UNIT:-I:-ELECTROSTATICS

LEVEL:- I

Problem 1.

Two small spheres spaced 35.0cm apart have equal charge. How many excess electrons must be present on each sphere if the magnitude of the force of repulsion between them is $2.20 * 10^{-21} N$?

Solution

Problem 2.

A point charge $q_1 = -7nC$ is at the point $x_1 = 0.6m$, $y_1 = 0.8m$, and a second point charge $q_2 = 4nC$ is at the point $x_2 = 0.6m$, $y_2 = 0m$. Find the magnitude and direction of the net electric field at the origin.

Solution

Problem 3.

What must the charge (sign and magnitude) of a particle of mass 5 *g* be for it to remain stationary when placed in a downward-directed electric field of magnitude 800 N/C?

Solution

Problem 4.

What is the magnitude of an electric field in which the electric force on a proton is equal in magnitude to its weight?

Solution

Problem 5.

A particle has a charge of -8.00 nC. Find the magnitude and direction of the electric field due to this particle at a point 0.5 m directly above it.

Solution

Problem 6.

Two particles having charges of 0.70 nC and 12 nC are separated by a distance of 2 m. At what point along the line connecting the two charges is the net electric field due to the two charges equal to zero?

Solution

Problem 7.

A closed surface encloses a net charge of 10 nC . What is the net electric flux through the surface?

Solution

Problem 8.

Each square centimeter of the surface of an infinite plane sheet of paper has $4 * 10^6$ excess electrons. Find the magnitude and direction of the electric field at a point 6.00 cm from the surface of the sheet, if the sheet is large enough to be treated as an infinite plane.

Solution

Problem 9.

A thin disk with a circular hole at its center, called an annulus has inner radius R_1 a nd outer radius R_2. The disk has a uniform positive surface charge density σ. Find the total electric charge on the annulus.

Solution

Problem 10.

A thin disk with a circular hole at its center has inner radius R_1 a nd outer radius R_2. The disk has a uniform positive surface charge density σ on its surface. The disk lies in the yz plane, with its center at the origin. For an arbitrary point on the x axis (the axis of the disk) find the magnitude of the electric field.

Solution

LEVEL:-II

Problem 11.

A thin disk with a circular hole at its center has inner radius a nd outer radius R_2. The disk has a uniform positive surgace charge density σ on its surface. The disk lies in the yz plane, with its center at the origin.

A point particle with mass m and negative charge -q is free to move along the x axis (but cannot move off the axis). The particle is originally placed at rest at x=0.01 R_1 and released. Find the frequency of oscillations.

Solution

Problem 12.

Suppose that $2\,\mu g$ of hydrogen is separated into its constituent protons and electrons, and that the protons are all grouped together at one point, and the electrons at another point, 3 meter distant. What is the magnitude of the force between the two groups of charge?

Solution

Problem 13.

Two small beads having positive charges 25q and q are fixed at the opposite ends of a horizontal insulating rod, extending from the origin (the location of the larger charge) to the point x = d. A third small charged bead is free to slide on the rod. At what position is the third bead in equilibrium?

Solution

Problem 14.

Each of the protons in a particle beam has a kinetic energy of $4 * 10^{-15} J$. What are the magnitude and direction of the electric field that will stop these protons in a distance of 2 m?

Solution

Problem 15.

Two identical spheres are each attached to a rope of length 1 m and hung from a common point. Each sphere has mass 1 kg. The radius of each sphere is very small compared to the distance between the spheres, so they may be treated as point charges. The spheres have positive charges. The spheres are in equilibrium and each rope makes an angle 30 degrees with the vertical. Find the tension of the ropes.

Solution

Problem 16.

A solid metal sphere with radius 0.75 m carries a net charge of 0.13 nC. Find the magnitude of the electric field at the following locations:

a) at a point 0.15 m outside the surface of the sphere.

b) at a point outside the sphere, 0.1 m below the surface.

Solution

Problem 17.

How many excess electrons must be added to an isolated spherical conductor 27 cm in diameter to produce an electric field of 1450 N/C just outside the surface?

Solution

Problem 18.

