Electrostatics

Question1

A metal cube of side 5 cm is charged with 6μC. The surface charge density on the cube is

[NEET 2024 Re]

Options:

A.

$0.125 \times 10^{-3} \mathrm{Cm}^{-2}$

B.

$0.25 \times 10^{-3} \mathrm{Cm}^{-2}$

C.

$4 \times 10^{-3} \mathrm{Cm}^{-2}$

D.

$0.4 \times 10^{-3} \mathrm{Cm}^{-2}$

Answer: D

Solution:

⇒ In metal all the charge is present on surface.

$Q = 6\mu C$

Total surface area $S = 6a^2$

$= 6 \times (5 \times 10^{-2})^2$

$= 6 \times 25 \times 10^{-4}$

$= 150 \times 10^{-4} \mathrm{m}^2$

Surface charge density $\sigma = \frac{Q}{S}$

$= \frac{6 \times 10^{-6}}{150 \times 10^{-4}}$

$= 0.4 \times 10^{-3} \mathrm{Cm}^{-2}$

Question2

The value of electric potential at a distance of 9 cm from the point charge 4×10^{-7}C is

[Given $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 \text{Nm}^2\text{C}^{-2}$] :

[NEET 2024 Re]

Options:

A.

4×10^2V

B.

44.4V

C.

4.4×10^5V

D.

4×10^4V

Answer: D

Solution:

$$V = \frac{kq}{r}$$

$$= 9 \times 10^9 \times \frac{4 \times 10^{-7}}{9 \times 10^{-2}}$$

$$= 4 \times 10^4 \text{V}$$

Question3

A 12pF capacitor is connected to a 50V battery, the electrostatic energy stored in the capacitor in nJ is

[NEET 2024 Re]

Options:

A.

15

B.

7.5

C.

0.3

D.

Answer: A

Solution:

Electrostatic energy stored $U = \frac{1}{2}CV^2$

$= \frac{1}{2} \times 12 \times 10^{-12} \times (50)^2$

$= 6 \times 25 \times 10^{-10}$

$= 15 \times 10^{-9} \text{J}$

$= 15 \text{ nJ}$

Question4

The capacitance of a capacitor with charge q and a potential difference V depends on

[NEET 2024 Re]

Options:

A.

both q and V

B.

the geometry of the capacitor

C.

q only

D.

V only

Answer: B

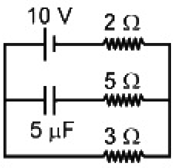
Solution:

Capacitance of capacitor $C = \frac{A\varepsilon_0}{d}$

so capacitance of capacitor is independent of charge (q) and potential (V), it depends on geometry of the capacitor and medium between plates of the capacitor.

Question5

The steady state current in the circuit shown below is



[NEET 2024 Re]

Options:

A.

0.67A

B.

1.5A

C.

2A

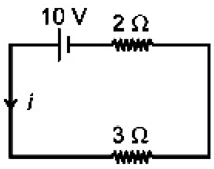
D.

1A

Answer: C

Solution:

At steady state, capacitor will be completely charged and will not allow current to pass through it. The simplified circuit will be :

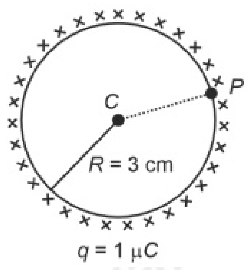


$i=\frac{V}{R} \Rightarrow i=\frac{10}{2+3}=2\text{A}$

Question6

A thin spherical shell is charged by some source. The potential difference between the two points C and P (in V) shown in the figure is:

(Take $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ SI units)



[NEET 2024]

Options:

A.

3×10^5

B.

1×10^5

C.

0.5×10^5

D.

Zero

Answer: D

Solution:

For uniformly charged spherical shell,

$V = \frac{kq}{R}$ (For $r \leq R$)

$\therefore V_c = V_P$

$V_c - V_P =$ Zero

Question7

Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R .

Assertion A: The potential (V) at any axial point, at 2m distance (r) from the centre of the dipole of dipole moment vector $\vec{P}$ of magnitude, 4×10^{-6}Cm , is $\pm 9 \times 10^3$V.

(Take $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9$ SI units)

Reason R: V = $\pm \frac{2P}{4\pi \epsilon_0 r^2}$, where r is the distance of any axial point, situated at 2m from the centre of the dipole.

In the light of the above statements, choose the correct answer from the options given below:

[NEET 2024]

Options:

A.

Both A and R are true and R is the correct explanation of A.

B.

Both A and R are true and R is NOT the correct explanation of A.

C.

A is true but R is false.

D.

A is false but R is true.

Answer: C

Solution:

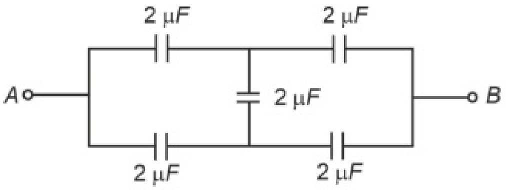
The potential V at any point, at distance r from centre of dipole $= \frac{KP\cos\theta}{r^2}$

At axial point where $\theta = 0^\circ$, $V = \frac{KP}{r^2} = \frac{9 \times 10^9 \times 4 \times 10^{-6}}{2^2} = 9 \times 10^3 \text{V}$

At axial point where $\theta = 180^\circ$, $V = \frac{-KP}{r^2} = -9 \times 10^3 \text{V}$

Question8

In the following circuit, the equivalent capacitance between terminal A and terminal B is :



[NEET 2024]

Options:

A.

2μF

B.

1μF

C.

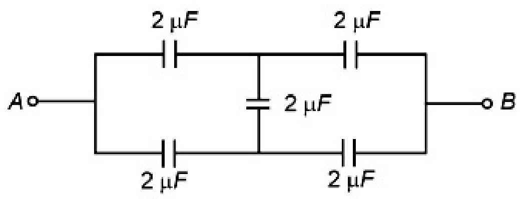
0.5μF

D.

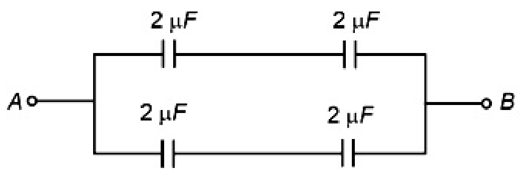
4μF

Answer: A

Solution:



Given circuit is balanced Wheatstone bridge



$C_{AB} = 1 + 1$

$= 2\mu F$

Question9

If the plates of a parallel plate capacitor connected to a battery are moved close to each other, then
A. the charge stored in it, increases.
B. the energy stored in it, decreases.
C. its capacitance increases.
D. the ratio of charge to its potential remains the same.
E. the product of charge and voltage increases.

Choose the most appropriate answer from the options given below:

[NEET 2024]

Options:

A.

A, B and E only

B.

A, C and E only

C.

B, D and E only

D.

A, B and C only

Answer: B

Solution:

Given $V = V =$ Constant

(i) $C' = \frac{\varepsilon_0 A}{d'}, C = \frac{\varepsilon_0 A}{d}$

$d' < d$

$C' > C$

Hence, final capacitance greater than initial capacitance,

(ii) $U' = \frac{1}{2}C'V^2$

$U = \frac{1}{2}CV^2$

$U' > U$

Hence final energy is greater than initial energy

(iii) $\frac{Q'}{V'} = C'$ and $\frac{Q}{V} = C$

$\frac{Q'}{V'} \neq \frac{Q}{V}$

(iv) Product of charge and voltage

$X' = Q'V = C'V^2$

$X = QV = CV^2$

$X' > X$

Question10

A parallel plate capacitor is charged by connecting it to a battery through a resistor. If I is the current in the circuit, then in the gap between the plates:

[NEET 2024]

Options:

A.

There is no current

B.

Displacement current of magnitude equal to I flows in the same direction as I

C.

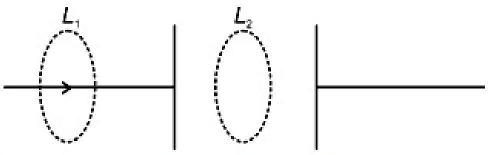
Displacement current of magnitude equal to I flows in a direction opposite to that of I

D.

Displacement current of magnitude greater than I flows but can be in any direction

Answer: B

Solution:



According to modified Ampere's law

$\oint B \, . \, dl = \mu_0 (I_C + I_D)$

For Loop L_1 $\quad I_C \neq 0$ and $I_D = 0$

For Loop L_2 $\quad I_C = 0$ and $I_D \neq 0$

Due to KCL $\quad I_C = I_D$

Question11

If $\oint_s \vec{E} \cdot \vec{dS} = 0$ over a surface, then

[NEET 2023]

Options:

A.

The magnitude of electric field on the surface is constant

B.

All the charges must necessarily be inside the surface

C.

The electric field inside the surface is necessarily uniform

D.

The number of flux lines entering the surface must be equal to the number of flux lines leaving it

Answer: D

Solution:

$$\varphi_{net} = \oint_s \vec{E} \cdot \vec{dS} = 0$$

Net flux through surface is zero.

Therefore, the number of flux lines entering the surface must be equal to the number of flux lines leaving it.

Question12

An electric dipole is placed at an angle of 30∘ with an electric field of intensity $2 \times 10^5 NC^{-1}$. It experiences a torque equal to 4Nm. Calculate the magnitude of charge on the dipole, if the dipole length is 2cm.

[NEET 2023]

Options:

A.

6 mC

B.

4 mC

C.

2 mC

D.

8 mC

Answer: C

Solution:

$E = 2 \times 10^5 N/C$

$l = 2\ cm$

$\tau = 4\ Nm$

$\vec{\tau} = \vec{p} \times \vec{E}$

$4 = pE \sin\theta$

$4 = p \times 2 \times 10^5 \times \sin 30^\circ$

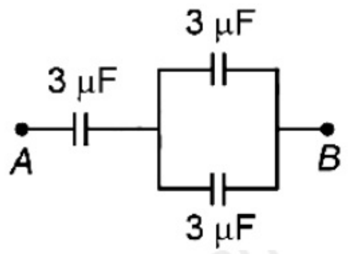
$p = 4 \times 10^{-5}\ cm$

$q = \frac{p}{l} = \frac{4 \times 10^{-5}}{0.02} = 2\ mC$

Question13

The equivalent capacitance of the system shown in the following circuit is

[NEET 2023]



Options:

A.

3μF

B.

6μF

C.

9μF

D.

2μF

Answer: D

Solution:

For parallel grouping

$C_1 = 3 + 3 = 6\mu F$

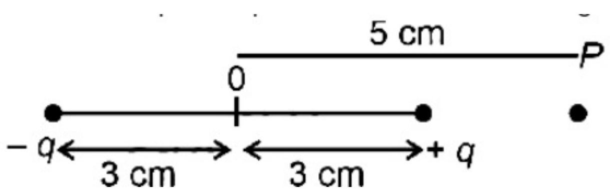
For series grouping

$$C_{eq} = \frac{C_1 C_2}{C_1 + C_2} = \frac{3 \times 6}{3 + 6} = \frac{18}{9}$$

$C_{eq} = 2\mu F$

Question14

An electric dipole is placed as shown in the figure.



The electric potential (in 10^2V) at point P due to the dipole is (E_0 =. permittivity of free space and $\frac{1}{4\pi E_0} = K$)

[NEET 2023]

Options:

A.

$\left(\frac{5}{8}\right)qK$

B.

$\left(\frac{8}{5}\right)qK$

C.

$\left(\frac{8}{3}\right)qK$

D.

$\left(\frac{3}{8}\right)qK$

Answer: D

Solution:

Solution:

Electrostatic potential due to a point charge is given by $\frac{Kq}{r}$

$$V_{\text{net at point } P} = \frac{Kq}{2 \times 10^{-2}} - \frac{Kq}{8 \times 10^{-2}}$$

$$= \frac{Kq \times 10^2}{2}\left(1 - \frac{1}{4}\right)$$

$$= \left(\frac{3}{8}Kq\right) \times 10^2 V = \frac{3}{8}qK$$

Question15

According to Gauss law of electrostatics, electric flux through a closed surface depends on :

[NEET 2023 mpr]

Options:

A.

the area of the surface

B.

the quantity of charges enclosed by the surface

C.

the shape of the surface

D.

the volume enclosed by the surface

Answer: B

Solution:

$$\varphi = \frac{q_{inside}}{\varepsilon_0}$$

only depends on charge enclosed by surface.

Question16

A charge QμC is placed at the centre of a cube. The flux coming out from any one of its faces will be (in SI unit) :

[NEET 2023 mpr]

Options:

A.

$$\frac{Q}{E_0} \times 10^{-6}$$

B.

$$\frac{2Q}{3E_0} \times 10^{-3}$$

C.

$$\frac{Q}{6E_0} \times 10^{-3}$$

D.

$$\frac{Q}{6E_0} \times 10^{-6}$$

Answer: D

Solution:

$$\text{Total flux from cube} = \frac{q}{\varepsilon_0}$$

∴ So flux of any one surface of cube

$$= \frac{q}{6\varepsilon_0} = \frac{Q \times 10^{-6}}{6\varepsilon_0}$$

Question17

If a conducting sphere of radius R is charged. Then the electric field at a distance r(r>R) from the centre of the sphere would be, (V= potential on the surface of the sphere)

[NEET 2023 mpr]

Options:

A.

rV/R^2

B.

R^2V/r^3

C.

RV/r^2

D.

V/r

Answer: C

Solution:

Solution:

$$\therefore V = \frac{KQ}{R}$$

$$E = \frac{KQ}{r^2}$$

$$E = \frac{VR}{r^2}$$

Question18

The distance between the two plates of a parallel plate capacitor is doubled and the area of each plate is halved. If C is its initial capacitance, its final capacitance is equal to:
[NEET Re-2022]

Options:

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

B. 2C

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

D. 4C

Answer: A

Solution:

$$C' = \frac{\frac{A}{2}\varepsilon_0}{2d} = \frac{C}{4}$$

Question19

The effective capacitances of two capacitors are 3μF and 16μF, when they are connected in series and parallel respectively. The capacitance of two capacitors are:
[NEET Re-2022]

Options:

A. 1.2μF, 1.8μF

B. 10μF, 6μF

C. 8μF, 8μF

D. 12μF, 4μF

Answer: D

Solution:

Let the capacitances are C_1 and C_2 In series $C_{eff} = 3\mu F$

$$\Rightarrow \frac{C_1C_2}{C_1+C_2} = 3\mu F \quad .... \quad (i)$$

In parallel $C_{eff} = 16\mu F$

$$\Rightarrow C_1 + C_2 = 16\mu F \quad \cdots\cdots (ii)$$

From (i) & (ii)

$$C_1C_2 = 48\mu F$$

$$(C_1 - C_2)^2 = (C_1 + C_2)^2 - 4C_1C_2$$

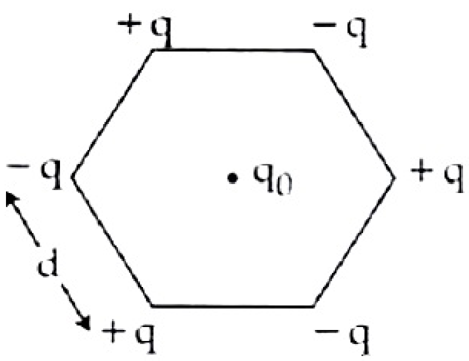
$$C_1 - C_2 = 8\mu F \quad ...... \quad (iii)$$

From (ii) & (iii)

$$C_1 = 12\mu F, C_2 = 4\mu F$$

Question20

Six charges $+q, -q, +q, -q, +q$ and $-$ qare fixed at the corners of a hexagon of side d as shown in the figure. The work done in bringing a charge q_0 to the centre of the hexagon from infinity is: (ε_0. - permittivity of free space)



[NEET Re-2022]

Options:

A. $\frac{-q^2}{4\pi\varepsilon_0 d}\left(6 - \frac{1}{\sqrt{2}}\right)$

B. Zero

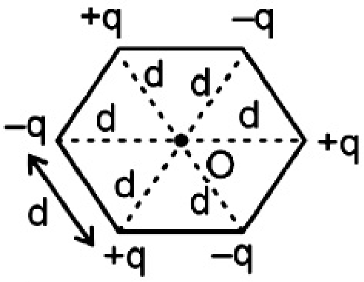
C. $\frac{-q^2}{4\pi\varepsilon_0 d}$

D. $\frac{-q^2}{4\pi\varepsilon_0 d}\left(3 - \frac{1}{\sqrt{2}}\right)$

Answer: B

Solution:

Potential at the centre of hexagon is zero.



