Electrostatics TIFR

https://snboseplc.com/electrostatics-tifr/

Q.No:1 TIFR-2012

Three equal charges Q are successively brought from infinity and each is placed at one of the three vertices of an equilateral triangle. Assuming the rest of the Universe as a whole to be neutral, the energy E_0 of the electrostatic field will increase, successively, to

$$E_0 + \Delta_1,\ E_0 + \Delta_1 + \Delta_2,\ E_0 + \Delta_1 + \Delta_2 + \Delta_3$$

where $\Delta_1 : \Delta_2 : \Delta_3 =$

1. $1 : 2 : 3$
2. $1 : 1 : 1$
3. $0 : 1 : 1$
4. $0 : 1 : 2$

Q.No:2 TIFR-2012

Five sides of a hollow metallic cube are grounded and the sixth side is insulated from the rest and is held at a potential Φ (see figure).

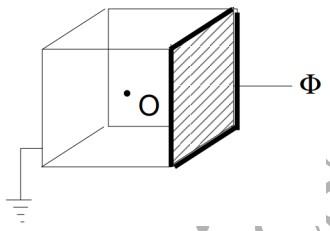


Figure 1: *

The potential at the center O of the cube is

1. 0
2. $\Phi/6$
3. $\Phi/5$
4. $2\Phi/3$

Q.No:3 TIFR-2013

A point charge q sits at a corner of a cube of side a, as shown in the figure on the right. The flux of the electric field vector through the shaded side is

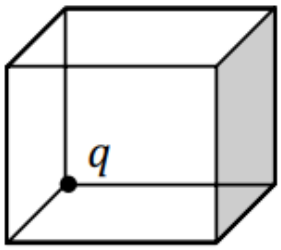


Figure 2: *

1. $\dfrac{q}{8\varepsilon_0}$
2. $\dfrac{q}{16\varepsilon_0}$
3. $\dfrac{q}{24\varepsilon_0}$
4. $\dfrac{q}{6\varepsilon_0}$

Q.No:4 TIFR-2013

A parallel plate capacitor of circular cross section with radius $r \gg d$, where d is the spacing between the plates, is charged to a potential V and then disconnected from the charging circuit. If, now, the plates are slowly pulled apart (keeping them parallel) so that their separation is increased from d to d', the work done will be

1. $\dfrac{\pi\varepsilon_0 r^2 V^2}{2d}\left(1 - \dfrac{d}{d'}\right)$
2. $\dfrac{\pi\varepsilon_0 r^2 V^2}{2d}\left(\dfrac{d'}{d} - 1\right)$
3. $\dfrac{\pi\varepsilon_0 r^2 V^2}{2d}\dfrac{d'}{d}$
4. $\dfrac{\pi\varepsilon_0 r^2 V^2}{2d}\dfrac{d}{d'}$

Q.No:5 TIFR-2013

Consider two charges $+Q$ and $-Q$ placed at the points $(a, 0)$ and $(-a, 0)$ in a plane, as shown in the figure on the right. If the origin is moved to the point (X, Y), the magnitude of the dipole moment of the given charge distribution with respect to this origin will be

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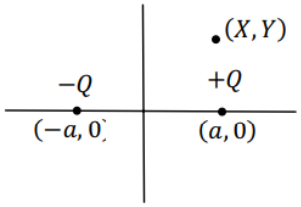


Figure 3: *

1. $Q\sqrt{(a-X)^2+y^2} - Q\sqrt{(a+X)^2+y^2}$
2. $2Qa$
3. $Q(a-X) - Q(-a+X)$
4. $2Qa\sqrt{X^2+Y^2}$

Q.No:6 TIFR-2014

A solid spherical conductor has a conical hole made at one end, ending in a point B, and a small conical projection of the same shape and size at the opposite side, ending in a point A. A cross-section through the centre of the conductor is shown in the figure on the right.

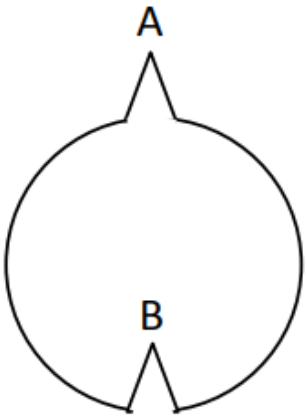


Figure 4: *

If, now, a positive charge Q is transferred to the sphere, then

1. the charge density at both A and B will be undefined.
2. the charge density at A will be the same as the charge density at B.
3. the charge density at A will be more than the charge density at B.
4. the charge density at B will be more than the charge density at A.

Q.No:7 TIFR-2014

Solving Poisson's equation $\Delta^2\varphi = -\rho_0/\varepsilon_0$ for the electrostatic potential $\varphi(\vec{x})$ in a region with a constant charge density ρ_0, two students find different answers, viz.

$$\varphi_1(\vec{x}) = -\frac{1}{2}\frac{\rho_0 x^2}{\varepsilon_0} \text{ and } \varphi_2(\vec{x}) = -\frac{1}{2}\frac{\rho_0 y^2}{\varepsilon_0}$$

The reason why these different solutions are both correct is because

1. space is isotropic and hence x and y are physically equivalent.
2. we can add solutions of Laplace's equation to both $\varphi_1(\vec{x})$ and $\varphi_2(\vec{x})$.
3. the electrostatic energy is infinite for a constant charge density.
4. the boundary conditions are different in the two cases.

Q.No:8 TIFR-2014

An electric dipole is constructed by fixing two circular charged rings, each of radius a, with an insulating contact (see figure).

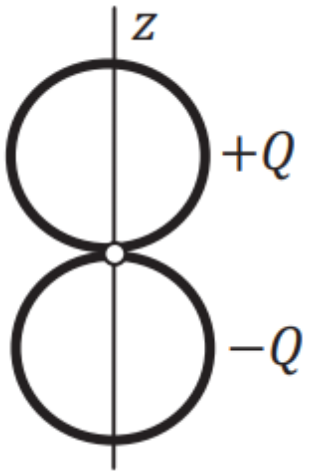


Figure 5: *

One of these rings has total charge $+Q$ and the other has total charge $-Q$. If the charge is distributed uniformly along each ring, the dipole moment about the point of contact will be

1. $\frac{Qa}{\pi}\hat{z}$
2. $4\pi Qa\hat{z}$
3. $2Qa\hat{z}$
4. zero

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Q.No:9 TIFR-2014

A spherical conductor, carrying a total charge Q, spins uniformly and very rapidly about an axis coinciding with one of its diameters. In the diagrams given below, the equilibrium charge density on its surface is represented by the thickness of the shaded region. Which of these diagrams is correct?

