. Draw the equipotential surfaces due to an electric dipole. Locate the points where potential due to the dipole is zero.

View Text Solution

23. wo uniformly large parallel thin plates having charge densities $+\sigma$ and $-\sigma$ are kept in the X-Z plane at a distance 'd' apart. Sketch an equipotential surface due to electric field between the plates. If a particle of mass m and charge'- q' remains stationary between the plates, what is the magnitude and direction of this field ?

View Text Solution

24. Two point charges $10\mu C$ and $-10\mu C$ are separated by a distance of 40 cm in air. Calculate the electrostatic potential energy of the system, assuming the zero of the potential energy to be at infinity.

View Text Solution

25. Two point charges $10\mu C$ and $-10\mu C$ are separated by a distance of 40 cm in air. Draw an equipotential surface of the system.

View Text Solution

26. Two point charges $+4\mu C$ and $-2\mu C$ are separated by a distance of 1 m in air. Calculate at what point on the line joining the two charges is the electric potential zero.

View Text Solution

27. Two point charges, $q_1 = 10 \times 10^{-8} C$ and $q_2 = -2 \times 10^{-8} C$, are separated by a distance of 60 cm in air.

Find at what distance from the 1st charge q_1, would the electric potential be zero.

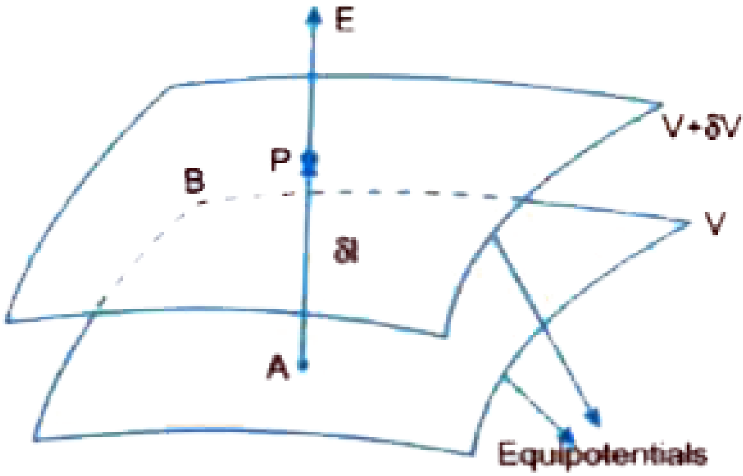
View Text Solution

28. Two point charges, $q_1 = 10 \times 10^{-8} C$ and $q_2 = -2 \times 10^{-8} C$, are separated by a distance of 60 cm in air.

Also calculate the electrostatic potential energy of the system.

View Text Solution

29. Two closely spaced equipotential surfaces A and B with potentials V and $V + \delta V$ (where SV is the change in V) are kept 8l distance apart as shown in the Fig. Deduce the relation between the electric field and the potential gradient between them. Write the two important conclusions concerning the relation between the electric field and the electric potential.



View Text Solution

30. Derive an expression for the potential energy of an electric dipole of dipole moment $\vec{p}$ in an electric field $\vec{E}$.

View Text Solution

View Text Solution

31. Calculate the amount of work done to dissociate a system of three charges of $1\mu C, 1\mu C$ and $-4\mu C$ placed on the vertices of an equilateral triangle of side 10 cm.

View Text Solution

32. In a quark model of elementary particles, a neutron is made of one up quark (charge $=\frac{2}{3}e$) and two down quarks (charges $=\frac{1}{3}e$

). Assume that they have a triangle configuration with side length of the order of $10^{-15}m$. Calculate electrostatic potential energy of neutron.

View Text Solution

33. Explain the working principle of a parallel plate capacitor.

View Text Solution

34. Define dielectric constant of a medium. Briefly explain why the capacitance of a parallel plate capacitor increases, on introducing a dielectric medium between the plates.

View Text Solution

35. Derive an expression for the energy stored in a charged parallel plate capacitor.

View Text Solution

36. Net capacitance of three identical capacitors in series is $1\mu F$. What will be their net capacitance if connected in parallel ?

Find the ratio of energy stored in the two configurations if they are both connected to the same source.

View Text Solution

37. Two identical capacitors of 12 pF each are connected in series across a 50 V battery.

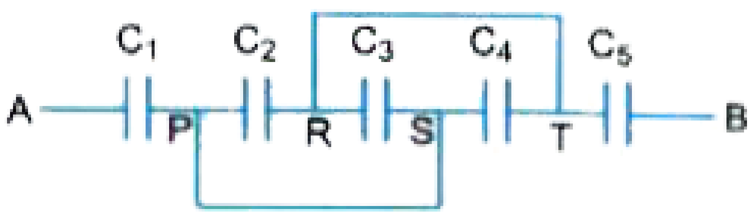
Calculate the electrostatic energy stored in the combination. If these were connected in parallel across the same battery, find out the value of the energy stored in this combination.

View Text Solution

38. Find the ratio of the potential differences that must be applied across the parallel and series combination of two capacitors C_1 and C_2 with their capacitances in the ratio 1 : 2 so that the energy stored in the two cases becomes the same.

View Text Solution

39. Find equivalent capacitance between A and B in the combination given below. Each capacitor is of $2\mu F$ capacitance.

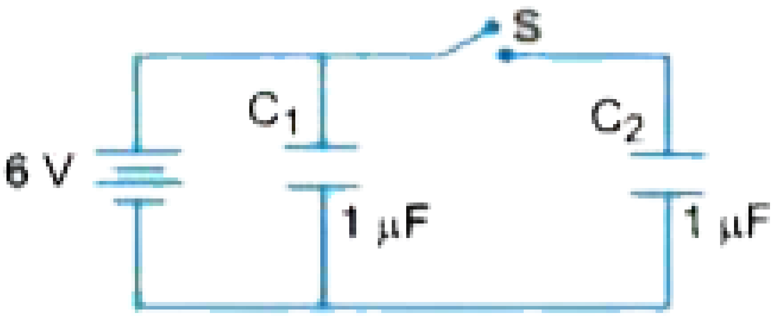


View Text Solution

40. If a.b.c source of 7V is connected across AB, how much charge is drawn from the source and what is the energy stored in the network ?

View Text Solution

41. Figure shows two idential capacitors, C_1 and C_2, each of $1\mu F$ capacitance connected to a battery of 6 V. Initially switch 'S' is closed. After sometime 'S' is left open and dielectric slabs of dielectric constant K = 3 are inserted to fill completely the space between the plates of the two capacitors. How will the (i) charge and (ii) potential difference between the plates of the capacitors be affected after the slabs are inserted?

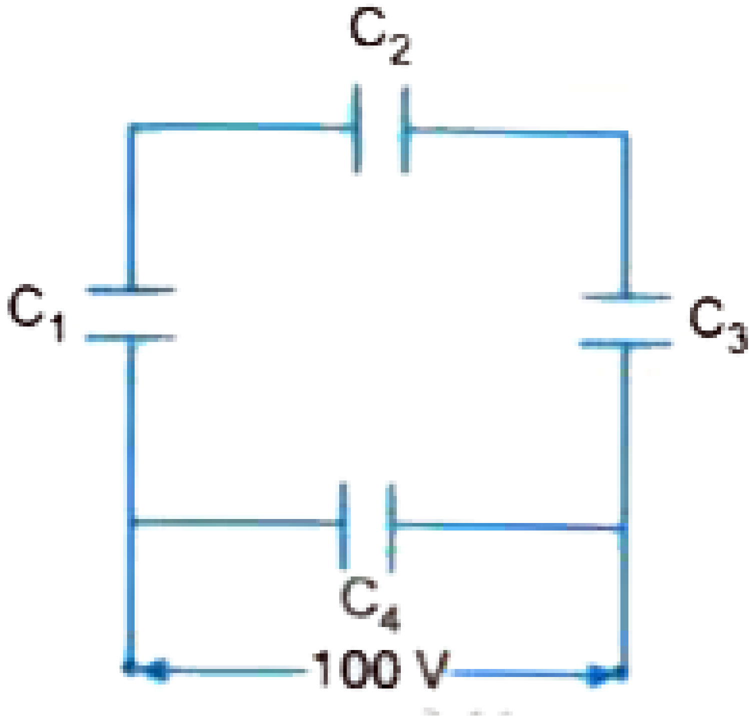


View Text Solution

42. Two capacitors of capacitance of $6\mu F$ and $12\mu F$ are connected in series with a battery. The voltage across the $6\mu F$ capacitor is 2 V.Compute the total battery voltage.

