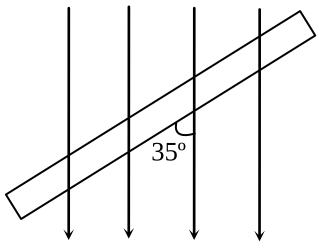
Q.1 A flat plate with dimensions 4 cm × 6 cm is set with its plane at 37º to a uniform electric field $\vec{E} = 600\,\hat{j}$ N/C, as shown below. What is the flux through the plate ?



(A) 2.15 N-m^2/C (B) 1.15 N-m^2/C

(C) 0.15 N-m^2/C (D) 3.15 N-m^2/C

[B]

Q.2 Mark the correct options -

(A) Gauss's Law is valid only for symmetrical charge distributions

(B) Gauss's Law is valid only for charges placed in vacuum

(C) The electric field calculated by Gauss's Law is the field due to the charges enclosed by the surface

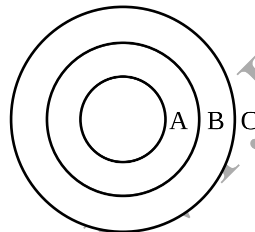
(D) The flux of the electric field through a closed surface due to all the charges is equal to the flux due to the charges enclosed by the surface **[D]**

Q.3 A charge Q is uniformly distributed over a large plastic plate. The electric field at a point P close to the centre of the plate is 10 V/m. If the plastic plate is replaced by a copper plate of the same geometrical dimensions and carrying the same charge Q, the electric field at the point P will become -

(A) Zero (B) 5 V/m

(C) 10 V/m (D) 20 V/m **[C]**

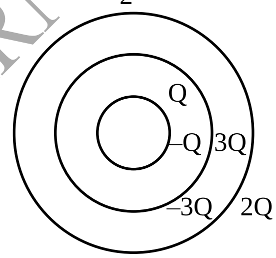
Q.4 Charges Q, 2Q, –Q are given to three concentric conducting spherical shells A, B, and C respectively, as shown in the figure. The ratio of charges on the inner and the outer surfaces of the shell C will be -



(A) $+\frac{3}{4}$ (B) $-\frac{3}{4}$ (C) $\frac{3}{2}$ (D) $-\frac{3}{2}$

[D]

Sol. Ratio $= -\frac{3}{2}$



Q.5 A positive point charge Q is brought near an isolated metal cube -

(A) The cube becomes negatively charged

(B) The cube becomes positively charged

(C) The interior becomes positively charged and the surface becomes negatively charged

(D) The interior remains charge free and the surface gets non-uniform charge distribution due to induction **[D]**

Q.6 In a region of space, the electric field is in the x-direction and proportional to x, i.e., $\vec{E} = E_0\, x\, \hat{i}$. Consider an imaginary cubical volume of edge a, with its edges parallel to the axis of co-ordinates. The charge inside this volume is -

(A) zero (B) $\varepsilon_0 E_0 a^3$

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(C) $\frac{1}{\varepsilon_0} E_0 a^3$ (D) $\frac{1}{6} \varepsilon_0 E_0 a^2$ **[B]**

Q.7 A metallic particle having no net charge is placed near a finite metal plate carrying a positive charge. The electric force on the particle will be -

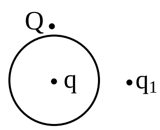
(A) towards the plate

(B) away from the plate

(C) parallel to the plate

(D) zero **[A]**

Q.8 A thin, metallic spherical shell contains a charge Q on it.



A point charge q is placed at the centre of the shell and another charge q_1 is placed outside it. All the three charges are positive. The force on the charge at the centre is -

(A) towards left

(B) towards right

(C) upward

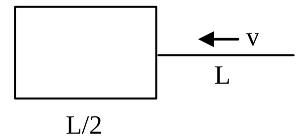
(D) zero **[D]**

Q.9 Consider the situation of the previous problem. The force on the central charge due to the shell is -

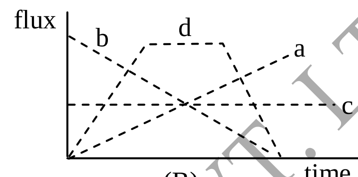
(A) towards left (B) towards right

(C) upward (D) zero **[B]**

Q.10 Figure (A) shows an imaginary cube of edge L/2. A uniformly charged rod of length L moves towards left at a small but constant speed v. At t = 0 the left end just touches the centre of the face of the cube opposite it. Which of the graphs shown in figure (B) represents the flux of the electric field through the cube as the rod goes through it –