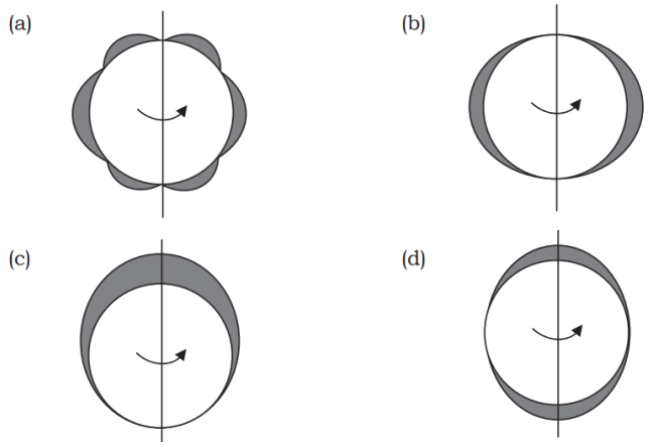


Figure 6: *

Q.No:10 TIFR-2015

The electrostatic potential $\varphi(r)$ of a distribution of point charges has the form $\varphi(r) \propto r^{-3}$ at a distance r from the origin $(0,0,0)$, where $r \gg a$. Which of the following distributions can give rise to this potential?

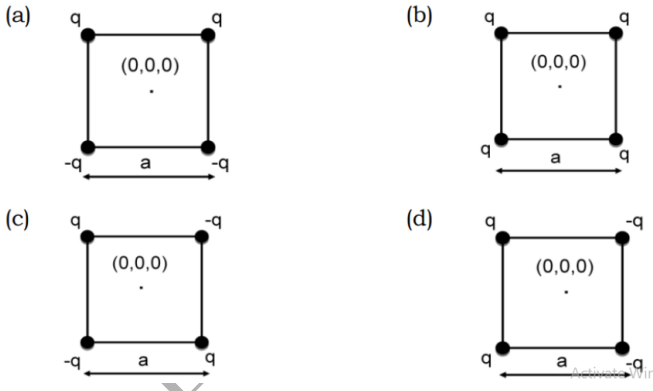


Figure 7: *

Q.No:11 TIFR-2015

Consider an infinitely long cylinder of radius R, placed along the z-axis, which carries a static charge density $\rho(r) = kr$, where r is the perpendicular distance from the axis of the cylinder and k is a constant. The electrostatic potential $\phi(r)$ inside the cylinder is proportional to

1. $-\frac{2}{3}\left(\frac{r^3}{R^3}+1\right)$
2. $-2\ln\left(\frac{r}{R}\right)$
3. $-\frac{2}{3}\left(\frac{r^3}{R^3}-1\right)$
4. $-2\ln\left(\frac{R}{r}\right)$

Q.No:12 TIFR-2015

A solid spherical conductor encloses 3 cavities, a cross-section of which are as shown in the figure. A net charge $+q$ resides on the outer surface of the conductor. Cavities A and C contain point charges $+q$ and $-q$, respectively.

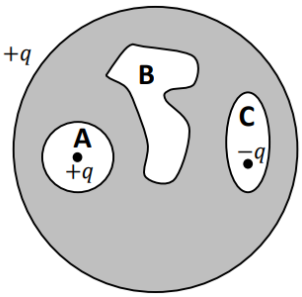


Figure 8: *

The net charges on the surfaces of these cavities are

1. $A = -q, B = q, C = 0$
2. $A = -q, B = 0, C = -q$
3. $A = +q, B = 0, C = -q$
4. $A = -q, B = 0, C = +q$

Q.No:13 TIFR-2016

A grounded conducting sphere of radius a is placed with its centre at the origin. A point dipole of dipole moment $\vec{p} = p\hat{k}$ is placed at a distance d along the x-axis, where $\hat{i}, \hat{k}$ are the units vector along the x and z-axes respectively. This leads to the formation of an image dipole of strength $\vec{p}'$ at a distance d' from the centre along the x-axis. If $d' = a^2/d$, then $\vec{p}' =$

1. $-\frac{a^4 p}{d^4}\hat{k}$
2. $-\frac{a^3 p}{d^3}\hat{k}$
3. $-\frac{a^2 p}{d^2}\hat{k}$
4. $-\frac{ap}{d}\hat{k}$

Q.No:14 TIFR-2016

A long, solid dielectric cylinder of radius a is permanently polarized so that the polarization is everywhere radially outward, with a magnitude proportional to the distance from the axis of the cylinder, i.e., $\vec{P} = \frac{1}{2}P_0 r\hat{r}$. The bound charge density in the cylinder is given by

1. $-P_0$
2. P_0
3. $-P_0/2$
4. $P_0/2$

Q.No:15 TIFR-2016

Three positively charged particles lie on a straight line at positions $0, x$ and 10 as indicated in the figure below. Their charges are $Q, 2Q$, and $4Qcm$ respectively.

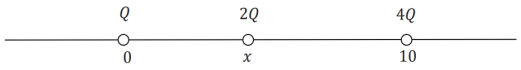


Figure 9: *

If the charges at $x = 0$ and $x = 10$ are fixed and the charge at x is movable, the system will be in equilibrium when $x =$

1. 8
2. 2
3. 20/3
4. 10/3

Q.No:16 TIFR-2016

In a simple stellar model, the density ρ of a spherical star of mass M varies according to the distance r from the centre according to

$$\rho(r) = \rho_0\left(1 - \frac{r^2}{R^2}\right)$$

where R is the radius of the star. The gravitational potential energy of this star (in terms of Newton's constant G_N) will be

1. $-G_N M^2/4\pi R$
2. $-3G_N M^2/5R$
3. $-5G_N M^2/7R$
4. $-3G_N M^2/7R$

Q.No:17 TIFR-2016

Two semi-infinite slabs A and B of dielectric constant ϵ_A and ϵ_B meet in a plane interface, as shown in the figure below.