$V_0 = 0$

$\therefore w_{\infty \to 0} = q\,\Delta v = q_0(0)$

$= 0$

Question21

The angle between the electric lines of force and the equipotential surface is
[NEET-2022]

Options:

A. 0°

B. 45°

C. 90°

D. 180°

Answer: C

Solution:

$dV = -\vec{E} \cdot d\vec{r}$

$dV = -E\,dr\cos\theta$

For equipotential surface,

$dV = 0$

$\cos\theta = 0$

$\Rightarrow \theta = 90^{\circ}$

Question22

Two hollow conducting spheres of radii R_1 and $R_2 (R_1 \gg R_2)$ have equal charges. The potential would be

[NEET-2022]

Options:

A. More on bigger sphere

B. More on smaller sphere

C. Equal on both the spheres

D. Dependent on the material property of the sphere

Answer: B

Solution:

Solution:

Potential of conducting hollow sphere $= \frac{KQ}{R}$

Now, $Q =$ same

$\Rightarrow V \propto \frac{1}{R} \Rightarrow$ more the radius less will be the potential.

$\Rightarrow$ Hence potential would be more on smaller sphere

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Question23

Two point charges −q and +q are placed at a distance of L, as shown in the figure.
The magnitude of electric field intensity at a distance R(R ≫ L) varies as:
[NEET-2022]

Options:

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

B. $\frac{1}{R^3}$

C. $\frac{1}{R^4}$

D. $\frac{1}{R^6}$

Answer: B

Solution:

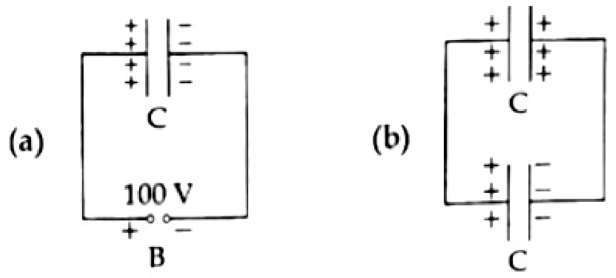
For $R \gg L$, arrangement is an electric dipole

$$E = \frac{2p}{4\pi\varepsilon_0 R^3}; \quad \text{where } p = qL$$

$$E \propto \frac{1}{R^3}$$

Question24

A capacitor of capacitance $C = 900\text{pF}$ is charged fully by 100V battery B as shown in figure (a). Then it is disconnected from the battery and connected to another uncharged capacitor of capacitance $C = 900\text{pF}$ as shown in figure (b). The electrostatic energy stored by the system (b) is



[NEET-2022]

Options:

A. $4.5 \times 10^{-6}\text{J}$

B. $3.25 \times 10^{-6}\text{J}$

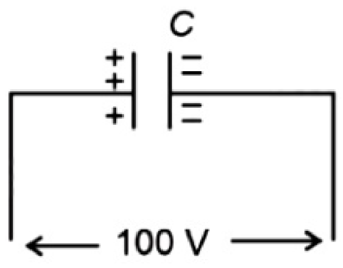
C. $2.25 \times 10^{-6}\text{J}$

D. $1.5 \times 10^{-6}\text{J}$

Answer: C

Solution:

$$q_1 = CV$$
$$= 900 \times 10^{-12} \times 100$$
$$= 9 \times 10^{-8} C$$



$$V = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$$

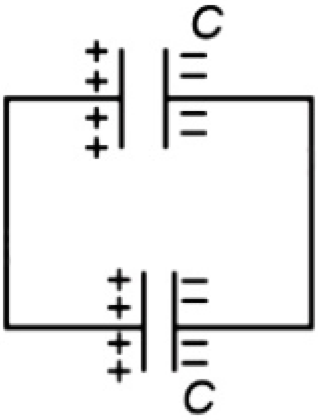
$$= \frac{9 \times 10^{-8} + 0}{1800 \times 10^{-12}} = \frac{100}{2} = 50V$$

$$U = \frac{1}{2}(C_1 + C_2)V^2$$

$$= \frac{1}{2} \times 1800 \times 10^{-12} \times 50 \times 50$$

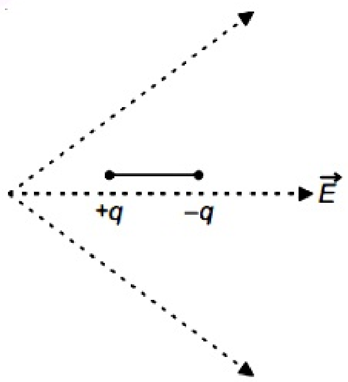
$$= 225 \times 10^{-8}$$

$$U = 2.25 \times 10^{-6} J$$



Question25

A dipole is placed in an electric field as shown. In which direction will it move?



[NEET 2021]

Options:

A. Towards the left as its potential energy will increase.

B. Towards the right as its potential energy willdecrease.

C. Towards the left as its potential energy will decrease.

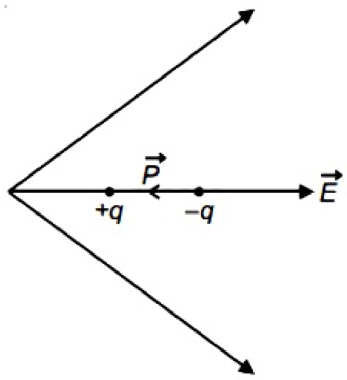
D. Towards the right as its potential energy will increase.

Answer: B

Solution:

Solution:

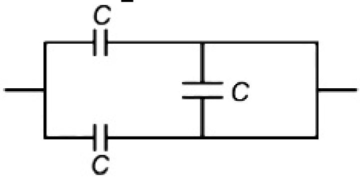
Potential energy of electric dipole in external electric field $U = -\vec{P} \cdot \vec{E}$



Angle between electric field and electric dipole is 180°
$U = -PE \cos\theta$
$U = -PE \cos 180°$
$U = +PE$
On moving towards right electric field strength decrease therefore potential energy decrease.
Net force on electric dipole is towards right and net torque acting on it is zero.
So, it will more towards right.

Question26

The equivalent capacitance of the combination shown in the figure is



[NEET 2021]

Options:

A. 3C

B. 2C

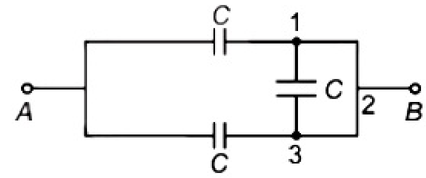
C. $\frac{C}{2}$

D. $\frac{3C}{2}$

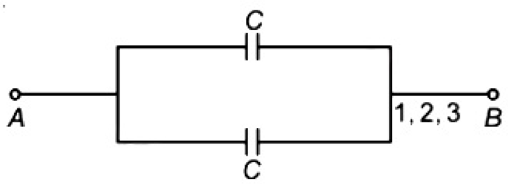
Answer: B

Solution:

Given circuit is



Points 1, 2, 3 are at same potential (as they are connected by conducting wire)
So the capacitor is short circuited. It does not store any charge.
The circuit can be redrawn as



$C_{AB} = C + C = 2C$ (Parallel combination)

Question27

Two charged spherical conductors of radius R_1 and R_2 are connected by a wire. Then the ratio of surface charge densities of the spheres (σ_1 / σ_2) is
[NEET 2021]

Options:

A. $\frac{R_1}{R_2}$

B. $\frac{R_2}{R_1}$

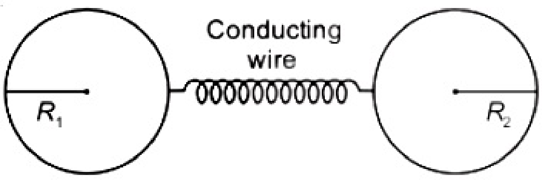
C. $\sqrt{\left(\frac{R_1}{R_2}\right)}$

D. $\frac{R_1^{\ 2}}{R_2^{\ 2}}$

Answer: B

Solution:

Solution:



When two conductors are connected by a conducting wire, then the two conductors should have same potential.
so, $V_1 = V_2$

$\therefore \frac{1}{4\pi\varepsilon_0}\frac{Q_1}{R_1} = \frac{1}{4\pi\varepsilon_0}\frac{Q_2}{R_2}$

$\Rightarrow \frac{1}{4\pi\varepsilon_0}\frac{Q_1}{R_1} \times \frac{R_1}{R_1} = \frac{1}{4\pi\varepsilon_0}\frac{Q_2}{R_2} \times \frac{R_2}{R_2}$

$\Rightarrow \frac{Q_1 R_1}{4\pi R_1^{\ 2}\varepsilon_0} = \frac{Q_2 R_2}{4\pi R_2^{\ 2}\varepsilon_0}$

$\Rightarrow \frac{\sigma_1 R_1}{\varepsilon_0} = \frac{\sigma_2 R_2}{\varepsilon_0}$

$\Rightarrow \frac{\sigma_1}{\sigma_2} = \frac{R_2}{R_1}$

Question28

A parallel plate capacitor has a uniform electric field ' $\vec{E}$' in the space between the plates. If the distance between the plates is ' d ' and the area of each plate is ' A ', the energy stored in the capacitor is (ε_0 = permittivity of free space)
[NEET 2021]

©

Options:

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

B. $\varepsilon_0 E Ad$

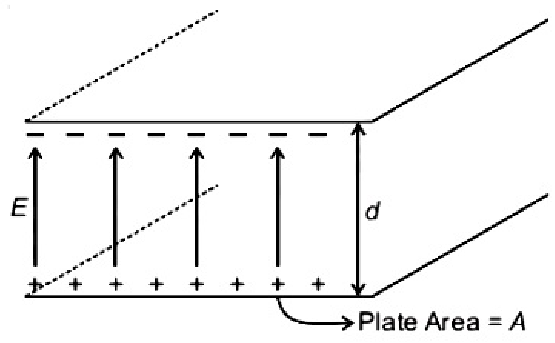
C. $\frac{1}{2}\varepsilon_0 E^2 Ad$

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

Answer: C

Solution:

Solution:



Energy density associated with electric field is given by

$u = \frac{dU}{dV} = \frac{1}{2}\varepsilon_0 E^2$

$\Rightarrow dU = \frac{1}{2}\varepsilon_0 E^2 dV$

Total energy stored in the space between the capacitor will be

$U = \int dU = \int \frac{1}{2}\varepsilon_0 E^2 dV$

$= \frac{1}{2}\varepsilon_0 E^2 \int dV$ [E is constant]

$= \frac{1}{2}\varepsilon_0 E^2 V = \frac{1}{2}\varepsilon_0 E^2 Ad$ [V = Ad]

Question29

Polar molecules are the molecules
[NEET 2021]

Options:

A. Having zero dipole moment

B. Acquire a dipole moment only in the presence of electric field due to displacement of charges

C. Acquire a dipole moment only when magnetic field is absent

D. Having a permanent electric dipole moment

Answer: D

Solution:

Solution:
In polar molecules, the centre of positive charges does not coincide with the centre of negative charges.
Hence, these molecules have a permanent electric dipole moment of their own.

Question30

Twenty seven drops of same size are charged at 220 V each. They combine to form a bigger drop.
Calculate the potential of the bigger drop.
[NEET 2021]

Options:

A. 660 V

B. 1320 V

C. 1520 V

D. 1980 V

Answer: D

Solution:

Solution:
Electric potential due to a charged sphere $= \frac{kQ}{R}$
$k = 9 \times 10^{9} N - m^{2} / C^{2}$
Q : charge on sphere
R : Radius of sphere
Let charge and radius of smaller drop is q and r respectively

For smaller drop, $V = \frac{kq}{r} = 220V$
Let R be radius of bigger drop,
As volume remains the same
$\left(\frac{4}{3}\pi r^3\right) \times 27 = \frac{4}{3}\pi R^3$
$\Rightarrow R = \sqrt[3]{27}r = 3r$
Now, using charge conservation,
$\Rightarrow Q = 27q$
$V_{bigdrop} = \frac{kQ}{R} = \frac{k(27q)}{3r} = 9\left(\frac{kq}{r}\right)$
$= 9 \times 220 = 1980$ V

Question31

A spherical conductor of radius 10cm has a charge of $3.2 \times 10^{-7}C$ distributed uniformly. What is the magnitude of electric field at a point 15cm from the centre of the sphere? ($1 / 4\pi E_0 = 9 \times 10^9 N\,m^2 \backslash /C^2$) [2020]

Options:

A. $1.28 \times 10^5 N / C$

B. $1.28 \times 10^6 N / C$

C. $1.28 \times 10^7 N / C$

D. $1.28 \times 10^4 N / C$

Answer: A

Solution:

Solution:
(a) If the charge on a spherical conductor of radius R is Q, then electric field at distance r from centre is
$E = 0 (\text{ if } r \angle R)$
$E = \frac{1}{4\pi E_0}\frac{Q}{r^2}(\text{ if } r \geq R)$
Electric field at a distance 15cm from the centre of sphere will be
$E = \frac{9 \times 10^9 \times 3.2 \times 10^{-7}}{225 \times 10^{-4}}$
$= 0.128 \times 10^6 = 1.28 \times 10^5 N / C$

Question32

**In a certain region of space with volume $0.2\ m^3$, the electric potential is found to be 5V throughout. The magnitude of electric field in this region is:
(2020)**

Options:

A. $0.5 \mathrm{N} / \mathrm{C}$

B. $1 \mathrm{N} / \mathrm{C}$

C. $5 \mathrm{N} / \mathrm{C}$

D. zero

Answer: D

Solution:

Solution:
(d) since, electric potential is constant throughout the volume, hence electric field,
$E = -\frac{dV}{dr} = 0$

Question33

A short electric dipole has a dipole moment of 16×10^{-9}Cm. The electric potential due to the dipole at a point at a distance of 0.6m from the centre of the dipole, situated on a line making an angle of 60° with the dipole axis is :
$\left(\frac{1}{4\pi E_0} = 9 \times 10^9 N\,m^2 / C^2 \right)$
[2020]

Options:

A. 200V

B. 400V

C. zero

D. 50V

Answer: A

Solution:

Solution:
(a) Given, Dipole moment of short electric dipole, $p = 16 \times 10^{-9}$Cm
Distance from centre of dipole, $r = 0.6$m
Electric potential, $V = \frac{kp\cos\theta}{r^2}$
$\Rightarrow V = \frac{9 \times 10^9 \times 16 \times 10^{-9} \times \cos 60}{0.36} = 200V$

Question34

The capacitance of a parallel plate capacitor with air as medium is 6μF . With the introduction of a dielectric medium, the capacitance becomes 30μF . The permittivity of the medium is:
$(E_0 = 8.85 \times 10^{-12} C^2 N^{-1} m^{-2})$
[2020]

Options:

A. $1.77 \times 10^{-12} C^2 N^{-1} m^{-2}$

B. $0.44 \times 10^{-10} C^2 N^{-1} m^{-2}$

C. $5.00 C^2 N^{-1} m^{-2}$

D. $0.44 \times 10^{-13} C^2 N^{-1} m^{-2}$

Answer: B

Solution:

Solution:
(b) Capacitance of a parallel plate capacitor with air is
$C = \frac{\varepsilon_0 A}{d}$ .... (i)
Here, $A =$ area of plates of capacitor, $d =$ distance between the plates Capacitance of a same parallel plate capacitor with introduction of dielectric medium of
dielectric constant K is
$C' = \frac{K \varepsilon_0 A}{d}$ .... (ii)
Dividing (ii) by(i)
$\Rightarrow \frac{C'}{C} = K \Rightarrow \frac{30}{6} = K \Rightarrow K = 5$
$\Rightarrow K = \frac{\varepsilon}{\varepsilon_0}$
$\Rightarrow \varepsilon = K \varepsilon_0 = 5 \times 8.85 \times 10^{-12}$
$= 0.44 \times 10^{-10} C^2 N^{-1} m^{-2}$

Question35

A hollow metal sphere of radius R is uniformly charged. The electric field due to the sphere at a distance r from the centre
(NEET 2019)

Options:

A. decreases as r increases for r < R and for r > R

B. increases as r increases for r < R and for r > R

C. zero as r increases for r < R, decreases as r increases for r > R

D. zero as r increases for $r < R$, increases as r increases for $r > R$

Answer: C

Solution:

Solution:
In a uniformly charged hollow conducting sphere,

(i) For $r < R$, $\vec{E} = 0$

(ii) For $r > R$, $\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{|\vec{r}^2|}\hat{r}$; $\vec{E}$ decreases

---

Question36

Two point charges A and B, having charges +Q and −Q respectively, are placed at certain distance apart and force acting between them is F . If 25% charge of A is transferred to B, then force between the charges becomes
(NEET 2019)

Options:

A. $\frac{4F}{3}$

B. F

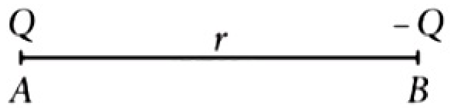
C. $\frac{9F}{16}$

D. $\frac{16F}{9}$

Answer: C

Solution:

Solution:



In case I : $F = -\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{r^2}$ ...(i)

In Case II : $Q_A = Q - \frac{Q}{4}$, $Q_B = -Q + \frac{Q}{4}$

$\therefore F' = \frac{1}{4\pi\varepsilon_0}\frac{\left(Q - \frac{Q}{4}\right)\left(-Q + \frac{Q}{4}\right)}{r^2}$

$= -\frac{1}{4\pi\varepsilon_0}\frac{9}{16}\frac{Q^2}{r^2}$

From equations (i) and (ii),

$F' = \frac{9}{16}F$

Question37

Two parallel infinite line charges with linear charge densities +λ C/m and -λ C/m are placed at a distance of 2R in free space. What is the electric field mid-way between the two line charges?
(NEET 2019)

Options:

A. $\frac{\lambda}{2\pi\varepsilon_0 R} N / C$

B. zero

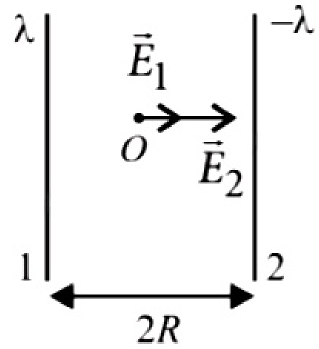
C. $\frac{2\lambda}{\pi\varepsilon_0 R} N / C$

D. $\frac{\lambda}{\pi\varepsilon_0 R} N / C$

Answer: D

Solution:

Solution:



Electric field due to an infinite line charge, $E = \frac{\lambda}{2\pi\varepsilon_0 r}$

Net electric field at mid-point O,

$\vec{E}_0 = \vec{E}_1 + \vec{E}_2$

As, $E_1 = E_2 = \frac{\lambda}{2\pi\varepsilon_0 R}$

$\therefore E_0 = 2E_1 = \frac{\lambda}{\pi\varepsilon_0 R} NC^{-1}$

Question38

Two metal spheres, one of radius R and the other of radius 2R respectively have the same surface charge density σ. They are brought in contact and separated. What will be the new surface charge densities on them?
(OD NEET 2019)

Options:

A. $\sigma_1 = \frac{5}{6}\sigma, \sigma_2 = \frac{5}{2}\sigma$

B. $\sigma_1 = \frac{5}{2}\sigma, \sigma_2 = \frac{5}{6}\sigma$

C. $\sigma_1 = \frac{5}{2}\sigma, \sigma_2 = \frac{5}{3}\sigma$

D. $\sigma_1 = \frac{5}{3}\sigma, \sigma_2 = \frac{5}{6}\sigma$

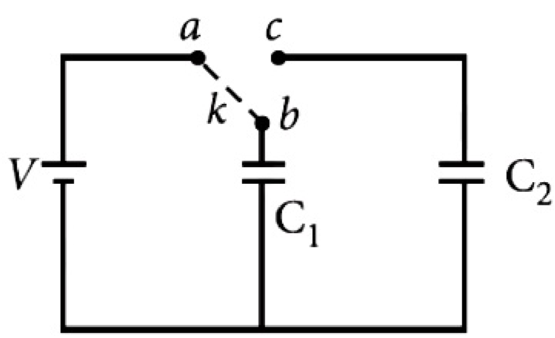
Answer: D

Solution:

Solution:
Before contact, $Q_1 = \sigma . 4\pi R^2$ and $Q_2 = \sigma . 4\pi(2R)^2$
As, surface charge density,
$\sigma = \frac{\text{Net charge (Q)}}{\text{Surface area (A)}}$
Now, after contact, $Q'_1 + Q'_2 = Q_1 + Q_2 = 5Q_1 = 5(\sigma . 4\pi R^2)$ ...(i)
They will be at equal potentials, so, $\frac{Q'_1}{R} = \frac{Q'_2}{2R} \Rightarrow Q'_2 = 2Q'_1$
$\therefore 3Q'_1 = 5(\sigma . 4\pi R^2)$ (From equation (i))
and $Q'_2 = \frac{10}{3}(\sigma . 4\pi R^2)$
$\therefore \sigma_1 = \frac{5}{3}\sigma$ and $\sigma_2 = \frac{5}{6}\sigma$

Question39

Two identical capacitors C_1 and C_2 of equal capacitance are connected shown in the circuit. Terminals a and b of the key k are connected to charge capacitor C_1 using battery of emf V volt. Now disconnecting a and b the terminals b and c are connected. Due to this, what will be the percentage loss of energy?



(OD NEET 2019)

Options:

A. 75%

B. 0%

C. 50%

D. 25%

Answer: C

Solution:

As we know that, loss of electrostatic energy,

$$E_{loss} = \frac{1}{2}\frac{C_1C_2}{(C_1 + C_2)}V^2 = \frac{1}{2} \times \frac{C^2}{2C}V^2$$

$$= \frac{1}{2}\left(\frac{1}{2}CV^2\right) = \frac{1}{2}E \ [\because C_1 = C_2 = C]$$

$\therefore$ Percentage of loss of energy $= \frac{\frac{1}{2}E}{E} \times 100\% = \frac{1}{2} \times 100\% = 50\%$

Question40

An electron falls from rest through a vertical distance h in a uniform and vertically upward directed electric field E. The direction of electric field is now reversed, keeping its magnitude the same. A proton is allowed to fall from rest in it through the same vertical distance h. The time of fall of the electron, in comparison to the time of fall of the proton is (NEET 2018)

Options:

A. smaller

B. 5 times greater

C. 10 times greater

D. equal

Answer: A

Solution:

Solution:

Force experienced by a charged particle in an electric field, $F = qE$

As $F = ma$

$\Rightarrow ma = qE \Rightarrow a = \frac{qE}{m}$ ....(i)

As electron and proton both fall from same height at rest. Then initial velocity $= 0$

From $s = ut + \frac{1}{2}at^2$ $(\because u = 0)$

$\therefore h = \frac{1}{2}at^2 \Rightarrow h = \frac{1}{2}\frac{qE}{m}t^2$ [Using (i)]

$\therefore t = \sqrt{\frac{2hm}{qE}} \Rightarrow t \propto \sqrt{m}$ as 'q' is same for electron and proton.

$\therefore$ Electron has smaller mass so it will take smaller time.

Question41

The electrostatic force between the metal plates of an isolated parallel plate capacitor C having a charge Q and area A, is
(NEET 2018)

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Options:

A. Independent of the distance between the plates

B. Linearly proportional to the distance between the plates

C. Proportional to the square root of the distance between the plates

D. Inversely proportional to the distance between the plates

Answer: A

Solution:

Solution:
For isolated capacitor, charge Q = constant.
Electrostatic force, $F_{plate} = \frac{Q^2}{2A\varepsilon_0}$

Question42

A toy car with charge q moves on a frictionless horizontal plane surface under the influence of a uniform electric field $\vec{E}$. Due to the force $q\vec{E}$, its velocity increases from 0 to $6ms^{-1}$ in one second duration. At that instant the direction of the field is reversed. The car continues to move for two more seconds under the influence of this field. The average velocity and the average speed of the toy car between 0 to 3 seconds are respectively
(NEET 2018)

Options:

A. $2ms^{-1}$, $4ms^{-1}$

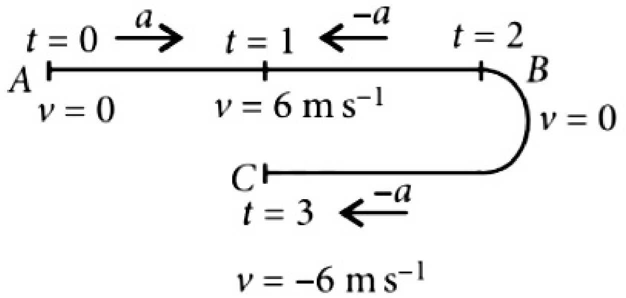
B. $1ms^{-1}$, $3ms^{-1}$

C. $1ms^{-1}$, $3.5ms^{-1}$

D. $1.5ms^{-1}$, $3ms^{-1}$

Answer: B

Solution:



Acceleration $a = \frac{6-0}{1} = 6ms^{-2}$

For t = 0 to t = 1s, $s_1 = \frac{1}{2} \times 6(1)^2 = 3m$ ...(i)

For t = 1 s to t = 2s, $s_2 = 6 \times 1 - \frac{1}{2} \times 6(1)^2 = 3m$ ...(ii)

For t = 2s to t = 3s, $s_3 = 0 - \frac{1}{2} \times 6(1)^2 = -3m$ ...(iii)

Total displacement $s = s_1 + s_2 + s_3 = 3m$

Average velocity $= \frac{3}{3} = 1ms^{-1}$

Total distance travelled $= 9m$

Average speed $= \frac{9}{3} = 3ms^{-1}$

Question43

A capacitor is charged by a battery. The battery is removed and another identical uncharged capacitor is connected in parallel. The total electrostatic energy of resulting system (2017 NEET)

Options:

A. decreases by a factor of 2

B. remains the same

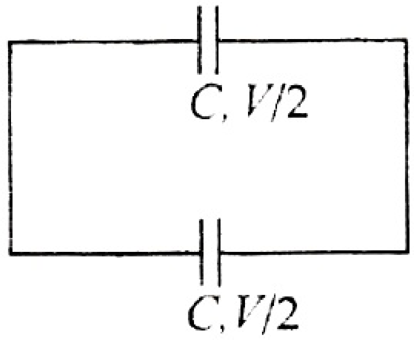
C. increases by a factor of 2

D. increases by a factor of 4

Answer: A

Solution:

Solution:
When the capacitor is charged by a battery of potential V, then energy stored in the capacitor,
$U_i = \frac{1}{2}CV^2$.....(i)
When the battery is removed and another identical uncharged capacitor is connected in parallel



Common potential,
$V' = \frac{CV}{C+C} = \frac{V}{2}$
∴
Then the energy stored in the capacitor, $U_f = \frac{1}{2}(2C)\left(\frac{V}{2}\right)^2 = \frac{1}{4}CV^2$.........(ii)

∴ From eqns. (i) and (ii)
$U_f = \frac{U_i}{2}$
that means the total electrostatic energy of resulting system will decreases by a factor of 2.

Question44

Suppose the charge of a proton and an electron differ slightly. One of them is -e , the other is (e+Δe).If the net of electrostatic force and gravitational force between two hydrogen atoms placed at a distance d (much greater than atomic size) apart is zero, then Δe is of the order of [given ma of hydrogen $m_h = 1.67 \times 10^{-27} kg$]
(2017 NEET)

Options:

A. $10^{-23}C$

B. $10^{-37}C$

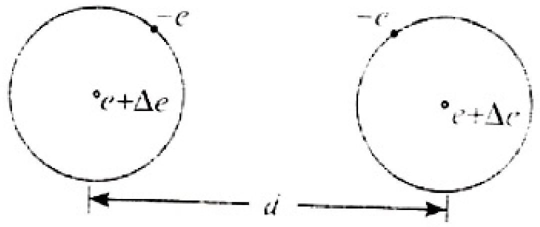
C. $10^{-47}C$

D. $10^{-20}C$

Answer: B

Solution:

A hydrogen atom consists of an electron and a proton.
∴ Charge on one hydrogen atom
$= q_e + q_p = -e + (e + \Delta e) = \Delta e$
Since a hydrogen atom carry a net charge Δe
∴ Electrostatic force, $F_e = \frac{1}{4\pi\varepsilon_0}\frac{(\Delta e)^2}{d^2}$.........(i)
will act between two hydrogen atoms.



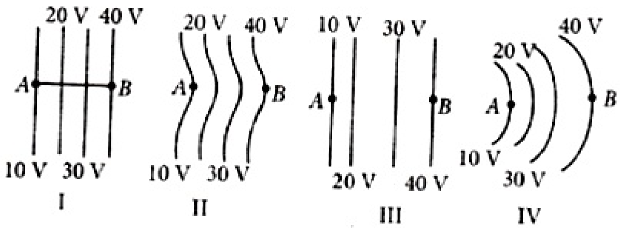
The gravitational force between two hydrogen atoms is given as
$F_g = \frac{Gm_h m_h}{d^2}$.......(ii)
Since, the net force on the system is zero, $F_e = F_g$
Using eqns. (i) and (ii), we get
$\frac{(\Delta e)^2}{4\pi\varepsilon_0 d^2} = \frac{Gm_h^2}{d^2}$
$(\Delta e)^2 = 4\pi\varepsilon_0 G m_h^2$

$= 6.67 \times 10^{-11} \times \frac{(1.67 \times 10^{-27})}{(9 \times 10^{9})}$

$\Delta e \approx 10^{-37} C$

Question45

The diagrams below show regions of equipotential.
A positive charge is moved from A to B in each diagram.



(2017 NEET)

Options:

A. In all the four cases the work done is the same.

B. Minimum work is required to move q in figure (I)

C. Maximum work is required to move q in figure (II).

D. Maximum work is required to move q in figure (III).

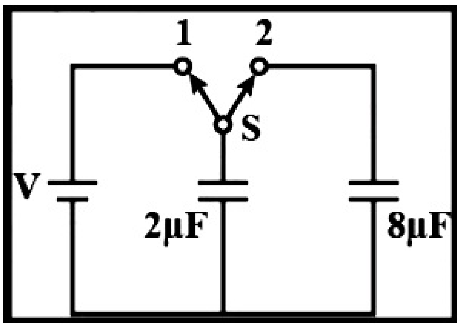
Answer: A

Solution:

Solution:
Work done is given as.W=qΔV
In all the four cases the potential difference from A to B is same.
∴ In all the four cases the work done is same.

Question46

A capacitor of 2 μF is charged as shown in the diagram. When the switch S is turned to position 2, the percentage of its stored energy dissipated is



(2016 NEET Phase-1)

Options:

A. 75%

B. 80%

C. 0%

D. 20%

Answer: B

Solution:

Initially, the energy stored in 2 μF capacitor is

$U_i = \frac{1}{2}CV^2 = \frac{1}{2}(2 \times 10^{-6})V^2 = V^2 \times 10^{-6}J$

Initially, the charge stored in 2μF capacitor is $Q_i = CV = (2 \times 10^{-6})V = 2V \times 10^{-6}$ coulomb.

