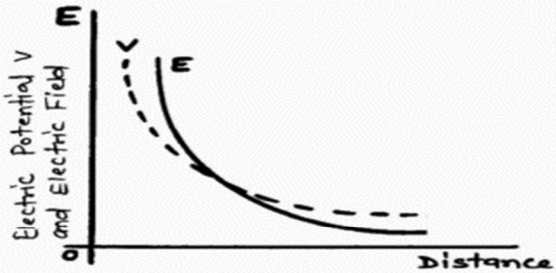
Chapter–2: Electrostatic Potential and Capacitance

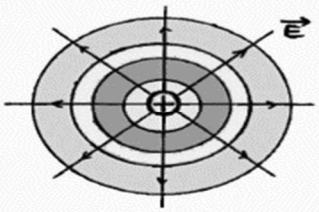
$$V = \frac{q}{4\pi\epsilon_0 r} \qquad V \propto \frac{1}{r}$$

$$E = \frac{q}{4\pi\epsilon_0 r^2} \qquad E \propto \frac{1}{r^2}$$

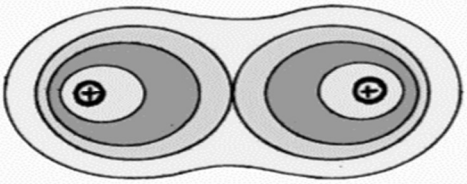


Variation of Electrostatic Potential and Electric field with distance

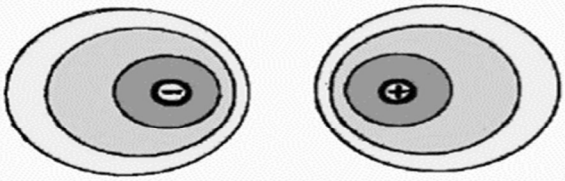
Some equipotential surfaces are shown in figures.



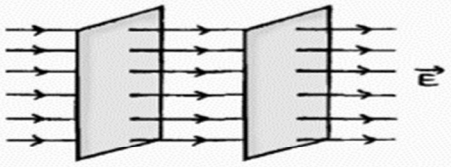
(a) For a point charge



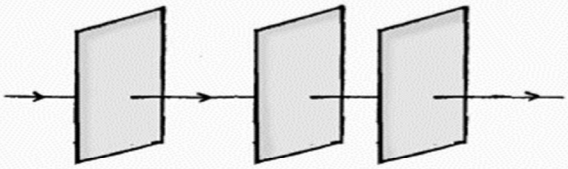
(b) For two identical Positive charges



(c) For an electric dipole

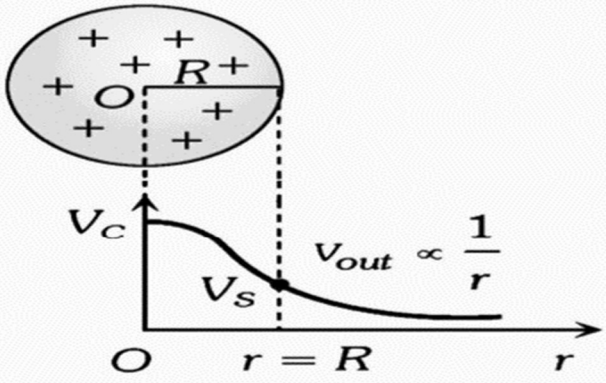


(d) For uniform electric field



(e) For nonuniform electric field.

Electric Potential due to an insulating Sphere



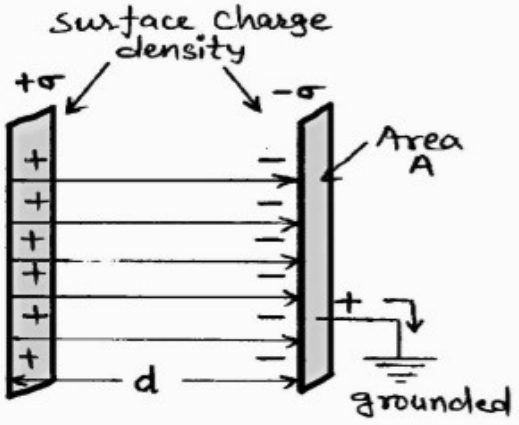
$$V_{out} = \frac{q}{4\pi\epsilon_0 r}$$

$$V_S = \frac{q}{4\pi\epsilon_0 R}$$

$$V_{in} = \frac{q}{4\pi\epsilon_0}\left[\frac{3R^2 - r^2}{2R^3}\right]$$

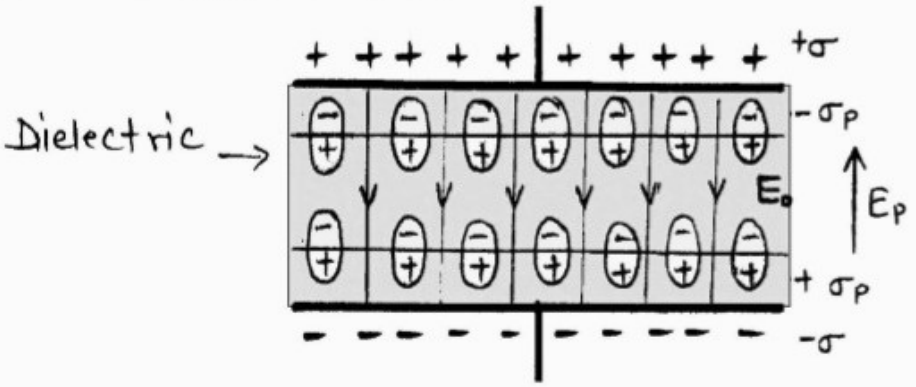
$$V_C = \frac{q}{4\pi\epsilon_0}\left(\frac{3}{2R}\right)$$