To study the structure of the lead nucleus, electrons are fixed at a lead target. Some of the electrons actually enter the nuclei of the target, and the deflection of these electrons is measured. The deflection is caused by the charge of the nucleus, which is distributed approximately uniformly over the spherical volume of the nucleus. A lead nucleus has a charge of +82e ($e = 1.6 * 10^{-19} C$) and a radius of $R = 7.1 * 10^{-15} m$. Find the acceleration of an electron at the following distances from the center of a nucleus.

(a) R

(b) 2R

(c) R/2

(d) 0 (at the center)

Solution

Problem 19.

An electrostatic field is given by $\vec{E} = (0.5 * x + 2 * y)\vec{i} + 2 * x\vec{j}\ (N/C)$

Determine the work done in moving the charge $q = -2\mu C$

(a) from (0,0,0) to (4,0,0) m

(b) from (4,0,0) to (4,2,0) m

(c) from (4,2,0) to (0,0,0) m along a straight path.

Solution

Problem 20.

A cylinder with radius r= 0.75 m and length l=0.6 m that has an infinite line of positive charge running along its axis. The charge per unit length on the line is $7\mu C/m$.

(a) What is the electric flux through the cylinder due to this line of charge?

(b) What is the flux through the cylinder if its radius increased to r= 0.32 m?

(c) What is the flux through the cylinder if its length increased to l= 0.8 m?

Solution

WORK SHEET I

SUBJECT : PHYSICS

CLASS – XII **LESSON—*ELECTROSTATICS***

Q1. Two point charges q_1 and q_2 are placed close to each other. What is the nature of the force between them when: (i) $q_1q_2 < 0$ and (ii) $q_1q_2 > 0$? 1

Q2. Name the quantity with unit J/C. Is it a scalar or vector quantity? 1

Q3. An electric dipole of dipole moment 2×10^{-6} C m is enclosed by a closed surface. What is the flux passing out of the surface? 1

Q4. What is the angle between the directions of electric field at any (i) axial point and (ii) equatorial point due to an electric dipole? 1

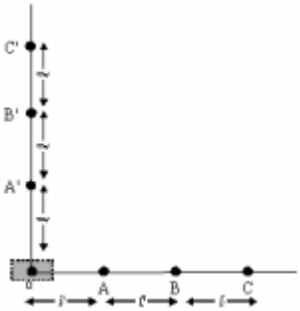
Q5. Two point charges placed at a distance *r* in air exert a force *F* on each other. At what distance will these charges experience the same force *F* in a medium of dielectric constant K? 1

Q6. Consider a dipole of length 2a. What is the magnitude and direction of electric field at the mid point of the length of the dipole 2

Q7. Two charges +10μC and -20μC are placed 15 cm apart. At what point on the line joining the two charges is the electric potential zero? 2

Q8. The following data was obtained for the dependence of the magnitude of electric field, with distance, from a reference point O, within the charge distribution in the shaded region.

Field points	A	B	A'	B'
Magnitude of field	E	E/8	E/2	E/16



Identify the charge distribution and justify your answer.

(i) If the potential due to this charge distribution has a value V at the point A, what is its value at the point B and C.

Q9. Derive expression for electric field at a point on the equatorial line of dipole. 3

Q10. Using Gauss Theorem, show mathematically that for a point outside a shell, the field due to a uniformly charged thin shell is the same as if the entire charge of the shell is concentrated at the centre. Why do you expect electric field inside the shell to be zero according to this theorem? 3

Q11. An electric dipole of dipole moment p is placed in a uniform electric field. Write the expression for the torque experienced by the dipole. Identify two pairs of perpendicular vectors in the expression. Show diagrammatically the orientation of the dipole in the field for which the torque is (i) Maximum (ii) Half the maximum value (iii) Zero. 3

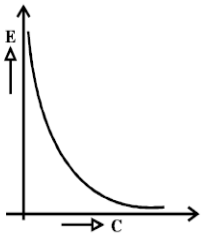
Q12. Derive expression for energy stored in parallel plate capacitor. Net capacitance of three identical capacitors in series is 1μF. What will be their net capacitance if connected in parallel? Find the ratio of energy stored in the two configurations if they are both connected to the same source. 5