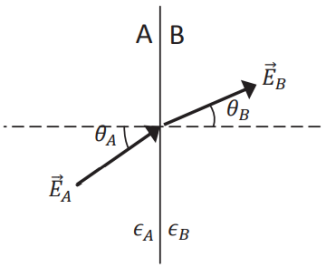


Figure 10: *

If the electric field in slab A makes an angle θ_A with the normal to the boundary and the electric field in slab B makes an angle θ_B with the same normal (see figure), then

1. $\cos\theta_A = \frac{\epsilon_A}{\epsilon_B}\cos\theta_B$
2. $\sin\theta_A = \frac{\epsilon_A}{\epsilon_B}\sin\theta_B$
3. $\tan\theta_A = \frac{\epsilon_A}{\epsilon_B}\tan\theta_B$
4. $\sin\theta_A = \frac{\epsilon_B}{\epsilon_A}\sin\theta_B$

Q.No:18 TIFR-2017

Two long hollow conducting cylinders, each of height h, are placed concentrically on the ground, as shown in the figure (top view). The outer cylinder is grounded, while the inner cylinder is insulated. A positive charge (the black dot in the figure) is placed between the cylinders at a height $h/2$ from the ground.

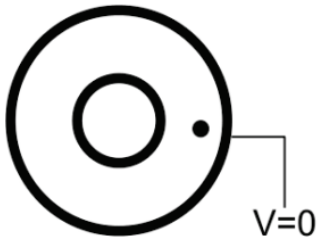


Figure 11: *

Which of the following figures gives the most accurate representation (top view) of the lines of force?

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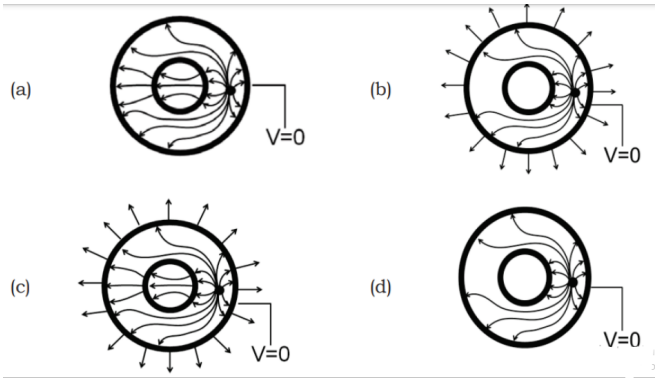


Figure 12: *

Q.No:19 TIFR-2017

A common model for the distribution of charge in a hydrogen atom has a point-like proton of charge $+q_0$ at the centre and an electron with a static charge density distribution

$$\rho(r) = -\frac{q_0}{\pi a^3} e^{-2r/a}$$

where a is a constant. The electric field $\vec{E}$ at $r = a$ due to this system of charges will be

1. $-\frac{5q_0}{4\pi\varepsilon_0 e^2 a^2}\hat{r}$
2. $-\frac{5q_0}{4\pi\varepsilon_0 e a^2}\hat{r}$
3. $\frac{5q_0}{4\pi\varepsilon_0 e^2 a^2}\hat{r}$
4. $\frac{3q_0}{4\pi\varepsilon_0 e^2 a^2}\hat{r}$

Q.No:20 TIFR-2017

Consider the following situations.

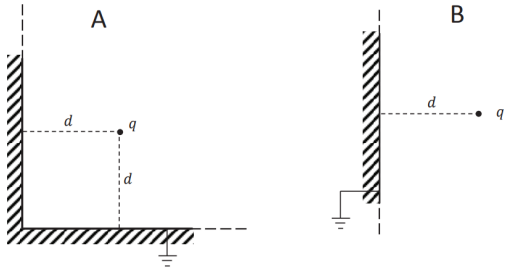


Figure 13: *

In situation A, two semi-infinite earthed conducting planes meet at right-angles. A point charge q, is placed at a distance d from each plane, as shown in the figure A. The magnitude of the force exerted on the charge q is denoted F_A.

In situation B, the same charge q is kept at the same distance d from an infinite earthed conducting plane, as shown in figure B. The magnitude of the force exerted on the charge q is denoted F_B.

Find the numerical ratio $\frac{F_A}{F_B}$

Q.No:21 TIFR-2017

Consider a spherical shell with radius R such that the potential on the surface of the shell in spherical coordinates is given by,

$$V(r = R, \theta, \varphi) = V_0 \cos^2\theta$$

where the angle θ is shown in the figure. There are no charges except for those on the shell. The potential outside the shell at the point P a distance $2R$ away from its center C (see figure) is

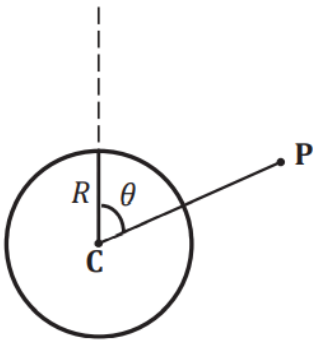


Figure 14: *

1. $V = \frac{V_0}{8}(1 + \cos^2\theta)$
2. $V = \frac{V_0}{8}(1 + 2\cos^2\theta)$
3. $V = \frac{V_0}{4}(1 - \cos^2\theta)$
4. $V = \frac{V_0}{2}(-2\cos\theta + \cos^3\theta)$

Q.No:22 TIFR-2018

Calculate the self-energy, in Joules, of a spherical conductor of radius 8.5 cm, which carries a charge 100 μC.

Q.No:23 TIFR-2018

An atom of atomic number Z can be modelled as a point positive charge surrounded by a rigid uniformly nega-

tively charged solid sphere of radius R. The electric polarisability α of this system is defined as

$$\alpha = \frac{p_E}{E}$$

where p_E is the dipole moment induced on application of electric field E which is small compared to the binding electric field inside the atom. It follows that $\alpha =$

1. $\frac{8\pi\varepsilon_0}{R^3}$
2. $\frac{4\pi\varepsilon_0}{R^3}$
3. $8\pi\varepsilon_0 R^3$
4. $4\pi\varepsilon_0 R^3$

Q.No:24 TIFR-2018

Consider an infinite plane with a uniform positive charge density σ as shown below.

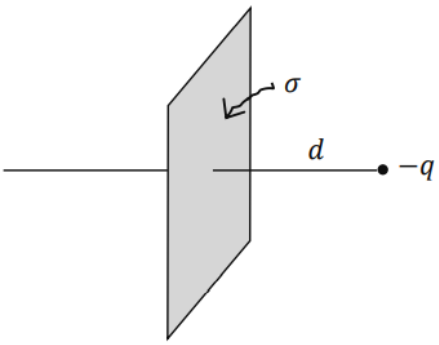


Figure 15: *

A negative point charge $-q$ with mass m is held at rest at a distance d from the sheet and released. It will then undergo oscillatory motion. What is the time period of this oscillation?