View Text Solution

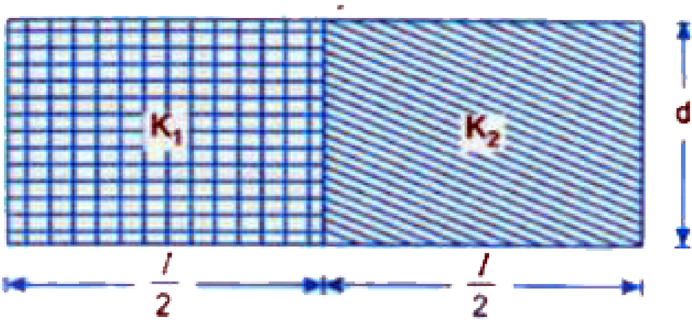
43. A network of four capacitors, each of capacitance $15\mu F$,is connected across a battery of 100 V as shown in the figure. Find the net capacitance and the charge on the capacitor C_4.



View Text Solution

44. Two dielectric slabs of dielectric constants

K_1 and K_2 are filled in between the two plates, each of area A, of the parallel plate capacitor as shown in the figure. Find the net capacitance of the capacitor.



View Text Solution

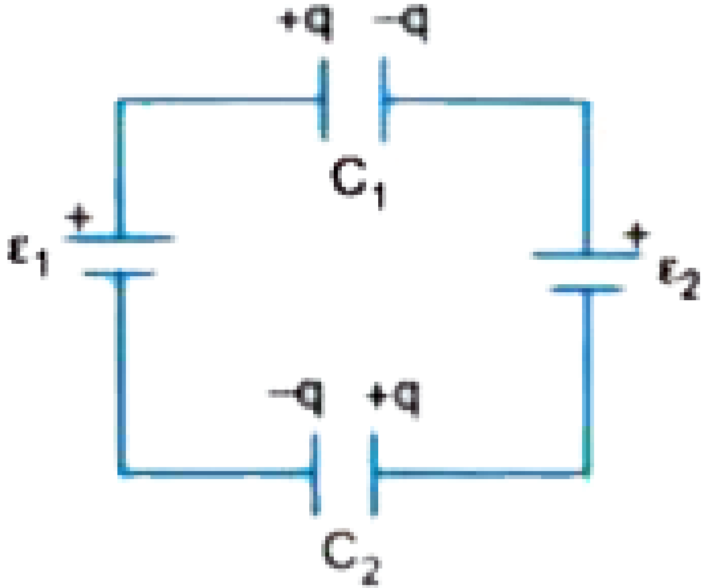
45. A parallel plate capacitor of capacitance C is charged to a potential V. It is then connected to another uncharged capacitor having the same capacitance. Find out the ratio of the electrostatic energy stored in the combined system to that stored initially in the single capacitor.

View Text Solution

46. A slab of material of dielectric constant K has the same area as that of the plates of a parallel plate capacitor but has the thickness d/2, where d is the separation between the plates. Find out the expression for its capacitance when the slab is inserted between the plates of the capacitor.

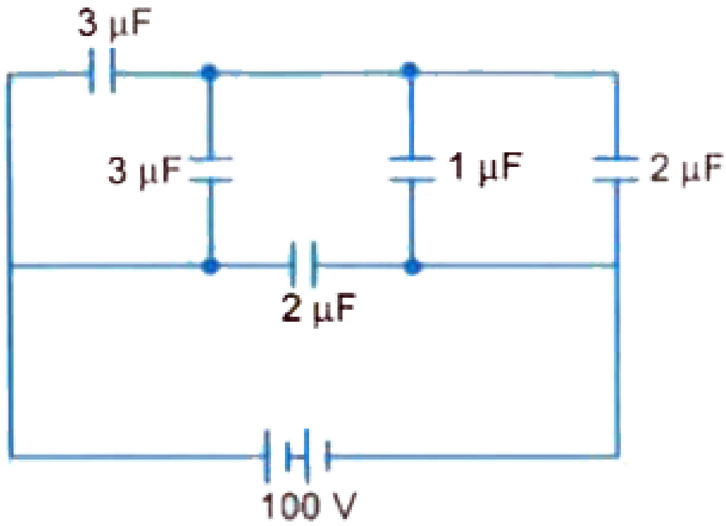
View Text Solution

47. Determine the potential difference across the plates of the capacitor C_1 of the network shown in the Fig. Assume $\varepsilon_1 > \varepsilon_2$.



View Text Solution

48. The figure shows a network of five capacitors connected to a 100 V supply, Calculate the total energy stored in the network.



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Long Answer Questions I

1. Two point charges q_1, q_2 initially at infinity are brought one by one points P_1 and P_2 specified by position vectors r_1 and r_2 , relative to some origin . What is the potential energy of this energy configuration ?

View Text Solution

2. Calculate the electrostatic potential energy of a system of three point charges q_1, q_2 and

q_3 located respectively at $\vec{r}_1$, $\vec{r}_2$ and $\vec{r}_3$ with respect to a common origin O.

View Text Solution

3. Depict the equipotential surfaces for a system of two identical positive point charges placed a distance 'd' apart.

View Text Solution

4. Deduce the expression for the potential energy of a system of two point charges q_1 and q_2 brought from infinity to the points $\overrightarrow{r}_1$ and $\overrightarrow{r}_2$ respectively in the presence of external electric field $\overrightarrow{E}$.

View Text Solution

5. Define the term electric potential due to a point charge .

Calculate the electric potential at the centre of a square , of side $\sqrt{2}$ m , having charges $100\mu C, -50\mu C, 20\mu C$ and $-60\mu C$ at the four corners of this square .

View Text Solution

6. Four point charges Q , q Q and q are placed at the corners of a square of side 'a' as shown in the Fig. Find the

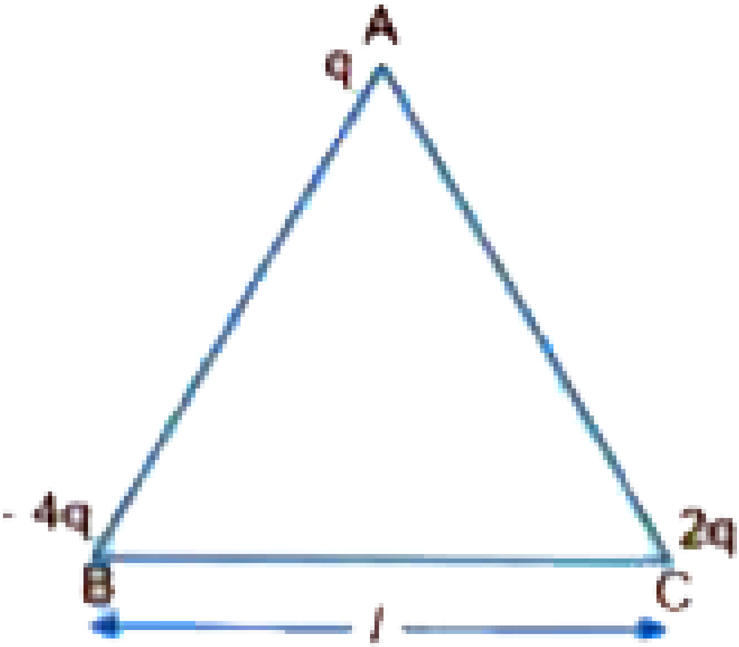
resultant electric force on a charge Q

View Text Solution

7. Four point charges Q , q Q and q are placed at the corners of a square of side 'a' as shown in the Fig. Find the potential energy of this system .

View Text Solution

8. Three point charges $q, -4q$ and $2q$ are placed at the vertices of an equilateral triangle ABC of side 'l' as shown in the Fig. Obtain the experssion for the magnitude of the resultant electric force acting on the charge q.