WORK SHEET II

SUBJECT : PHYSICS

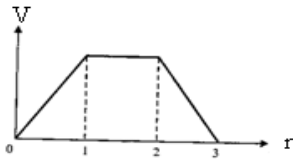
CLASS – XII **LESSON—*ELECTROSTATICS***

Q1. The graph shown here, shows the variation of the total energy I stored in a capacitor against the value of the capacitanceI itself. Which of the two – the charge on the capacitor or the potential used to charge it is kept constant for this graph? 1



Q2. In which orientation a dipole placed in uniform electric field is in (i) stable (ii) unstable equilibrium? 1

Q3. The electric potential as a function of distance *x* is shown in Fig . Construct a graph of the electric field strength *E*. 2



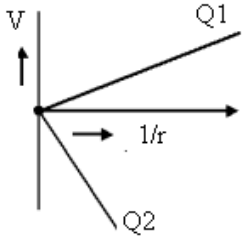
2

1

Q4. The two graphs drawn below, show the variation of electrostatic potential (V) with I being distance of point from the point charge for two point charges Q_1 and Q_2. 1

(ii) What are the signs of the two charges?

(ii) Which of the two charges has a larger magnitude?



Q5. 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 sphere.

Q6. Define electric potential. Derive an expression for the electric potential at a distance *r* from a point charge *q*. **2**

Q7. Why two equipotential do not cross each. Draw equipotential surface for electric field which is decreasing along X-axis. 2

Q8. A uniformly charged conducting sphere of 2.4m diameter has a surface charge density

$8.0 \times 10^{-7} C/m^2$. Find the charge on the sphere. What is the total flux leaving the surface? 2

Q9 A parallel plate capacitor is charged to a potential difference 'V' by a dc source. The capacitor is then disconnected from the source and a dielectric slab of dielectric constant 'K' is inserted between the plates. How does the (i) the capacitance, (ii) electric field between the plates and (iii) the energy stored in the capacitor be affected? Justify your answer in each case. 3

Q10. A conducting slab of thickness't' is introduced between the plates of a parallel plate capacitor, separated by a distance 'd' (t<d). Derive expression for capacity of capacitor. 3

Q11. State Gauss's Law in electrostatics. Using it derive expression for electric field due to uniformly charged infinite plane sheet. 3

Q12. Briefly explain the principle and working of Van de graff generator with the help of labeled diagram. 5

WORKSHEET 3

1. A proton is placed is a uniform electric field directed along the positive X-axis. In which direction will it tend to move? 1
2. What is the electric potential due to an electric dipole at an equatorial point? 1
3. If the radius of the Gaussian surface enclosing a charge is halved, how does the electric flux through the Gaussian surface change? 1
4. Can two equipotential surfaces intersect each other? Justify your answer. 1
5. A metal plate is introduced between the plates of a charged parallel plate capacitor. What is its effect on the capacitance of the capacitor? 1
6. Calculate the amount of work done in turning an electric dipole of dipole moment 3×10^{-8} C-m from its position of unstable equilibrium to the position of stable equilibrium in a uniform electric field of intensely $10^3 NC^{-1}$. 2
7. The sum of two point charges in 7Nc they repel each other with a force of 1N when kept 30cm apart in free space. Calculate the value of each charge. 2
8. Two point charges $q_1 = 10 \times 10^{-8} C$ and $q_2 = -2 \times 10^{-8} C$ are separated by a distance of 10cm in air

(iii) What is distance from charge q_1 would the electric potential be zero?
(ii) Also, calculate the electric potential energy of the system. 2

