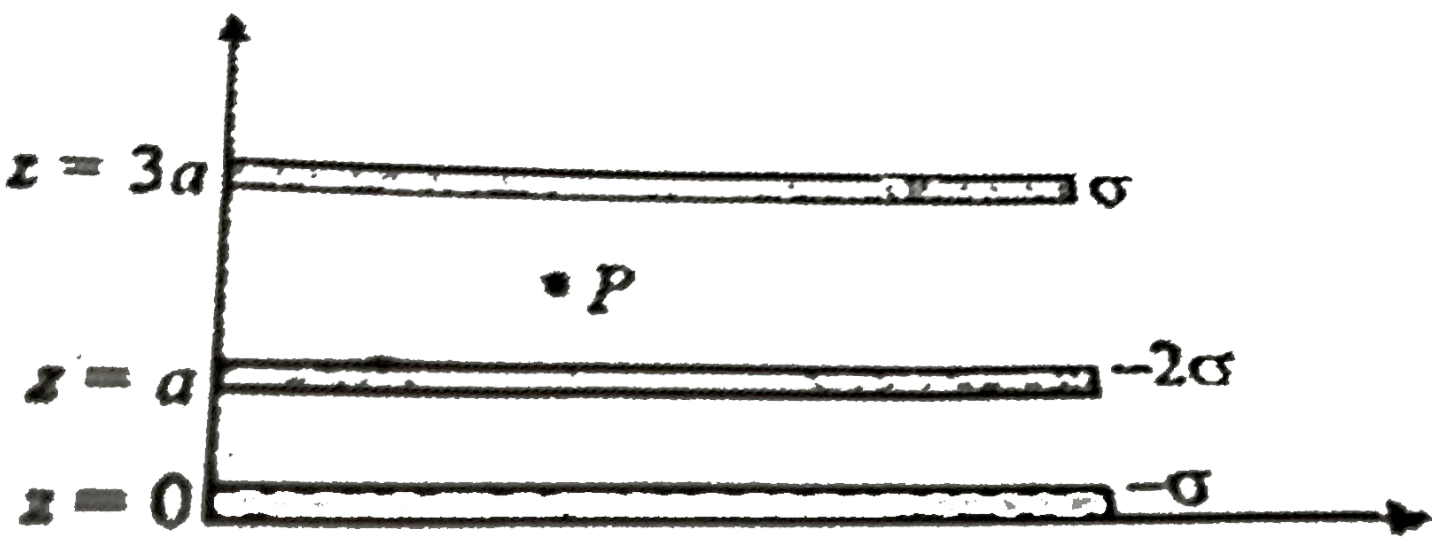
Revise Most Important Questions to Crack NEET 2020

Q-1 - 16592009

Three infinite long charged sheets of charge densities $-\sigma, \ -2\sigma$ and σ are placed parallel to,y-plane at z= 0, z= a, z= 3a. Electric field at point Pis given as :



(A) $-\dfrac{2\sigma}{\in_0}\hat{k}$

(B) $\dfrac{2\sigma}{\in_0}\hat{k}$

(C) $\dfrac{-4\sigma}{\in_0}\hat{k}$

(D) $\dfrac{4\sigma}{\in_0}\hat{k}$

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Q-2 - 10059606

A charge $+q$ is fixed at each of the points $x = x_0, x = 3x_0$, $x = 5x_0$,$x = \infty$ on the x axis, and a charge $-q$ is fixed at each of the points $x = 2x_0, x = 4x_0, x = 6x_0, x = \infty$. Here x_0 is a positive constant. Take the electric potential at a point due to a charge Q at a distance r from it to be $Q / (4\pi\varepsilon_0 r)$.Then, the potential at the origin due to the above system of

(A) (a) 0

(B) (b) $\dfrac{q}{8\pi\varepsilon_0 x_0 \ln 2}$

(C) (c) ∞

(D) (d) $\dfrac{q \ln 2}{4\pi\varepsilon_0 x_0}$

CORRECT ANSWER: D

SOLUTION:

Potential at origin will be given by

$$V = \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{x_0} - \frac{1}{2x_0} + \frac{1}{3x_0} - \frac{1}{4x_0} + \right]$$

$$V = \frac{q}{4\pi\varepsilon_0 x_0} 1n(2)$$

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Q-3 - 10966896

A uniform electric field pointing in positive x-direction exists in a region. Let A be the origin, B be the point on the x-axis at $x = +1cm$ and C be the point on the y-axis at $y = +1\text{cm}$. then the potetial at the points A,B and C satisfy