Parallel Plate Capacitor



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

Effect of Dielectric on Capacitance

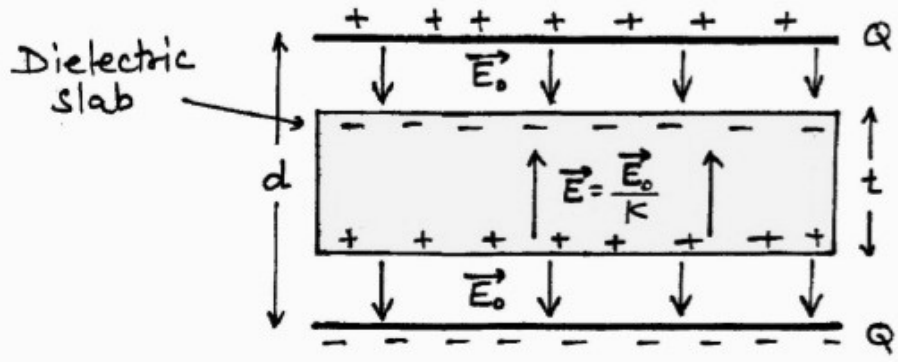


$$C = \frac{K\epsilon_0 A}{d}$$

$$K = \frac{\epsilon}{\epsilon_0}$$

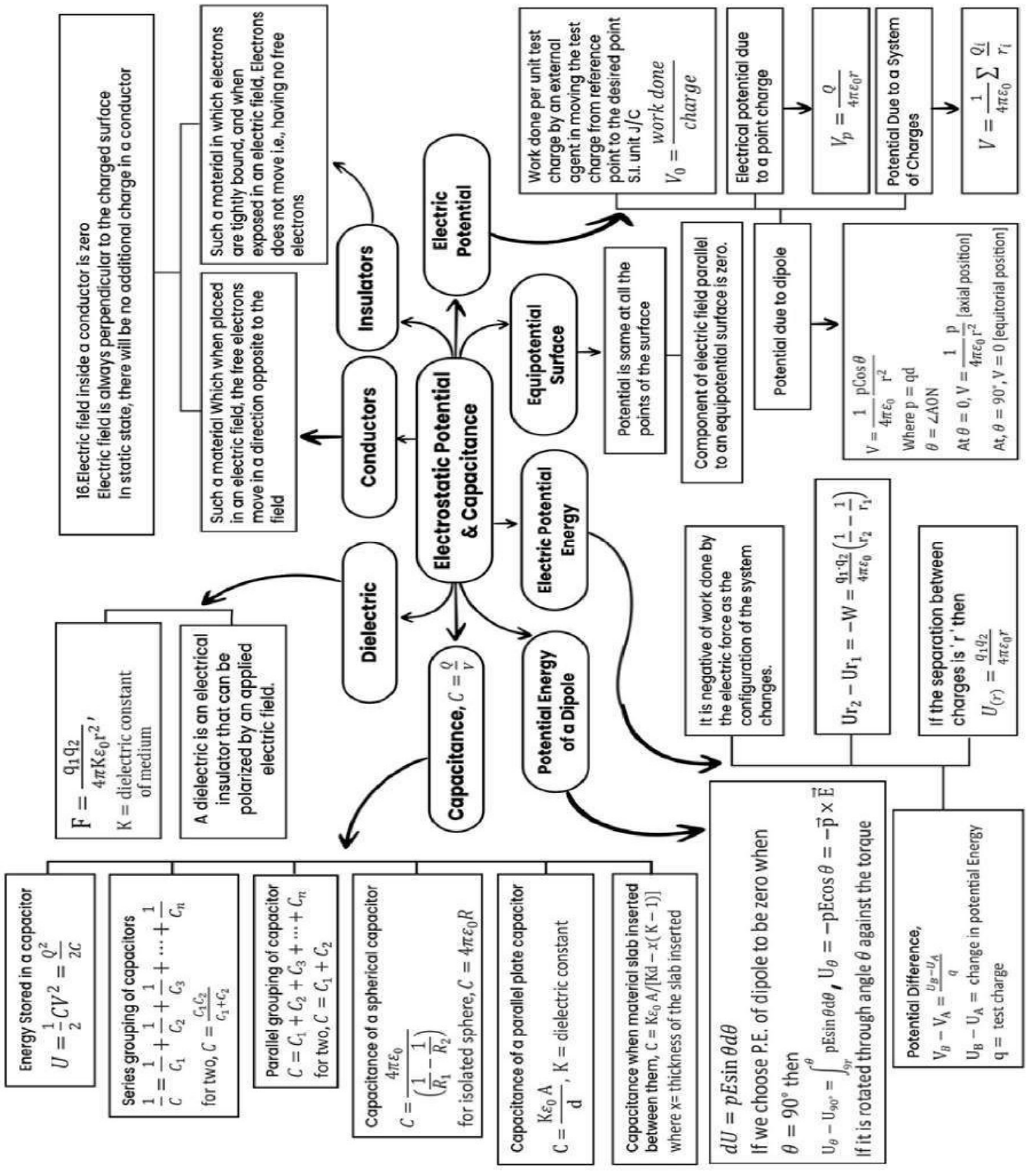
$$C = K C_0$$

Capacitance of a Parallel plate capacitor with a dielectric slab –



$$C = \frac{\epsilon_0 A}{d - t + \frac{t}{K}}$$

Mind-Map


Electrostatic Potential & Capacitance
Electric Potential
Work done per unit test charge by an external agent in moving the test charge from reference point to the desired point
S.I. unit J/C
$V_0 = \frac{work\ done}{charge}$
Electrical potential due to a point charge
$V_p = \frac{Q}{4\pi\varepsilon_0 r}$
Potential Due to a System of Charges
$V = \frac{1}{4\pi\varepsilon_0}\sum \frac{Q_i}{r_i}$
Equipotential Surface
Potential is same at all the points of the surface
Component of electric field parallel to an equipotential surface is zero.
Potential due to dipole
$V = \frac{1}{4\pi\varepsilon_0}\frac{p\cos\theta}{r^2}$
Where p = qd
$\theta = \angle AON$
At $\theta = 0$, $V = \frac{1}{4\pi\varepsilon_0}\frac{p}{r^2}$ [axial position]
At, $\theta = 90°$, V = 0 [equitorial position]
Conductors
Such a material Which when placed in an electric field, the free electrons move in a direction opposite to the field
Insulators
Such a material in which electrons are tightly bound, and when exposed in an electric field, Electrons does not move i.e., having no free electrons
16.Electric field inside a conductor is zero
Electric field is always perpendicular to the charged surface
In static state, there will be no additional charge in a conductor
Electric Potential Energy
It is negative of work done by the electric force as the configuration of the system changes.
$Ur_2 - Ur_1 = -W = \frac{q_1 \cdot q_2}{4\pi\varepsilon_0}\left(\frac{1}{r_2} - \frac{1}{r_1}\right)$
If the separation between charges is 'r' then
$U_{(r)} = \frac{q_1 q_2}{4\pi\varepsilon_0 r}$
Potential Energy of a Dipole
$dU = pE\sin\theta d\theta$
If we choose P.E. of dipole to be zero when $\theta = 90°$ then
$U_\theta - U_{90°} = \int_{90°}^{\theta} pE\sin\theta d\theta$, $U_\theta = -pE\cos\theta = -\vec{p}\times\vec{E}$
If it is rotated through angle θ against the torque
Potential Difference,
$V_B - V_A = \frac{U_B - U_A}{q}$
$U_B - U_A$ = change in potential Energy
q = test charge
Capacitance, $C = \frac{Q}{V}$
Energy Stored in a capacitor
$U = \frac{1}{2}CV^2 = \frac{Q^2}{2C}$
Series grouping of capacitors
$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots + \frac{1}{C_n}$
for two, $C = \frac{C_1 C_2}{C_1 + C_2}$