9. State Gauss's law in electrostatics. Use this law derive an expression for the electric field due to a long straight wire of linear charge density λ C-m. 3
10. State the principle of the device that can build-up high voltages of the order of a few million volts. Draw its labeled diagram. A stage reaches in this device when the potential at the outer sphere cannot be increased further by piling up more charge on it. Explain why? 3
11. A parallel plate capacitor is changed by a battery. After some-times, the battery is disconnected and a dielectric slab of dielectric constant K is inserted between the plates. How would
    (iv) the capacitances
    (ii) the electric field between plates
    (v) the energy stored in the capacitor, be affected?
    Justify your answer. 3
12. (i)Define electric flux. Write its SI units.
    (vi) Using Gauss's law, prove that electric field at a point due to a uniformly charged infinite plane sheet is independent of the distance from it.
    (iii)How is the field directed if
        (a) the sheet is positively charged
        (b) Negatively charged? 5

****

CHAPTER: II

ELECTRRIC POENTIAL AND CAPACITANCE

Q.1 A hollow metal sphere of radius 5 cm is charged such that the potential on its surface is 10V. What is the potential at the centre of the sphere?

Q.2 Name the physical quantity whose SI unit is JC^{-1}.Is it a scalar or a vector quantity?

Q.3 What is the amount of work done in moving 100 μC charge between two points 5 cm apart on an equipotential surface?

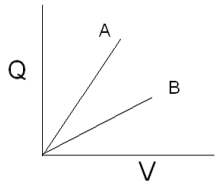
Q.4 The distance of the field point on the axis of a small electric dipole is doubled. By what factor will the electric field due to the dipole change?

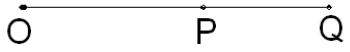
Q.5 In a parallel plate capacitor the potential difference of 10^2 V is maintained between the plates. What will be electric field at points A and B.?

. A

. B

Q6. The given graph shows that the variation of charge versus potential difference V for the two capacitors C1 & C2. The two capacitors have same plate separation but the plate area of C2 is double that of C1.Which of the line in the graph corresponds to C1 &C2 and why?





Q7. A point charge q is placed at O as shown in the figure. Is V_P-V_Q +ve or –ve when (i) q>0, (ii) q<0? Justify your answer.

Q8. Why does the electric field inside a dielectric decrease when it is placed in an external electric field?

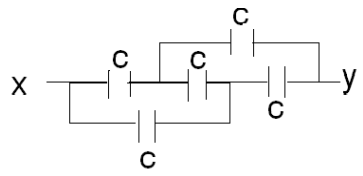
Q9. If V (=q/4πεor) is the potential at a distance r due to a point charge q, then determine the electric field due to a point charge q, at a distance r.

Q10. Draw an arrangement of three point charges separated by finite distances, that has zero electric Potential energy.

Q11. A charged particle q is shot towards another charged particle Q which is fixed, with a speed v. It approaches Q up to a closest distance r and then returns. If q were given a speed 2v,then find the closest distance of approach.

Q12. Two capacitors of capacitance 6mF and 12mF are connected in series with the battery .The voltage across the 6mF capacitor is 2 volt .Compute the total battery voltage.

Q13. Five identical capacitors, each of capacitance C are connected between points X and Y as shown in the figure. If the equivalent capacitance of the combination between X and Y is 5mF. Calculate the capacitance of each capacitor.

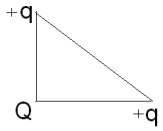


Q14. A parallel plate capacitor with air between the plates has a capacitance of 8 pF . The separation between the plates is now reduced by half and the space between them is filled with a medium of dielectric constant 5. Calculate the value of capacitance of parallel plate capacitor in second case.

Q15. A uniform electric field of 2 kNC^{-1} is in the x-direction. A point charge of 3 μC initially at rest at the origin is released. What is the kinetic energy of this charge at x = 4m?

Q.16. Two identical metal plates are given the charges Q_1 and Q_2 ($Q_2 < Q_1$) respectively. If they are now brought close together to form a parallel plate capacitor with capacitance C then what is the potential difference between them?

Q17 Three charges Q, +q and +q are placed at the vertices of a right angle isosceles triangle as shown. Find the magnitude of Q for which net electrostatic energy of the configuration is zero.



Q.18. A charge Q is distributed over the two concentric hollow spheres of radii 'r' and 'R'(R>r) such that the surface densities are equal. Find the potential at the common centre.

Q19 The field potential inside a charged ball depends only on the distance from its centre as $V=ar^2+b$, where a and b are constants. Find the space charge distribution r(r) inside the ball.