[You may assume that the point charge can move freely though the charged plane without disturbing the charge density.].

Q.No:25 TIFR-2018

The electrostatic charge density $\rho(r)$ corresponding to the potential

$$\varphi(r) = \frac{q}{4\pi\varepsilon_0}\frac{1}{r}\left(1+\frac{\alpha r}{2}\right)\exp(-\alpha r)$$

is $\rho =$

1. $q\delta(r) - 2q\alpha^3\exp(-\alpha r)$
2. $q\delta(r) - q\frac{\alpha^3}{4}\exp(-\alpha r)$
3. $q\delta(r) - q\frac{\alpha^3}{2}\exp(-\alpha r)$
4. $-q\delta(r) - 2q\alpha^3\exp(-\alpha r)$

Q.No:26 TIFR-2019

A point charge $q < 0$ is brought in front of a grounded conducting sphere. If the induced charge density on the sphere is plotted such that that the thickness of the black shading is proportional to the charge density, the correct plot will most closely resemble

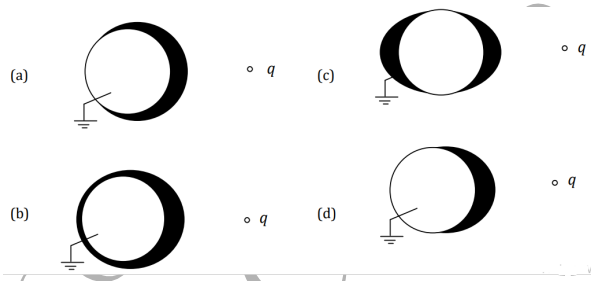


Figure 16: *

Q.No:27 TIFR-2019

A monsoon cloud has a flat bottom of surface area 125 km^2. It floats horizontally over the ground at a level such that the base of the cloud is 1.13 km above the ground (see figure). Due to friction with the air below, the base of the cloud acquires a uniform electric charge density. This keeps increasing slowly with time.

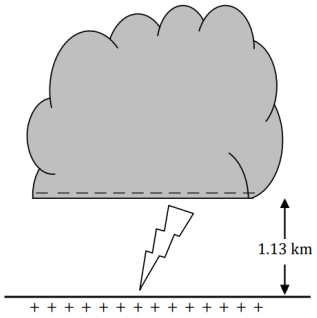


Figure 17: *

When the uniform electric field below the cloud reaches the value 2.4 MV m^{-1} a lightning discharge occurs, and the entire charge of the cloud passes to the Earth below – which, in this case, behaves like a grounded conductor.

Neglecting edge effects and inhomogeneities inside the cloud and the air below, the energy released in this lightning discharge can be estimated, in kilowatt-hours (kWh), as about

1. 10^9

2. 10^5

3. 10

4. 10^{-1}

Q.No:28 TIFR-2020

Consider two concentric spheres of radii a and b, where $a < b$ (see figure). The (shaded) space between the two spheres is filled uniformly with total charge Q. The electric field at any point between the two spheres at distance r from the centre is given by

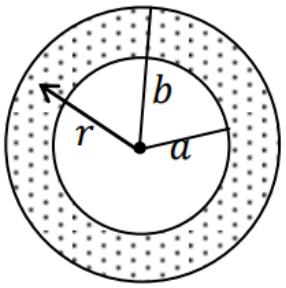


Figure 18: *

1. $\frac{Q}{4\pi\varepsilon_0}\frac{r^3-a^3}{r^2(b^3-a^3)}$

2. $\frac{Q}{4\pi\varepsilon_0}\frac{1}{r^2}$

3. $\frac{Q}{4\pi\varepsilon_0}\left(\frac{b}{r^4}-\frac{a}{r^4}\right)^{2/3}$

4. zero

Q.No:29 TIFR-2020

A two-dimensional electrostatic field is defined as

$$\vec{E}(x,y) = -x\hat{i} + y\hat{j}$$

A correct diagram for the lines of force is

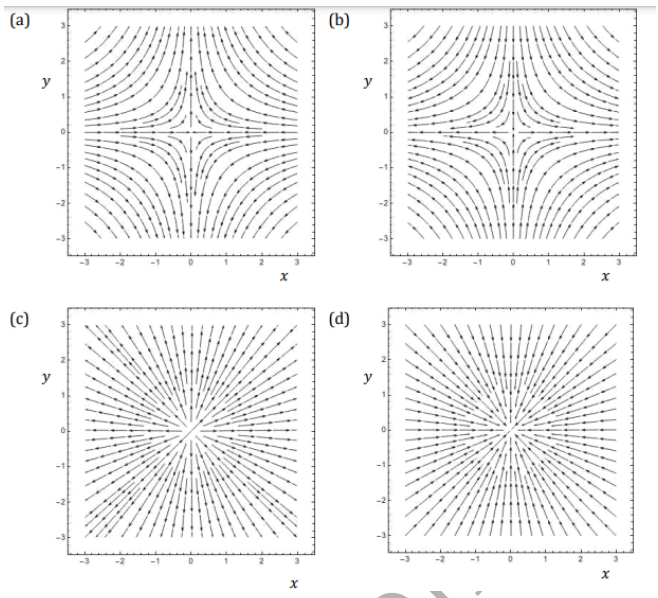


Figure 19: *

Q.No:30 TIFR-2020

A light rigid insulating rod of length ℓ is suspended horizontally from a rigid frictionless pivot at one of the ends (see figure). At a vertical distance h below the rod there is an infinite plane conducting plane, which is grounded.

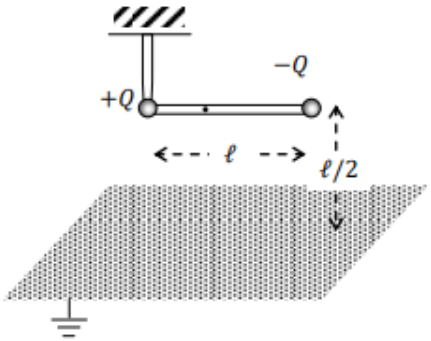


Figure 20: *

If two small, light spherical conductors are attached at the ends of the rod and given charges $+Q$ and $-Q$ as indicated in the figure, the torque on the rod will be

1. $\frac{Q^2}{4\pi\varepsilon_0\ell}\hat{k}$

2. $-\frac{Q^2}{4\pi\varepsilon_0\ell}\hat{k}$

3. $\frac{(4-\sqrt{2})}{16\pi\varepsilon_0}\frac{Q^2}{\ell}\hat{k}$

4. $-\frac{(4-\sqrt{2})}{16\pi\varepsilon_0}\frac{Q^2}{\ell}\hat{k}$

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Q.No:31 TIFR-2020

Two conducting uncharged spheres of radii R_1 and R_2 are connected by an infinitesimally thin wire. The centres of the spheres are located at $\vec{r}_1$ and $\vec{r}_2$ respectively with respect to the origin O. The system is subjected to an uniform external electric field $\vec{E}_0$.