When switch S is turned to position 2, the charge flows and both the capacitors share charges till a common potential V_C is reached

$V_C = \frac{\text{totalcharge}}{\text{total capacitance}} = \frac{2V \times 10^{-6}}{(2+8) \times 10^{-6}} = \frac{V}{5}$ volt

Finally, the energy stored in both the capacitors

$U_f = \frac{1}{2}[(2+8) \times 10^{-6}]\left(\frac{V}{5}\right)^2 = \frac{V^2}{4} \times 10^{-6}J$

% loss of energy, $\Delta U = \frac{U_i - U_f}{U_i} \times 100$

$= \frac{(V^2 - V^2/5) \times 10^{-6}}{V^2 \times 10^{-6}} \times 100 = 80\%$

Question47

Two identical charged spheres suspended from a common point by two massless strings of lengths l, are initially at a distance d (d < < I) apart because of their mutual repulsion. The charges begin to leak from both the spheres at a constant rate. As a result, the spheres approach each other with a velocity v. Then v varies as a function of the distance x between the spheres, as
(2016 NEET Phase-I)

Options:

A. $v \propto x^{-\frac{1}{2}}$

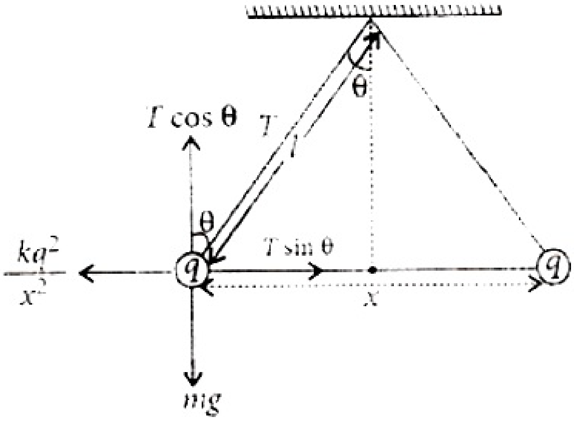
B. $v \propto x^{-1}$

C. $v \propto x^{\frac{1}{2}}$

D. $v \propto x$

Answer: A

Solution:



From figure, $T\cos\theta = mg$........(i)

$T\sin\theta = \frac{kq^2}{x^2}$......(ii)

From eqns. (i) and (ii), $\tan\theta = \frac{kq^2}{x^2 mg}$

Since θ is small, $\therefore \tan\theta \approx \sin\theta = \frac{x}{2l}$

$\therefore \frac{x}{2l} = \frac{kq^2}{x^2 mg} \Rightarrow q^2 = x^3 \frac{mg}{2lk}$ or $q \propto x^{\frac{3}{2}}$

$\Rightarrow \frac{dq}{dt} \propto \frac{3}{2}\sqrt{x}\frac{dx}{dt} = \frac{3}{2}\sqrt{x}v.$

Since, $\frac{dq}{dt} =$ constant

$\therefore v \propto \frac{1}{\sqrt{x}}$

Question48

An electric dipole is placed at an angle of 30° with an electric field intensity $2 \times 10^5 N\,C^{-1}$.It experiences a torque equal to 4 N m. The charge on the dipole, if the dipole length is 2 cm, is
(2016 NEET Phase-II)

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Options:

A. 8 mC

B. 2 mC

C. 5 mC

D. 7 μC

Answer: B

Solution:

Solution:

Here $\theta = 30°$, $E = 2 \times 10^5 N\,C^{-1}$

$\tau = 4 N\,m$, $l = 2cm = 0.02m$, $q = ?$

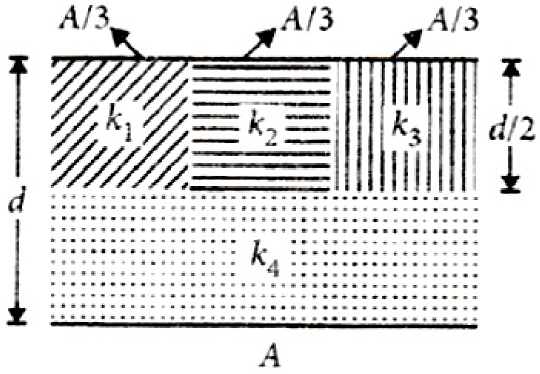
$\tau = pE\sin\theta = (ql)E\sin\theta$

$\therefore q = \frac{\tau}{E\,l\sin\theta} = \frac{4}{2 \times 10^5 \times 0.02 \times \frac{1}{2}}$

$= \frac{4}{2 \times 10^3} = 2 \times 10^{-3} C = 2mc$

Question49

A parallel-plate capacitor of area A, plate separation d and capacitance C is filled with four dielectric materials having dielectric constants k_1, k_2, k_3 and k_4 as shown in the figure. If a single dielectric material is to be used to have the same capacitance C in this capacitor, then its dielectric constant k is given by



(NEET II 2016)

Options:

A. $k = k_1 + k_1 + k_3 + 3k_4$

B. $k = \frac{2}{3}(k_1 + k_2 + k_3) + 2k_4$

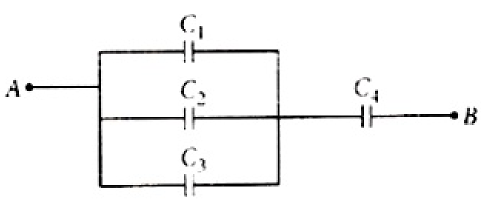
C. $\frac{2}{k} = \frac{3}{k_1 + k_2 + k_3} + \frac{1}{k_4}$

D. $\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2} + \frac{1}{k_3} + \frac{3}{2k_4}$

Answer: C

Solution:

Solution:
Here
$C_1 = \frac{2\varepsilon_0 k_1 A}{3d}, C_2 = \frac{2\varepsilon_0 k_2 A}{3d}, C_3 = \frac{2\varepsilon_0 k_3 A}{3d}, C_4 = \frac{2\varepsilon_0 k_4 A}{d}$
Given system of C_1, C_2, C_3 and C_4 can be simplified as



$\therefore \frac{1}{C_{AB}} = \frac{1}{C_1 + C_2 + C_3} + \frac{1}{C_4}$
Suppose,
$C_{AB} = \frac{k\varepsilon_0 A}{d}$

$$\frac{1}{k\left(\frac{\varepsilon_0 A}{d}\right)} = \frac{1}{\frac{2}{3}\frac{\varepsilon_0 A}{d}(k_1 + k_2 + k_3)} + \frac{1}{\frac{2\varepsilon_0 A}{d}k_4}$$

$$\Rightarrow \frac{1}{k} = \frac{3}{2(k_1 + k_2 + k_3)} + \frac{1}{2k_4}$$

$$\therefore \frac{2}{k} = \frac{3}{k_1 + k_2 + k_3} + \frac{1}{k_4}$$

Question50

The electric field in a certain region is acting radially outward and is given by E = Ar. A charge contained in a sphere of radius 'a' centred at the origin of the field, will be given by
(2015)

Options:

A. $4\pi\varepsilon_0 A a^3$

B. $\varepsilon_0 A a^3$

C. $4\pi\varepsilon_0 A a^2$

D. $A\varepsilon_0 a^2$

Answer: A

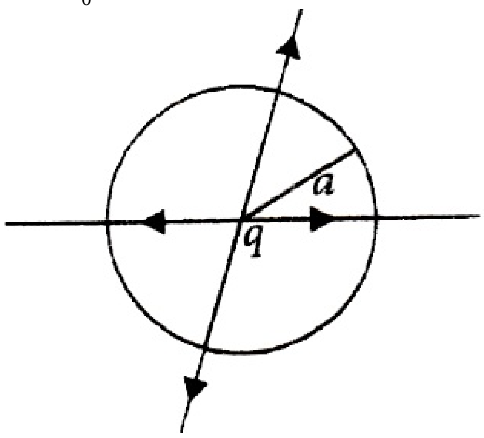
Solution:

Solution:
According to question, electric field varies as E = Ar
Here r is the radial distance.
At r = a, E = Aa...........(i)
Net flux emitted from a spherical surface of radius a is

$\phi_{net} = \frac{q_{en}}{\varepsilon_0}$

$\Rightarrow (Aa) \times (4\pi a^2) = \frac{q}{\varepsilon_0}$ [Using equation (i)]

$\therefore q = 4\pi\varepsilon_0 A a^3$



Question51

A parallel plate air capacitor of capacitance C is connected to a cell of emf V and then disconnected from it. A dielectric slab of dielectric constant K, which can just fill the air gap of the capacitor, is now inserted in it. Which of the following is incorrect?
(2015)

Options:

A. The change in energy stored is $\frac{1}{2}CV^2\left(\frac{1}{K}-1\right)$

B. The charge on the capacitor is not conserved.

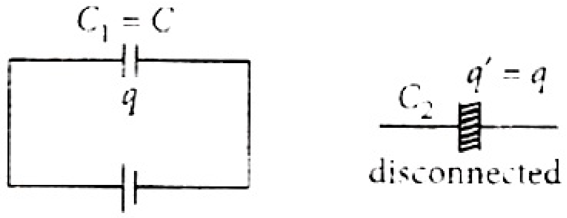
C. The potential difference between the plates decreases K times.

D. The energy stored in the capacitor decreases K. times.

Answer: B

Solution:

Solution:
$q = CV \Rightarrow V = \frac{q}{C}$
Due to dielectric insertion, new capacitance
$C_2 = CK$
Initial energy stored in capacitor, $U_1 = \frac{q^2}{2C}$
Final energy stored in capacitor, $U_2 = \frac{q^2}{2KC}$
Change in energy stored,
$\Delta U = U_2 - U_1$
$\Delta U = \frac{q^2}{2C}\left(\frac{1}{K}-1\right) = \frac{1}{2}CV^2\left(\frac{1}{K}-1\right)$
New potential difference between plates
$V' = \frac{q}{CK} = \frac{V}{K}$



Question52

A parallel plate air capacitor of capacitance C is connected to a cell of emf V and then disconnected from it. A dielectric slab of dielectric constant K, which can just fill the air gap of the capacitor, is now inserted in it. Which of the following is incorrect ?
(2015)

Options:

A. The energy stored in the capacitor decreasesK times.

B. The change in energy stored is $\frac{1}{2}CV^2\left(\frac{1}{K}-1\right)$

C. The charge on the capacitor is not conserved.

D. The potential difference between the platesdecreases K times.

Answer: C

Solution:

Once the capacitor is charged, its charge will be constant Q = CV
When dielectric slab is inserted
$C_{New} = KC$
$E = \frac{Q^2}{2C} \Rightarrow E_{New} = \frac{1}{K}E_{initial}$
$V = \frac{Q}{C}$ so $V_{new} = \frac{1}{K}V$
Hence option (3)

Question53

If potential (in volts) in a region is expressed as V (x, y, z) = 6xy—y + 2yz, the electric field (in N/C) at point (1, 1, 0) is (2015)

©

Options:

A. $-\left(2\hat{i}+3\hat{j}+\hat{k}\right)$

B. $-\left(6\hat{i}+9\hat{j}+\hat{k}\right)$

C. $-\left(3\hat{i}+5\hat{j}+3\hat{k}\right)$

D. $-\left(6\hat{i}+5\hat{j}+2\hat{k}\right)$

Answer: D

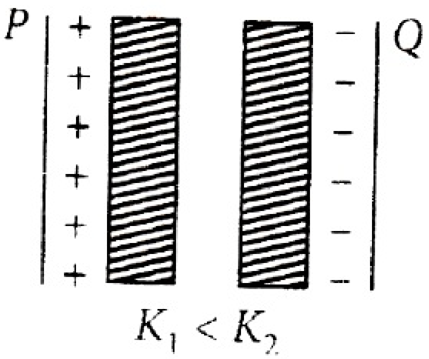
Solution:

Solution:
The electric field $\vec{E}$ and potential V in a region are related as
$\vec{E} = -\left[\frac{V}{x}\hat{i} + \frac{V}{y}k = \hat{j} + \frac{V}{z}\hat{k}\right]$
Here,V $(x, y, z) = 6xy - y + 2yz$
$\therefore \vec{E} = -\left[\frac{}{x}(6xy - y + 2yz)\hat{i} + \frac{}{y}(6xy - y + 2yz)\hat{j} + \frac{}{z}(6xy - y + 2yz)\hat{k}\right]$
$= -\left[(6y)\hat{i} + (6x - 1 + 2z)\hat{k} + (2y)\hat{k}\right]$
At point $(1, 1, 0)$
$\vec{E} = -\left[(6(1))\hat{i} + (6(1) - 1 + 2(0))\hat{j} + (2(1))\hat{k}\right]$

$= -\left(6\hat{i} + 5\hat{j} + 2\hat{k}\right)$

Question54

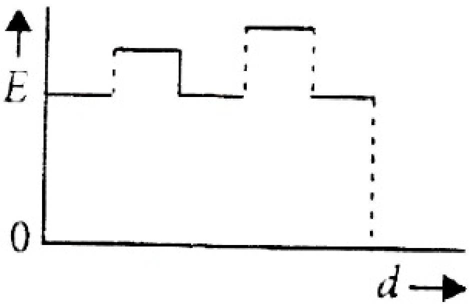
Two thin dielectric slabs of dielectric constants K_1 and $K_2 (K_1 < K_2)$ are inserted between plates of a parallel plate capacitor, as shown in the figure. The variation of electric field E between the plates with distance d as measured from plate P is correctly shown by



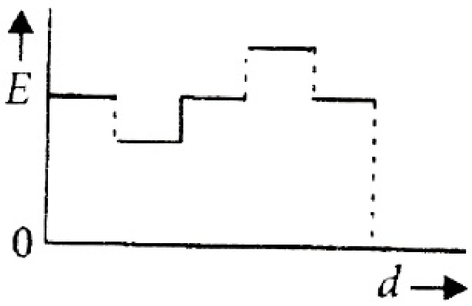
(2014)

Options:

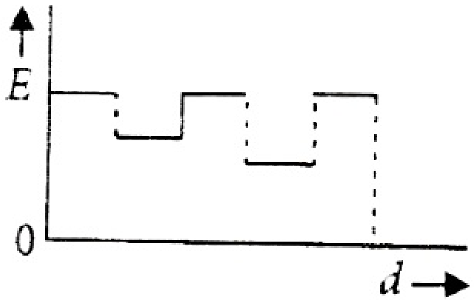
A.



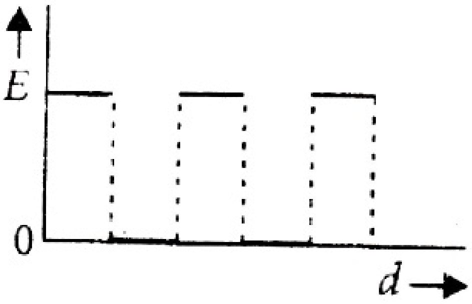
B.



C.



D.



Answer: C

Solution:

Solution:

$E_{\text{medium}} = \frac{E_{\text{vacuum}}}{K}$

The electric field inside the dielectrics will be less than the electric field in vacuum. The electric field inside the dielectric could not be zero. As $K_2 > K_1$ the drop in electric field for K_2 dielectric must be more than K_1.

Question55

A conducting sphere of radius R is given a charge Q. The electric potential and the electric field at the centre of the sphere respectively are
(2014)

Options:

A. zero and $\frac{Q}{4\pi\varepsilon_0 R^2}$

B. $\frac{Q}{4\pi\varepsilon_0 R}$ and zero

C. $\frac{Q}{4\pi\varepsilon_0 R}$ and $\frac{Q}{4\pi\varepsilon_0 R^2}$

D. both are zero

Answer: B

Solution:

For the conducting sphere,

Potential at the centre = Potential on the sphere $= \frac{1}{4\pi\varepsilon_0}\frac{Q}{R}$

Electric field at the centre = 0

Question56

In a region, the potential is represented by V (x, y, z) = 6x − 8xy − 8y + 6yz, where V is in volts and x, y, z are in metres. The electric force experienced by a charge of 2 coulomb situated at point (1, 1, 1) is (2014)

Options:

A. $6\sqrt{5}$

B. 30 N

C. 24 N

D. $4\sqrt{35}$ N

Answer: D

Solution:

Solution:

Here V (x, y, z) = 6x − 8xy − 8y + 6yz,

The x,y and z components of electric field $\vec{E}$ are

$E_x = -\frac{V}{x} = -\frac{}{x}(6x - 8xy - 8y + 6yz)$

$-(-6 - 8y) = -6 + 8y$

$E_y = -\frac{V}{y} = -\frac{}{y}(6x - 8xy - 8y + 6yz)$

$= -(-8x * 8 + 6z) = 8x + 8 - 6z$

$E_z = -\frac{V}{z} = -\frac{}{z}(6x - 8xy - 8y + 6yz) = -6y$

$\therefore \vec{E} = E_x\hat{i} + E_y\hat{j} + E_z\hat{k} = (-6 + 8y)\hat{i} + (8x + 8 - 6z)\hat{j} - 6y\hat{k}$

At point (1, 1, 1)

$\vec{E} = (-6 + 8)\hat{i} + (8 + 8 - 6)\hat{j} - 6\hat{k} = 2\hat{i} + 10\hat{j} - 6\hat{k}$

The magnitude of electric field $\vec{E}$ is

$|\vec{E}| = \sqrt{E_x^2 + E_y^2 + E_z^2} = \sqrt{(2)^2 + (10)^2 + (-6)^2}$

$= \sqrt{140} = 2\sqrt{35}\,N\,C^{-1}$

Electric force experienced by the charge

$F = qE = 2C \times 2\sqrt{35}\,N\,C^{-1} = 4\sqrt{35}\,N$

Question57

An electric dipole of dipole moment p is aligned parallel to a uniform electric field E. The energy required to rotate the dipole by 90° is

(KN NEET 2013)

Options:

A. p^2E

B. pE

C. infinity

D. pE^2

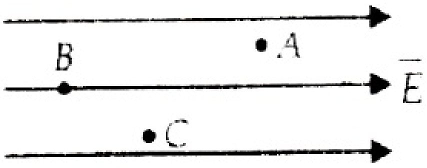
Answer: B

Solution:

Solution:
Potential energy of dipole,
$U = -pE(\cos\theta_2 - \cos\theta_1)$
Here, $\theta_1 = 0°$, $\theta_2 = 90°$
$\therefore U = -pE(\cos 90° - \cos 0°) = -pE(0-1) = pE$

Question58

A, B and C are three points in a uniform electric field. The electric potential is



(2013 NEET)

Options:

A. maximum at C

B. same at all the three

C. maximum at A

D. maximum at B

Answer: D

Solution:

Solution:
In the direction of electric field, electric potential decreases.
$\therefore V_B > V_C > V_A$

Question59

A charge q is placed at the centre of the line joining two equal charges Q. The system of the three charges will be in equilibrium if q is equal to (KN NEET 2013)

Options:

A. $-\frac{Q}{4}$

B. $\frac{Q}{4}$

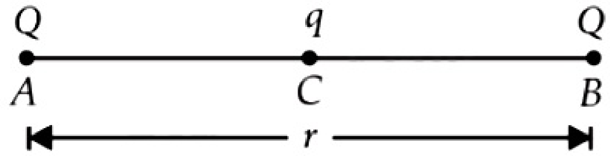
C. $-\frac{Q}{2}$

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

Answer: A

Solution:

Solution:
The situation is as shown in the figure.