a. $V_A < V_B$, b. $V_A > V_B$ c. $V_A < V_C$ d. $V_A > V_C$

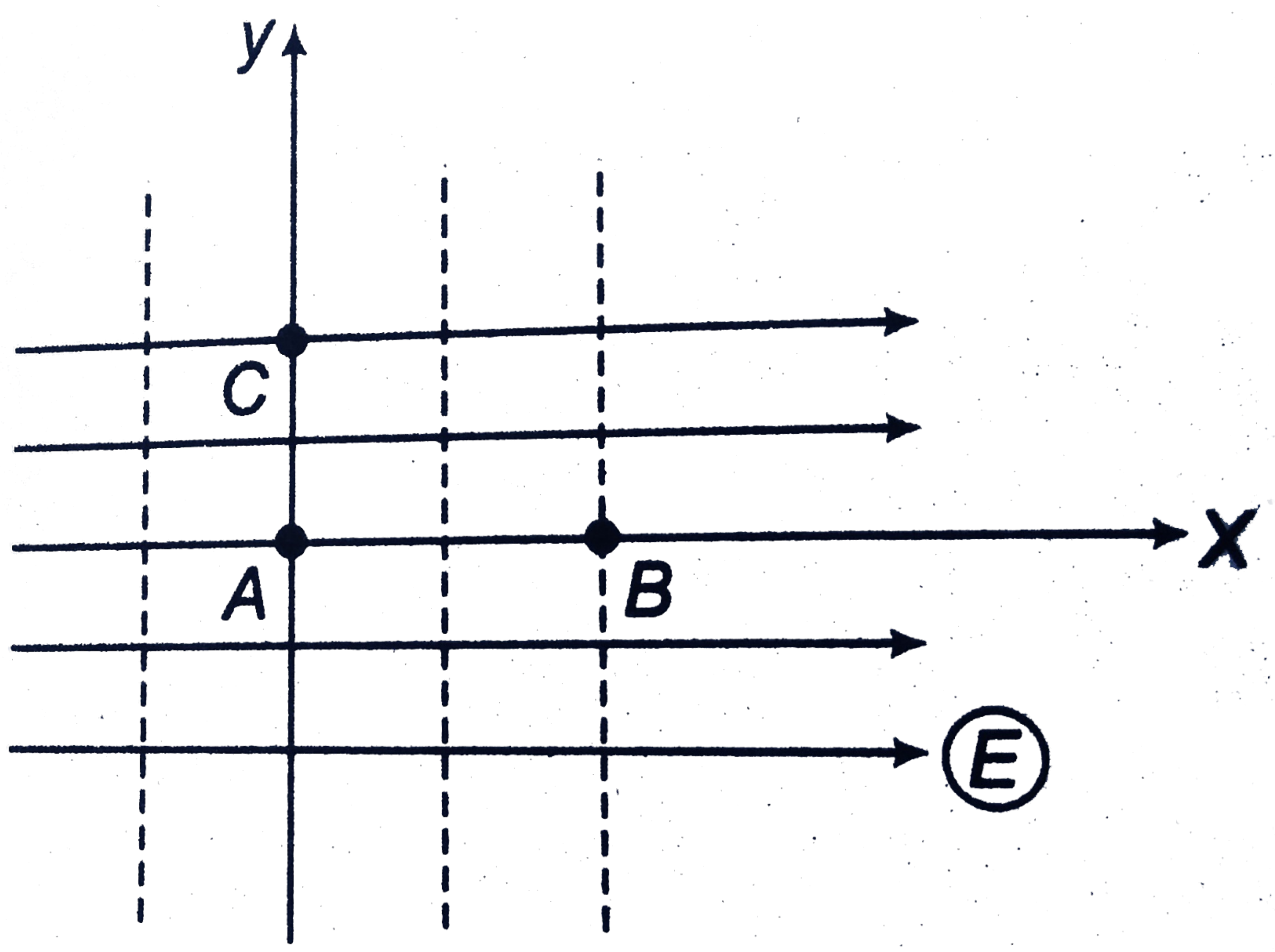
SOLUTION:

Potential decrease in the direction of electric field.

Dotted lines are equiptontial lines.

$\therefore V_A = V_C$ and $V_A > V_B$

Hence the corrent option is b.



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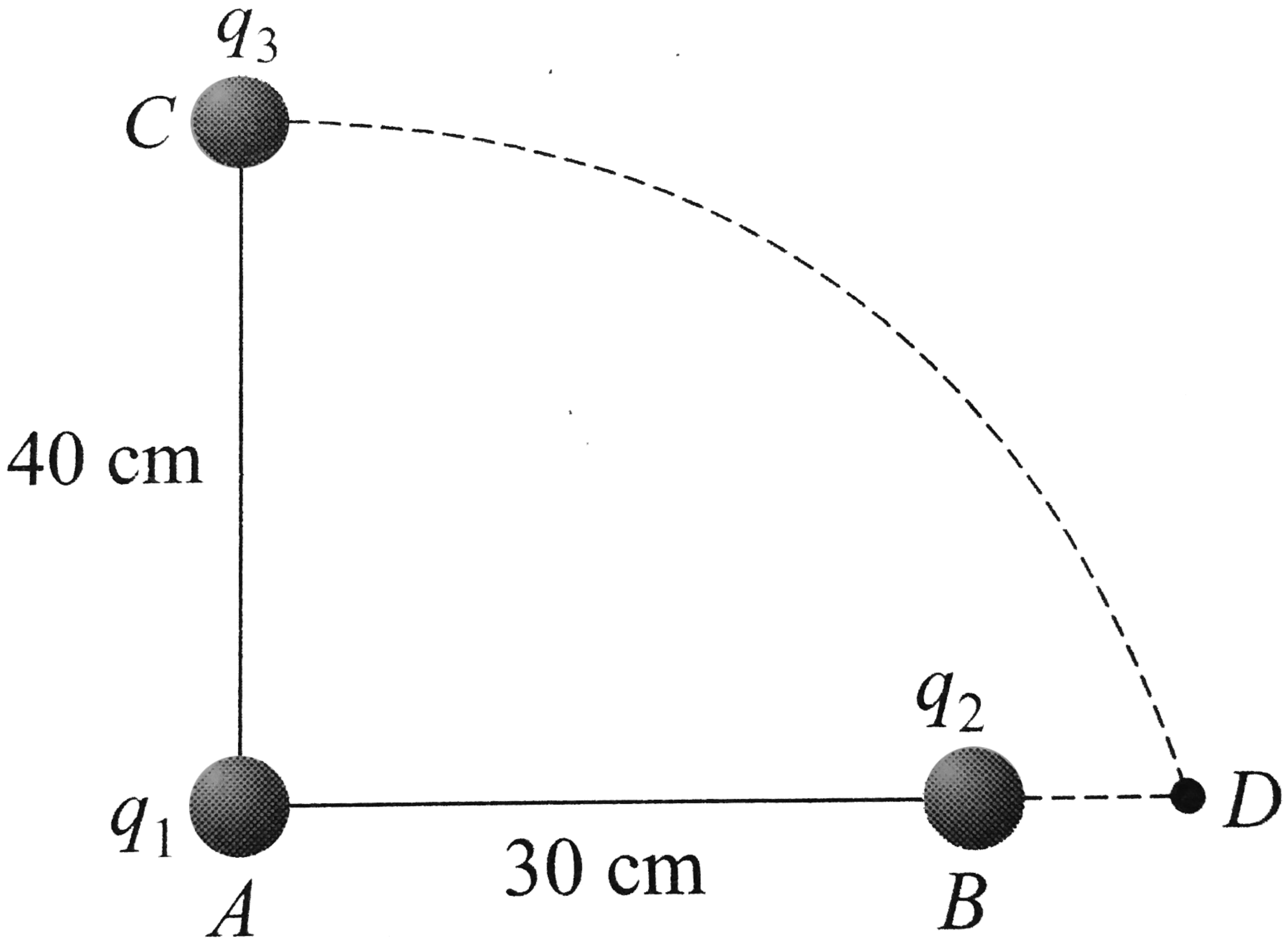
Q-4 - 11964498