View Text Solution

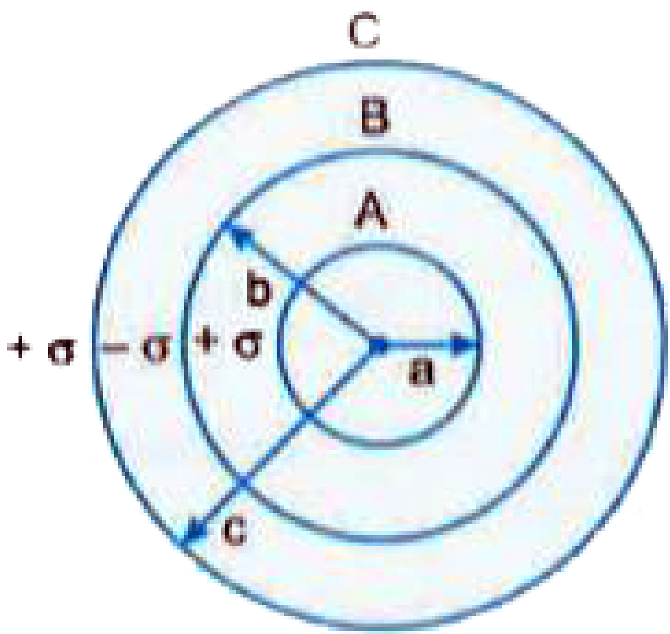
9. Find out the amount of the work done to separate the charges at infinite distance .

View Text Solution

10. A charge Q is distributed over the surfaces of two concentric hollow spheres of radii r and $R(R > > r)$, such that their surface charge densities are equal . Derive the expression for the potential at the common centre.

View Text Solution

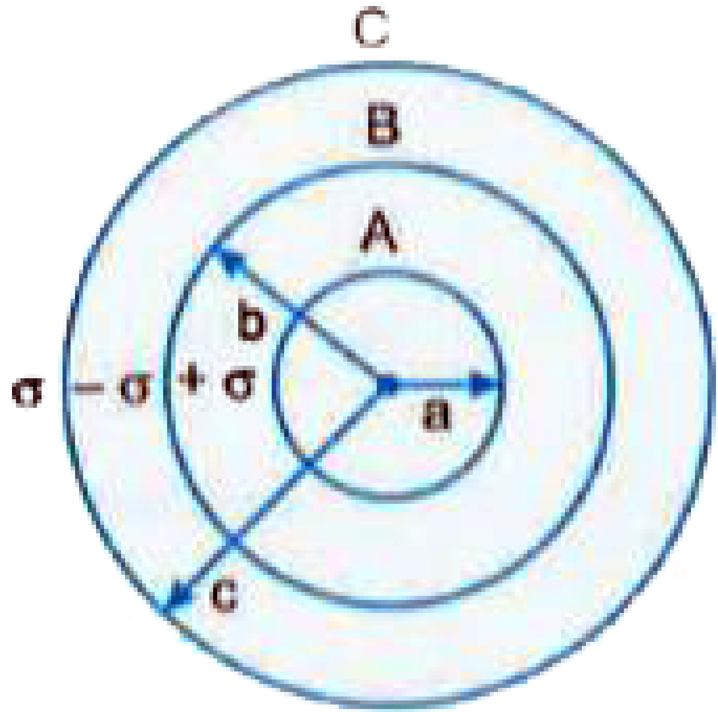
11. Three concentric metallic shells A , B and C of radii a, b and c $(a < b < c)$ have surface densities $+\sigma, \; -\sigma$ and $+\sigma$ respectively as shown in Fig.



Obtain the expressions for the potential of three shells A , B and C .

View Text Solution

12. Three concentric metallic shells A , B and C of radii a, b and c $(a < b < c)$ have surface densities $+\sigma, -\sigma$ and $+\sigma$ respectively as shown in Fig.



If shells A and C are at the same potential , obtain the relation between a , b and c.

View Text Solution

13. Establish a relation for electric potential due to short dipole at a point distance r from the dipole along a line inclined at an angle θ from the dipole axis . Hence obtain value of electric potential at a point lying along (i) axial line , (ii) equatoral line of the dipole .

View Text Solution

14. Explain the underlying principle of working of a parallel plate capacitor .

If two similar plates , each of area A , having surface charge densities $+\sigma$ and $-\sigma$ are separated by a distance 'd' in air , write expression for :

the electric field at points between the plates .

View Text Solution

15. Explain the underlying principle of working of a parallel plate capacitor .

If two similar plates , each of area A , having surface charge densities $+\sigma$ and $-\sigma$ are separated by a distance 'd' in air , write

expression for :

the potential difference between the plates.

View Text Solution

16. Explain the underlying principle of working of a parallel plate capacitor .

If two similar plates , each of area A , having surface charge densities $+\sigma$ and $-\sigma$ are separated by a distance 'd' in air , write expression for :

the capacitance of the capacitor so formed .

View Text Solution

17. Find an expression for the equivalent capacitance of a combination of three capacitors in series .

View Text Solution

18. Deduce an expression for the capacitance of a parallel plate capacitor having plate area 'A' and plate separation 'd'.

View Text Solution

19. Obtain an expression for the capacitance of a combination of three capacitors in parallel .

View Text Solution

20. Deduce an expression for the electrostatic energy stored in a capacitance 'C' and having charge Q

How will the energy stored

View Text Solution

21. Deduce an expression for the electrostatic energy stored in a capacitance 'C' and having charge Q

How will the electric field inside capacitor be affected when it is completely filled with a dielectric material of dielectric constant K ?

View Text Solution

22. A parallel plate capacitor of capacitance C is charged to a potential V by a battery . Without disconnecting the battery , the distance between the plates is tripled and a dielectric medium of dielectric constant 10 is introduced between the plates of the capacitor . Explain giving reasons , how will the

following be affected :

capacitance of the capacitor

View Text Solution

23. A parallel plate capacitor of capacitance C is charged to a potential V by a battery . Without disconnecting the battery , the distance between the plates is tripled and a dielectric medium of dielectric constant 10 is introduced between the plates of the capacitor . Explain giving reasons , how will the

following be affected :

charge on the capacitor

View Text Solution

24. A parallel plate capacitor of capacitance C is charged to a potential V by a battery . Without disconnecting the battery , the distance between the plates is tripled and a dielectric medium of dielectric constant 10 is introduced between the plates of the capacitor . Explain giving reasons , how will the

following be affected :

energy density of the capacitor .

View Text Solution

25. A parallel plate capacitor is charged by a battery . After sometime the battery is disconnected and a dielectric slab with its thickness equal to the plate separation is inserted between the plates . How will the capacitancee of the capacitor. ? Justify your answer

View Text Solution

26. A parallel plate capacitor is charged by a battery . After sometime the battery is disconnected and a dielectric slab with its thickness equal to the plate separation is inserted between the plates . How will potential difference between the plates ? Justify your answer

View Text Solution

27. A parallel plate capacitor is charged by a battery . After sometime the battery is disconnected and a dielectric slab with its thickness equal to the plate separation is inserted between the plates . How will the energy stored in the capacitor be affected ? Justify your answer

View Text Solution

28. A parallel plate capacitor , each with plate area A and separation d , is charged to a potential difference V . The battery used to charge it remains connected . A dielectric slab of thickness of and dielectric constant K is now placed between the plates . What change , if any , will take place in :

charge on plates ?

Justify your answer

View Text Solution

29. A parallel plate capacitor , each with plate area A and separation d , is charged to a potential difference V . The battery used to charge it remains connected . A dielectric slab of thickness of and dielectric constant K is now placed between the plates . What change , if any , will take place in :

electric filed intensity between the plates ? Justify your answer .

View Text Solution

30. A parallel plate capacitor , each with plate area A and separation d , is charged to a potential difference V . The battery used to charge it remains connected . A dielectric slab of thickness of and dielectric constant K is now placed between the plates . What change , if any , will take place in :

capacitance of the capacitor ? Justify your answer .

View Text Solution

31. A capacitor of unknown capacitance is connected across a battery of V volts . The charge stored in it is $360\mu C$. When potential across the capacitor is reduced by 120 V , the charge stored in it becomes 120 μC . Calculate :

The potential V and the unknown capacitance C .