(A)

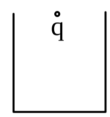


(B)

(A) a (B) b

(C) c (D) d **[D]**

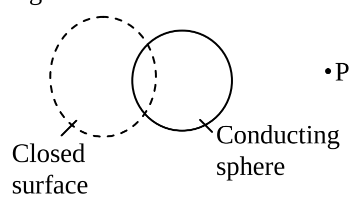
Q.11 A charge q is placed at the centre of the open end of a cylindrical vessel (figure). The flux of the electric field through the surface of the vessel is -



(A) zero (B) q/ε_0

(C) $q/2\varepsilon_0$ (D) $2q/\varepsilon_0$ **[C]**

Q.12 Figure shows a closed surface which intersects a conducting sphere. If a positive charge is placed at the point P, the flux of the electric field through the closed surface-



(A) wil remain zero

(B) will become positive

(C) wll become negative

(D) will become undefined **[B]**

Q.13 A long string with a charge of λ per unit length passes through an imaginary cube of edge a. The maximum flux of the electric field through the cube will be

(A) $\lambda a/\varepsilon_0$ (B) $\sqrt{2}\, \lambda a/\varepsilon_0$

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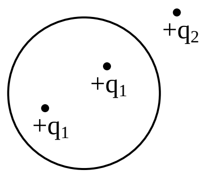
(C) $6\lambda a^2/\varepsilon_0$ (D) $\sqrt{3}\,\lambda a/\varepsilon_0$ **[D]**

Q.14 In the given figure, charges q_1 and $-q_1$ are inside a Gaussian surface. Where as charges q_2 is outside the surface. Electric field on the Gaussian surface will be–

[IIT- 2003]



(A) only due to q_2

(B) zero on the Gaussian surface

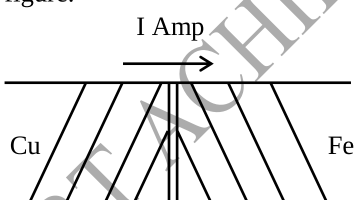
(C) uniform on the Gaussian surface

(D) due to all **[D]**

Q. 15 A Gaussian sphere encloses an electric dipole within it. The total electric flux across the sphere is -
(A) zero
(B) half that due to a single charge
(C) double that due to a single charge
(D) dependent on the position of the dipole

[A]

Q.16 A current of I Amp flow through a wire made of a piece of copper and a piece of iron of identical cross sections welded end to end as shown in the figure.



How much electric charge accumulates at the boundary between the two metals? ρ_{Fe} & ρ_{Cu} are resistivity of Fe & Cu respectively -
(A) $\in_0 I(\rho_{Fe} + \rho_{Cu})$ (B) $\in_0 I(\rho_{Fe} - \rho_{Cu})$
(C) $\in_0 I(\rho_{Fe} + 3\rho_{Cu})$ (D) $\in_0 I(\rho_{Fe} + 2\rho_{Cu})$

[B]

Sol. I = current in wire
A = cross section Area of wire

$$V = I \times R = \frac{I\rho L}{A}$$

$$E = \frac{V}{L} = \frac{\rho I}{A}$$

According to gauss Law

$$\frac{Q}{\in_0} = \left(\frac{\rho_{Fe} I}{A}\right) A - \left(\frac{\rho_{Cu} I}{A}\right) A$$

$$\frac{Q}{\in_0} = (\rho_{Fe} - \rho_{Cu})\, I$$

$$Q = \in_0 I\,(\rho_{Fe} - \rho_{Cu})$$

Q.17 The region between two concentric spheres of radius a < b contain volume charge density $\rho(r) = \frac{c}{r}$, where c is constant and r is radial distance, as shown in figure. A point charge q is placed at the origin, r = 0. Value of c is in such a way for which the electric field in the region between the spheres is constant (i.e. independent of r). Find the value of c –