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 o fthe system is $\frac{q_3}{4\pi\varepsilon_0}k$., where k is



(A) $8q_2$

(B) $8q_1$

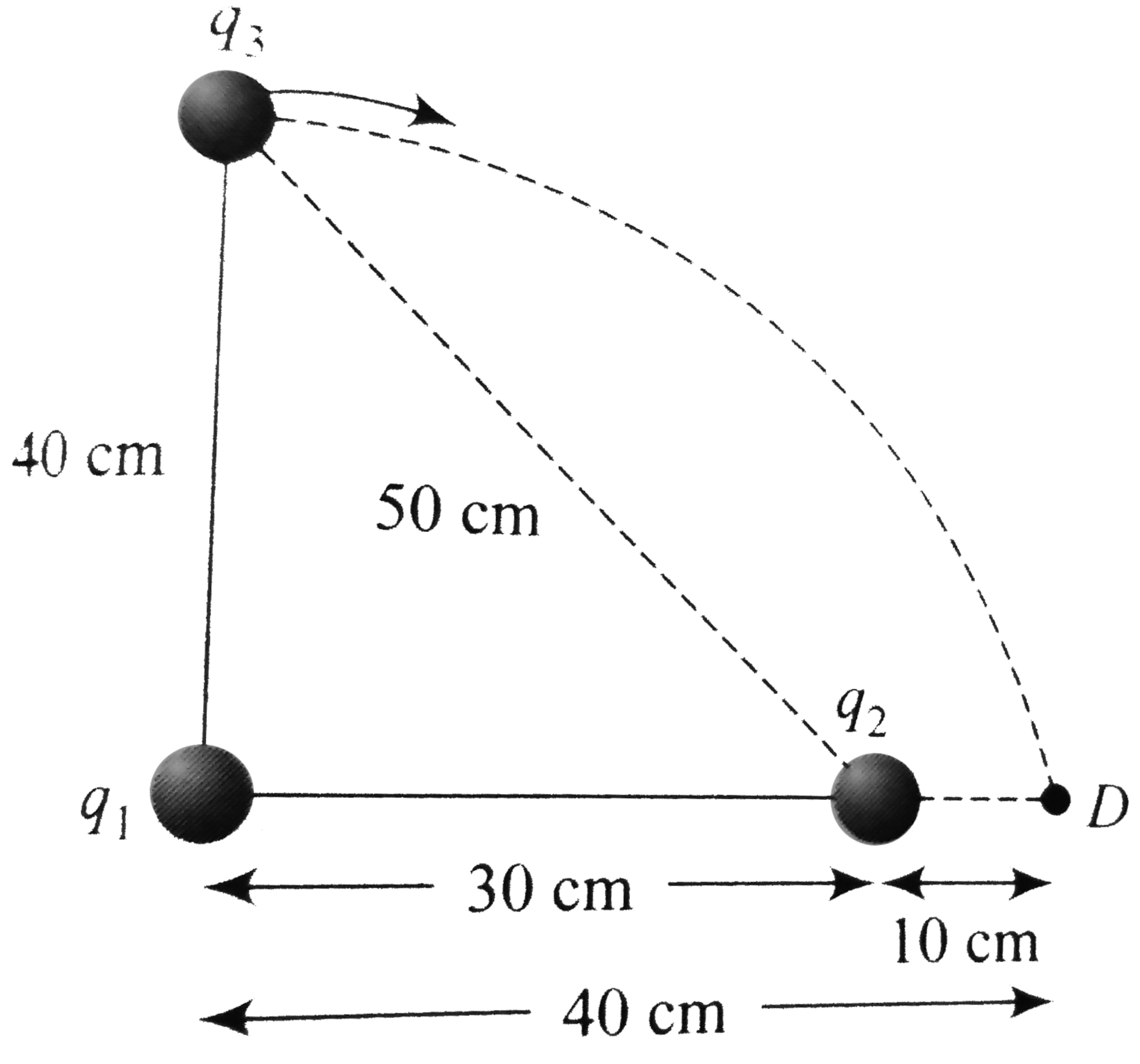
(C) $6q_2$

(D) $6q_1$

CORRECT ANSWER: A

SOLUTION:

Change in potential energy $(\Delta U) = U_f - U_i$



$$\Rightarrow \Delta U = \frac{1}{4\pi\varepsilon_0}\left[\left(\frac{q_1 q_3}{0.4} + \frac{q_2 q_3}{0.1}\right) - \left(\frac{q_1 q_3}{0.4} + \frac{q_2 q_3}{0.5}\right)\right]$$