View Text Solution

32. A capacitor of unknown capacitance is connected across a battery of V volts . The charge stored in it is $360\mu C$. When potential across the capacitor is reduced by 120 V , the charge stored in it becomes 120 μC . Calculate :

What will be the charge stored in the capacitor , if the voltage applied had increased by 120 V ?

View Text Solution

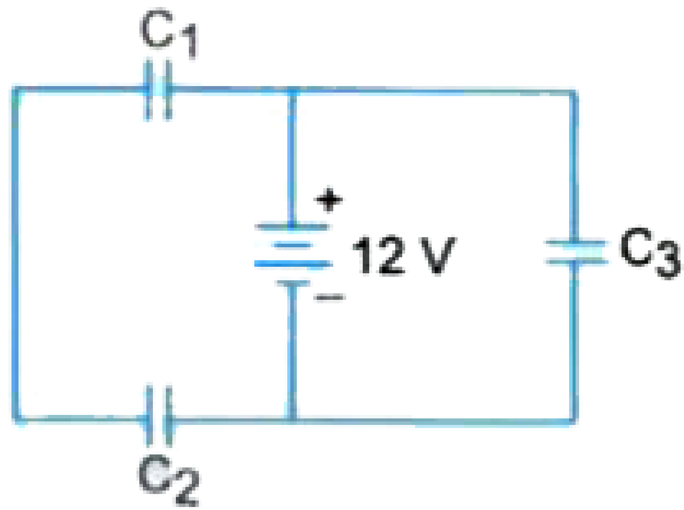
33. Two capacitors of unknown capacitances C_1 and C_2 are connected first in series and then in parallel across a battery of 100 V . If the energy stored in the two combinations is 0.045 J and 0.25 J respectively , determine the value of C_1 and C_2 . Also calculate the charge on each capacitor in parallel combination .

View Text Solution

34. Find the total energy stored in the capacitors in the given network of Fig.

View Text Solution

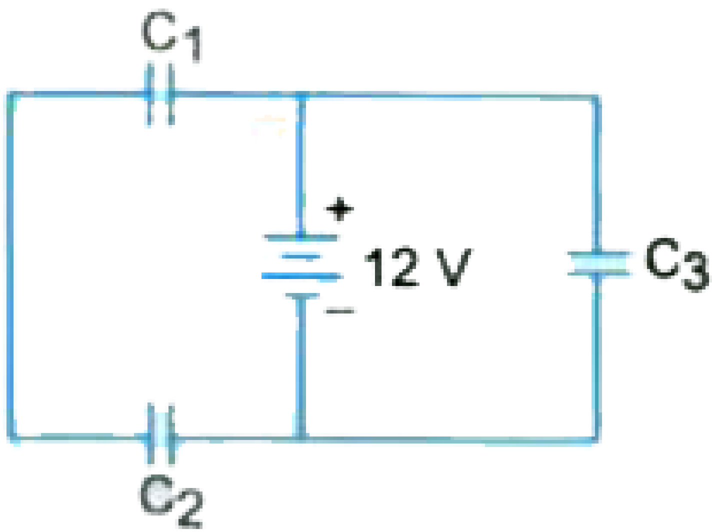
35. Three identical capacitors C_1, C_2 and C_3 of capacitance $6\mu F$ each are connected to a 12 V battery as shown in Fig



charge on each capacitor

View Text Solution

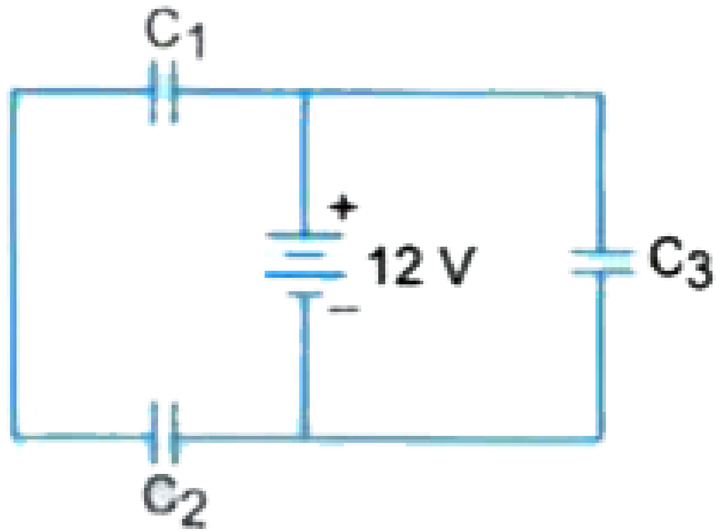
36. Three identical capacitors C_1, C_2 and C_3 of capacitance $6\mu F$ each are connected to a 12 V battery as shown in Fig



equivalent capacitance of the network

View Text Solution

37. Three identical capacitors C_1, C_2 and C_3 of capacitance $6\mu F$ each are connected to a 12 V battery as shown in Fig



energy stored in the network of capacitors .

View Text Solution

38. Two parallel plate capacitors X and Y have the same area of plates and same separation between them , X has air between the plates while Y contains a dielectric medium of $\varepsilon_r = 4$. Calculate capacitance of each capacitor if equivalent capacitance of the combination is $4 \mu F$.

View Text Solution

39. Two parallel plate capacitors X and Y have the same area of plates and same separation between them , X has air between the plates while Y contains a dielectric medium of $\varepsilon_r = 4$. Calculate the potential difference between the plates of X and Y.

View Text Solution

40. Two parallel plate capacitors X and Y have the same area of plates and same separation between them , X has air between the plates while Y contains a dielectric medium of $\varepsilon_r = 4$. Estimate the ratio of electrostatic energy stored in X and Y .

View Text Solution

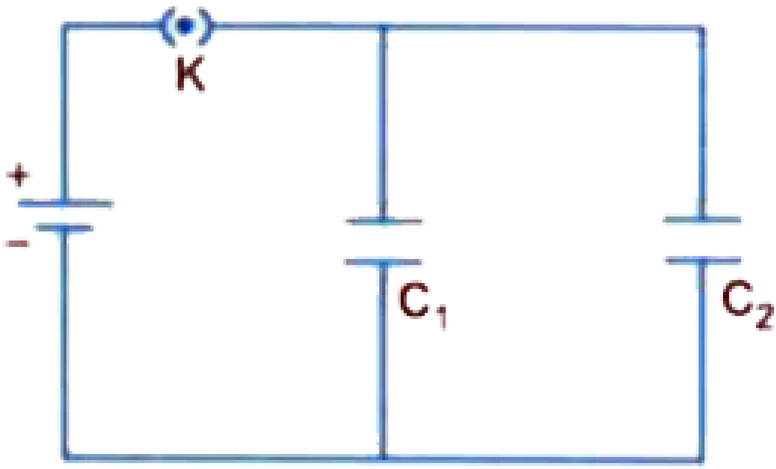
41. Two identical capacitors of 12 pF each are connected in series across a battery of 50 V . How much electrostatic energy is stored in the combination ? If these were connected in parallel across the same battery , how much energy will be stored in the combination now ?

Also find the charge drawn from the battery in each case.

View Text Solution

42. Two parallel plate capacitors of capacitances C_1 and C_2 such that $C_2 = 2C_1$ are connected across battery of V volts as shown in the Fig . Initially the key K is kept closed to fully charge the capacitors . The key

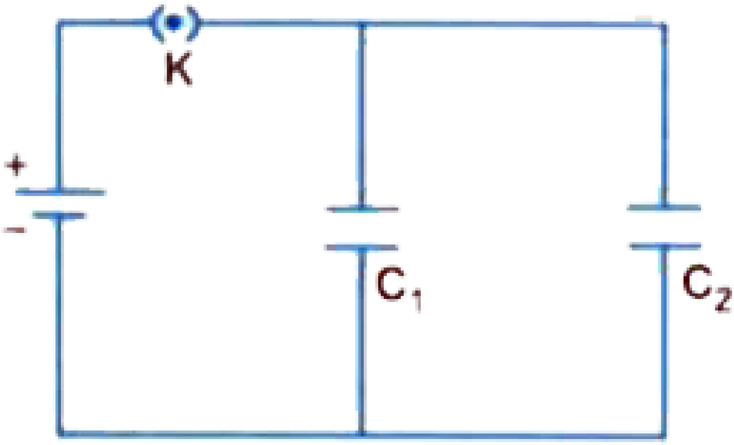
K is now thrown open and dielectric slabs of dielectric constant K_0 are inserted in the two capacitors to completely fill the gap between the plates .