(A) $\frac{q}{2\pi a^2}$ (B) $\frac{q}{4\pi a^2}$

(C) $\frac{q}{\pi a^2}$ (D) $\frac{q}{a^2}$ **[B]**

Sol. Total flux = $\frac{\text{Total charge}}{\varepsilon_0}$ (Gauss law)

$$E \times 4\pi r^2 = \frac{q}{\varepsilon_0} + \frac{4\pi}{\varepsilon_0}\int_a^r \frac{c}{r} \times r^2 dr$$

$$E \times 4\pi r^2 = \frac{q}{\varepsilon_0} + \frac{4\pi c[r^2 - a^2]}{\varepsilon_0}$$

$$E = \frac{q}{4\pi r^2 \varepsilon_0} + \frac{c[r^2 - a^2]}{r^2 \varepsilon_0}$$

$$E = \frac{q}{4\pi r^2 \varepsilon_0} + \frac{c}{\varepsilon_0} - \frac{ca^2}{r^2 \varepsilon_0}$$

as E is independent of r

$$\therefore \frac{q}{4\pi r^2 \varepsilon_0} = \frac{ca^2}{r^2 \varepsilon_0}$$

$$c = \frac{q}{4\pi a^2}$$

Now E is $\frac{q}{4\pi\varepsilon_0 a^2}$

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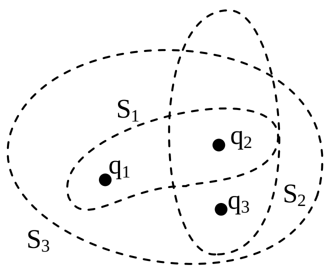
Q.18 A charge q is placed at the centre of the open end of a cylindrical vessel. The flux of the electric field through the surface of the vessel is

(A) zero (B) q/ε_0

(C) $q/2\varepsilon_0$ (D) none of these **[C]**

Q.19 Three charges $q_1 = 1 \times 10^{-6}$C, $q_2 = 2 \times 10^{-6}$C and $q_3 = -3 \times 10^{-6}$C have been placed as shown in the figure. Then the outward electric flux will be maximum for the surface -

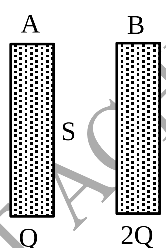


(A) S_1 (B) S_2

(C) S_3 (D) same for all three

[A]

Q.20 Two large conducting plates A and B are placed parallel to each other. A is given a charge Q and B is given a charge 2Q. Then the charge on the inner surface S of the plate A is –



(A) –Q/2 (B) +Q/2

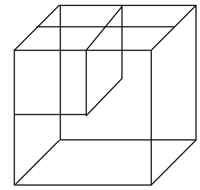
(C) +Q (D) +3Q/2 **[A]**

Q.21 Consider a solid cube of uniform charge density of insulating material. What is the ratio of the electrostatic potential at a corner to that at the centre : (Take the potential to be zero at infinity, as usual)

(A) $\frac{1}{1}$ (B) $\frac{1}{2}$

(C) $\frac{1}{4}$ (D) $\frac{1}{9}$ **[B]**

Sol.



ρ – Charge density of the cube

V_{ℓ}^{corner} – Potential at the corner of a cube of side ℓ

V_{ℓ}^{centre} – Potential at the centre of a cube of side ℓ

$V_{\ell/2}^{centre}$ – Potential at the center of a cube of side $\frac{\ell}{2}$

$V_{\ell/2}^{corner}$ – Potential at the corner of a cube of side $\frac{\ell}{2}$

By dimensional analysis

$V_{\ell}^{corner} \propto \frac{Q}{\ell} = \rho\ell^2$

$V_{\ell}^{corner} = 4\ V_{\ell/2}^{corner}$

But by superposition $V_{\ell}^{centre} = 8V_{\ell/2}^{corner}$

Because of the centre of the larger cube lies at a corner of the eight smaller cubes of which it is made

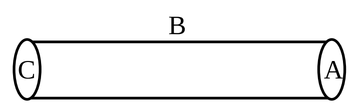
Therefore, $\frac{V_{\ell}^{corner}}{V_{\ell}^{centre}} = \frac{4V_{\ell/2}^{corner}}{8V_{\ell/2}^{corner}} = \frac{1}{2}$

Q.22 A point charge Q is placed at centre of a cylinder. If flux passing through it's curved surface is ϕ_1 then the flux associated with it's circular part will be -

(A) $\frac{Q}{3\varepsilon_0}$ (B) $\frac{\frac{Q}{\varepsilon_0} + \phi_1}{2}$

(C) $\frac{\frac{Q}{\varepsilon_0} - \phi_1}{2}$ (D) $\frac{Q}{\varepsilon_0} - \frac{\phi_1}{2}$ **[C]**