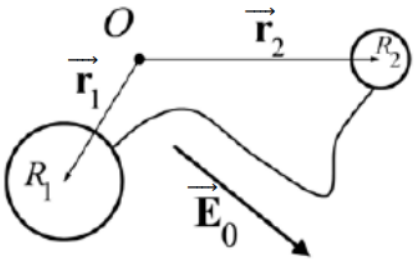


Figure 21: *

If the wire cannot support a net charge and the two spheres are separated by distance much larger than the radii of each of them, the induced dipole moment in the system would be

1. $4\pi\varepsilon_0 \dfrac{R_1 R_2}{R_1+R_2}\left\{\vec{E}_0\cdot(\vec{r}_2-\vec{r}_1)\right\}(\vec{r}_2-\vec{r}_1)$
2. $\dfrac{1}{4\pi\varepsilon_0}\dfrac{R_1 R_2}{(R_1+R_2)}\left\{\vec{E}_0\cdot(\vec{r}_2-\vec{r}_1)\right\}(\vec{r}_2-\vec{r}_1)$
3. $4\pi\varepsilon_0 \dfrac{R_1+R_2}{R_1 R_2}\left\{\vec{E}_0\cdot(\vec{r}_2-\vec{r}_1)\right\}(\vec{r}_2-\vec{r}_1)$
4. zero

Q.No:32 TIFR-2021

Consider 6 charges fixed at the vertices of a regular hexagon of side a, as shown in the figure below.

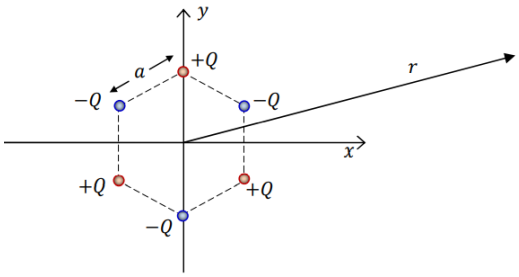


Figure 22: *

The behaviour of the electrostatic potential at distance $r \to \infty$ in the xy plane is proportional to

1. $1/r^4$
2. $1/r^5$
3. $1/r^3$
4. $1/r^2$

Q.No:33 TIFR-2021

Consider an infinite uniform layer of point-like dipoles, placed in the y-z plane, with a constant dipole strength $\vec{p} = p\hat{x}$ per unit area, as shown in figure below.

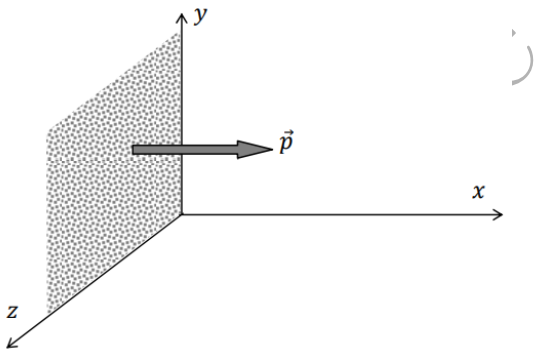


Figure 23: *

Which graph best represents the variation of potential along the x direction?

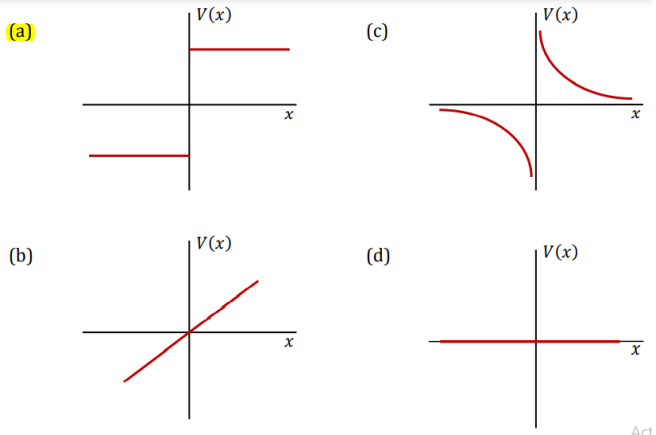


Figure 24: *

Q.No:34 TIFR-2021

Three concentric spherical metallic shells with radii $c > b > a$ (see figure) are charged with charges e_c, e_b, and e_a respectively. The outermost shell (of radius c) is at a potential V_c^0.

Now, the innermost shell (of radius a) is grounded, and the potential of the outermost shell becomes V_c^g.

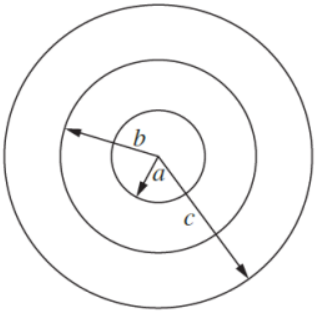


Figure 25: *

The difference $V_c^g - V_c^0$ will be

1. $-\frac{1}{4\pi\varepsilon_0}\frac{a}{c}\left(\frac{e_a}{a}+\frac{e_b}{b}+\frac{e_c}{c}\right)$
2. $-\frac{1}{4\pi\varepsilon_0}\frac{c}{a}\left(\frac{e_a}{a}+\frac{e_b}{b}+\frac{e_c}{c}\right)$
3. $-\frac{1}{4\pi\varepsilon_0}\frac{c}{a}\left(\frac{e_a}{c}+\frac{e_b}{b}+\frac{e_c}{a}\right)$
4. $-\frac{1}{4\pi\varepsilon_0}\frac{a}{c}\left(\frac{e_c}{c-a}+\frac{e_b}{b}\right)$

Q.No:35 TIFR-2021

Two positive charges Q and q are placed on opposite sides of a grounded sphere of radius R at distances of $2R$ and $4R$ respectively, from the centre of the sphere, as shown in the diagram below.