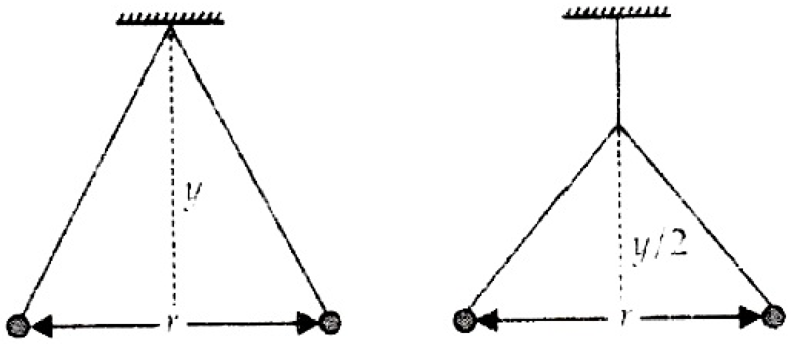
Let two equal charges Q each placed at points A and B at a distance r apart. C is the centre of AB where charge q is placed. For equilibrium, net force on charge Q = 0

$\therefore \frac{1}{4\pi\varepsilon_0}\frac{QQ}{r^2} + \frac{1}{4\pi\varepsilon_0}\frac{Qq}{(r/2)^2} = 0$

$\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{r^2} = -\frac{1}{4\pi\varepsilon_0}\frac{4Qq}{r^2}$ or $Q = -4q$ or $q = -\frac{Q}{4}$

Question60

Two pith balls carrying equal charges are suspended from a common point by strings of equal length, the equilibrium separation between them is r. Now the strings are rigidly clamped at half the height. The equilibrium separation between the balls now become



(2013 NEET)

Options:

A. $\left(\frac{2r}{\sqrt{3}}\right)$

B. $\left(\frac{2r}{3}\right)$

C. $\left(\frac{1}{\sqrt{2}}\right)^2$

D. $\frac{r}{\sqrt[3]{2}}$

Answer: D

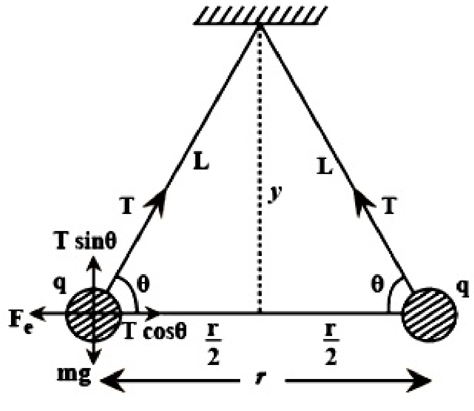
Solution:

Solution:
Let the length of the strings be L and mass of the ball be m and charge be q.
At equilibrium, $\sum F_x = 0$ and $\sum F_y = 0$
$\therefore T \sin\theta = mg$
Also $T \cos\theta = F_e \implies T \cos\theta = \frac{Kq^2}{r^2}$ .... (2) where $K = \frac{1}{4\pi E_0}$
Dividing (1) and (2) gives $r^2 = \frac{mg}{Kq^2}\tan\theta$
Now as $\frac{mg}{Kq^2} =$ constant $= C$ and $\tan\theta = \frac{y}{\frac{r}{2}}$

$\therefore r^2 = C \times \frac{2y}{r} \implies r \propto (y)^{\frac{1}{3}}$

Thus $\frac{r'}{r} = \frac{(y')^{\frac{1}{3}}}{y^{\frac{1}{3}}}$

Now $y' = \frac{y}{2} \implies r' = \frac{r}{2^{\frac{1}{3}}}$



Question61

An electric dipole of moment p is placed in an electric field of intensity E. The dipole acquires a position such that the axis of the dipole makes an angle θ with the direction of the field. Assuming that the potential energy of the dipole to be zero when θ = 90° , the torque and the potential energy of the dipole will respectively be

(2012)

Options:

A. pE sinθ, −pE cosθ

B. pEsinθ,-2pEcosθ

C. pEsinθ,2pEcosθ

D. pEcosθ,-pEsinθ

Answer: A

Solution:

Torque $\tau = pE\sin\theta$
Potntial energy,U $= -pE\cos\theta$

Question62

Four point charges −Q, −q, 2q and 2Q are placed, one at each comer of the square. The relation between Q and q for which the potential at the centre of the square is zero is
(2012)

Options:

A. $Q = -q$

B. $Q = -\frac{1}{q}$

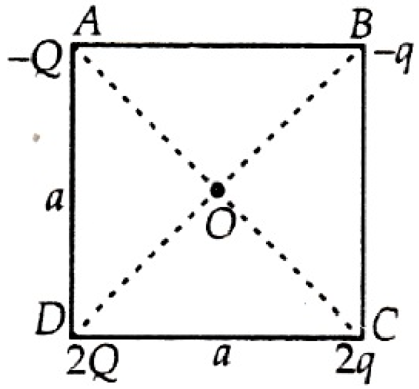
C. $Q = q$

D. $Q = \frac{1}{q}$

Answer: A

Solution:

Solution:



Let a be the side length of the square ABCD.

$\therefore AC = BD = \sqrt{a^2 + a^2} = a\sqrt{2}$

$OA = OB = OC = OD = \frac{a\sqrt{2}}{2} = \frac{a}{\sqrt{2}}$

Potential is a scalar quantity.

Potential at the centre O due to given charge configuration is

$$V = \frac{1}{4\pi\varepsilon_0}\left[\frac{(-Q)}{\left(\frac{a}{\sqrt{2}}\right)} + \frac{(-q)}{\left(\frac{a}{\sqrt{2}}\right)} + \frac{(2q)}{\left(\frac{a}{\sqrt{2}}\right)} + \frac{2Q}{\left(\frac{a}{\sqrt{2}}\right)}\right] = 0$$

$\Rightarrow -Q - q + 2q + 2Q = 0$ or $Q = -q$

Question63

What is the flux through a cube of side a if a point charge of q is at one of its comer. (2012)

Options:

A. $\frac{2q}{\varepsilon_0}$

B. $\frac{q}{8\varepsilon_0}$

C. $\frac{q}{\varepsilon_0}$

D. $\frac{q}{2\varepsilon_0}6a^2$

Answer: B

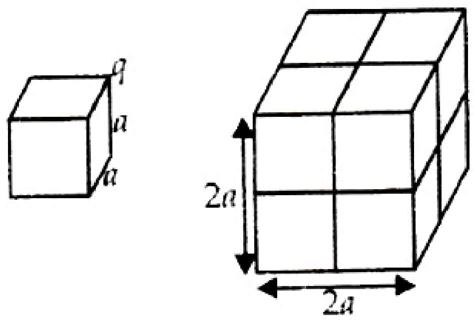
Solution:

Solution:

Eight identical cubes are required so that the given charge q appears at the centre of the bigger cube.

Thus, the electric flux passing through the given cube is

$\phi = \frac{1}{8}\left(\frac{q}{\varepsilon_0}\right) = \frac{q}{8\varepsilon_0}$



Question64

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

(2012 Mains)

Options:

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

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

C. $\frac{1}{2}\varepsilon_0E^2Ad$

D. $\varepsilon_0E\,Ad$

Answer: C

Solution:

Capacitance of a parallel plate capacitor is
$C = \frac{\varepsilon_0A}{d}$.........(i)
Potential difference between the plates is
$V = E\,d$...........(ii)
The energy stored in the capacitor is

$$U = \frac{1}{2}CV^2 = \frac{1}{2}\left(\frac{\varepsilon_0A}{d}\right)(E\,d)^2 \quad \text{(Using (i) and (ii))}$$

$$= \frac{1}{2}\varepsilon_0E^2Ad$$

Question65

Two metallic spheres of radii 1 cm and 3 cm are given charges of -1×10^{-2}C and 5×10^{-2}C, respectively. If these are connected by a conducting wire, the final charge on the bigger sphere is (2012 Mains)

Options:

A. 2×10^{-2}C

B. 3×10^{-2}C

C. 4×10^{-2}C

D. 1×10^{-2}C

Answer: B

Solution:

Charge flows from high potential to low potential

$\frac{KQ_1}{3} = \frac{KQ_2}{1}$

$Q_1 = 3Q_2$

also, $Q_1 + Q_2 = 4 \times 10^{-2}$

$4Q_2 = 4 \times 10^{-2}$

$Q_2 = 10^{-2}$

$Q_1 = 3 \times 10^{-2} C$

Question66

A charge Q is enclosed by a Gaussian spherical surface of radius R. If the radius is doubled, then the outward electric flux will (2011)

Options:

A. increase four time

B. be reduced to half

C. remain the same

D. be doubled

Answer: C

Solution:

Solution:
According to Gauss's law,

$\phi_E = \frac{Q_{enclosed}}{\varepsilon_0}$

If the radius of the Gaussian surface is doubled, the outward electric flux will remain the same. This is because electric flux depends only on the charge enclosed by the surface.

Question67

A parallel plate condenser has a uniform electric field E (V/m) in the space between the plates. If the distance between the plates is d (m) and area of each plate is A(m^2) the energy (joules) stored in the condenser is (2011)

Options:

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

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

C. $\varepsilon_0 E\,Ad$

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

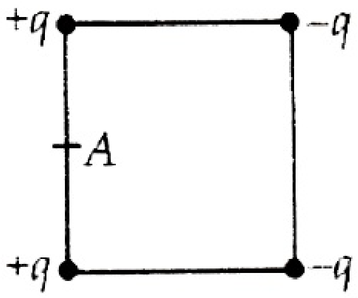
Answer: D

Solution:

Capacitance of a parallel plate capacitor is
$C = \frac{\varepsilon_0 A}{d}$...(i)
Potential difference between the plates is $V = Ed$ ...(ii)
The energy stored in the capacitor is
$U = \frac{1}{2}CV^2 = \frac{1}{2}\left(\frac{\varepsilon_0 A}{d}\right)(Ed)^2$ (Using (i) and (ii))
$= \frac{1}{2}\varepsilon_0 E^2 Ad$

Question68

Four electric charges +q, +q, −q and −q are placed at the comers of a square of side 2L (see figure). The electric potential at points, midway between the two charges +q and +q, is
(2011)



Options:

A. $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}(1+\sqrt{5})$

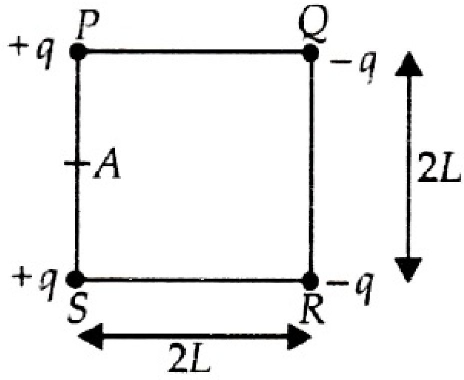
B. $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1+\frac{1}{\sqrt{5}}\right)$

C. $\frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left(1-\frac{1}{\sqrt{5}}\right)$

D. zero

Answer: C

Solution:



A is the midpoint of PS

$\therefore PA = AS = L$

$AR = AQ = \sqrt{(SR^2) + (AS)^2} = \sqrt{(2L)^2 + (L)^2} = L\sqrt{5}$

Electric potential at point A due to the given charge configuration is

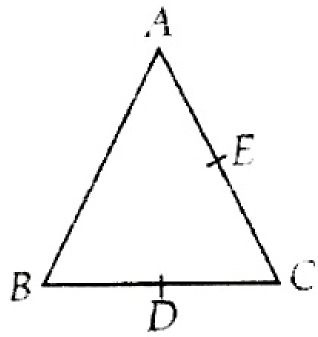
$$V_A = \frac{1}{4\pi\varepsilon_0}\left[\frac{q}{PA} + \frac{q}{AS} + \frac{(-q)}{AQ} + \frac{(-q)}{AQ}\right]$$

$$= \frac{1}{4\pi\varepsilon_0}\left[\frac{q}{L} + \frac{q}{L} - \frac{q}{l\sqrt{5}} - \frac{q}{L\sqrt{5}}\right]$$

$$= \frac{1}{4\pi\varepsilon_0}\left[\frac{2q}{L} - \frac{2q}{L\sqrt{5}}\right] = \frac{1}{4\pi\varepsilon_0}\frac{2q}{L}\left[1 - \frac{1}{\sqrt{5}}\right]$$

Question69

Three charges, each +q, are placed at the comers of an isosceles triangle ABC of sides BC and AC, la. D and E are the mid points of BC and CA. The work done in taking a charge Q from D to E is (2011 Mains)



Options:

A. $\frac{3qQ}{4\pi\varepsilon_0 a}$

B. $\frac{3qQ}{8\pi\varepsilon_0 a}$

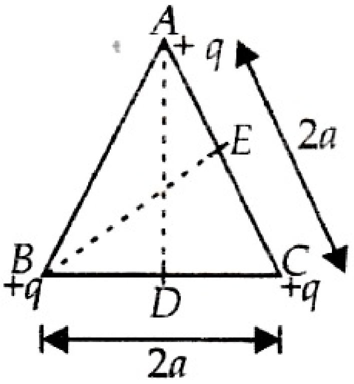
C. $\frac{qQ}{4\pi\varepsilon_0 a}$

D. zero

Answer: D

Solution:

Here, AC = BC = 2a
D and E are the midpoints of BC and AC
∴ AE = EC = a and BD = DC = a
In ΔADC, $(AD)^2 = (AC)^2 - (DC)^2 = (2a)^2 - (a)^2 = 4a^2 - a^2 = 3a^2$
$AD = a\sqrt{3}$
Similarly, $BE = a\sqrt{3}$
Potential at point D due to the given charge configuration is
$$V_D = \frac{1}{4\pi\varepsilon_0}\left[\frac{q}{BD} + \frac{q}{DC} + \frac{q}{AD}\right]$$
$$= \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{a} + \frac{1}{a} + \frac{1}{\sqrt{3}a}\right] = \frac{q}{4\pi\varepsilon_0 a}\left[2 + \frac{1}{\sqrt{3}}\right] \text{...........(i)}$$
Potential at point E due to the given charge configuration is
$$V_E = \frac{1}{4\pi\varepsilon_0}\left[\frac{q}{AE} + \frac{q}{EC} + \frac{q}{BE}\right]$$
$$= \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{a} + \frac{1}{a} + \frac{1}{a\sqrt{3}}\right] = \frac{q}{4\pi\varepsilon_0 a}\left[2 + \frac{1}{\sqrt{3}}\right] \text{.....(ii)}$$
From the (i) and (ii), it is clear that
$V_D = V_E$
The work done in taking a charge Q from D to E is
$W = Q(V_E - V_D) = 0 \quad (\because V_D = V_E)$



Question70

Two positive ions, each carrying a charge q, are separated by a distance d. If F is the force of repulsion between the ions, the number of electrons missing from each ion will be (e being the charge on an electron)
(2010)

©

Options:

A. $\frac{4\pi\varepsilon_0 F d^2}{e^2}$

B. $\sqrt{\frac{4\pi\varepsilon_0 F e^2}{d^2}}$

C. $\sqrt{\frac{4\pi\varepsilon_0 F d^2}{e^2}}$

D. $\frac{4\pi\varepsilon_0 F d^2}{q^2}$

Answer: C

Solution:

According to Coulomb's law, the force of repulsion between the two positive ions each of charge q, separated by a distance d is given by

$F = \frac{1}{4\pi\varepsilon_0}\frac{(q)(q)}{d^2}$; $F = \frac{q^2}{4\pi\varepsilon_0 d^2}$; $q^2 = 4\pi\varepsilon_0 F d^2$

$q = \sqrt{4\pi\varepsilon_0 F d^2}$...........(i)

Since, $q = ne$

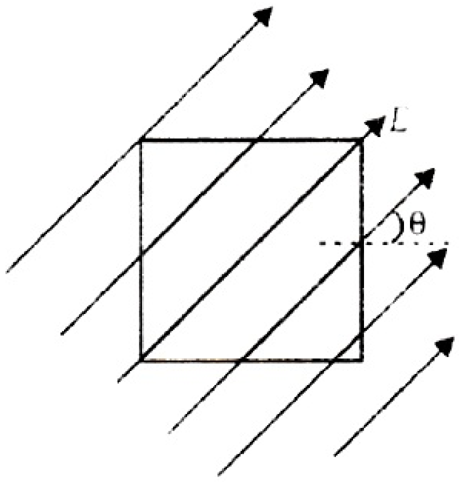
Where, n = number of electrons missing from each ion

e = magnitude of charge on electron

$\therefore n = \frac{q}{e} = \sqrt{\frac{4\pi\varepsilon_0 F d^2}{e^2}}$ (Using (i))

Question71

A square surface of side L metre in the plane of the paper is placed in a uniform electric field E(volt/m) acting along the same plane at an angle θ with the horizontal side of the square as shown in figure. The electric flux linked to the surface, in units of volt m is
(2010)



Options:

A. $E L^2$

B. $E L^2 \cos\theta$

C. $E L^2 \sin\theta$

D. zero

Answer: D

Question72

A series combination of n_1 capacitors, each of value C_1 is charged by a source of potential difference 4V. When another parallel combination of n_2 capacitors, each of value C_2 is charged by a source of potential difference V, it has the same (total) energy stored in it, as the first combination has. The value of C_2 in terms of C_1 is then
(2010)

Options:

A. $\frac{2C_1}{n_1}n_2$

B. $16\frac{n_2}{n_1}C_1$

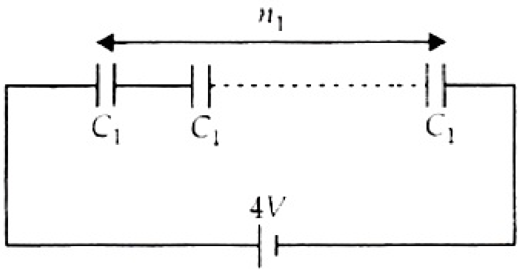
C. $2\frac{n_2}{n_1}C_1$

D. $\frac{16C_1}{n_1 n_2}$

Answer: D

Solution:

Solution:
A series combination of n_1 capacitors each of capacitance C_1 are connected to 4 V source as shown in the figure.