Find the ratio of the net capacitance

View Text Solution

43. Two parallel plate capacitors of capacitances C_1 and C_2 such that $C_2 = 2C_1$ are connected across battery of V volts as shown in the Fig . Initially the key K is kept closed to fully charge the capacitors . The key K is now thrown open and dielectric slabs of dielectric constant K_0 are inserted in the two capacitors to completely fill the gap between the plates .



Find the ratio of the energies stored in the combination before and after the introduction of dielectric slabs .

View Text Solution

44. A 12 pF capacitor is connected to a 50 V battery . How much electrostatic energy is stored in the capacitor ? If another capacitor of 6 pF is connected in series with it with the same battery connected across the combination , find the charge stored and potential difference across each capacitor.

View Text Solution

45. Calculate the potential difference and the energy stored in the capacitor C_2 in the circuit shown in the Fig. Given potential at A is 90 V ,

$C_1 = 20\mu F, C_2 = 30\mu F$ and $C_3 = 15\mu F$

View Text Solution

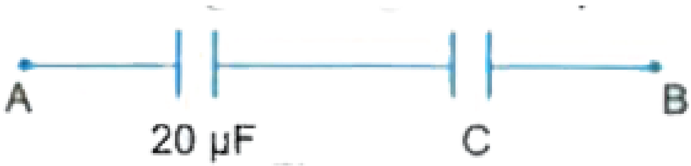
46. The equivalent capacitance of the combination between A and B in the given figure is $4\mu F$.

Calculate capacitance of the capacitor C.

View Text Solution

47. The equivalent capacitance of the combination between A and B in the given figure is $4\mu F$.

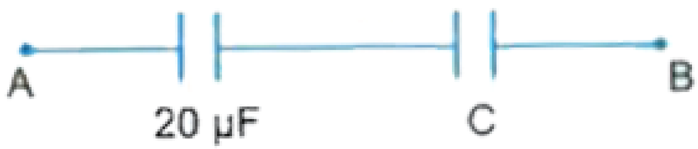
Calculate charge on each capacitor if a 12 V battery is connected across terminals A and B .



View Text Solution

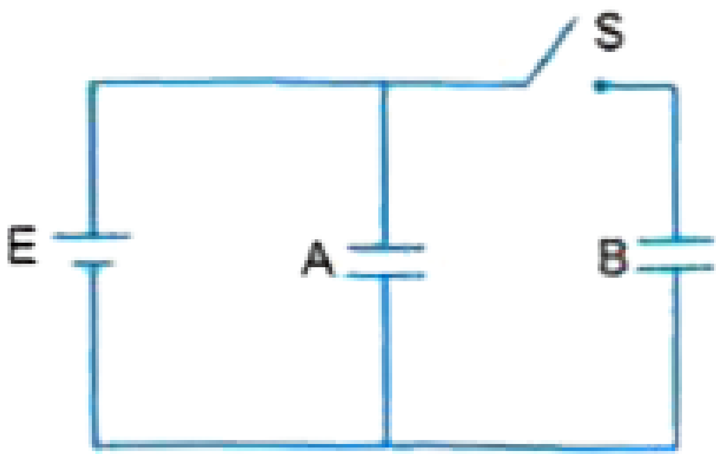
48. The equivalent capacitance of the combination between A and B in the given figure is $4\mu F$.

What will be the potential drop across each capacitor ?



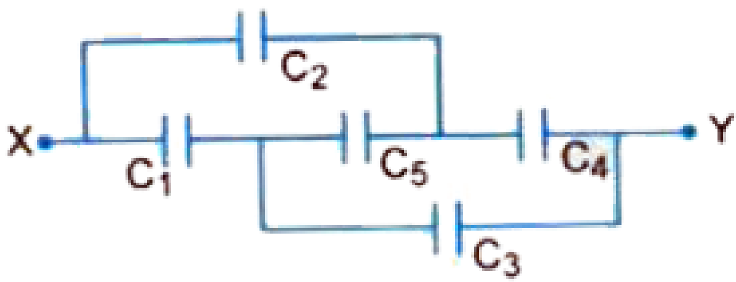
View Text Solution

49. Two identical parallel plate capacitors A and B are connected to a battery of V volts with the switch S closed . The switch is now opened and the free space between the plates of the capacitors is filled with dielectric of dielectric constant K . Find the ratio of the total electrostatic energy stored in both capacitors before and after the introduction of the dielectric .



View Text Solution

50. Find the equivalent capacitance of the network shown in the fig , when each capacitor is of 1 μF . When the ends X and Y are connected to a 6 V battery , find out (i) the charge and (ii) the energy stored in the network



View Text Solution

51. Two metallic spheres of radii R and 2 R are charged so that both of these have same surface charge density σ. If they are connected to each other with a conducting wire , in which direction will the charge flow and why ?

View Text Solution

52. A conducting slab of thickness 't' is introduced without touching between the plates of a parallel plate capacitor , separated by a distance 'd' $(t < d)$. Derive an expression for the capacitance of the capacitor .

View Text Solution

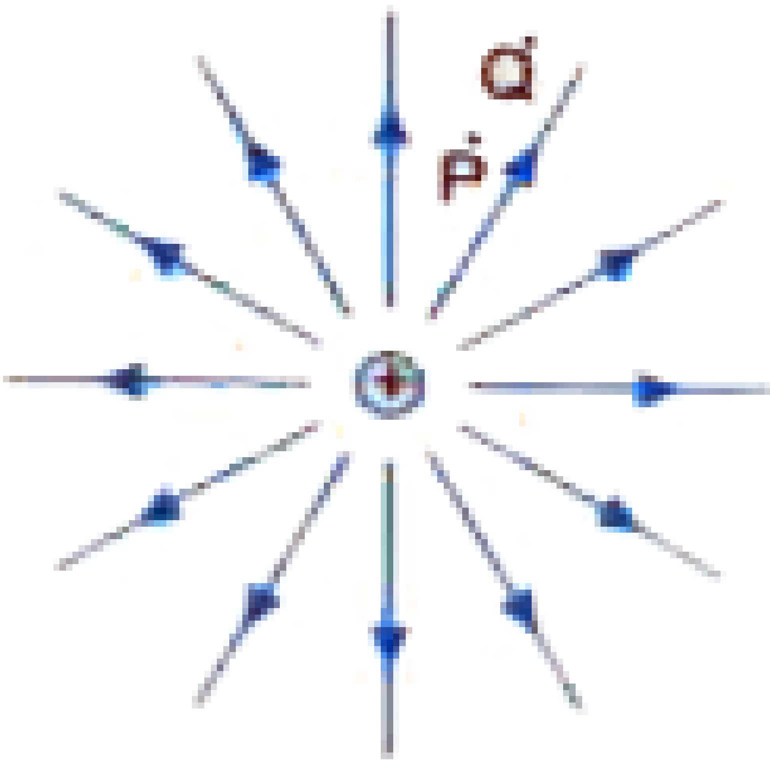
53. A dielectric slab of thickness 't' is kept between the plates of a parallel plate capacitor separated by a distance 'd' $(t < d)$. Derive the expression for the capacity of the capacitor .