Parallel grouping of capacitor
$C = C_1 + C_2 + C_3 + \cdots + C_n$
for two, $C = C_1 + C_2$
Capacitance of a spherical capacitor
$C = \frac{4\pi\varepsilon_0}{\left(\frac{1}{R_1} - \frac{1}{R_2}\right)}$
for isolated sphere, $C = 4\pi\varepsilon_0 R$
Capacitance of a parallel plate capacitor
$C = \frac{K\varepsilon_0 A}{d}$, K = dielectric constant
Capacitance when material slab inserted between them, $C = K\varepsilon_0 A/[Kd - x(K-1)]$
where x= thickness of the slab inserted
Dielectric
A dielectric is an electrical insulator that can be polarized by an applied electric field.
$F = \frac{q_1 q_2}{4\pi K\varepsilon_0 r^2}$,
K = dielectric constant of medium

FREQUENTLY ASKED QUESTIONS

Electric Potential and Capacitance

2 MARKS

1) 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 k =10 is introduced between the plates of the capacitor. Explain giving reasons, how will the following be affected:
   a) Capacitance of the capacitor (2017)
   b) Charge on the capacitor, and
   c) Energy density of the capacitor.

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

3) A 12 pF capacitor is connected to a 50V 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. (2018)

4) Two uniformly large parallel thin plates having charge densities +σ and –σ 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?

5) Draw a plot showing the variation of 1) electric filed (E) and 2) Electric potential (V) with distance r due to a point charge Q.

3 MARKS

6) a) Draw the equipotential surfaces due to an electric dipole.
   b) Derive an expression for the electric potential at any point along the axial line of an electric dipole. (2019)

7) 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 no? Also find the charge drawn from the battery in each case. (2017)

8) 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. (2015)

9) A 600 pF capacitor is charged by a 200 V supply. It is then disconnected from the supply and is connected to another uncharged 300 pF capacitor. Calculate how much electrostatic energy is lost in the process. What is the source of energy loss? (2015)

10) Four charges +q, -q, +q and –q are to be arranged respectively at the four corners of a square ABCD of side a.

a) Find the work required to put together this arrangement.

b) A charge q_0 is bought to the centre of the square, the four charges being held fixed. How much extra work is needed to do this? (2015)

5 MARKS

11) Briefly explain the principle of a capacitor. Derive an expression for the capacitance of a parallel plate capacitor, whose plates are separated by a dielectric medium.