Total capacitance of the series combination of the capacitors is

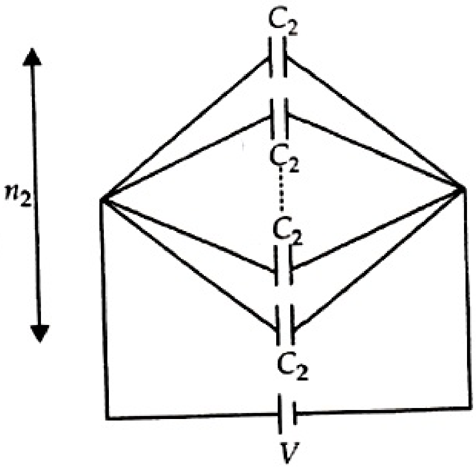
$\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_1} + \frac{1}{C_1} + \ldots\ldots$ upto n_1 terms $= \frac{n_1}{C_1}$

or $C_s = \frac{C_1}{n_1}$..................(i)

Total energy stored in a series combination of the capacitors is

$U_s = \frac{1}{2}C_s(4V)^2 = \frac{1}{2}\left(\frac{C_1}{n_1}\right)(4V)^2$ (Using (i))

A parallel combination of n_2 capacitors each of capacitance C_2 are connected to V source as shown in the figure.



Total capacitance of the parallel combination of capacitors is $C_p = C_2 + C + \ldots\ldots.. +$ upto n_2 terms $= n_2C_2$
or $C_P = n_2C_2$......(iii)
Total energy stored in a parallel combination of capacitors is
$U_P = \frac{1}{2}C_PV^2 = \frac{1}{2}(n_2C_2)(V)^2$ (Usimg (iii)).....(iv)
According to the given problem, $U_s = U_p$
Substituting the values of U_s and U_p from equation (ii) and (iv) we get
$\frac{1}{2}\frac{C_1}{n_1}(4V)^2 = 12(n_2C_2)(V)^2$
or $\frac{C_1 16}{n_1} = n_2C_2$ or $C_2 = \frac{16C_1}{n_1n_2}$

Question73

Two parallel metal plates having charges +Q and -Q face each other at a certain distance between them. If the plates are now dipped in kerosene oil tank, the electric field between the plates will (2010 Mains)

Options:

A. Become zero

B. increase

C. decrease

D. remains same

Answer: C

Solution:

Solution:
Electric field between two parallel plates placed in Vacuum is giveb by $E = \frac{\sigma}{\varepsilon_0}$
In a medium of dielectric constant K,$E' = \frac{\sigma}{\varepsilon_0 K}$
For kerosene oil $K > 1 \Rightarrow E' < E$

Question74

The electric field at a distance $\frac{3R}{2}$ from the centre of a charged conducting spherical shell of radius R is E. The electric field at a distance $\frac{R}{2}$ from the centre of the sphere is
(2010 Mains)

Options:

A. zero

B. E

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

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

Answer: A

Solution:

Solution:
Electric field inside a charged conductor is always zero. So, the electric field between two plates will decreased

---

Question75

The electric potential V at any point (x,y, z), all in metres in space is given by V $= 4x^2$ volt. The electric field at the point (1, 0, 2) in volt/meter, is
(2010 Mains)

Options:

A. 8 along negative X-axis

B. 8 along positive X-axis

C. 16 along negative X-axis

D. 16 along positive X-axis

Answer: A

Solution:

$\vec{E} = -\vec{\nabla} V$

Where $\vec{\nabla} = \hat{i}\frac{}{x} + \hat{j}\frac{}{x} + \hat{k}\frac{}{z}$

$\therefore \vec{E} = -\left[\hat{i}\frac{V}{x} + \hat{j}\frac{V}{y} + \hat{k}\frac{V}{z}\right]$

Here $V = 4x^2 \therefore \vec{E} = -8x\hat{i}$

The electric field at point (1, 0, 2) is

$\vec{E}_{(1, 0, 2)} - 8\hat{i} \, V m^{-1}$

So electric field is along the negative X-axis.

Question76

Three concentric spherical shells have radii a, b and c (a < b < c) and have surface charge densities σ, σ and σ respectively. If V_A, V_B and V_C denote the potentials of three shells, then, for c = a + b,we have (2009)

Options:

A. $V_C = V_B \neq V_A$

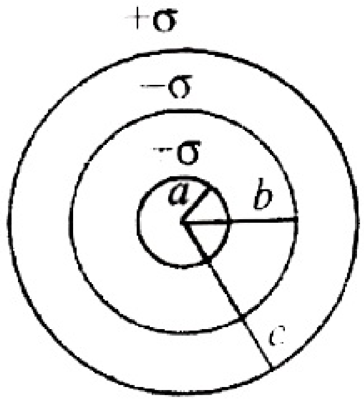
B. $V_C \neq V_B \neq V_A$

C. $V_C = V_B = V_A$

D. $V_C = V_A \neq V_B$

Answer: D

Solution:



$V_A = \frac{1}{4\pi\varepsilon_0}\left\{\frac{q_A}{a} + \frac{q_B}{b} + \frac{q_C}{c}\right\}$

$= \frac{4\pi}{4\pi\varepsilon_0}\left\{\frac{a^2\sigma}{a} - \frac{b^2\sigma}{b} + \frac{c^2\sigma}{c}\right\}$

$V_A = \frac{1}{\varepsilon_0}\left\{\frac{a^2\sigma}{a} - \frac{b^2\sigma}{b} + \frac{c^2\sigma}{c}\right\}$

$V_B = \frac{1}{\varepsilon_0}\left\{\frac{a^2\sigma}{b} - \frac{b^2\sigma}{b} + \frac{c^2\sigma}{c}\right\}$

$V_C = \frac{1}{\varepsilon_0}\left\{\frac{a^2\sigma}{c} - \frac{b^2\sigma}{c} + \frac{c^2\sigma}{c}\right\}$

Given: $c = a + b$

If $a = a$, $b = 2a$ and $c = 3a$ for example, as $c > b > a$

$V_A = \frac{1}{\varepsilon_0}\left\{\frac{a^2\sigma}{a} - \frac{4a^2\sigma}{2a} + \frac{9a^2\sigma}{3a}\right\}$

$V_B = \frac{1}{\varepsilon_0}\left\{\frac{a^2\sigma}{2a} - \frac{4a^2\sigma}{2a} + \frac{9a^2\sigma}{3a}\right\}$

It can be seen by taking out common factors that

$V_A = V_C > V_B$ i.e., $V_A = V_C \neq V_B$

Question77

Three capacitors each of capacitance C and of breakdown voltage V are joined in series. The capacitance and breakdown voltage of the combination will be
(2009)

Options:

A. 3C, $\frac{V}{3}$

B. $\frac{C}{3}$, 3V

C. 3C, 3V

D. $\frac{C}{3}$, $\frac{V}{3}$

Answer: B

Solution:

Solution:
Three capacitors of capacitance C each are in series.

$\therefore$ Total capacitance, $C_{total} = \frac{C}{3}$

The charge Q, is the same, when capacitors are in series.

$V_{total} = \frac{Q}{C} = \frac{Q}{\frac{C}{3}} = 3V$

Question78

The electric potential at a point (x, y, z) is given by V $= x^2y - xz^3 + 4$
The electric field $\vec{E}$ at that point is
(2009)

Options:

A.

$\vec{E} = \hat{i}2xy + \hat{j}(X^2 + y^2) + \hat{k}(3xz - y^2)$

B. $\vec{E} = \hat{i}z^3 + \hat{j}xyz + \hat{k}z^2$

C. $\vec{E} = \hat{i}(2xy - z^3) + \hat{j}xy^2 + \hat{k}3z^2x$

D. $\vec{E} = \hat{i}(2xy + z^3) + \hat{j}x^2 + \hat{k}2xz^2$

Answer: D

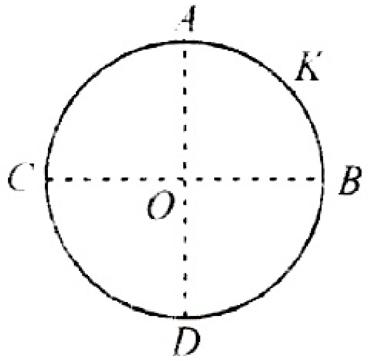
Solution:

Solution:
The electric potential at a point,
$V = -x^2y - xz^3 + 4$
The filed
$\vec{E} = -\vec{\nabla}V = -\left(\frac{V}{x}\hat{i} + \frac{V}{y}\hat{j} + \frac{V}{z}\hat{k}\right)$

$\therefore \vec{E} = \hat{i}(2xy + z^3) + \hat{j}x^2 + \hat{k}(3xz^2)$

Question79

A thin conducting ring of radius R is given a charge +Q. The electric field at the centre O of the ring due to the charge on the part AKB of the ring is E. The electric field at the centre due to the charge on the part ACDB of the ring is
(2008)



Options:

A. E along KO

B. 3E along OK

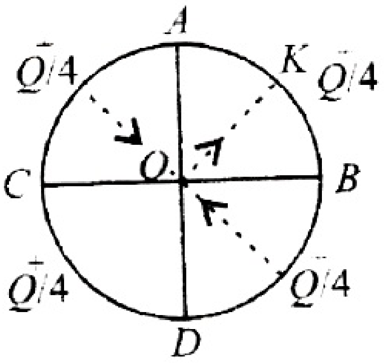
C. 3E along KO

D. E along OK

Answer: D

Solution:

The fields at O due to AC and BD cancel each other. The field due to CD is acting in the direction OK and equal in magnitude to E due to AKB.



Question80

The electric potential at a point in free space due to charge Q coulomb is Q × 10^{11} volts. The electric field at that point is
(2008)

Options:

A. $4\pi\varepsilon_0 Q \times 10^{20}$ volt/m

B. $12\pi\varepsilon_0 Q \times 10^{22}$ volt/m

C. $4\pi\varepsilon_0 Q \times 10^{22}$ volt/m

D. $12\pi\varepsilon_0 Q \times 10^{20}$ volt/m

Answer: C

Solution:

Solution:

$V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r} = Q \times 10^{11}$ volts;

$\therefore \frac{1}{r} = 4\pi\varepsilon_0 \times 10^{11}$

$E = \frac{\text{potential}}{r} = Q \times 10^{11} \times 4\pi\varepsilon_0 \times 10^{11}$

$\Rightarrow E = 4\pi\varepsilon_0 Q \times 10^{22}$volt/m

Question81

The energy required to charge a parallel plate condenser of plate separation d and plate area of cross-section A such that the uniform electric field between the plates E, is
(2008)

Options:

A. $\varepsilon_0 E^2 Ad$

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

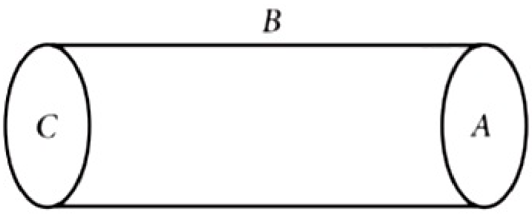
C. $\frac{1}{2}\varepsilon_0 E^2/Ad$

D. $\varepsilon_0 E^2/Ad$

Answer: B

Question82

A hollow cylinder has a charge q coulomb within it. If ϕ is the electric flux in units of voltmeter associated with the curved surface B, the flux linked with the plane surface A in units of V − m will be (2007)



Options:

A. $\frac{q}{2\varepsilon_0}$

B. $\frac{\phi}{3}$

C. $\frac{q}{\varepsilon_0} - \phi$

D. $\frac{1}{2}\left(\frac{q}{\varepsilon_0} - \phi\right)$

Answer: D

Solution:

Let ϕ_A, ϕ_B and ϕ_C are the electric flux linked with A, B and C.
According to Gauss theorem,

$$\phi_A + \phi_B + \phi_C = \frac{q}{\varepsilon_0}$$

since $\phi_A = \phi_C$

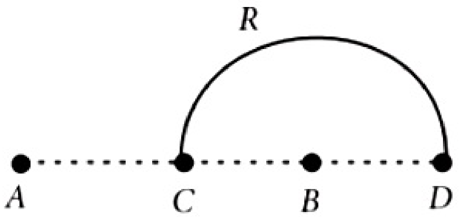
$\therefore 2\phi_A + \phi_B = \frac{q}{\varepsilon_0}$ or $2\phi_A = \frac{q}{\varepsilon_0} - \phi_B$

or, $2\phi_A = \frac{q}{\varepsilon_0} - \phi$ (Given $\phi_B = \phi$)

$\therefore \phi_A = \frac{1}{2}\left(\frac{q}{\varepsilon_0} - \phi\right)$

Question83

Charges +q and −q are placed at points A and B respectively which are a distance 2L apart, C is the midpoint between A and B. The work done in moving a charge +Q along the semicircle CRD is (2007)



Options:

A. $\frac{qQ}{2\pi\varepsilon_0 L}$

B. $\frac{qQ}{6\pi\varepsilon_0 L}$

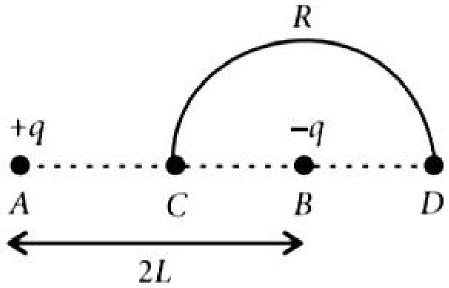
C. $-\frac{qQ}{6\pi\varepsilon_0 L}$

D. $\frac{qQ}{4\pi\varepsilon_0 L}$

Answer: C

Solution:

Solution:



From figure, AC = L, BC = L, BD = BC = L

AD = AB + BD = 2L + L = 3L

Potential at C is given by

$V_C = \frac{1}{4\pi\varepsilon_0}\left[\frac{q}{AC} + \frac{(-q)}{BC}\right] = \frac{1}{4\pi\varepsilon_0}\left[\frac{q}{L} - \frac{q}{L}\right] = 0$

Potential at D is given by

$V_D = \frac{1}{4\pi\varepsilon_0}\left[\frac{q}{AD} + \frac{(-q)}{BD}\right] = \frac{1}{4\pi\varepsilon_0}\left[\frac{q}{3L} - \frac{q}{L}\right] = -\frac{q}{6\pi\varepsilon_0}$

Work done in moving charge +Q along the semicircle CRD is given by

$W = [V_D - V_C](+Q) = \left[\frac{-q}{6\pi\varepsilon_0} - 0\right](Q) = \frac{-qQ}{6\pi\varepsilon_0 L}$

Comments : Potential at C is zero because the charges are equal and opposite and the distances are the same. Potential at D due to $-q$ is greater than that at $A(+q)$, because D is closer to B. Therefore it is negative.