View Text Solution

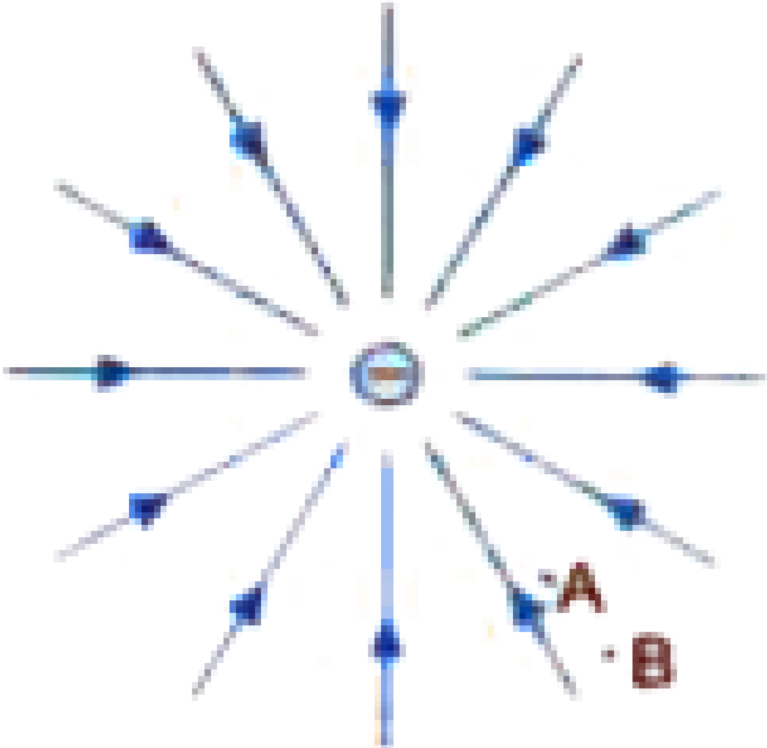
54. Fig (a) and (b) show the field lines of a single positive and negative charges respectively .

Give the signs of the potential difference :

$V_P - V_Q, V_B - V_A$



(a)

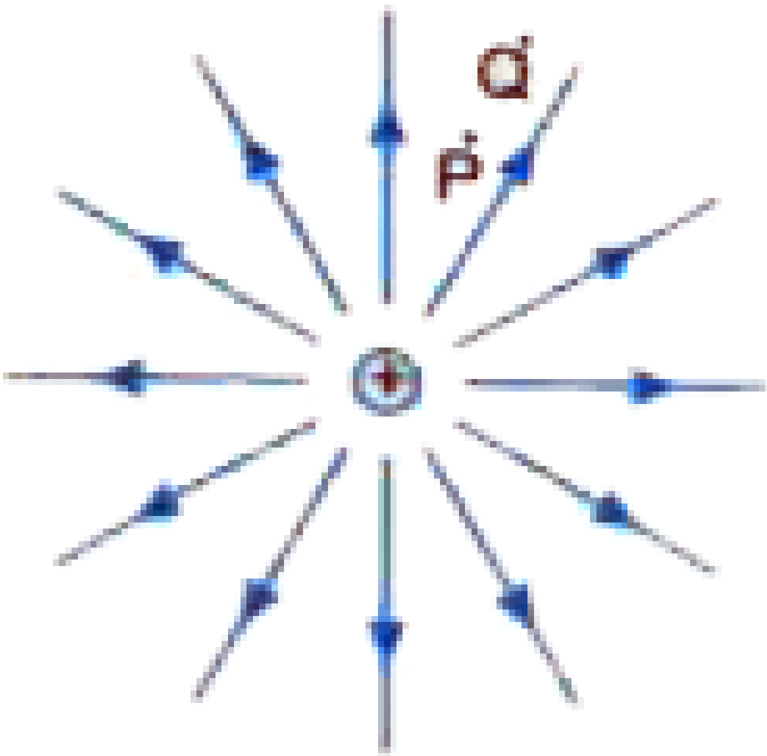


(b)

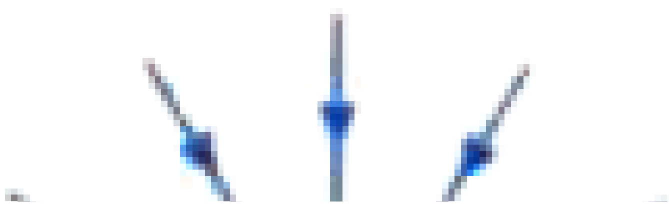
View Text Solution

55. Fig (a) and (b) show the field lines of a single positive and negative charges respectively .

Give the sign of the potential energy difference of a small negative charge between the points Q and P , A and B .



(a)



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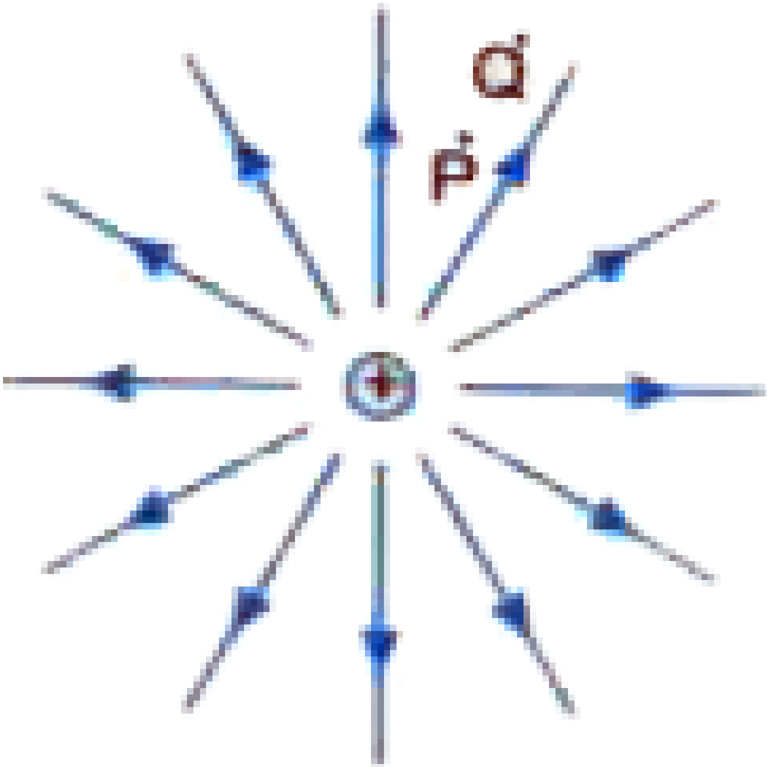
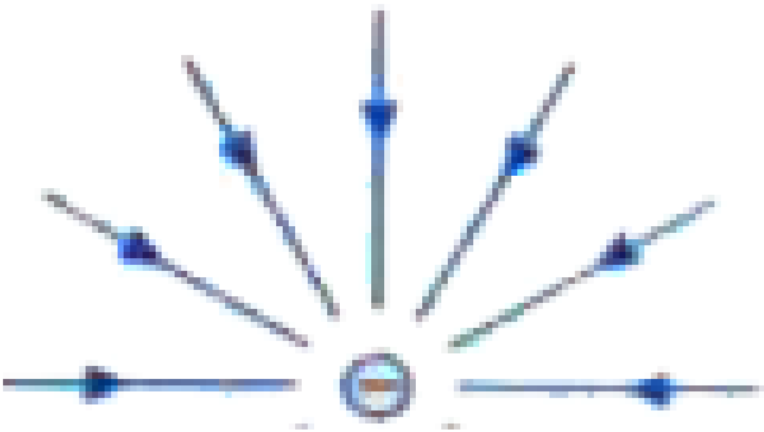
56. Fig (a) and (b) show the field lines of a single positive and negative charges respectively .

Give the sign of the work done by the field in moving a small positive charge from Q to P.



(a)



(b)