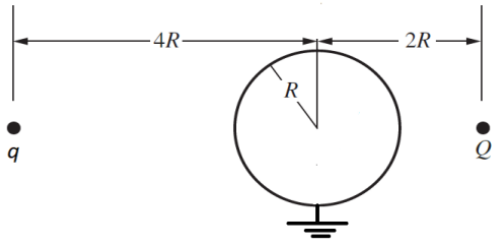


Figure 26: *

The charge q feels a force AWAY from the centre of the sphere if

1. $\frac{q}{Q} < \frac{25}{144}$
2. $\frac{q}{Q} < \frac{25}{16}$
3. $\frac{q}{Q} < \frac{25}{36}$
4. $\frac{q}{Q} < \frac{49}{144}$

Q.No:36 TIFR-2022

A falling raindrop, spherical in shape, with a diameter of 1 μm, acquires a uniform negative charge due to friction with air. The electric field at a distance of 10 μm from the surface of the droplet is measured to be 101 V m^{-1}.

The number of excess electrons acquired by the droplet is

1. 7
2. 7.02×10^6
3. 1.4×10^{23}
4. 1414

Q.No:37 TIFR-2022

Two equal positive point charges $Q = +1$ are placed on either side of an x-axis normal to a grounded infinite conducting plane at distances of $x = +2$ units and $x = -1$ unit respectively (see figure) w.r.t. the point of intersection of the axis with the conducting plane as origin.

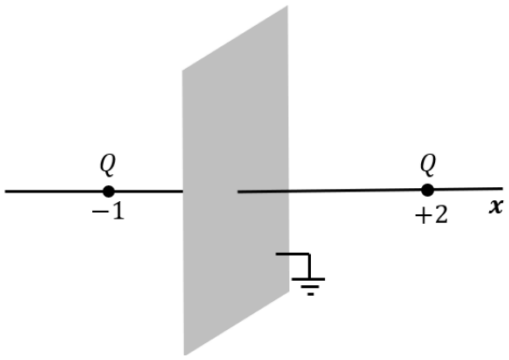


Figure 27: *

The electrostatic potential along the axis will correspond to the graph in

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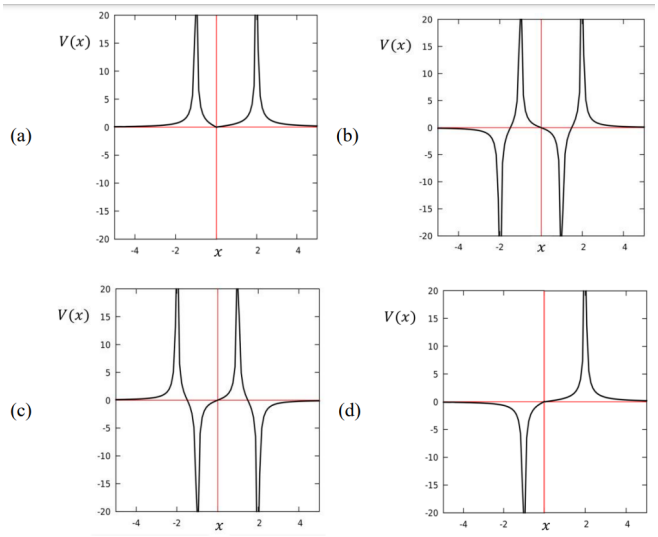


Figure 28: *

Q.No:38 TIFR-2023

The electric field lines due to a uniformly polarized dielectric sphere (polarization along the positive z-axis as shown in the figure).

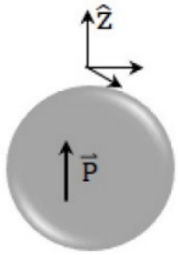
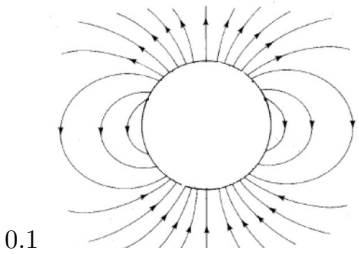


Figure 29: *

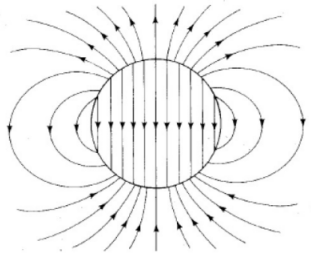
will look like



0.1

Figure 30: *

(a)



0.1

Figure 31: *

(b) 0.1

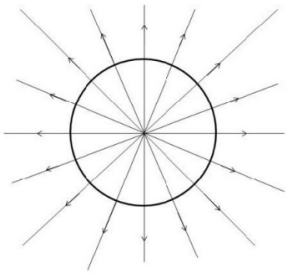
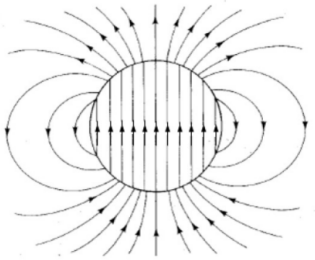


Figure 32: *

(c)



0.1

Figure 33: *

(d)

Q.No:39 TIFR-2023

Consider a solid sphere of radius R with a total charge Q distributed uniformly throughout its volume (see figure, left). The electric field measured at a distance $x = 2R$ from the centre of the sphere along the equatorial plane is found to be E_1.

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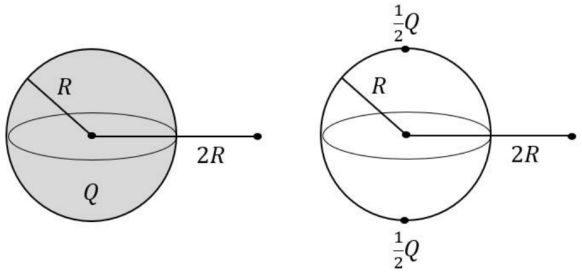


Figure 34: *

Next, the same charge is distributed differently, such that $Q/2$ is concentrated at the north pole, and the remaining $Q/2$ is concentrated at the south pole (see figure, right). The electric field is measured again at the same point on the equatorial plane and found to be E_2.

The value of E_2/E_1 is

1. $\frac{8}{5\sqrt{5}}$
2. 1
3. $\frac{2}{\sqrt{5}}$
4. $\frac{4}{5}$

Q.No:40 TIFR-2024

A thin spherical shell of radius R has a constant surface charge density σ. This shell is cut symmetrically into two pieces. What is the electrostatic force between the two halves?