Question84

Three point charges $+q$, $-2q$ and $+q$ are placed at points $(x = 0, y = a, z = 0)$ $(x = 0, y = 0, z = 0)$ and $(x = a, y = 0, z = 0)$ respectively. The magnitude and direction of the electric dipole moment vector of this charge assembly are
(2007)

Options:

A. $\sqrt{2}qa$ along the line joining points $(x = 0, y = 0, z = 0)$ and $(x = a, y = a\ z = 0)$

B. qa along the line joining points $(x = 0, y = 0, z = 0)$ and $(x = a, y = a, z = 0)$

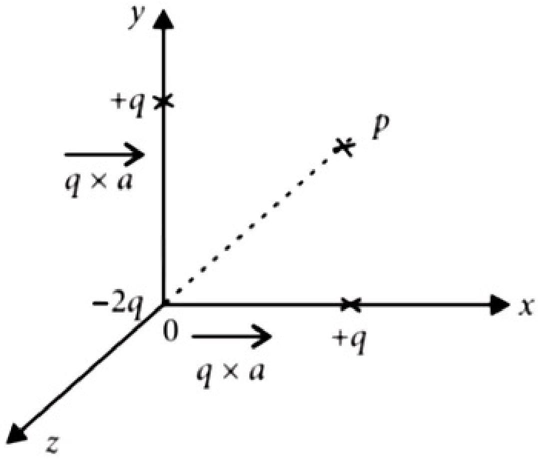
C. $\sqrt{2}qa$ along $+x$ direction

D. $\sqrt{2}qa$ along $+y$ direction.

Answer: A

Solution:

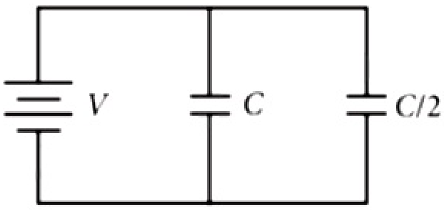
Solution:
This consists of two dipoles, $-q$ and $+q$ with dipole moment along with the $+y$ -direction and $-q$ and $+q$ along the x -direction.



$\therefore$ The resultant moment $= \sqrt{q^2a^2 + q^2a^2} = \sqrt{2}qa$.
Along the direction 45° that is along OP where P is $(+a, +a, 0)$.

Question85

Two condensers, one of capacity C and other of capacity $\frac{C}{2}$ are connected to a V -volt battery, as shown in the figure. The work done in charging fully both the condensers is
(2007)



Options:

A. $\frac{1}{4}CV^2$

B. $\frac{3}{4}CV^2$

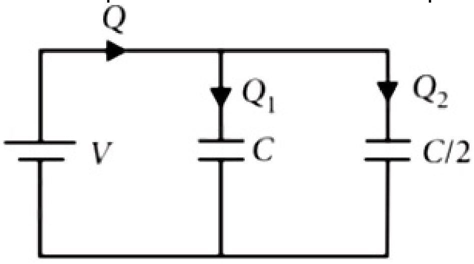
C. $\frac{1}{2}CV^2$

D. $2CV^2$

Answer: B

Solution:

Solution:
As the capacitors are connected in parallel, therefore potential difference across both the condensers remains the same.



$Q_1 = CV$; $Q_2 = \frac{C}{2}V$

Also, $Q = Q_1 + Q_2 = CV + \frac{C}{2}V = \frac{3}{2}CV$

Work done in charging fully both the condensers is given by

$W = \frac{1}{2}QV = \frac{1}{2} \times \left(\frac{3}{2}CV\right)V = \frac{3}{4}CV^2$

Question86

A parallel plate air capacitor is charged to a potential difference of V volts. After disconnecting the charging battery the distance between the plates of the capacitor is increased using an insulating handle. As a result the potential difference between the plates (2006)

Options:

A. increases

B. decreases

C. does not change

D. becomes zero

Answer: A

Solution:

Solution:
Capacitance of a parallel plate capacitor
$C = \frac{\varepsilon_0 A}{d}$
Also Capacitance $= \frac{\text{Charge}}{\text{Potential difference}}$
When battery is disconnected and the distance between the plates of the capacitor is increased then capacitance decreases and charge remains constant.
since Charge = Capacitance × Potential difference
∴ Potential difference increases.

Question87

An electric dipole of moment $\vec{p}$ is lying along a uniform electric field $\vec{E}$. The work done in rotating the dipole by 90° is (2006)

Options:

A. pE

B. $\sqrt{2}$pE

C. $\frac{pE}{2}$

D. 2pE

Answer: A

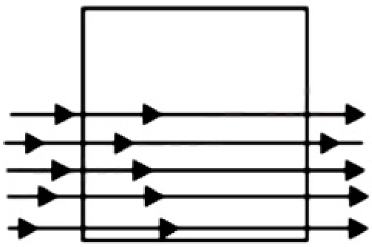
Solution:

Solution:
Work done in deflecting a dipole through an angle θ is given by
$W = \int_0^\theta pE \sin\theta \, d\theta = pE(1 - \cos\theta)$
since θ = 90°
$\therefore W = pE(1 - \cos 90°)$ or, $W = pE$

Question88

A square surface of side L metres is in the plane of the paper. A uniform electric field $\vec{E}$ (volt/m), also in the plane of the paper is limited only to the lower half of the square surface (see figure). The electric flux in SI

units associated with the surface is
(2005)



Options:

A. $E L^2$

B. $E L^2 / 2\varepsilon_0$

C. $E L^2 / 2$

D. zero

Answer: D

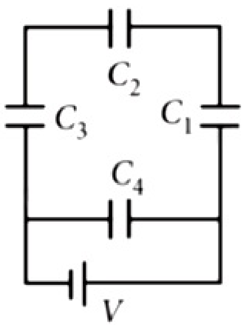
Solution:

Solution:

Electric flux, $\phi_E = \int \vec{E} . d\vec{S} = \int E\, d S \cos\theta = \int E\, d S \cos 90° = 0$
The lines are parallel to the surface.

Question89

A network of four capacitors of capacity equal to C_1 = C, C_2 = 2C, C_3 = 3C and C_4 = 4C are connected to a battery as shown in the figure. The ratio of the charges on C_2 and C_4 is
(2005)



Options:

A. $\frac{4}{7}$

B. $\frac{3}{22}$

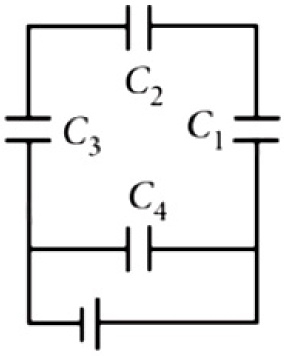
C. $\frac{7}{4}$

D. $\frac{22}{3}$

Answer: B

Solution:

Solution:



C_1, C_2 and C_3 are in series

$\frac{1}{C'} = \frac{1}{C} + \frac{1}{2C} + \frac{1}{3C} = \frac{11}{6C}$

$\Rightarrow C' = \frac{6C}{11}$

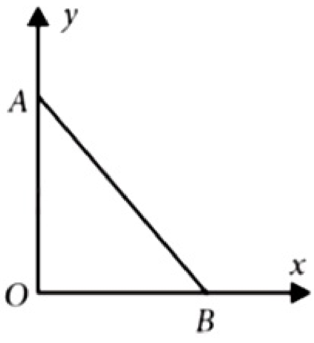
All the capacitors in branch 1 is in series so the charge on each capacitor is $Q' = \frac{6}{11}CV$

Also charge on capacitor C_4 is $Q = 4CV$

$\therefore$ Ratio $= \frac{Q'}{Q} = \frac{6CV}{11 \times 4CV} = \frac{3}{22}$

Question90

As per the diagram a point charge +q is placed at the origin O. Work done in taking another point charge −Q from the point A [coordinates (0, a)] to another point B[coordinates (a, 0)] along the straight path AB is
(2005)



Options:

A. zero

B. $\left(\frac{qQ}{4\pi\varepsilon_0}\frac{1}{a^2}\right) . \sqrt{2}a$

C. $\left(\frac{-qQ}{4\pi\varepsilon_0}\frac{1}{a^2}\right) . \sqrt{2}a$

D. $\left(\frac{qQ}{4\pi\varepsilon_0}\frac{1}{a^2}\right) . \frac{a}{\sqrt{2}}$

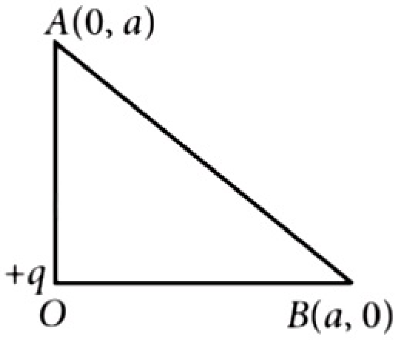
Answer: A

Solution:

Solution:

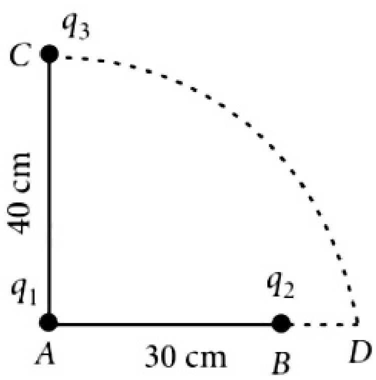
Work done is equal to zero because the potential of A and B are the same $= \frac{1}{4\pi\varepsilon_0}\frac{q}{a}$

No work is done if a particle does not change its potential energy.
i.e., initial potential energy = final potential energy.



Question91

Two charges q_1 and q_2 are placed 30cm apart, as shown in the figure. A third charge q_3 is moved along the arc of a circle of radius 40cm from C to D.
The change in the potential energy of the system is $\frac{q_3}{4\pi\varepsilon_0}k$, where k is (2005)



Options:

A. $8q_1$

B. $6q_1$

C. $8q_2$

D. $6q_2$

Answer: C

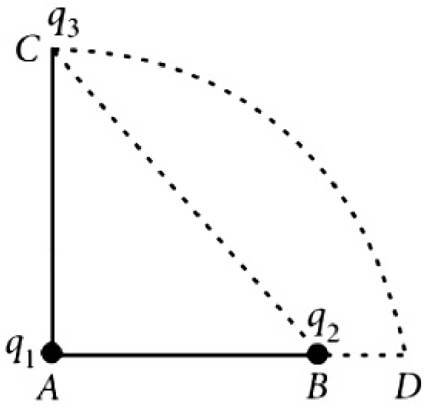
Solution:

Solution:
The potential energy when q_3 is at point C

$$U_1 = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1q_3}{0.40} + \frac{q_2q_3}{\sqrt{(0.40)^2 + (0.30)^2}}\right]$$

The potential energy when q_3 is at point D

$$U_2 = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1q_3}{0.40} + \frac{q_2q_3}{0.10}\right]$$



Thus change in potential energy is $\Delta U = U_2 - U_1$

$$\Rightarrow \frac{q_3}{4\pi\varepsilon_0}k = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1q_3}{0.40} + \frac{q_2q_3}{0.10} - \frac{q_1q_3}{0.40} - \frac{q_2q_3}{0.50}\right]$$

$$\Rightarrow k = \frac{5q_2 - q_2}{0.50} = \frac{4q_2}{0.50} = 8q_2$$

Question92

A bullet of mass 2g is having a charge of 2μC. Through what potential difference must it be accelerated, starting from rest, to acquire a speed of 10m / s ?
(2004)

Options:

A. 5 kV

B. 50 kV

C. 5V

D. 50V

Answer: B

Solution:

Using $\frac{1}{2}mv^2 = qV$

$V = \frac{1}{2} \times \frac{2 \times 10^{-3} \times 10 \times 10}{2 \times 10^{-6}} = 50\,kV$

Question93

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 (2004)

Options:

A. $2q \cdot E$ and minimum

B. $q \cdot E$ and $p \cdot E$

C. zero and minimum

D. $q \cdot E$ and maximum

Answer: C

Solution:

Solution:
The total force on dipole is zero because $F = qE$ is applied on each charge but in opposite direction. The potential energy is $U = -\vec{p} \cdot \vec{E}$, which is minimum when $\vec{P}$ and $\vec{E}$ are parallel.

Question94

Three capacitors each of capacity 4μF are to be connected in such a way that the effective capacitance is 6μF. This can be done by (2003)

Options:

A. connecting all of them in series

B. connecting them in parallel

C. connecting two in series and one in parallel

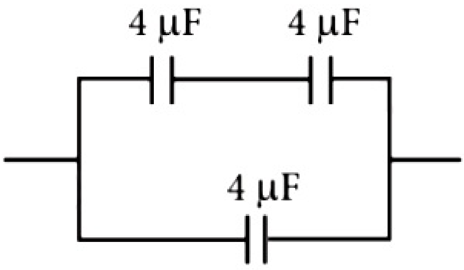
D. connecting two in parallel and one in series

Answer: C

Solution:

To get equivalent capacitance $6\mu F$. Out of the $4\mu F$ capacitance, two are connected in series and third one is connected in parallel.

$C_{eq} = \frac{4 \times 4}{4 + 4} + 4 = 2 + 4 = 6\mu F$



Question95

A charge q is located at the centre of a cube. The electric flux through any face is
(2003)

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Options:

A. $\frac{2\pi q}{6(4\pi\varepsilon_0)}$

B. $\frac{4\pi q}{6(4\pi\varepsilon_0)}$

C. $\frac{\pi q}{6(4\pi\varepsilon_0)}$

D. $\frac{q}{6(4\pi\varepsilon_0)}$

Answer: B

Solution:

The total flux through the cube

$\phi_{total} = \frac{q}{\varepsilon_0}$

∴ The electric flux through any face

$\phi_{face} = \frac{q}{6\varepsilon_0} = \frac{4\pi q}{6(4\pi\varepsilon_0)}$

Question96

Identical charges $(-q)$ are placed at each corners of cube of side b then electrostatic potential energy of charge $(+q)$ which is placed at centre of cube will be
(2002)

Options:

A. $\frac{-4\sqrt{2}q^2}{\pi\varepsilon_0 b}$

B. $\frac{-8\sqrt{2}q^2}{\pi\varepsilon_0 b}$

C. $\frac{-4q^2}{\sqrt{3}\pi\varepsilon_0 b}$

D. $\frac{8\sqrt{2}q^2}{4\pi\varepsilon_0 b}$

Answer: C

Solution:

Solution:
There are eight corners of a cube and in each corner there is a charge of $(-q)$. At the centre of the corner there is a charge of $(+q)$ Each corner is equidistant from the centres of the cube and the distance (d) is half of the diagonals of the cube.
Diagonal of the cube $= \sqrt{b^2 + b^2 + b^2} = \sqrt{3}b$
$\therefore d = \frac{\sqrt{3}b}{2}$
Now, electric potential energy of the charge $(+q)$ due to a charge $(-q)$ at one corner $= U$
$= \frac{q_1 q_2}{4\pi\varepsilon_0 r} = \frac{(+q) \times (-q)}{4\pi\varepsilon_0(\sqrt{3}b / 2)} = -\frac{q^2}{2\pi\varepsilon_0(\sqrt{3}b)}$
$\therefore$ Total electric potential energy due to all the eight identical charges $= 8U = \frac{-4q^2}{\sqrt{3}\pi\varepsilon_0 b}$

Question97

A capacitor of capacity C_1 charged upto V volt and then connected to an uncharged capacitor of capacity C_2. The final potential difference across each will be
(2002)

Options:

A. $\frac{C_2 V}{C_1 + C_2}$

B. $\frac{C_1 V}{C_1 + C_2}$

C. $\left(1 + \frac{C_2}{C_1}\right)$

D. $\left(1 - \frac{C_2}{C_1}\right) V$

Answer: B

Solution:

Solution:
Charge on first capacitor $= q_1 = C_1V$
Charge on second capacitor $= q_2 = 0$
When they are connected, in parallel the total charge $q = q_1 + q_2$
$\therefore q = C_1V$
and capacitance, $C = C_1 + C_2$
Let V' be the common potential difference across each capacitor, then $q = CV'$
$V' = \frac{q}{C} = \frac{C_1}{C_1 + C_2}V$

Question98

Some charge is being given to a conductor. Then its potential is (2002)

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Options:

A. maximum at surface

B. maximum at centre

C. remain same throughout the conductor

D. maximum somewhere between surface and centre.

Answer: C

Solution:

Solution:
Electric field intensity E is zero within a conductor due to charge given to it.
Also, $E = -\frac{dV}{dx}$ or $\frac{dV}{dx} = 0$
$\therefore$ V is constant
So potential remains same throughout the conductor.