$$\Rightarrow \Delta U = \frac{1}{4\pi\varepsilon_0}[8q_2q_3]$$

$$= \frac{q_3}{4\pi\varepsilon_0}(8q_2)$$

$$\Rightarrow k = 4q_2$$

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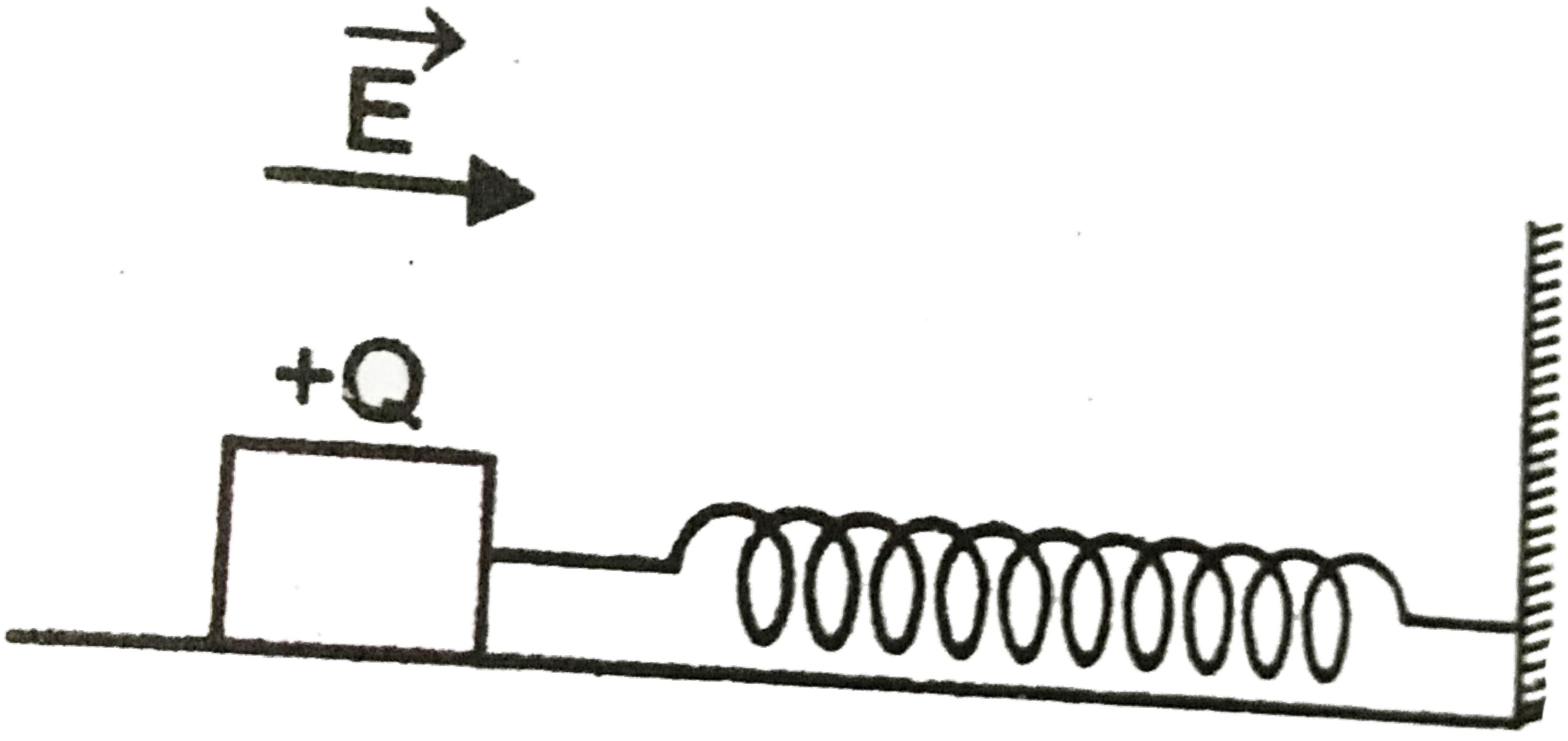
Q-5 - 12010291

A wooden block performs SHM on a frictionless surface with frequency, v_0. The block carries a charge $+Q$ on its surface. If now a uniform electric field $\overrightarrow{E}$ is switched on as shwon in figure., then the SHM of the block will be



(A) of the same frequency and with shifted mean position.

(B) of the same frequency and with the same mean position.

(C) of changes freqency and with shifted mean position.

(D) of changed frequency and with the same mean position.I

CORRECT ANSWER: A

SOLUTION:

As frequency of oscillation of wooden block,

$v_0 = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$, does not depend on constat external force due to electric field, hence the frequency of oscillation will be the same. But due to constant external force, the mean position of the wooden block gets shifted. Hence, option (a) is correct.

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Q-6 - 15088897

Let $[\in_0]$ denote the dimensional formula of the permittivity of vacuum. If M= mass, L=length, T=Time and A= electric current, then:

(A)
$[\in_0] = [M^{-1}L^{-3}T^2A]$

(B)

$[\in_0] = [M^{-1}L^{-3}T^4A^2]$

(C)

$[\in_0] = [M^{-1}L^2T^{-1}A^{-2}]$

(D)

$[\in_0] = [M^{-1}L^2T^{-1}A]$

CORRECT ANSWER: B

SOLUTION:

$$F = \frac{1}{4\pi \in_0} \frac{q_1 q_2}{r^2}$$

$$\Rightarrow [MLT^{-2}] = \left[\frac{1}{\in_0}\right] \frac{A^2T^2}{L^2}$$

$$\Rightarrow [\varepsilon_0] = [M^{-1}L^{-3}T^4A^2]$$

Q-7 - 11964004

An electric dipole 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 $\theta = 90$, the torque and the potential energy of the dipole will respectively be

(A) $pE \cos\theta, \ -pE \sin\theta$

(B) $pE \sin\theta, \ -pE \cos\theta$

(C) $pE \sin\theta, \ -2pE \cos\theta$

(D) $pE \sin\theta, 2pE \cos\theta$

CORRECT ANSWER: B

SOLUTION:

Here, torque $\tau = pE \sin \theta$, here θ is the anlge between electric field and dipole moment