1. $\frac{\pi\sigma^2R^2}{2\varepsilon_0}$
2. $\frac{\pi\sigma^2R^2}{4\varepsilon_0}$
3. $\frac{\pi\sigma^2R^2}{\varepsilon_0}$
4. $\frac{2\pi\sigma^2R^2}{\varepsilon_0}$

Q.No:41 TIFR-2024

Consider a charge particle detection chamber as shown in the figure below. The chamber is made of a set of parallel plates separated by 20 mm distance and connected to the external resistance ($R = 100\,\Omega$) as shown in the figure along with the high voltage power supply of 1 kV.

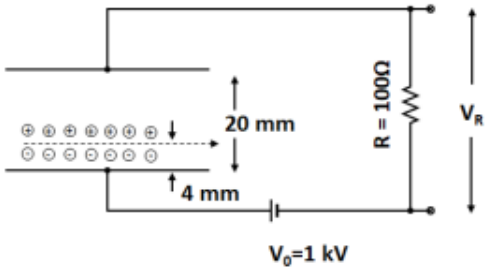


Figure 35: *

The chamber is filled with Argon (Ar) gas (ionization energy 16 eV). If a charged particle passes through the chamber and loses sufficient energy, it ionizes the Ar atoms and generates a small voltage pulse across the resistance R.

In an experiment, an alpha particle of energy 5.5 MeV enters the chamber at a distance of 4 mm from the bottom plate, as shown, generating ion-electron pairs. If the effective capacitance of the chamber is 100 pF, the measured voltage pulse shape would be best described as:

1. A sharp voltage pulse followed by a very weak broad pulse
2. Two sharp voltage pulses of equal magnitude and opposite signs
3. Two sharp voltage pulses of the same magnitude and sign
4. No voltage pulse would be generated as both electrons and ions will neutralise the charge collected by the capacitor

Q.No:42 TIFR-2024

Consider an electric dipole of strength p placed near a grounded infinite conducting sheet in the xy plane at a distance d from it in the z direction as shown below. The center of the dipole (C) is fixed to a pivot but the dipole is free to rotate about the x axis (coming out of the page).

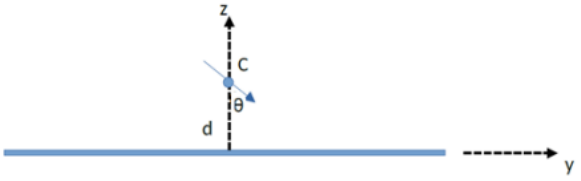


Figure 36: *

What is the magnitude of the torque on the dipole when the angle between the dipole and the positive z axis is $(\pi - \theta)$ as shown?

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1. $\tau = \dfrac{p^2}{(64\pi\epsilon_0 d^3)}\sin(2\theta)$
2. $\tau = \dfrac{p^2}{(16\pi\epsilon_0 d^3)}\cos(2\theta)$
3. $\tau = \dfrac{p^2}{(64\pi\epsilon_0 d^3)}\cos(\theta)$
4. $\tau = \dfrac{p^2}{(16\pi\epsilon_0 d^3)}\sin(\theta)$

Q.No:43 TIFR-2024

Consider a system of three electric charges: (1) a charge $-q$ placed at the point $(x, y, z) = (0, 0, d)$, (2) a charge $+\alpha q$ placed at the origin and (3) a charge $-\beta q$ placed at the point $(x, y, z) = (0, 0, -d)$.

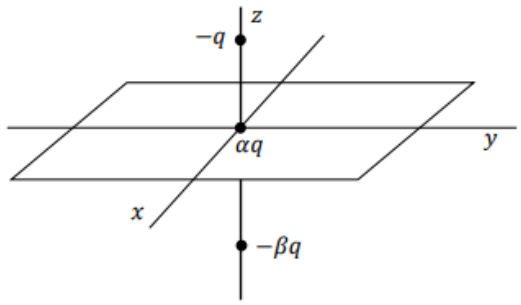


Figure 37: *

The values of α and β are such that the monopole and dipole terms vanish in the multipole expansion of the electrostatic potential.

What is the quadrupole term of the potential at a point $(x, y, 0)$?

1. $\dfrac{qd^2}{4\pi\varepsilon_0(x^2+y^2)^{3/2}}$
2. $\dfrac{qd^2}{2\pi\varepsilon_0(x^2+y^2)^{3/2}}$
3. 0
4. $\dfrac{q}{4\pi\varepsilon_0(x^2+y^2)^{1/2}}$

Q.No:44 TIFR-2025

The figure on the right shows a regular pentagon. The black solid circles on its vertices represent point charges with charge $-q$. There is no charge at the position of the white circle at r (measured from the origin O, placed at the centre of the pentagon). The electric field at O is given by:

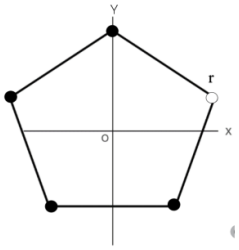


Figure 38: *

1. $\mathbf{E} = \dfrac{-q\,\mathbf{r}}{4\pi\epsilon_0 r^3}$
2. $\mathbf{E} = \dfrac{-4q\,\mathbf{r}}{4\pi\epsilon_0 r^3}$
3. $\mathbf{E} = \dfrac{q\,\mathbf{r}}{4\pi\epsilon_0 r^3}$
4. $\mathbf{E} = \dfrac{-4q(\sin\frac{\pi}{10}\,\hat{x} + \cos\frac{\pi}{10}\,\hat{y})}{4\pi\epsilon_0 r^2}$

Q.No:45 TIFR-2025

The given figure shows some charges and their coordinates in the $x - y$ plane. The electric potential at a point $\vec{r}$, far from the origin, is given by:

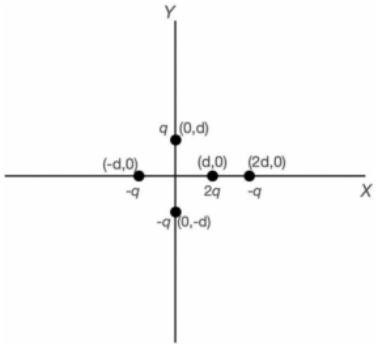


Figure 39: *

1. $\phi = \dfrac{qd(\vec{r}\cdot\hat{x} + 2\,\vec{r}\cdot\hat{y})}{4\pi\epsilon_0 r^3}$
2. $\phi = \dfrac{qd}{4\pi\epsilon_0 r^2}$
3. $\phi = \dfrac{qd\,\vec{r}\cdot\hat{z}}{4\pi\epsilon_0 r^3}$
4. $\phi = \dfrac{qd\,\vec{r}\cdot\hat{x}}{4\pi\epsilon_0 r^3}$

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Q.No:46 TIFR-2026

The figure shows a positive point charge $(+q)$ placed above an interface (horizontal line in the figure) between two dielectrics with permittivities, ϵ_1 and ϵ_2. The curves shown are field lines of the electric displacement, $\vec{D}$. Which of the following statements is true?