12) Derive an expression for the energy stored in a parallel plate capacitor with air between the plates. How does .the stored energy change if air is replaced by a medium of dielectric constant 'K'? ; Also show that the energy density of a capacitor is. (2019)

13) A parallel-plate capacitor is charged to a potential difference V by a dc source. The capacitor is then disconnected from the source. If the distance between the plates is doubled, state with reason how the following change

(i) Electric field between the plates

(ii) Capacitance, and

(iii) Energy stored in the capacitor (2022)

14) Explain the underlying principle of working of a parallel plate capacitor. If two similar plates, each of area 'A' having surface charge densities '+ σ' & -σ are separated by a distance 'd' in air, write expressions for (i) the electric field at points between the two plates, (ii) the potential difference between the plates & (iii) the capacity of the capacitor so formed

15) A parallel plate capacitor is charged by a battery and the battery remains connected, a dielectric slab is inserted in the space between the plates. Explain what changes if any , occur in the values of

(i) Potential difference between the plates

(ii) Electric field between the plates (2020)

(ii) Energy stored in the capacitor.

16) i) Draw equipotential surfaces for an electric dipole.

ii) Two point charges q_1 and q_2 are located at $\vec{r_1}$ and $\vec{r_2}$ respectively in an external electric field $\vec{E}$. Obtain an expression for the potential energy of the system.

iii) The dipole moment of a molecule is 10^{-30} Cm. It is placed in an electric field $\vec{E}$ of 10^5 V/m such that its axis is along the electric field. The direction of $\vec{E}$ is suddenly changed by 60^0 at an instant. Find the change in the potential energy of the dipole, at that instant.

(2024)

17) (i) Two point charges 5μC and -1μC are placed at points (-3 cm, 0,0) and (3 cm, 0, 0) respectively. An external electric field $\vec{E} = \frac{A}{r^2}\hat{r}$ where A = 3 × 10^5 Vm is switched on in the region. Calculate the change in electrostatic energy of the system due to the electric field.

(ii) A system of two conductors is placed in air and they have net charge of +80μC and -80μC which causes a potential difference of 16V between them.

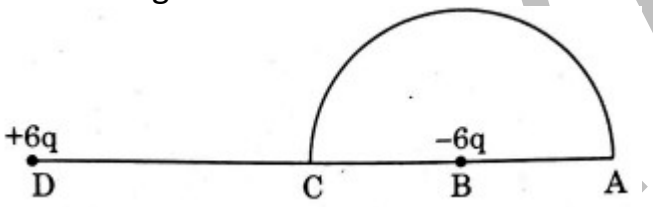
(1) Find the capacitance of the system.

(2) If the air between the capacitor is replaced by a dielectric medium of dielectric constant 3, what will be the potential difference between the two conductors?

(3) If the charges on two conductors are changed to +160 μC and -160 μC, will the capacitance of the system change? Give reason for your answer. **(2025)**

18) (i) Consider three metal spherical shells A, B and C, each of radius R. Each shell is having a concentric metal ball of radius R/10. The spherical shells A, B and C are given charges +6q, -4q and 14q respectively. Their inner metal balls are also given charges -2q, +8q and -10q respectively. Compare the magnitude of the electric fields due to shells A, B and C at a distance 3R from their centers.

(ii) A charge -6 μC is placed at the centre B of a semicircle of radius 5 cm, as shown in the figure. An equal and opposite charge is placed at point D at a distance of 10cm form B. A charge +5 μC is moved from point 'C' to point 'A' along the circumference. Calculate the work done on the charge.



(2025)

Chap Gye Questions

1) Two charged particles, each having charge 2μC are brought from infinity to positions separated by 10 cm. calculate the increase in potential energy during the process.

(0.36J)

2) An electron moves from rest to a point at which potential is 100V. What is its final energy, when it initially started from a point where electric potential was 80V?

(3.2×10^{-18} joule)

3) A charge of 3.2×10^{-19} C is moved through a potential difference of 2 volt. Find the kinetic energy of this charge.

(4eV)

4) Can a single isolated spherical conductor have a capacitance of 1F?

5) A 0.5μF capacitor is connected in parallel to 0.75 μF capacitor and this combination is joined to 100 volt DC source. Calculate charge taken from the source and charge on each capacitor. **(50 μC,75 μC,125μC)**

6) A 10pF capacitor is connected to a 100V battery. How much electrostatic energy is stored in the capacitor? **(5×10^{-8} J)**

7) Calculate the electric potential at the surface of a gold nucleus. Given, radius of nucleus 6.6×10^{-15}m and atomic number of gold is 79. **(1.72×10^{7}V)**

8) Find the potential of a sphere having charge of 5μC and capacitance of 1nF.

(5×10^{3} V)

9) A parallel plate capacitor has a capacitance of 50μF in air and 110μF when immersed in oil. Calculate the dielectric constant of the dielectric.

(2.2)

10) A parallel plate capacitor of plate area 2 m^2 and plate separation 2mm is charged to 1000V in vacuum. Calculate the capacitance of the capacitor and charge on each plate.

(8.85×10^{-9} F)

11) Four capacitors of capacitances 1pF, 2pF, 3pF and 4pF are connected in parallel. Calculate:
a) the capacitance of the combination of the capacitors.
b) the charge on each capacitor if the combination is connected to 200V.

12) What capacitance is required to store energy of 100 kWh at a potential difference of 10^4 V? **(7.2 F)**

13) Two capacitor of capacitance **3μF** and **6μF** arranged in series are connected in parallel with a third capacitor **4μF**. The arrangement is connected to a 6 volt battery. Calculate the energy stored in the capacitors.

(1.08×10^{-4}J)

14) Two point charges A and B of values **5×10^{-9}C** and **3×10^{-9}C** are kept 6cm apart in air. Calculate the work done when charge B is moved by 1 cm towards charge A.