Potential energy of the dipole

$$U = -\int \tau d\theta$$

$$= -\int_{\pi/2}^{0} pE \sin \theta d\theta$$

$$= pE[\cos \theta - 0]$$

$$= -pE \cos \theta$$

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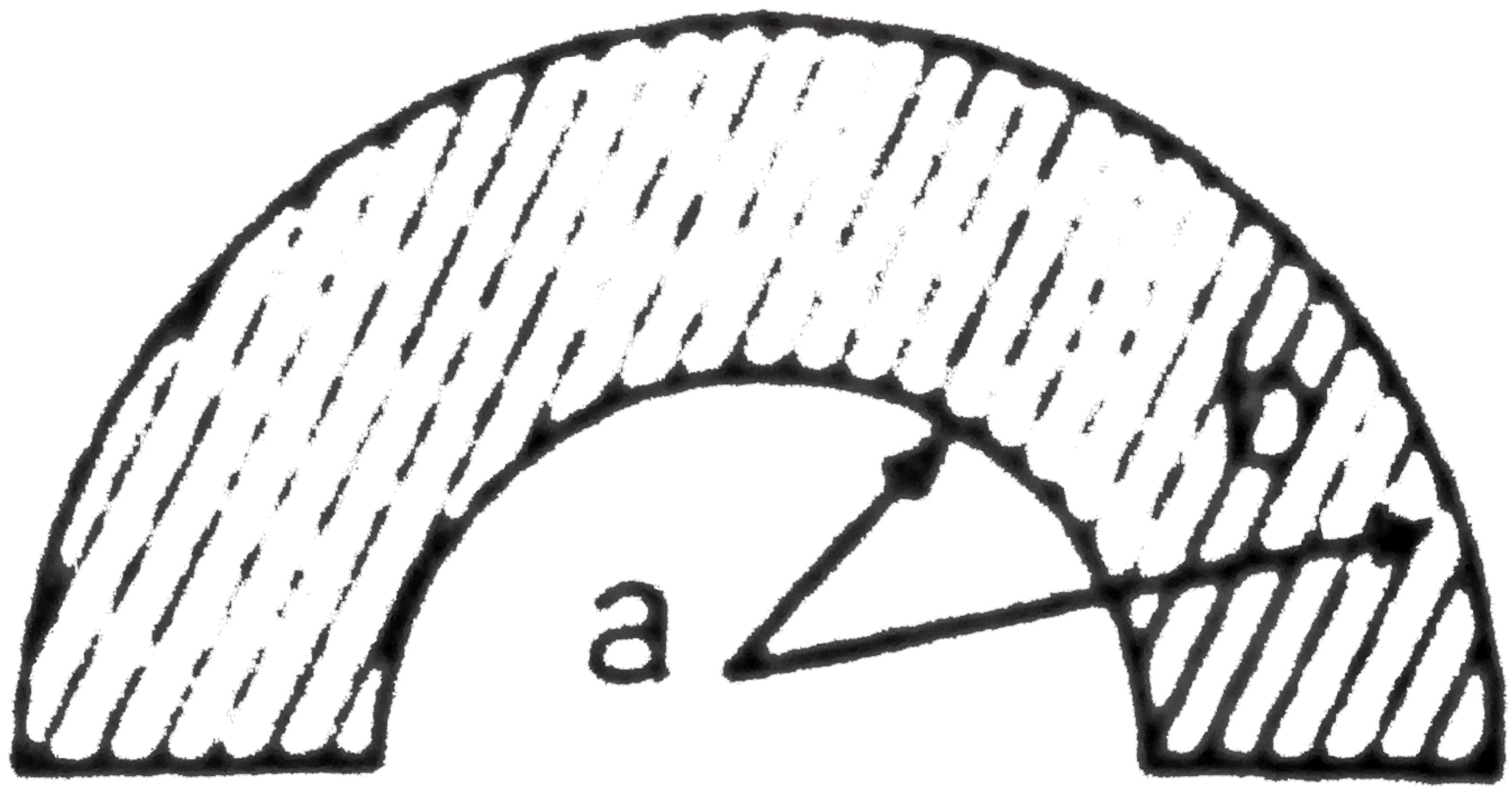
Q-8 - 14279651

A non-conducting semi circular disc (as shown in figure) has a uniform surface charge density σ. The ratio of electric field to electric potential at the centre of the disc will be



(A) $\dfrac{1}{\pi}\dfrac{\ln b/a}{(b-a)}$

(B) $\dfrac{2}{\pi}$

(C) $\dfrac{1}{\pi}\dfrac{\ln(b/a)^2}{(b-a)}$

(D) $\dfrac{\pi(b-a)}{2\ln(b/a)}$

CORRECT ANSWER: C

SOLUTION:

$$E = \int dE =$$

$$\int_{x=a}^{b} \frac{2K\sigma dx}{x} = 2K\sigma ln\frac{b}{a}$$

$$V = \int dv =$$

$$\int_{x=1}^{b} \frac{K\pi x\sigma dx}{x} = K\sigma\pi(b - a)$$

$$\Rightarrow \frac{E}{V} = \frac{2k\sigma ln(b/a)}{k\sigma\pi(b-a)} = \frac{\ln(b/a)^2}{\pi(b-a)}$$

.

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Q-9 - 13656413

Electric field intensity at a point due to an infinite sheet of charge having surface charge density σ is E.If sheet were conducting electric intensity would be

(A) $E/2$

(B) E

(C) $2E$

(D) $4E$

CORRECT ANSWER: 3

Q-10 - 11963838

There is a uniform electric field of strength $10^3 V/m$ along y-axis. A body of mass $1g$ and charge $10^{-6} C$ is projected into the field from origin along the positive x-axis with a velocity $10m/s$. Its speed in m/s after $10s$ is (Neglect gravitation)