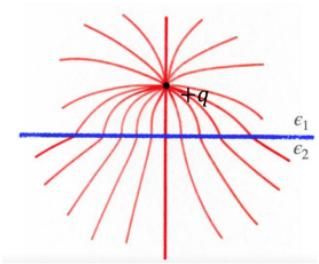


Figure 40: *

1. $\epsilon_2 > \epsilon_1$ and the sign of the net surface charge at the interface is negative
2. $\epsilon_1 > \epsilon_2$ and the sign of the net surface charge at the interface is positive
3. $\epsilon_2 > \epsilon_1$ and the sign of the net surface charge at the interface is positive
4. $\epsilon_1 > \epsilon_2$ and the sign of the net surface charge at the interface is negative

Q.No:47 TIFR-2026

Four infinitely long electrodes of negligible thickness are placed parallel to the z-axis and pass through the points at the edges of a square in the (x, y) plane at $(\pm a, 0)$ and $(0, \pm a)$. The potential at $(0, 0)$ is 0. If the electrodes at $(\pm a, 0)$ are maintained at a potential V_0, while the electrodes at $(0, \pm a)$ are maintained at a potential $-V_0$, the electric field in the vicinity of the electrodes is given by:

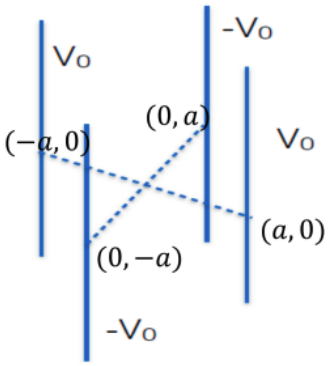


Figure 41: *

1. $\vec{E} = -\frac{2V_0}{a^2}(x\hat{x} - y\hat{y})$
2. $\vec{E} = -\frac{V_0}{a}(\hat{x} - \hat{y})$
3. $\vec{E} = \frac{2\pi V_0}{a^2}\left[\sin\left(\frac{2\pi x}{a}\right)\hat{x} - \sin\left(\frac{2\pi y}{a}\right)\hat{y}\right]$
4. $\vec{E} = -\frac{V_0}{x^2+y^2}(\hat{x} - \hat{y})$

Q.No:48 TIFR-2026

The figure shows point charges arranged in the x, y plane on the centre, vertices, and some edges of a square with vertices at $(\pm 1, \pm 1, 0)$ in standard units. Given the charge distribution in the figure, the electric field far away from the charges ($r = \sqrt{x^2 + y^2 + z^2}$ denotes the distance from the origin) falls off as:

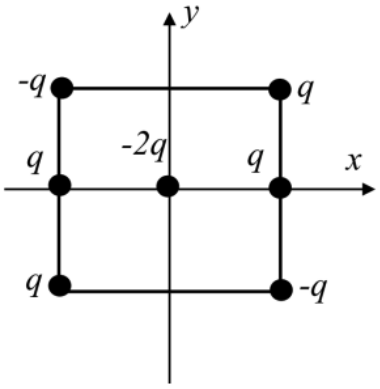


Figure 42: *

1. $\frac{1}{r^4}$
2. $\frac{1}{r^2}$
3. $\frac{1}{r^3}$

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4. $\frac{1}{r^5}$

Q.No:49 TIFR-2026

The vector field,

$$\vec{E} = (2xy^2 + z^3,\ 2x^2y,\ 3xz^2)\,\mathrm{V/m}$$

gives the electric field in a region where (x, y, z) are the cartesian coordinates, given in metres. The difference in electric potential between the two points with coordinates $(x, y, z) = (1, 1, 1)$ and $(x, y, z) = (1, 2, 3)$, is given by:

1. $-29\,\mathrm{V}$
2. $-16\,\mathrm{V}$
3. $0\,\mathrm{V}$
4. An electric potential cannot be defined for this electric field configuration

Question No.	Entrance with year	Answers
1	TIFR-2012	Option d
2	TIFR-2012	Option b
3	TIFR-2013	Option c
4	TIFR-2013	Option b
5	TIFR-2013	Option b
6	TIFR-2014	Option c
7	TIFR-2014	Option d
8	TIFR-2014	Option c
9	TIFR-2014	Option b
10	TIFR-2015	Option c
11	TIFR-2015	Option c
12	TIFR-2015	Option d
13	TIFR-2016	Option b
14	TIFR-2016	Option a
15	TIFR-2016	Option d
16	TIFR-2016	Option c
17	TIFR-2016	Option c
18	TIFR-2017	Option d
19	TIFR-2017	Option c
20	TIFR-2017	0.9142
21	TIFR-2017	Option a
22	TIFR-2018	529
23	TIFR-2018	Option d
24	TIFR-2018	$T = 8\sqrt{\frac{\epsilon_0\, m\, d}{q\, \sigma}}$
25	TIFR-2018	Option c
26	TIFR-2019	Option b
27	TIFR-2019	Option a
28	TIFR-2020	Option a
29	TIFR-2020	Option a
30	TIFR-2020	Option d
31	TIFR-2020	Option c
32	TIFR-2021	Option a
33	TIFR-2021	Option a
34	TIFR-2021	Option a
35	TIFR-2021	Option a
36	TIFR-2022	Option a
37	TIFR-2022	Option a
38	TIFR-2023	Option b
39	TIFR-2023	Option a
40	TIFR-2024	Option a
41	TIFR-2024	Option a
42	TIFR-2024	Option a
43	TIFR-2024	Option a
44	TIFR-2025	Option a
45	TIFR-2025	Option a
46	TIFR-2026	Option a
47	TIFR-2026	Option a
48	TIFR-2026	Option a
49	TIFR-2026	Option a

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