Q20 Four charges each having charge 'q' are along x-axis at x=1 cm ,x=2 cm, x=4 cm,x=8 cm . Find the electric field at x=0 due to these charges.

OR

A 4μF capacitor is charged by a 200V supply. The supply is then disconnected and the charged capacitor is connected to another uncharged 2μF capacitor. How much electrostatic energy of the first capacitor is lost in the process of attaining the steady situation?

Q21.The electric field in a region is radially outward and varies with distance r as E=250 r Vm^{-1}.Calculate the charge contained in a sphere of radius 0.2 m centered at the origin.

Q.22 There is an isolated parallel plate capacitor of capacitance C charged to a potential difference V.If the separation between the plates is doubled, how the following quantities will vary: (i) Capacitance (ii)Potential difference (iii) Charge

on the capacitor (iv) Electric field inside the plates (v) Energy stored. OR What is an electric dipole? Give its SI unit. Find an expression for electric field along the axial line of electric dipole..

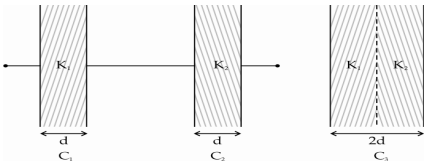
Q.23 What is an electric polarization of a dielectric? What is the effect on capacitance of a capacitor when a dielectric of width‘t’is placed between the two plates of parallel plate capacitor?

OR

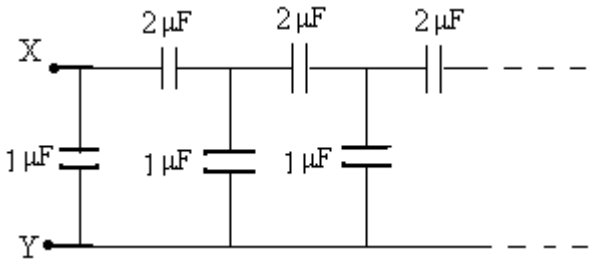
What is electric potential? Give its SI unit. Find the expression for the electric potential at any point due to a point charge.

Q24 Net capacitance of three identical capacitors in series is 1F. 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.

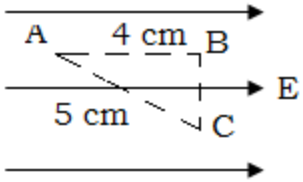
Q.25 The capacitors C1, and C2, having plates of area A each, are connected in series, as shown. Compare the capacitance of this combination with the capacitor C3,again having plates of area A each, but ‘made up’ as shown in the figure.



Q26.Find the capacitance of the infinite ladder between the points X and Y



Q27. Three points A, B and C lie in uniform electric field E of $5x10^3$N/C as shown in the figure. Find potential difference between A and C.



Q28. Three charges –q, +Q and –q are placed at equal distance on a straight line. If the potential energy of the system of three charges is zero, find the ratio of Q:q