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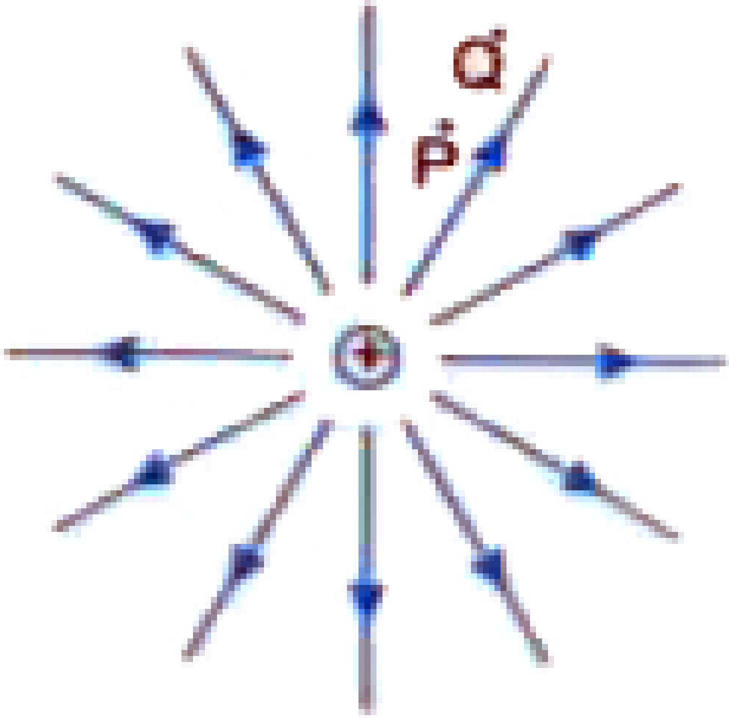
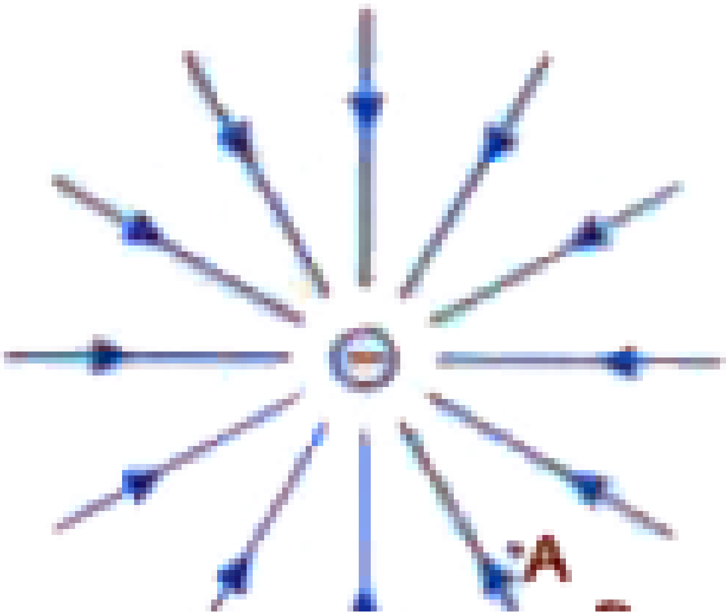
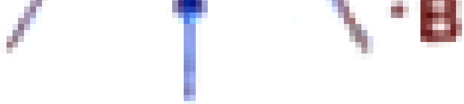
57. Fig (a) and (b) show the field lines of a single positive and negative charges respectively .

Give the sign of the work done by an external agency in moving a small negative charge from B to A .



(a)





(b)

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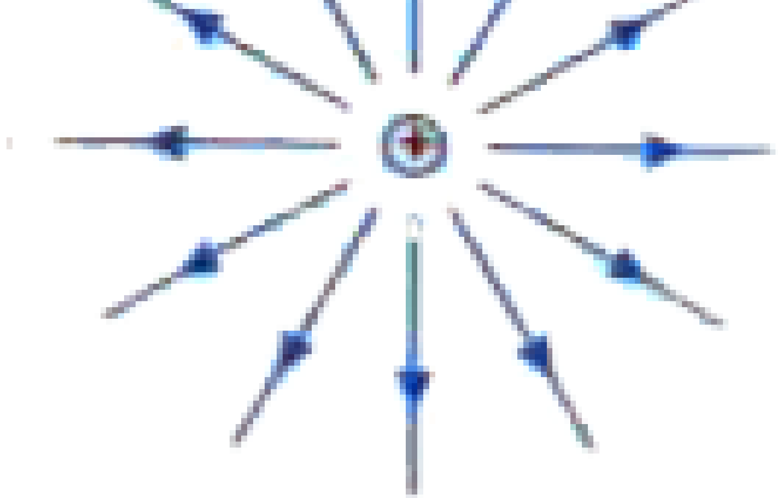
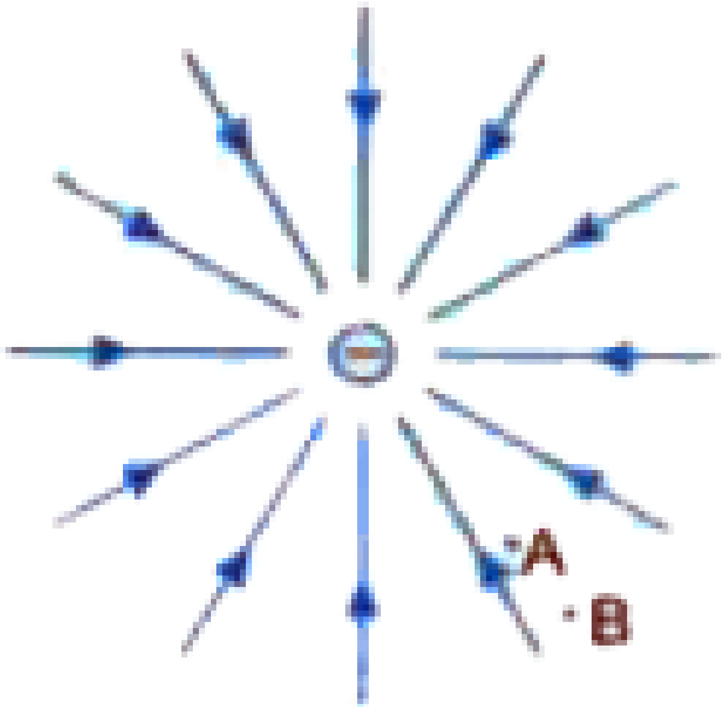
58. Fig (a) and (b) show the field lines of a single positive and negative charges respectively .

Does the kinetic energy of a small negative charge increase or decrease in going from B to A ?



(a)



(b)

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59. The two plates of a parallel plate capacitor are 4 mm apart . A slab of dielectric constant 3 and thickness 3 mm is introduced between the plates with its face parallel to them . The distance between the plates is so adjusted that the capacity of the capacitor becomes $\frac{2}{3}$ rd of its original value . What is the new distance the plates ?

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60. Find an expression for loss of electrical energy when two capacitors (or conductors) maintained at different potential are allowed to share their charges .

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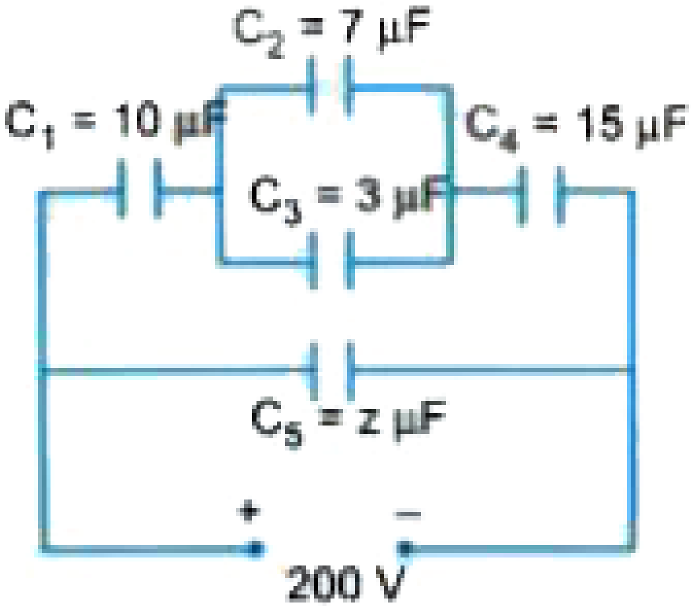
61. A system of capacitors , connected as shown , has a total energy of 160 mJ stored in it . Obtain the value of the equivalent capacitance of this system and the value of x .



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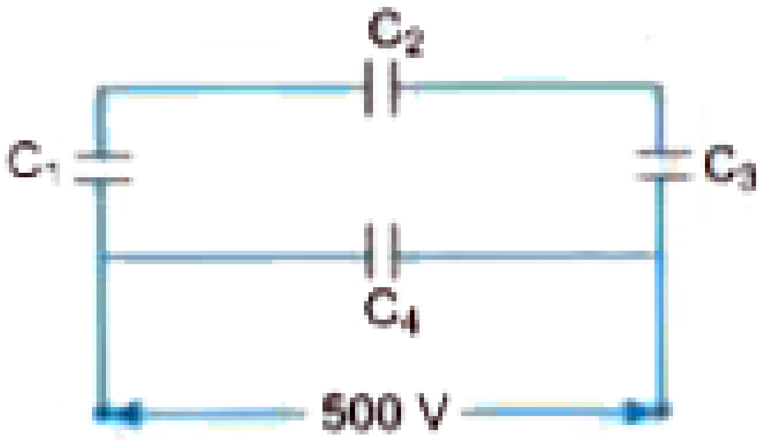
62. A network of four capacitors each of 12 μF capacitance is connected to a 500 V supply as shown in the Fig .