Q.23 A hollow cylinder has a charge q coulomb with in it. If ϕ is the electric flux in unit of voltmeter associated with the curved surface B, the flux linked with the plane A in unit of voltmeter will be -



(A) $\frac{1}{2}\left(\frac{q}{\varepsilon_0} - \phi\right)$ (B) $\frac{q}{2\varepsilon_0}$

(C) $\frac{\phi}{3}$ (D) $\frac{q}{\varepsilon_0} - \phi$ **[A]**

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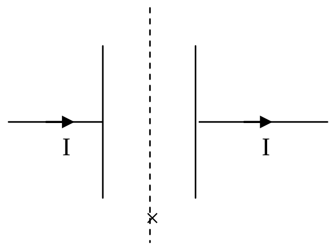
Q.24 A circular parallel plate capacitor of radius R and distance d between the plate is given. A capacitor is being charged with a current I flowing through the wire. Neglect fringing effect.



What is the rate of change of electric flux through plane in middle of capacitor with respect to time (i.e. $\frac{d\phi}{dt}$) –

(A) $\frac{2I}{\varepsilon_0}$ (B) $\frac{I}{\varepsilon_0}$

(C) $\frac{4I}{\varepsilon_0}$ (D) $\frac{6I}{\varepsilon_0}$ **[B]**

Sol. $\phi = \frac{Q}{A\varepsilon_0} \times A$

$\phi = \frac{Q}{\varepsilon_0}$

$\frac{d\phi}{dt} = \frac{1}{\varepsilon_0} \times \frac{dQ}{dt} = \frac{I}{\varepsilon_0}$

Q.25 Charge is uniformly distributed in a space. The net flux passing through the surface of an imaginary cube of side a in the space is ϕ. The net flux passing through the surface of an imaginary sphere of radius a in the space will be

(A) ϕ (B) $\frac{3}{4\pi}\phi$

(C) $\frac{2\pi}{3}\phi$ (D) $\frac{4\pi}{3}\phi$ **[D]**

Sol. $\phi = \frac{\rho \times a^3}{\epsilon_0}$

$\phi_2 = \rho \times \frac{4\pi a^3}{3\epsilon_0}$

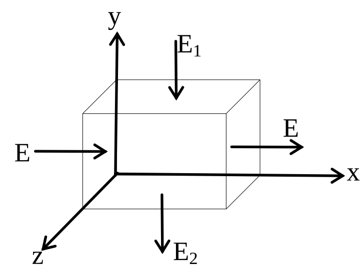
$\phi_2 = \phi \times \frac{4}{3}\pi$

Q.26 An electric field given by $E = 4\hat{i} - 3(y^2 + 2)\hat{j}$ pierces Gaussian cube of side 1m placed at origin such that its three sides represent x, y and z axes. The net charge enclosed within cube is -

(A) $4\epsilon_0$ (B) $3\epsilon_0$

(C) $5\epsilon_0$ (D) zero **[B]**

Sol.



$E_1 = 3(1^2 + 2) = 9$

$E_2 = 3(0 + 2) = 6$

Net flux $= (9 - 6) \times |x|$

$\frac{q}{\epsilon_0} = 3$

$q = 3\epsilon_0$

Q.27 The tangent drawn at a point on a line of electric force shows the-

(A) intensity of gravity field

(B) intensity of magnetic field

(C) intensity of electric field

(D) direction of electric field **[D]**

Q.28 Which of the following statements concerning the electrostatics is correct-

(A) electric line of force never intersect each other

(B) electric lines of force start from positive charge and end at the negative charge

(C) electric lines of force start or ends perpendicular to the surface of a charged metal.

(D) all of the above **[D]**

Q.29 When no charge is confined with in the Gauss's surface, it implies that-

(A) E = 0

(B) $\vec{E}$ and $\vec{ds}$ are parallel

(C) $\vec{E}$ and $\vec{ds}$ are mutually perpendicular

(D) $\vec{E}$ and $\vec{ds}$ are inclined at some angle **[C]**

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Q.30 If electric field flux coming out of a closed surface is zero, the electric field at the surface will be-

(A) zero

(B) same at all places

(C) dependent upon the location of points

(D) infinites **[C]**

Q.31 If three electric dipoles are placed in some closed surface, then the electric flux emitting from the surface will be-