IMPORTANT FORMULAE IN ELECTROSTATICS

1. **Electrostatic force between two charges**
   $F = K.\frac{q_1 q_2}{r^2} = \frac{1}{4\pi\epsilon_0\epsilon_r}.\frac{q_1 q_2}{r^2}$
   For air, $\epsilon_r = 1$
   Fair = $\frac{1}{4\pi\epsilon_0}.\frac{q_1 q_2}{r^2} = 9\times10^9\ \frac{q_1 q_2}{r^2}$
2. **Electric field intensity due to a point charge,** $\vec{E} = \lim_{q_0\to 0}\frac{\vec{F}}{q_o}$
3. **Electric field intensity due to infinite linear charge density (λ)**
   $E = \frac{1}{4\pi\epsilon_0}.\frac{2\lambda}{r}$
4. **Electric field intensity near an infinite thin sheet of surface charge density** σ
   $E = \frac{\sigma}{2\epsilon_0}$
   For thick sheet $= \frac{\sigma}{\epsilon_0}$**.**
5. **Electric potential,** $V = \lim_{q_0\to 0}\frac{w}{q_o}$
   Electric potential due to a point charge, $V = \frac{1}{4\pi\epsilon_0}.\frac{q}{r}$
6. **Relation between electric field and potential** $E = -\frac{dV}{dr} = \frac{V}{r}$ **(numerically)**
7. **Dipole moment,** $\vec{P} = q.2\vec{l}$
8. **Torque on a dipole in uniform electric field,** $\vec{\tau} = \vec{p}\times\vec{E}$**.**
9. **Potential energy of dipole,** $\cup = -\vec{p}.\vec{E} = -pE\cos\theta$
10. **Work done in rotating the dipole in uniform electric field from orientation** Q_1 **to** Q_2 **is**
    $W = U_2 - U_1 = pE(\cos\theta_1 - \cos\theta_2)$
11. **Electric field due to a short dipole**
    (i) **at axial point,** $E_{axis} = \frac{1}{4\pi\epsilon_0}.\frac{2p}{r^3}$
    (ii) **at equatorial point,** $E_1 = \frac{1}{4\pi\epsilon_0}.\frac{p}{r^3}$
12. **Electric potential due to a short dipole**
    (i) **At axial point,** $V_{axis} = \frac{1}{4\pi\epsilon_0}.\frac{p}{r^2}$
    (ii) **At equatorial point,** $V = 0$**.**
13. **Dielectric constant,** $K = \frac{\epsilon}{\epsilon_0} = \frac{C_{med}}{C_{air}}$

14. Capacitance of parallel plate capacitor

(i) $C = \frac{A\epsilon_0 K}{d}$**, in medium of dielectric constant K**

(ii) $C = \frac{A\epsilon_0}{d - t(1 - \frac{1}{K})}$**; if space between plate partially filled with dielectric of thickness t.**

15. Combination of capacitors :-

(i) **In series,** $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$ **,** $q_1 = q_2 = q_3$, $V = V_1 + V_2 + V_3$

(ii) **In parallel,** C= $C_1 + C_2 + C_3$, $q = q_1 + q_2 + q_3$, $V_1 = V_2 = V_3 = V$

16. Energy stored by capacitor

$$\cup = \frac{1}{2}CV^2 = \frac{Q^2}{2C} = \frac{1}{2}QV$$

17. Electrostatic energy density

$\vartheta_e = \frac{1}{2}\epsilon_0 E^2$**, in air**

$\vartheta_e = \frac{1}{2}\epsilon E^2$**, in medium**

18. Total electric flux, $\Phi = \oint \vec{E}.\overrightarrow{ds} = \frac{1}{\epsilon_0} \times net\ charge\ enclosed\ by\ the\ surface$

NUMERICALS

LEVEL I

1. What is the charge acquired by a body when 1 million electrons are transferred to it?

   _____

   _____

2. An attractive force of 5N is acting between two charges of +2.0 μC & -2.0 μC placed at some distance. If the charges are mutually touched and placed again at the same distance, what will be the new force between them?

   _____

   _____

3. A charge of $+3.0 \times 10^{-6}$ C is 0.25 m away from a charge of -6.0×10^{-6}C.
   a. What is the force on the 3.0×10^{-6} C charge?
   b. What is the force on the -6.0×10^{-6} C charge?

   _____

   _____

4. An electric dipole consist of a positive and a negative charge of 4μC each placed at a distance of 5mm. Calculate dipole moment.

   _____

   _____

5. Three capacitors of capacitances 2μF, 3μF and 4μF are connected in parallel. What is the equivalent capacitance of the combination? Determine charge on each capacitor, if the combination is connected to 100V supply?

   _____

   _____

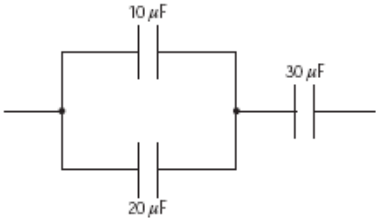
6. An electric dipole with dipole moment $4x10^{-9}$C-m is aligned at 30^0 with direction of electric field of magnitude $5x10^4$N/C. Calculate the magnitude of the torque acting on the dipole.

7. A point charge of 2μC is at the centre of cubic Gaussian surface 9.0 cm in edge. What is the net electric flux through the surface?