Question99

A dipole of dipole moment $\vec{p}$ is placed in uniform electric field $\vec{E}$ then torque acting on it is given by (2001)

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Options:

A. $\vec{\tau} = \vec{p} . \vec{E}$

B. $\vec{\tau} = \vec{p} \times \vec{E}$

C. $\vec{\tau} = \vec{p} + \vec{E}$

D. $\vec{\tau} = \vec{p} - \vec{E}$

Answer: B

Solution:

Solution:
Dipole moment of the dipole p and uniform Electric field E.
we know that dipole moment $p =$ qa (where q is charge and a is the dipole length).
when a dipole of Dipole moment p is placed in a uniform Electric field E,
the torque $\tau =$ Either force × perpendicular distance between the two forces $= qaE \sin\theta$ or $\tau = pE \sin\theta$ or $\tau = p \times E$

Question100

Energy per unit volume for a capacitor having area A and separation d kept at potential difference V is given by (2001)

Options:

A. $\frac{1}{2}\varepsilon_0\frac{V^2}{d^2}$

B. $\frac{1}{2\varepsilon_0}\frac{V^2}{d^2}$

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

D. $\frac{Q^2}{2C}$

Answer: A

Solution:

Solution:
Energy density $= \frac{1}{2}\varepsilon_0\frac{V^2}{d^2}$

Question101

A charge QμC is placed at the centre of a cube, the flux coming out from each face will be (2001)

Options:

A. $\frac{Q}{6\varepsilon_0} \times 10^{-6}$

B. $\frac{Q}{6\varepsilon_0} \times 10^{-3}$

C. $\frac{Q}{24\varepsilon_0}$

D. $\frac{Q}{8\varepsilon_0}$

Answer: A

Solution:

Solution:

For complete cube $\phi = \frac{Q}{\varepsilon_0} \times 10^{-6}$

For each face, $\phi = \frac{1}{6}\frac{Q}{\varepsilon_0} \times 10^{-6}$

Question102

A charge Q is situated at the corner of a cube, the electric flux passed through all the six faces of the cube is (2000)

Options:

A. $\frac{Q}{6\varepsilon_0}$

B. $\frac{Q}{8\varepsilon_0}$

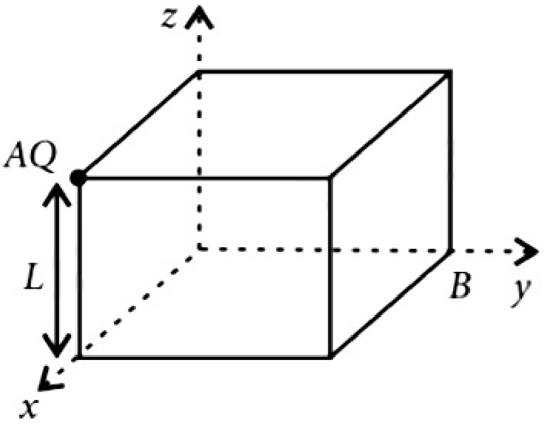
C. $\frac{Q}{\varepsilon_0}$

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

Answer: B

Solution:

Solution:



As at a corner, 8 cubes can be placed symmetrically, flux linked with each cube (due to a charge Q at the corner will be $\frac{Q}{8\varepsilon_0}$.

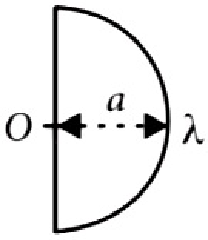
Now for the faces passing through the edge A, electric field E at a face will be parallel to area of face and so flux for these three faces will be zero.

Now as the cube has six faces and flux linked with three faces (through A) is zero, so flux linked with remaining three faces will be $\frac{Q}{8\varepsilon_0}$.

Hence, electric flux passed through all the six faces of the cube is $\frac{Q}{8\varepsilon_0}$.

Question103

Electric field at centre O of semicircle of radius a having linear charge density λ given as
(2000)



Options:

A. $\frac{2\lambda}{\varepsilon_0 a}$

B. $\frac{\lambda\pi}{\varepsilon_0 a}$

C. $\frac{\lambda}{2\pi\varepsilon_0 a}$

D. $\frac{\lambda}{\pi\varepsilon_0 a}$

Answer: C

Question104

A capacitor is charged with a battery and energy stored is U . After disconnecting battery another capacitor of same capacity is connected in parallel to the first capacitor. Then energy stored in each capacitor is (2000)

Options:

A. $\frac{U}{2}$

B. $\frac{U}{4}$

C. 4U

D. 2U

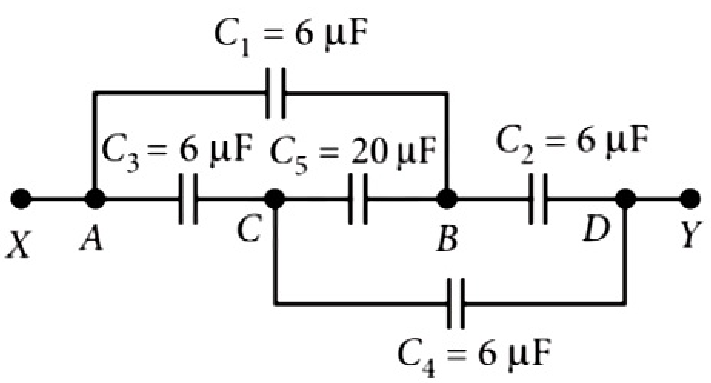
Answer: B

Solution:

Solution:
Let q be the charge on each capacitor.
∴ Energy stored, $U = \frac{1}{2}CV^2 = \frac{1}{2}\frac{q^2}{C}$
Now, when battery is disconnected and another capacitor of same capacity is connected in parallel to the first capacitor, then voltage across each capacitor, $V = \frac{q}{2C}$
∴ Energy stored $= \frac{1}{2}C\left(\frac{q}{2C}\right)^2 = \frac{1}{4}\cdot\frac{1}{2}\frac{q^2}{C} = \frac{1}{4}U$

Question105

What is the effective capacitance between points X and Y ? (1999)



Options:

A. 12

B. 18 μF

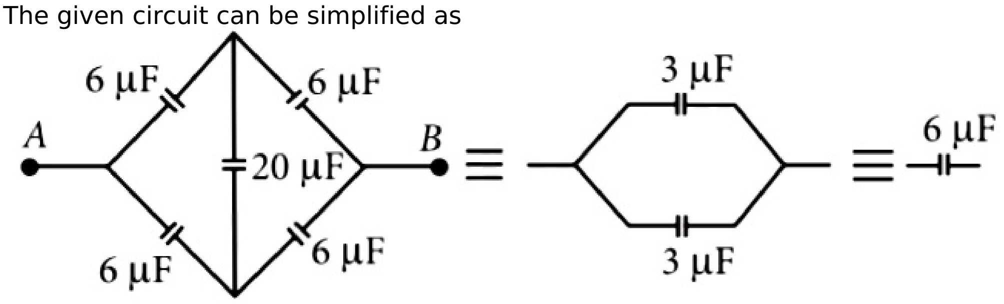
C. 24 μF

D. 6 μF

Answer: D

Solution:

Solution:
The given circuit can be simplified as



Question106

When air is replaced by a dielectric medium of constant K, the maximum force of attraction between two charges separated by a distance
(1999)

Options:

A. increases K times

B. remains unchanged

C. decreases K times

D. increases K^{-1} times.

Answer: C

Solution:

Solution:
$F_m = \frac{F_0}{K}$ i.e., decreases K times

Question107

In bringing an electron towards another electron, the electrostatic potential energy of the system
(1999)

Options:

A. becomes zero

B. increases

C. decreases

D. remains same

Answer: B

Solution:

Solution:
In bringing an electron towards another electron, work has to be done (since same charges repel each other). The work done stored as electrostatic potential energy, and hence, electrostatic potential energy of the system increases.

Question108

A parallel plate condenser with oil between the plates (dielectric constant of oil K = 2) has a capacitance C. If the oil is removed, then capacitance of the capacitor becomes (1999)

Options:

A. $\frac{C}{\sqrt{2}}$

B. 2C

C. $\sqrt{2}C$

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

Answer: D

Solution:

Solution:

Capacitance of capacitor with oil between the plate, $C = \frac{K\varepsilon_0 A}{d}$

If oil is removed capacitance, $C' = \frac{\varepsilon_0 A}{d} = \frac{C}{K} = \frac{C}{2}$

Question109

A hollow insulated conduction sphere is given a positive charge of 10μC.

What will be the electric field at the centre of the sphere if its radius is 2 metres?
(1998)

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Options:

A. $20\mu Cm^{-2}$

B. $5\mu Cm^{-2}$

C. zero

D. $8mCm^{-2}$

Answer: C

Solution:

Solution:
Field inside a conducting sphere $= 0$.

Question110

A particle of mass m and charge q is placed at rest in a uniform electric field E and then released. The kinetic energy attained by the particle after moving a distance y is
(1998)

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Options:

A. $qE\,y$

B. qE^2y

C. $qE\,y^2$

D. $q^2E\,y$

Answer: A

Solution:

As $v^2 = 0^2 + 2ay = 2\left(\frac{F}{m}\right)y = 2\left(\frac{qE}{m}\right)y$

$K.E. = \frac{1}{2}mv^2$

$\therefore K.E. = \frac{1}{2}m\left[2\frac{(qE)}{m}y\right]$

$\Rightarrow K.E. = qE\,y$

Question111

A point Qlies on the perpendicular bisector of an electrical dipole of dipole moment p. If the distance of Q from the dipole is r (much larger than the size of the dipole), then the electric field at Q is proportional to (1998)

Options:

A. p^2 and r^{-3}

B. p and r^{-2}

C. p^{-1} and r^{-2}

D. p and r^{-3}

Answer: D

Solution:

Solution:
The electric field at a point on equatorial line (perpendicular bisector) of dipole at a distance r is given by,

$$E = \frac{p}{4\pi\varepsilon_0} \cdot \frac{1}{(r^2 + a^2)^{\frac{3}{2}}}$$

where 2a = length of dipole
For, r> > a

$$\therefore E = \frac{p}{4\pi\varepsilon_0} \cdot \frac{1}{r^3}$$ i.e., $E \propto p$ and $E \propto r^{-3}$

Question112

A point charge +q is placed at the centre of a cube of side l . The electric flux emerging from the cube is (1996)

Options:

A. $\frac{6ql^2}{\varepsilon_0}$

B. $\frac{q}{6l^2\varepsilon_0}$

C. zero

D. $\frac{q}{\varepsilon_0}$

Answer: D

Solution:

Solution:
Electric flux emerging from the cube does not depend on size of cube.
Total flux $= \frac{q}{\varepsilon_0}$

Question113

The energy stored in a capacitor of capacity C and potential V is given by
(1996)

Options:

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

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

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

D. $\frac{CV^2}{2}$

Answer: D

Question114

Two metallic spheres of radii 1cm and 2cm are given charges 10^{-2}C and 5×10^{-2}C respectively. If they are connected by a conducting wire, the final charge on the smaller sphere is
(1995)

Options:

A. 3×10^{-2}C

B. 4×10^{-2}C

C. 1×10^{-2}C

D. 2×10^{-2}C

Answer: D

Solution:

Radii of sphere $(R_1) = 1\text{cm} = 1 \times 10^{-2}\text{m}$
$(R_2) = 2\text{cm} = 2 \times 10^{-2}\text{m}$ and charges on sphere;
$(Q_1) = 10^{-2} \times \text{C}$ and $(Q_2) = 5 \times 10^{-2}\text{C}$
Common potential $(V) = \dfrac{\text{Total charge}}{\text{Total capacity}} = \dfrac{Q_1 + Q_2}{C_1 + C_2}$
$= \dfrac{(1 \times 10^{-2}) + (5 \times 10^{-2})}{4\pi\varepsilon_0 10^{-2} + 4\pi\varepsilon_0(2 \times 10^{-2})} = \dfrac{6 \times 10^{-2}}{4\pi\varepsilon_0(3 \times 10^{-2})}$
Therefore final charge on smaller sphere $(C_1 V)$
$= 4\pi\varepsilon_0 \times 10^{-2} \times \dfrac{6 \times 10^{-2}}{4\pi\varepsilon_0 \times 3 \times 10^{-2}} = 2 \times 10^{-2}\text{C}$

Question115

There is an electric field E in x - direction. If the work done on moving a charge of 0.2 C through a distance of 2m along a line making an angle 60° with x -axis is 4J, then what is the value of E ? (1995)

Options:

A. $5\text{N} / \text{C}$

B. $20\text{N} / \text{C}$

C. $\sqrt{3}\text{N} / \text{C}$

D. $4\text{N} / \text{C}$.

Answer: B

Solution:

Solution:
Charge $(q) = 0.2$ C; Distance $(d) = 2\text{m}$;
Angle $\theta = 60°$ and work done $(W) = 4\text{J}$.
Work done in moving the charge $(W) = F \cdot d\cos\theta = qEd\cos\theta$
$E = \dfrac{W}{qd\cos\theta} = \dfrac{4}{0.2 \times 2 \times \cos 60°} = \dfrac{4}{0.4 \times 0.5} = 20\text{N} / \text{C}$

Question116

A charge q is placed at the centre of the line joining two exactly equal positive charges Q. The system of three charges will be in equilibrium, if q is equal to (1995)

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Options:

A. $-Q$

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

C. $-\frac{Q}{4}$

D. $+Q$

Answer: C

Solution:

Solution:
For equilibrium of charge Q, the force of repulsion due to similar charges Q should be balanced by the force of attraction due to charge q and Q

$$\frac{1}{4\pi\varepsilon_0} \times \frac{Qq}{\left(\frac{r}{2}\right)^2} \times \frac{1}{4\pi\varepsilon_0} \times \frac{Q^2}{r^2} = 0$$

or $4 \times \frac{Q}{r^2} q = -\frac{Q^2}{r^2}$ or $4q = -Q$ or $q = -\frac{Q}{4}$

Question117

An electric dipole of moment p is placed in the position of stable equilibrium in uniform electric field of intensity E . This is rotated through an angle theta from the initial position. The potential energy of the electric dipole in the final position is
(1994)

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Options:

A. $-pE\cos\theta$

B. $pE(1-\cos\theta)$

C. $pE\cos\theta$

D. $pE\sin\theta$

Answer: B

Solution:

Solution:
To orient the dipole at any angle θ from its initial position, work has to be done on the dipole from $\theta = 0°$ to θ
$\therefore$ Potential energy $= pE(1-\cos\theta)$

Question118

Charge q_2 is at the centre of a circular path with radius r. Work done in carrying charge q_1, once around this equipotential path, would be (1994)

Options:

A. $\frac{1}{4\pi\varepsilon_0} \times \frac{q_1 q_2}{r^2}$

B. $\frac{1}{4\pi\varepsilon_0} \times \frac{q_1 q_2}{r}$

C. zero

D. infinite.

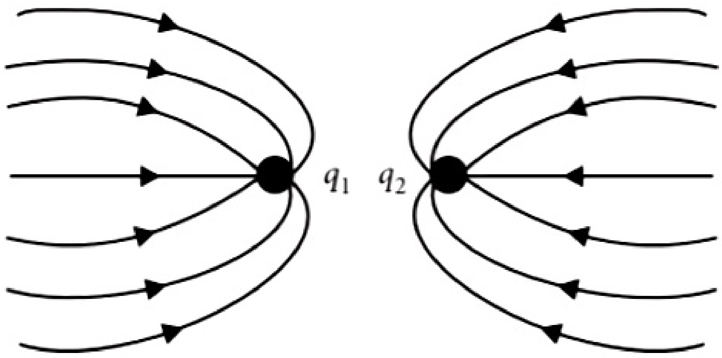
Answer: C

Solution:

Solution:
Work done on carrying a charge from one place to another on an equipotential surface is zero.

Question119

The given figure gives electric lines of force due to two charges q_1 and q_2. What are the signs of the two charges? (1994)



Options:

A. q_1 is positive but q_2 is negative

B. q_1 is negative but q_2 is positive

C. both are negative

D. both are positive.

Answer: C

Solution:

Solution:
Electric lines of force start from the positive charge and end at the negative charge. since the electric lines for both the charges are ending, therefore both q_1 and q_2 are negative charges.

Question120

A hollow metallic sphere of radius 10 cm is charged such that potential of its surface is 80V. The potential at the centre of the sphere would be (1994)

Options:

A. 80V

B. 800V

C. zero

D. 8V

Answer: A

Solution:

Solution:
Potential inside the sphere is the same as that on the surface i.e., 80V.

Question121

Point charges $+4q$, $-q$ and $+4q$ are kept on the X -axis at point $x = 0$, $x = a$ and $x = 2a$ respectively. Then (1988)

Options:

A. only $-q$ is in stable equilibrium

B. all the charges are in stable equilibrium

C. all of the charges are in unstable equilibrium

D. none of the charges is in equilibrium

Answer: C

Solution:

Net force on each of the charge due to the other charges is zero. However, disturbance in any direction other than along the line on which the charges lie, will not make the charges return

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