(4.5×10^{-7} J)

15) A 600 pF capacitor is charged by a **200V** supply. It is then disconnected from the supply and connected to another uncharged **600pF** capacitor. How much electrostatic energy is lost in the process **(6×10^{-6} J)**

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

17. Why there is no work done in moving a charge from one point to another on an equipotential surface?

18. Can two equipotential surface intersect each other? Justify your answer.

19. Draw equipotential surface due to a single point charge.

20. Name the physical quantity whose SI unit is J/C. Is it a scalar or a vector quantity?

21. What is the electric potential due to an electric dipole at an equatorial point?

22. What is the work done in moving a 2C point charge from corner A to corner B of a square ABCD when a 10C charge exist at the center of the square?

23. What happens to the capacitance of a capacitor when a dielectric slab is placed between its plates?

24. Find the number of field lines originating from a point charge of q = 8.854 C.

25. Two point charges, $Q_1 = 10 \times 10^{-8}$C and $Q_2 = -2 \times 10^{-8}$ C are separated by a distance of 60cm in air.

a) What a distance from the 1st charge Q would the electric potential be zero?
b) Also, calculate the electrostatic potential energy of the system.

(50cm, -30μj)

26. Two charges of 5nC and -2nC are placed at points (5 cm, 0, 0) and (23 cm,0,0) in the region of space, where there is no other external field. Calculate the electrostatic potential energy of this charge system. **(-0.5μj)**

27. a) How many electrons must be added to one plate and removed from the other so as to store 25.0 J of energy in a 5.0 nF parallel plate capacitor?

b) How would you modify this capacitor so that it can store 50.0 J of energy without changing the charge on its plates?

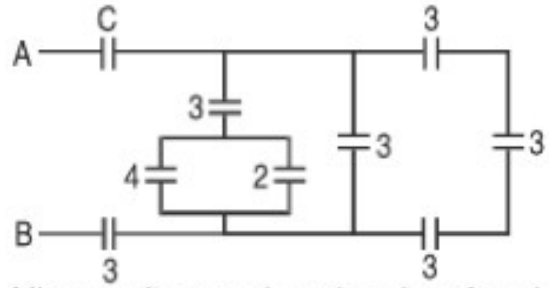
28. A dielectric slab of thickness 1cm and dielectric constant 5 is placed between the plates of a parallel plate capacitor having plate area of 0.01 m^2 and plate separation of 2cm.

a) Determine the increase in capacity on introduction of the dielectric

b) What would be the increase in capacity if the dielectric slab were a conducting slab?

(2.95 μF, 4.425 μF)

29. For what value of C does the equivalent capacitance between A and B is 1μF in the given circuit.



All capacitance given in micro farad

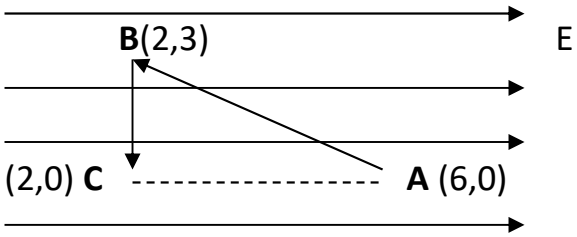
30. Two point charges 6μC and 2μC are separated by 3cm in free space. Calculate the work done in separating them to infinity.

(3.6 joule)

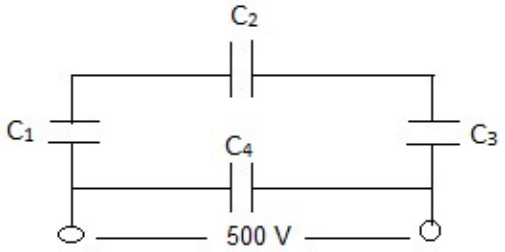
31. A test charge 'q' is moved without acceleration from A to C along the path from A to B and then from B to C in electric field E as shown in the figure.

i) Calculate the potential difference between A and C.

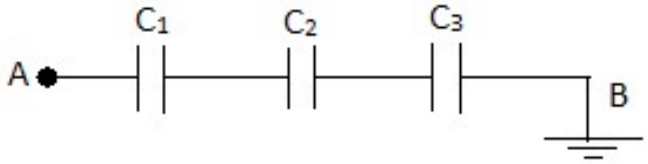
ii) At which point (of the two) is the electric potential more and why?



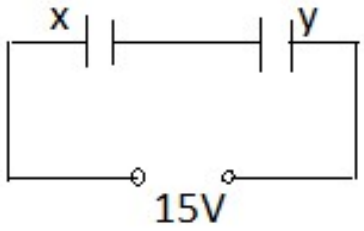
32. A network of four capacitors each of 12μF capacitance is connected to a 500 V supplies a shown in the figure. Determine a) equivalent capacitance of the network and b) charge on each capacitor.



33. Calculate the potential difference and the energy stored in the capacitor C_2 in the circuit shown in the figure. Given potential at A is 90V, C_1=20μF, C_2=30μF and C_3=15μF.



34. 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 of K= 4



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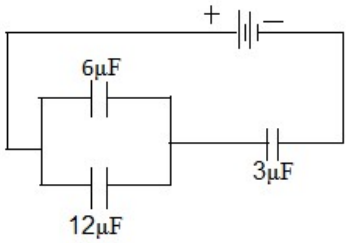
i) Calculate capacitance of each capacitor if equivalent capacitance of the combination is 4μF.

ii) Calculate the potential difference between the plates of X and Y.

iii) Estimate the ratio of electrostatic energy stored in X and Y.