8. What is the amount of work done in moving a 200nC charge between two points 5 cm apart on an equipotential surface?

9. How much work must be done to charge a 24 μF capacitor, when the potential difference between the plates is 500 V?

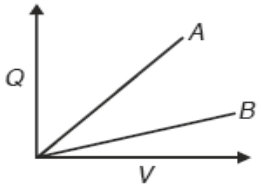
10. What is the equivalent capacity of the network given below?



LEVEL II

1. What is the work done in moving a charge of 100μC through a distance of 1cm along the equatorial line of dipole?

2. The given graph shows that variation of charge q versus potential difference V for two capacitors C_1 and C_2. The two capacitors have same plate separation but the plate area of C_2 is double than that of C_1. Which of the lines in the graph correspond to C_1 and C_2 and why?



3. Two point charges 5μC and – 4 μC are separated by a distance of 1 m in air. At what point on the line joining the charges is the electric potential zero?

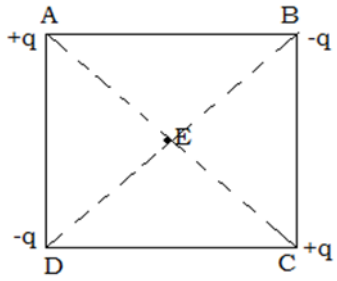
4. Two charges +5μC and +20μC are placed 15 cm apart. At what point on the line joining the two charges is the electric field zero?

5. Two charges +16μC and −9μC are placed 8 cm apart. At what point on the line joining the two charges is the electric field zero?

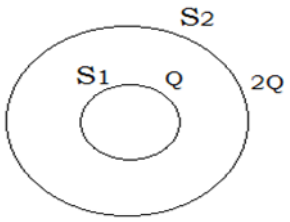
6. A 600 pF capacitor is charged by a 200 V supply. It is then disconnected and from the supply and is connected to another uncharged 600 pF capacitor. How much electrostatic energy is lost in the process.

7. Keeping the voltage of the charging source constant, what will be the percentage change in the energy stored in a parallel plate capacitor if the separation between its plates were to be decreased by 10%.

8. Four charges are placed at the vertices of a square of side d as shown in the figure.(i) Find the work done to put together this arrangement. (ii) A charge $q_0$is brought to the center E of the square, the four charges being held fixed at its corners. How much extra work is needed to do this?



9. If S_1 and S_2 are two hollow spheres enclosing charges Q and 2Q respectively as shown in the figure



(i) What is the ratio of the electric flux through S_1 and S_2?
(ii) How will the flux through the sphere S_1 change, if a medium of dielectric constant 5 is filled in the space inside S_1.

10. A charge of 24μC is given to a hollow sphere of radius 0.2m. Find the potential
(i) at the surface of the sphere, and
(ii) at a distance of 0.1 m from the centre of the sphere.
(iii)at the centre

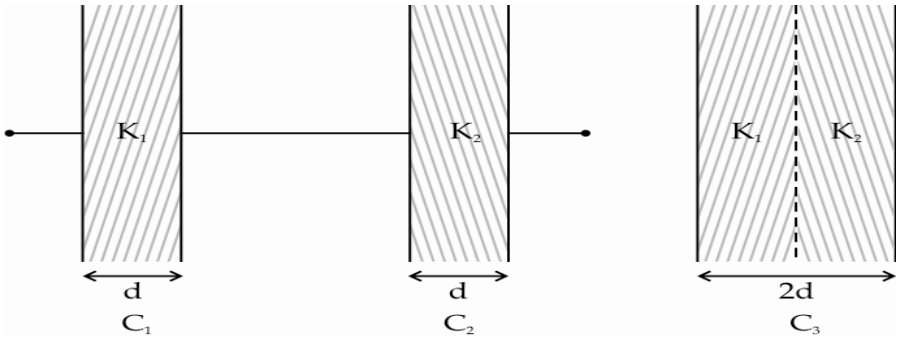
LEVEL III

1. A slab of material of dielectric constant κhas the same area as the plates of a parallel plate capacitor but has a thickness *3d /* 4, where *d* is the separation of the plates. How is the capacitance changed when the slab is inserted between the plates?