(A) 10

(B) $5\sqrt{2}$

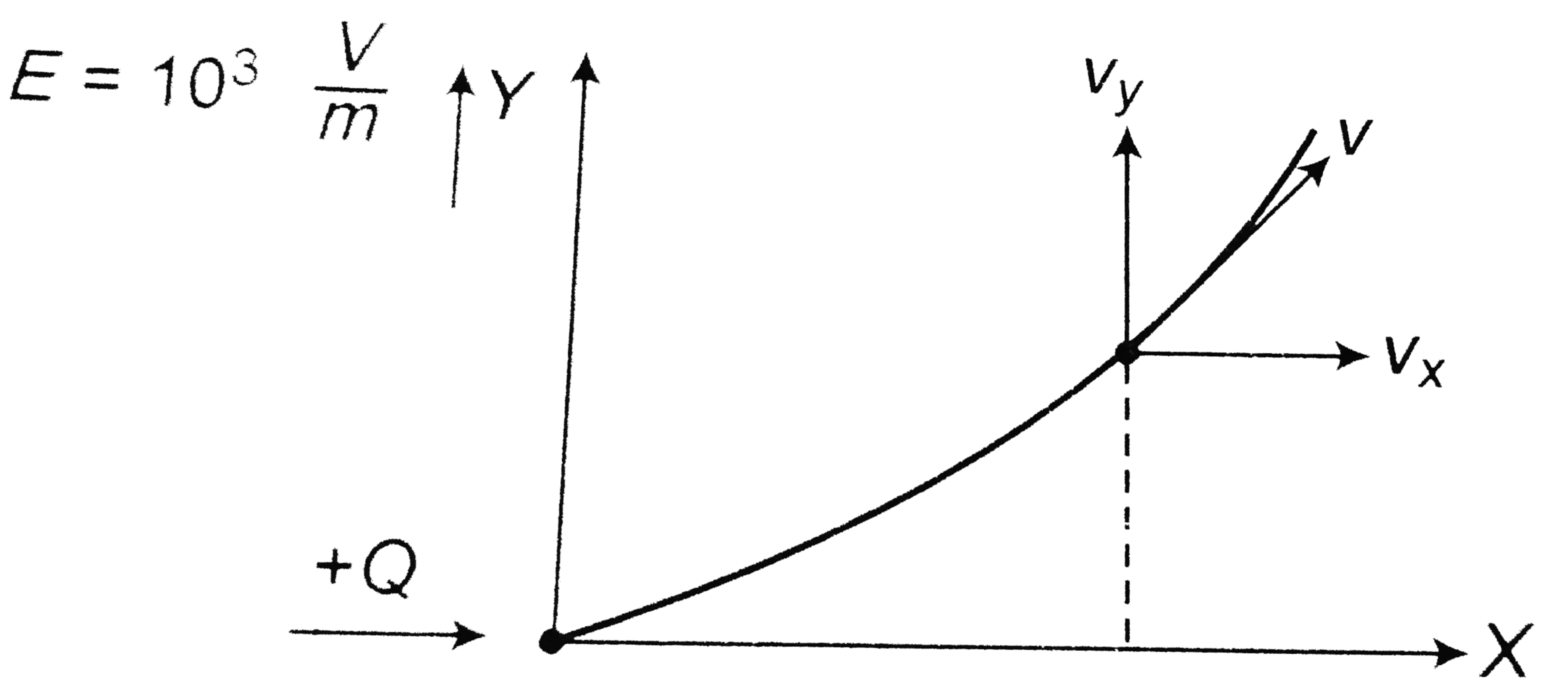
(C) $10\sqrt{2}$

(D) 20

CORRECT ANSWER: C

SOLUTION:

Body moves along the parabolic path.



For vertical: By using $v = u + at$

$$\Rightarrow v_y = 0 + \frac{QE}{m} . t$$

$$= \frac{10^{-6} \times 10^3}{10^{-3}} \times 10$$

$$= 10m / \sec$$

For horizontal motion-Its horizontal velocity remains the same i.e., after $10 \sec$, hortizontal velocity of body

$v_x = 10m / \sec$

Velocity after

$10 \sec V = \sqrt{v_x^2 + v_y^2}$

$= 10\sqrt{2}m / \sec$

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Q-11 - 11308814

The linear charge density on a dielectric ring of radius R vanes with θ as $\lambda = \lambda_0 \cos\theta / 2$, where λ_0 is constant. Find the potential at the center O of the ring [in volt].

CORRECT ANSWER: 0

SOLUTION:

The charge on the infinitesimal elements of arc that

subtends an angle $d\theta$ at the center of the ring is

$$dQ = \lambda R d\theta = \lambda_0 \cos \frac{\theta}{2} R d\theta$$

Potential at the center of ring due to charge dQ is

$$dV = \frac{1}{4\pi\varepsilon_0} \frac{dQ}{R}$$

$$= \frac{\lambda_0 \cos \frac{\theta}{2} R d\theta}{4\pi\varepsilon_0 R}$$

or

$$V = \int dV = \frac{\lambda_0}{4\pi\varepsilon_0} \int_0^{2\pi} \cos \frac{\theta}{2} d\theta$$

=

$$\frac{\lambda_0}{4\pi\varepsilon_0}\left[\frac{\sin\ \frac{\theta}{2}}{\frac{1}{2}}\right]_0^{2\pi}$$

$$= 0V$$

.

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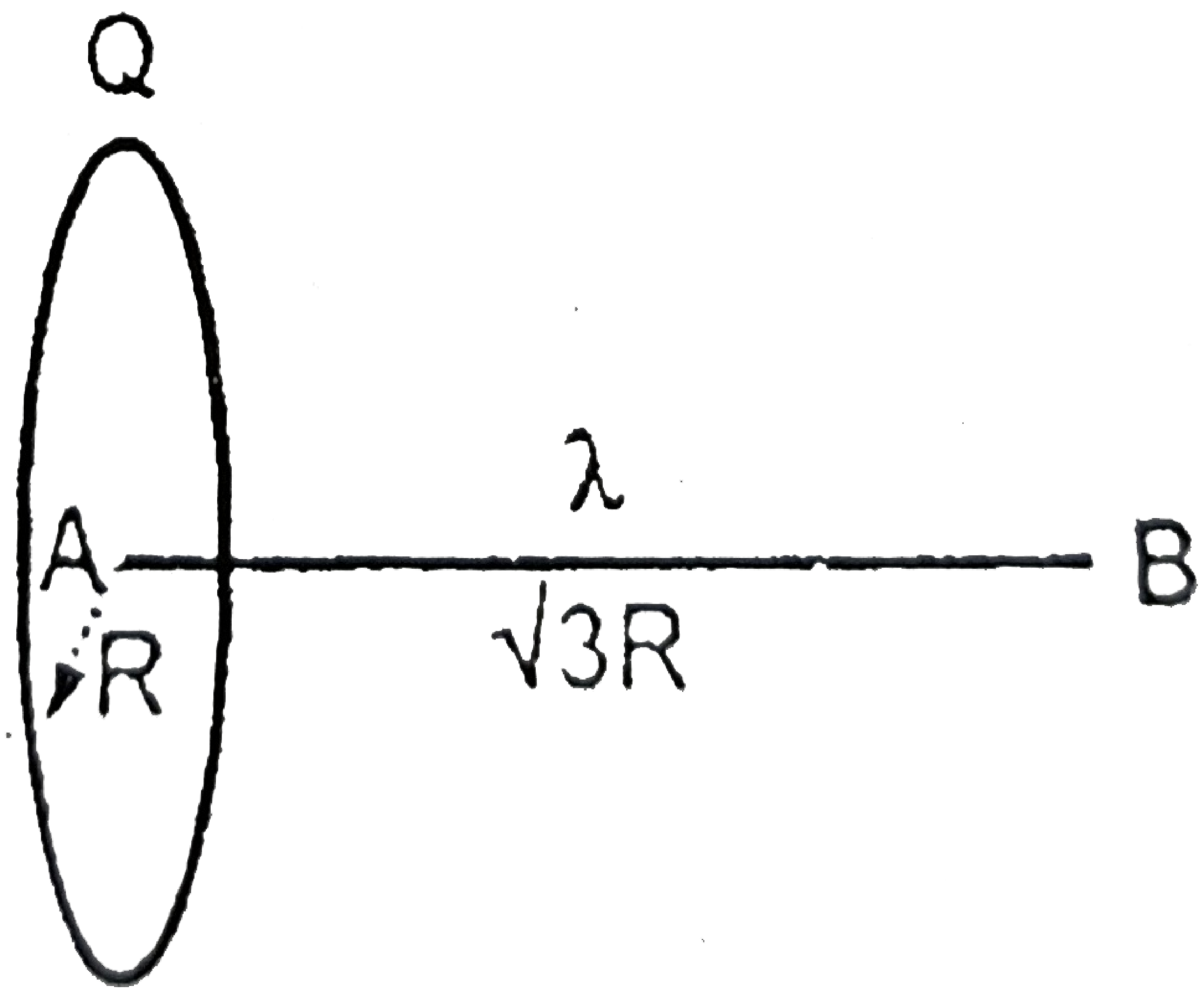
Q-12 - 15518030