35. In the following arrangement of capacitors, the energy stored in the 6μF capacitor is E.



Find the value of

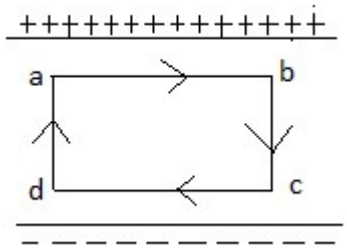
i) Energy stored in 12μF capacitor

ii) Energy stored in 3μF capacitor

iii) Total energy drawn from the battery.

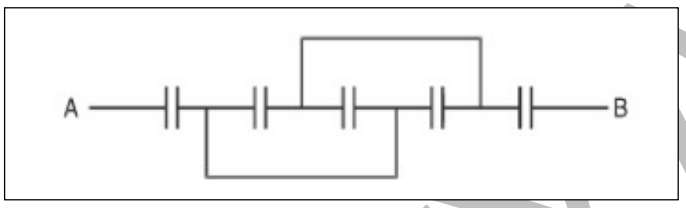
36. A) Obtain the expression for the energy stored per unit volume in a charged parallel plate capacitor.

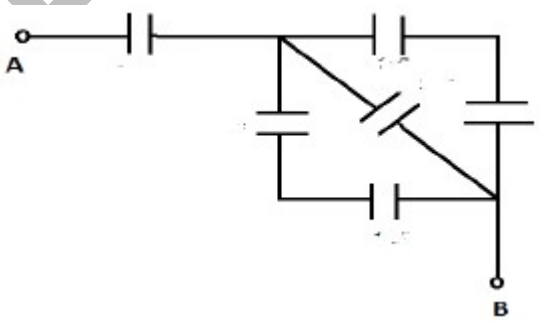
B) The electric field inside a parallel plate capacitor is E. Find the amount of work done in moving a charge q over a closed rectangular loop a b c d a.



37. Find the ratio of the potential difference that must be applied across the parallel and the series combination of two identical capacitors so that the every stored in the two cases, becomes the same.

38. Find equivalent capacitance between A and B in the combination given below: each capacitor is of 2μF





39. You are given an air filled parallel plate capacitor. Two slabs of dielectric constants K_1 and K_2 having been filled in between the two plates of the capacitor as shown in Fig. What will be the capacitance of the capacitor of initial area was A distance between pates d?

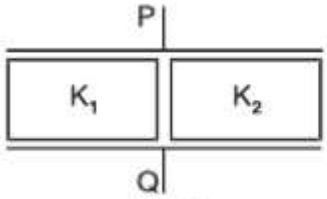


Fig. 1

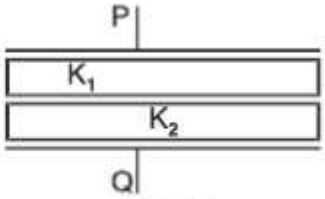
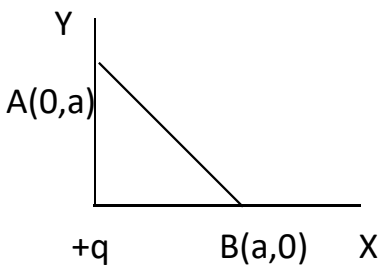


Fig. 2

40. Three point charges of 1C, 2C and 3C are placed at the corners of an equilateral triangle of side 1m. Calculate the work done to move these charges to the corners of a smaller equilateral triangle of sides 0.5m. **(9.9×10^{10}J)**

MCQ (Multiple-choice question)

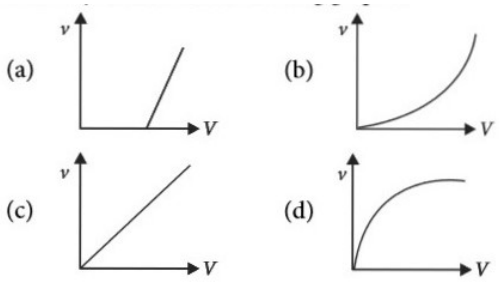
1) **Four equal charges, each of charge, Q are placed at the four corners of a body of side a each. Work done to remove a charge –Q from the centre of the body to infinity is:**
   a) 0
   b) $\sqrt{2}\ Q^2/ 4\pi\epsilon_0 a$
   c) $\sqrt{2}\ Q^2/ \pi\epsilon_0 a$
   d) $\sqrt{2}Q^2/ 2\pi\epsilon_0 a$
2) **Equipotential surfaces associated with an electric field which is increasing in magnitude along x direction are:**
   a) Planes parallel to YZ plane
   b) Planes parallel to XY plane
   c) Planes parallel to XZ plane
   d) Coaxial cylinders of increasing radii around x-axis.
3) **Which of the following is not the property of equipotential surfaces?**
   a) They do not cross each other
   b) They are concentric spheres for non-uniform electric field
   c) Rate of change of potential with the distance on them is zero.
   d) They can be imaginary spheres.
4) **Charges +q and –q are placed at points A and B respectively which are at distance 2L apart. C is the mid-point between A and B. The work done in moving a charge +Q along the semicircle CRD is:**
   a) $Q/6\pi\epsilon_0 L$
   b) $-Q/6\pi\epsilon_0 L$
   c) $qQ/6\pi\epsilon_0 L$
   d) $-qQ/6\pi\epsilon_0 L$
5) **A point charge +q is placed at the origin O as shown in figure. Work done in taking another charge –Q from point A (0,a) to another point B(a,0) along the straight path AB is:**
   a) $\frac{1}{4\pi\epsilon_0}\frac{qQ}{a^2}$
   b) $\left(-\frac{1}{4\pi\epsilon_0}\frac{qQ}{a^2}\right)\sqrt{2}a$
   c) $\left(-\frac{1}{4\pi\epsilon_0}\frac{qQ}{a^2}\right)\frac{a}{\sqrt{2}}$
   d) Zero