(A) zero (B) positive

(C) negative (D) None **[A]**

Q.32 For which of the following fields, Gauss's law is valid-

(A) fields following square inverse law

(B) uniform field

(C) all types of field

(D) this law has no concern with the field **[A]**

Q.33 The electric flux coming out of the equi-potential surface is-

(A) perpendicular to the surface

(B) parallel to the surface

(C) in all directions

(D) zero **[A]**

Q.34 A charge of Q coulomb is located at the centre of a cube. If the corner of the cube is taken as the origin, then the flux coming out from the faces of the cube in the direction of X- axis will be-

(A) $4\pi Q$ (B) $Q/6 \in_0$

(C) $Q/3 \in_0$ (D) $Q/4 \in_0$ **[C]**

Q.35 A rectangular surface of 2 metre width and 4 metre length, is placed in an electric field of intensity 20 Newton/C, there is an angle of 60º between the perpendicular to surface and electrical field intensity. Then total flux emitted from the surface will be- (In Volt- metre)

(A) 80 (B) 40

(C) 20 (D) 160 **[A]**

Q.36 A charge q is inside a closed surface and charge – q is outside. The out going electric flux is-

(A) $-q/\in_0$ (B) zero

(C) $q/\in_0$ (D) $2q/\in_0$ **[C]**

Q.37 If the electric field is uniform, then the electric lines of forces are-

(A) Divergent (B) Convergent

(C) Circular (D) Parallel **[D]**

Q.38 Electric lines of forces-

(A) Exist everywhere

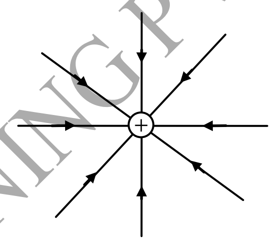
(B) Are imaginary

(C) Exist only in the immediate vicinity of electric charges

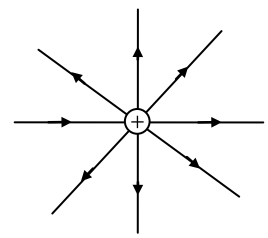
(D) None of the above **[B]**

Q.39 Which one of the following diagrams shows the correct lines of force ?

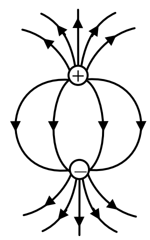
(A)



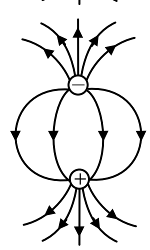
(B)



(C)



(D)



[B]

Q.40 In fig. shown the electric lines of force emerging from a charged body. If the electric fields at A and B are E_A and E_B are respectively, If the distance between A and B is r then -

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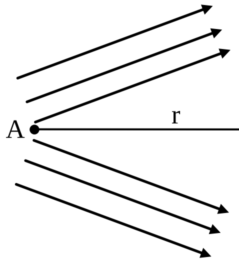
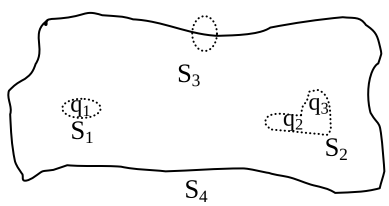


(A) $E_A > E_B$ (B) $E_A < E_B$

(C) $E_A = E_B$ (D) $E_A = (E_B)/r^2$ **[A]**

Q.41 Three charges $q_1 = 1\mu C$, $q_2 = 2\ \mu C$ and $q_3 = -3\ \mu C$ and four surfaces S_1, S_2, S_3 and S_4 are shown. The flux emerging through surface S_2 in N-m^2 / C is -



(A) 36×10^3 (B) -36×10^3

(C) 36×10^9 (D) -36×10^9 **[B]**

Q.42 A surface enclosed an electric dipole, the flux through the surface is-

(A) Infinite (B) Positive

(C) Negative (D) Zero **[D]**

Q.43 Total flux coming out of some closed surface is-

(A) $q/\in_0$ (B) $\in_0/q$

(C) $q\in_0$ (D) $\sqrt{\dfrac{q}{\in_0}}$ **[A]**

Q.44 A square of side 20 cm is enclosed by a surface of sphere of 80 cm radius. Square and sphere have the same centre. four charges $+2 \times 10^{-6}$ C, -5×10^{-6} C, -3×10^{-6} C, $+6 \times 10^{-6}$C are located at the four corners of a square, Then out going total flux from spherical surface in N-m^2/C will be-