Determine equivalent capacitance of the network .

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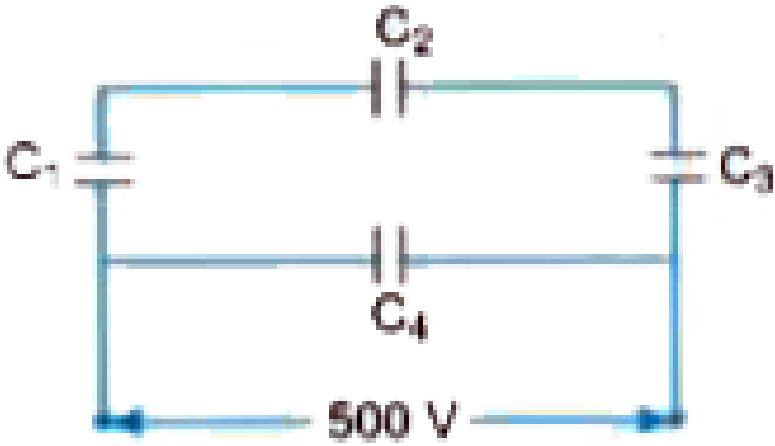
63. A network of four capacitors each of 12 μF capacitance is connected to a 500 V supply as shown in the Fig .



Determine charge on each capacitor .

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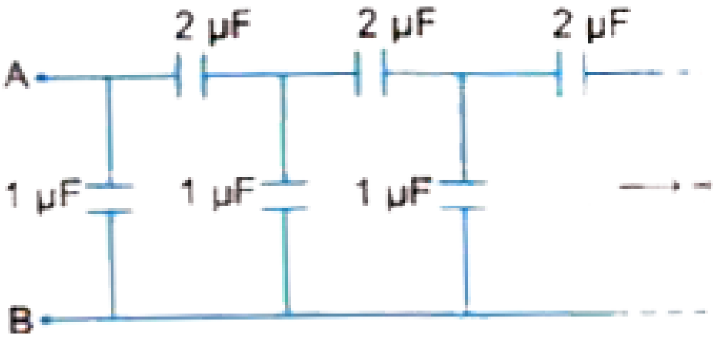
64. Find the capacitance of the infinite ladder of capacitors shown in Fig between points A and B .



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Long Answer Questions Ii

1. Why are the equipotential surfaces about a single charge are not equidistant ?

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2. Can electric field exist longitudinal to an equipotential surface ? Give reason .

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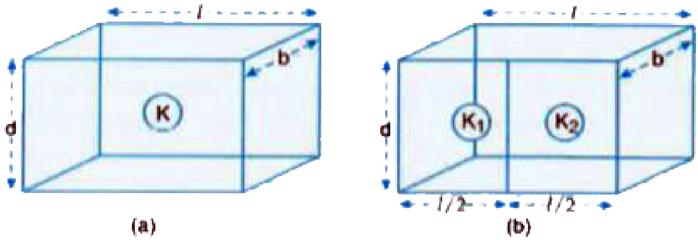
3. Two identical capacitors of plate dimensions $l \times b$ and plate separation 'd' have dielectric slabs filled in between the space of the plates as shown in Fig

Obtain the relation between the dielectric constants K, K_1 and K_2.



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4. Derive an expression for the energy stored in a parallel plate capacitor.

On charging a parallel plate capacitor to a potential V , the spacing between the plates is halved and a dielectric medium of $\in_r$ = 10 is introduced between the plates , without disconnecting the d.c. source . explain , using suitable expressions , how the

(i) capacitance , (ii) electric field , and

(iii) energy density of the capacitor change .

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5. A fully charged parallel plate capacitor is connected across an unchanged identical capacitor . Show that the energy stored in the combination is less than that stored initially in the single capacitor .

6. A capacitor of capacitance C_1 is charged to a potential V_1 , while another capacitor of capacitance C_2 is charged to a potential difference V_2 . The capacitors are now disconnected from their respective charging batteries and connected in parallel to each other

Find the total energy stored in the two capacitors before they are connected .

7. A capacitor of capacitance C_1 is charged to a potential V_1 , while another capacitor of capacitance C_2 is charged to a potential difference V_2 . The capacitors are now disconnected from their respective charging batteries and connected in parallel to each other

Find the total energy stored in the parallel combination of two capacitors.

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8. A capacitor of capacitance C_1 is charged to a potential V_1 , while another capacitor of capacitance C_2 is charged to a potential difference V_2 . The capacitors are now disconnected from their respective charging batteries and connected in parallel to each other

Explain the reason for the difference of energy in parallel combination in comparison to the total energy before they are connected .

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9. Explain , using suitable diagrams , the difference in the behaviour of a (i) conductor and (ii) dielectric in the presence of external electric field . Define the terms polarisation of a dielectric and write its relation with susceptibility.

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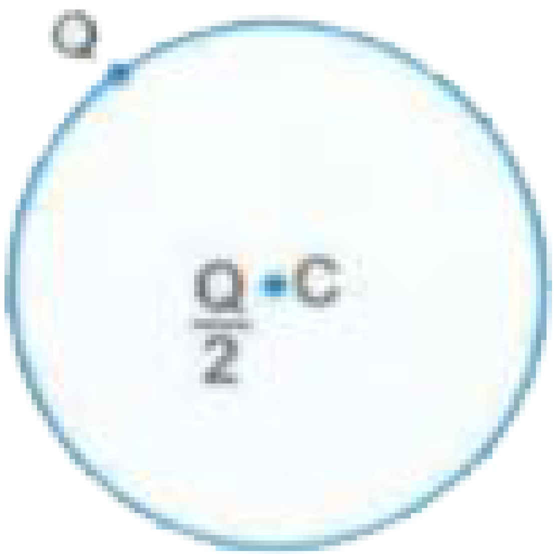
10. A thin metallic spherical shell of radius R carries a charge Q on its surface . A point charge $\frac{Q}{2}$ is placed at its centre C and an other charge +2 Q is placed outside the shell at a distance x from the centre as shown in the Fig . Find (i) the force on the charge at the centre of shell and at the point A , (ii) the electric flux through the shell .



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11. When a parallel plate capacitor is connected across a d.c. battery. Explain briefly how the capacitor gets charged .

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12. A parallel plate capacitor of capacitance 'C' is charged to 'V' volt by a battery . After some time the battery is disconnected and the distance between the plates is doubled . Now a slab of dielectric constant $1 < k < 2$ is introduced to fill the space between the plates

.

How will the following be affected ?

(i) The electric field between the plates of the capacitor .

(ii) The energy stored in the capacitor .

Justify your answer in each case.

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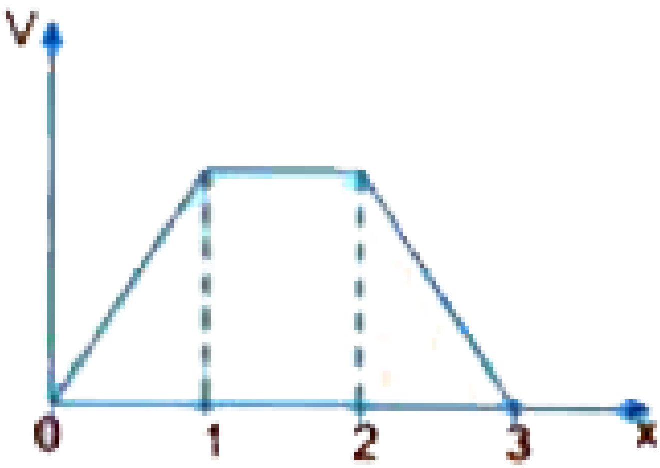
13. The electric potential as a function of distance 'x' is shown in the figure . Draw a graph of the electric field E as a function of x.



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Self Assessment Test

1. Three capacitors of a capacitances $3\mu F, 9\mu F$ and $18\mu F$ are connected initially in series and subsequently in parallel . The ratio of equivalent capacitance in the two cases $\left(\frac{C_s}{C_p}\right)$ will be

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