6) An electron initially at rest is accelerated through a potential difference of 200V so that it acquires a velocity 8.4×10^6 m/s. The value of e/m of electron will be:

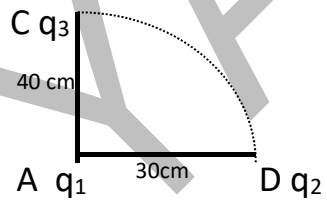
a) 1.76×10^{11} C/Kg
b) 2.76×10^{12} C/Kg
c) 0.76×10^{12} C/Kg
d) None of these

7) The velocity v acquired by an electron starting from rest and moving through a potential difference V is shown by which of the following graphs?



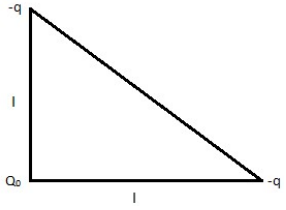
8) Two charge q_1 and q_2 are placed 30 cm apart as shown in figure. A third charge q_3 is moved along the arc of a circle of radius 40 cm from C to D. The change in P.E. of the system is $\frac{q_3 K}{4\pi\epsilon_0}$ where k is:

a) $8q_2$
b) $8q_1$
c) $6q_2$
d) $6q_1$



9) Three charges Q_0, -q and –q are placed at the vertices of an isosceles triangles as shown in figure. The net electrostatic potential energy is zero if Q_0 is equal to:

a) q/4
b) $2q/\sqrt{32}$
c) $\sqrt{2q}$
d) +q



10) Capacity of parallel plate capacitor in air and on immersing it into oil is 50μF and 110μF respectively. The dielectric constant of oil is

a) 0.45
b) 0.55
c) 1.10
d) 2.20

11) Energy per unit volume for a capacitor having area A and separation d kept at potential difference V is given by:

a) $\frac{1}{2}\frac{\epsilon_0 V^2}{d^2}$ b) $\frac{1}{2\epsilon_0}\frac{V^2}{d^2}$

b) c) $\frac{1}{2}\ CV^2$ d) $\frac{Q^2}{2C}$

12) If n drops, each of capacitance C, coalesce to form a single big drop, then the ratio of the energy stored in the big drop to that in each small drop will be:

a) n : 1 b) n^2 : 1

c) $n^{1/3}$: 1 d) $n^{5/3}$: 1

13) A parallel plate air capacitor has a capacitance C when it is half filled with a dielectric of dielectric constant 5, the percentage increase in the capacitance will be:

a) 400% b) 66.6 %

c) 33.3% d) 200%

14) 27 small drops each having charge q and radius r coalesce to form big drop. How many times charge and capacitance will be:

a) 3, 27 b) 27 , 3

c) 27 , 27 d) 3, 3

15) When an additional charge of 2C is given to a capacitor, energy stored in it is increasing by 21%. The original charge of the capacitor is

a) 30 C b) 40 C

c) 10 C d) 20 C

16) A parallel plate capacitor with air between the plates has a capacitor of 9pF. The separation between its plates is'd'. The space between its plates is now filled with two dielectric. One of the dielectric has dielectric constant K_1=3 and thickness d/3 while the other one has dielectric constant K_2=6 and thickness 2d/3. Capacitance of the capacitor is now

a) 40.5 pF b) 20.25 pF

c) 1.8 pF d) 4.5 pF

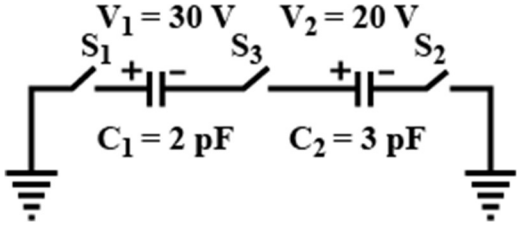
17) Which one of the following statements is true for the given circuit?

a) With S_1 closed, V_1=15V, V_2=20V

b) With S_3 closed, $V_1 = V_2 = 25V$

c) With S_1 and S_2 closed $V_1 = V_2 = 0$

d) With S_1 and S_3 closed $V_1 = 30V$ and $V_2 = 20V$



18) An electric dipole consisting of charges +q and –q separated by a distance L is in stable equilibrium in a uniform electric field E. The electrostatic potential energy of the dipole is

a) qLE b) zero
c) –qLE d) -2qEL

19) Two identical metallic plates are given positive charges Q_1 and Q_2 ($Q_2 < Q_1$). If these plates are brought together to form a parallel plate capacitor, then potential difference between them will be

a) $\frac{Q_1+Q_2}{2C}$ b) $\frac{Q_1+Q_2}{C}$
b) c) $\frac{Q_1-Q_2}{C}$ d) $\frac{Q_1-Q_2}{2C}$

20) A parallel plate capacitor is made by stacking n equally spaced plates connected alternatively. If the capacitance between any two adjacent plates is 'C', then the resultant capacitance is

a) (n +1) C b) (n – 1)C
c) nC d) C

21) Which of the following is a polar molecule?

a) O_2 b) H_2
c) N_2 d)HCl

22) Which of the following statements about dielectrics is correct?

a) A polar dielectric has a net dipole moment in absence of an external electric field which gets modified due to the induced dipoles.
b) The net dipole moments of induced dipoles is along the direction of the applied electric field.
c) Dielectrics contain free charges.
d) The electric field produce due to induced surface charges inside a dielectric is along the external electric field.