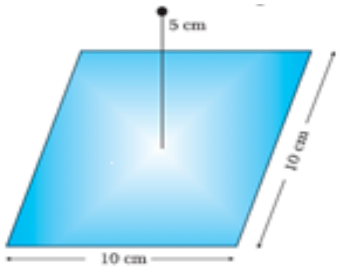
2. A parallel plate capacitor with air between the plates has a capacitance of 8μF. What will be the capacitance if the distance between the plates is doubled and the space between them is filled with a substance of dielectric constant K=6?

3. Two dipoles, made from charges $\pm$q and $\pm$Q, respectively, have equal dipole moments. Give the (i) ratio between the 'separations' of these two pairs of charges (ii) angle between the dipole axis of these two dipoles.

4. The capacitors C1, and C2, having plates of area A each, are connected in series, as shown. Compare the capacitance of this combination with the capacitor C3, again having plates of area A each, but 'made up' as shown in the figure.



5. A point charge +10μC is at a distance 5cm directly above the centre of a square of side 10cm as shown in fig. What is the magnitude of flux through the square?

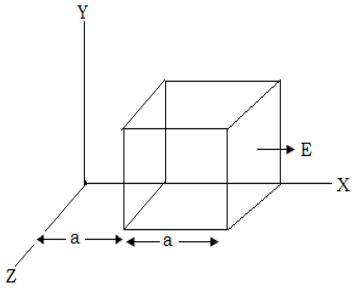


6. Calculate equivalent capacitance of the given network and determine the charge and voltage across each capacitor.

7. Two identical charges ,Q each are kept at a distance r from each other. A third charge q is placed on the line joining the two charges such that all the three charges are in equilibrium. What is magnitude, sign and position of the charge q?

8. ABCD is a square of side 5m. Charges of +50C, -50C and +50C are placed at A,C and D respectively . Find the magnitude of resultant electric field at B.

9. A cube with each side a is kept in electric field given by E = Cx as shown in the figure where C is a positive dimensional constant. Find
   (i) The electric flux through the cube, and
   (ii) The net charge inside the cube.



10. Two parallel plate capacitor X and Y have same area of plates and same separation between them. X has air between the plates whereas Y has a dielectric of constant k=4
    (i) Calculate capacitance of each capacitor if equivalent capacitance is4 μF.
    (ii) Calculate potential difference between the plates of X and Y.
    (iii) What is the ratio of electrostatic energy stored in X and Y.

UNIT: I ELECTROSTATICS

ANSWERS

LEVEL I

1. Q = Ne 1.6 x10^{-13}C
2. F=0
3. $F_{AB} = F_{BA}$=2.736N
4. P=2x10^{-8} C-m
5.
6. 10^{-4}Nm
7. 2,26x$10^{5}$$Nm^2$/C
8. W=0
9. W=3J
10. C=15µF

LEVEL II

1. 0
2. A
3. $\frac{5}{9}m$ from 5µC charge
4. 5 cm from 5 µC charge
5. 24cm from -9 µC charge
6. 6x10^{-6} J
7. 11.11%
8. $\frac{q^2}{4\pi\epsilon_0}(4-\sqrt{2})$, 0
9. 1: 3, $\emptyset = \frac{Q}{5\epsilon_0}$
10. (i) 1.08x10^{6}V (ii) 1.08x10^{6}V (iii)1.08x10^{6}V

LEVEL III

1. $\frac{4k}{k+3}C_0$
2. 24 µF
3. q a=Q A or a/A=Q/q θ = 0
4. $C_3 = C_{eq}$

5. $1.88 \times 10^5 Nm^2/C$

6. $\frac{200}{3} pF$,100 V, 50V, 50V, 200V,10^{-8}C, 10^{-8}C, 10^{-8}C,2×10^{-8} C

7. Q/4, Positive, r/2
8. 2.7×10^{10}N/C
9. a^3C N-m^2/C, $a^3 C\epsilon_0$ Coulombs.
10. C_x=5μF C_y= 20Mf