(A) zero (B) $(16\pi) \times 10^{-6}$

(C) $(8\pi) \times 10^{-6}$ (D) $(36\ \pi) \times 10^{-6}$ **[A]**

Q.45 The flux emerging out from any one face of the cube will be -

(A) $\dfrac{q}{6\varepsilon_0}$ (B) $\dfrac{q}{3\varepsilon_0}$

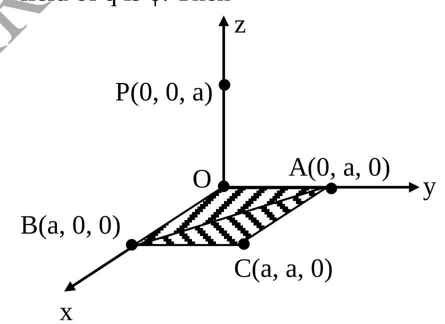
(C) $\dfrac{q}{\varepsilon_0}$ (D) $\dfrac{q}{4\varepsilon_0}$ **[A]**

Q.46 A charge Q is distributed over two concentric hollow spheres of radii (r) and (R) > (r) such the surface densities are equal. Find the potential at the common centre-

(A) $\dfrac{Q}{4\pi\varepsilon_0}\times\dfrac{(r+R)}{(R+r)^2}$ (B) $\dfrac{Q(R^2+r)^2}{4\pi\varepsilon_0(r+R)}$

(C) $\dfrac{Q(r+R)}{4\pi\varepsilon_0(R^2+r^2)}$ (D) none of these **[C]**

Q.47 A point charge q is placed at P(0, 0, a). The electric flux through CAB due to the electric field of q is ϕ. Then –



(A) $\phi = \dfrac{q}{48\varepsilon_0}$ (B) $\phi < \dfrac{q}{48\varepsilon_0}$

(C) $\dfrac{q}{48\varepsilon_0} < \phi > \dfrac{q}{24\varepsilon_0}$ (D) $\phi > \dfrac{q}{24\varepsilon_0}$

Sol. **[B]**

The flux is greater in the nearer half of the square OACB.

Q.48 An electric field given by $E = 4\hat{i} - 3(y^2 + 2)\hat{j}$ pierces Gaussian cube of side 1 m placed at origin such that its three sides represent x, y and z axes. The net charge enclosed within cube is -

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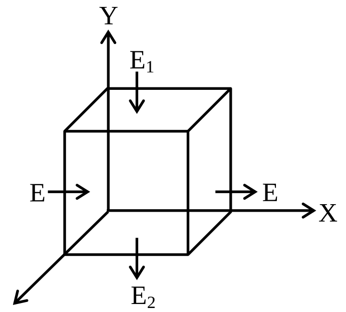


(A) $4\epsilon_0$ (B) $3\epsilon_0$ (C) $5\epsilon_0$ (D) zero

Sol. **[B]**

$E_1 = 3\,(1^2 + 2) = 9$

$E_2 = 3\,(0 + 2) = 6$

Net flux = (9 – 6) × 1 × 1

$\frac{q}{\epsilon_0} = 3$

$q = 3\,\epsilon_0$

Q.49 The electric potential at the surface of an atomic nucleus (Z = 50) of radius 9×10^{-15} m is -

(A) 80V (B) 8×10^6 V

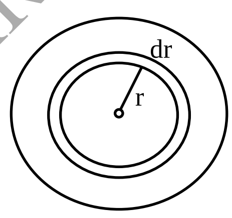
(C) 8×10^4 V (D) 8×10^2 V **[B]**

Q.50 An insulating solid sphere of radius R is charged in a non-uniform manner such that volume charge density $\rho = \frac{A}{r}$, where A is a positive constant and r is the distance from centre. Potential difference between centre and surface of sphere is -

(A) $\frac{AR}{\epsilon_0}$ (B) $\frac{AR}{4\epsilon_0}$

(C) $\frac{AR}{\pi\epsilon_0}$ (D) $\frac{AR}{2\epsilon_0}$

Sol. [D]



$E \times 4\pi r^2 = \frac{q}{\epsilon_0}$

$E \times 4\pi r^2 = \int_0^r \frac{A}{r} \times 4\pi r^2\, dr$

$E = \frac{A}{2\epsilon_0}$

Potential difference = E × d

$= \frac{A}{2\epsilon_0} \times R = \frac{AR}{2\epsilon_0}$

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