23) When a dielectric slab is inserted between the plates of an isolated charged capacitor, the energy stored in in:

a) Increases and the electric field inside it also increases.
b) Decreases and the electric field also decreases.
c) Decreases and the electric field increases.
d) Increases and the electric field decreases.

24) Two capacitor of capacitances $2C_0$ and $6C_0$ are first connected in series and then in parallel across the same battery. The ratio of energies stored in series combination to that in parallel is

a) 1/4 b) 1/6

c) 2/15 d) 3/16

25) An air- filled capacitor with plate area A and plate separation d has capacitance C_0. A slab of dielectric constant K, area A and thickness (d/5) is inserted between the plates. The capacitance of the capacitor will become

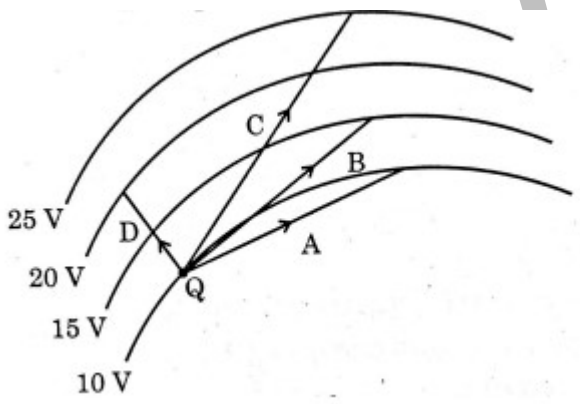
a) $\left[\frac{4K}{5K+1}\right] C_0$

b) $\left[\frac{K+5}{4}\right] C_0$

c) $\left[\frac{5K}{4K+1}\right] C_0$

d) $\left[\frac{K+4}{5K}\right] C_0$

26) In the figure curved lines represent equipotential surfaces. A charge Q is moved along different paths A, B, C and D. The work done on the charge will be maximum along the path



a) A b) B

c) C d) D **(2025)**

ASSERTION AND REASON QUESTIONS

Directions: These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following four responses.

(a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.

(b)If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.

(c) If the Assertion is correct but Reason is incorrect.

(d) If both the Assertion and Reason are incorrect.

Q.1 **Assertion (A):** The electrostatic force between the plates of a charged isolated capacitor decreases when dielectric fills whole space between plates.
Reason (R): The electric field between the plates of a charged isolated capacitance increases when dielectric fills whole space between plates.

Q.2 **Assertion (A):** Two equipotential surfaces cannot cut each other.
Reason (R): Two equipotential surfaces are parallel to each other.

Q.3 **Assertion (A):** The potential difference between any two points in an electric field depends only on initial and final position.
Reason (R): Electric field is a conservative field so the work done per unit positive charge does not depend on path followed.

Q.4 **Assertion (A):** Work done in moving a charge between any two points in an electric field is independent of the path followed by the charge, between these points.
Reason (R): Electrostatic force is a non-conservative force.

Q.5 **Assertion (A):** Two adjacent conductors of unequal dimensions, carrying the same positive charge have a potential difference between them.
Reason (R): The potential of a conductor depends upon the charge given to it.

Q.6 **Assertion (A):** For a charged particle moving from point P to point Q, the net work done by an electrostatic field on the particle is independent of the path connecting point P to point
Reason (R): The net work done by a conservative force on an object moving along a closed loop is zero.

Q.7 **Assertion (A):** Dielectric polarisation means formation of positive and negative charges inside the dielectric.
Reason (R): Free electrons are formed in this process.

Q.8 **Assertion (A):** In the absence of an external electric field, the dipole moment per unit volume of a polar dielectric is zero.
Reason (R): The dipoles of a polar dielectric are randomly oriented.

Q.9 **Assertion (A):** When a dielectric slab is gradually inserted between the plates of an isolated parallel-plate capacitor, the energy of the system decreases.
Reason (R): The force between the plates decreases.

Q.10 **Assertion (A):** A parallel plate capacitor is connected across battery through a key. A dielectric slab of dielectric constant k is introduced between the plates. The energy stored becomes k times.
Reason (R): The surface density of charge on the plate remains constant.

Q.11 **Assertion (A):** The electric potential at any point on the equatorial plane of a dipole is zero.
Reason (R): The work done in bringing a unit positive charge from infinity to a point in equatorial plane is equal for the two charges of the dipole.

Q.12 **Assertion (A):** Two equipotential surfaces can be orthogonal.
Reason (R): Electric field lines are normal to the equipotential surface.

Q.13 **Assertion (A):** Two equipotential surfaces cannot cut each other.
Reason (R): Two equipotential surfaces are parallel to each other.

Q.14 **Assertion (A):** If the distance between parallel plates of a capacitor is halved and dielectric constant is three times, then the capacitance becomes 6 times.
Reason (R): Capacity of the capacitor does not depend upon the nature of the material.

Q.15 **Assertion (A):** A parallel plate capacitor is connected across battery through a key. A dielectric slab of dielectric constant K is introduced between the plates. The energy which is stored becomes K times.
Reason (R): The surface density of charge on the plate remains constant or unchanged.

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