A non conducting rod AB of length $\sqrt{3}R$, uniformly distributed charge of linear charge density λ and a non-conducting ring of uniformly distributed charge Q, are placed as shown in the figure. Point A is the centre of ring and line AB is the axis of the ring, perpendicular to plane of ring. The electrostatic interaction energy between ring and rod is



(A) $\frac{Q\lambda}{4\pi\varepsilon_0}\ln(2+\sqrt{3})$

(B) $\frac{Q\lambda}{2\pi\varepsilon_0}\ln(2+\sqrt{3})$

(C) $\frac{Q\lambda}{4\pi\varepsilon_0}\ln(2-\sqrt{3})$

(D) $\frac{Q\lambda}{2\pi\varepsilon_0}\ln(2-\sqrt{3})$

SOLUTION:

$$dU = V_{P(\text{ring})}\lambda dx$$

$$= \frac{kQ\lambda}{\sqrt{R^2+x^2}}dx$$

$$U = \frac{Q\lambda}{4\pi\varepsilon_0}$$

$$\int_0^{\sqrt{3}R}\frac{dx}{\sqrt{R^2+x^2}}$$

Let $x = R\tan\theta$

$\Rightarrow dx = R\sec^2\theta d\theta$

If $x = 0 \Rightarrow \theta = 0$, and $x = \sqrt{3}R$

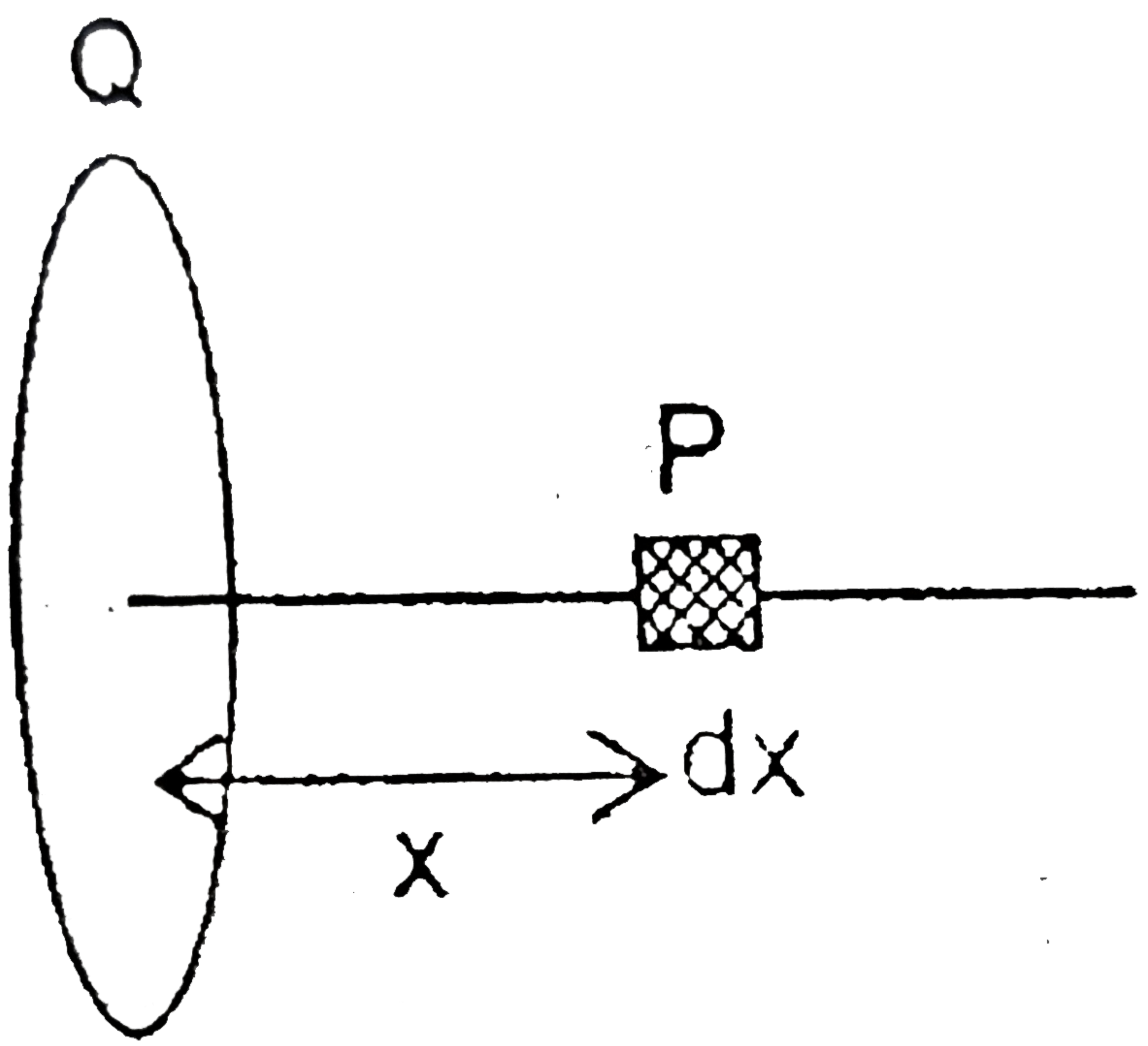
$$\Rightarrow \theta = \pi / 3$$

$$U = \frac{Q\lambda}{4\pi\varepsilon_0}$$

$$\int_0^{\pi / 3} \sec \theta d\theta$$

$$= \frac{Q\lambda}{4\pi\varepsilon_0}[\ln(\sec \theta + \tan \theta)]_0^{\pi / 3}$$

$$= \frac{Q\lambda}{4\pi\varepsilon_0}\ln\left(2 + \sqrt{3}\right)$$



Q-13 - 11963979

Assertion: Two charges q_1 and q_2 are placed at separation r. Then magnitude of the force on each charge is F.

Reason: Now a third charge q_3 is placed near q_1 and q_2. Then force on q_1 and q_2 remains F.

(A) if both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

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

(C) if Assertion is true, but the Reason is false.

(D) if both Assertion and Reason are false

CORRECT ANSWER: B

SOLUTION:

Force of interaction between two charges is independent of presence of other charges.

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Q-14 - 18248313

Three concentric metallic spherical shells of radii R, 2R, 3R are given charges $Q_1 Q_2 Q_3$, respectively. It is found that the surface charge densities on the outer surface of the shells are equal. Then, the ratio of the charges given to the shells $Q_1 : Q_2 : Q_3$ is

(A) $1:2:3$

(B) $1:3:5$

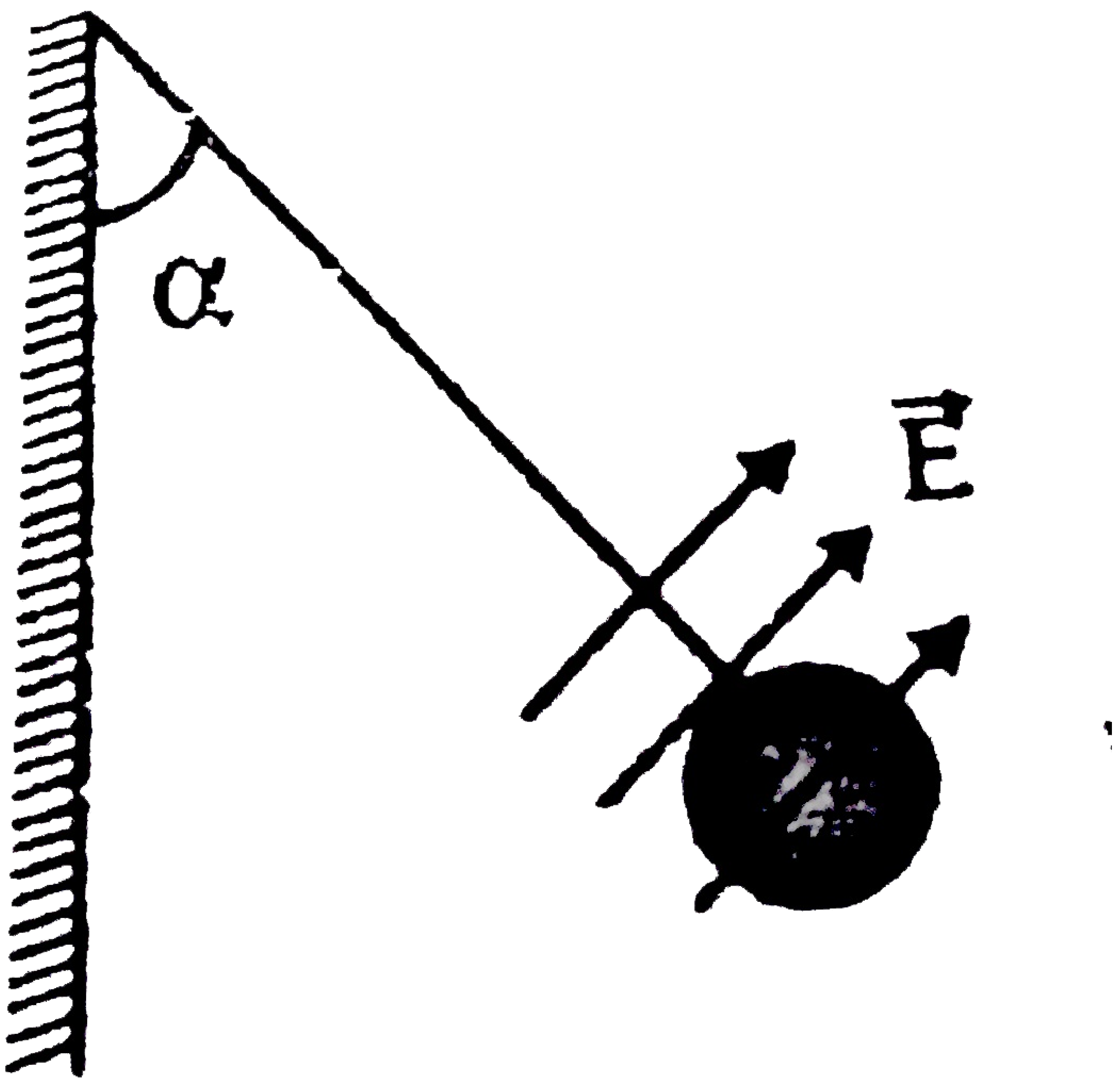
(C) $1:4:9$

(D) $1:8:18$

CORRECT ANSWER: B

Q-15 - 15088971

A charges cork of mass m suspended by a light stright is placed in uniform electric field strength $E = \left(\hat{i} + \hat{j}\right) \times 10^5 NC^{-1}$ as shown in the figure. If in equilibrium position tension in the string is $\dfrac{2mg}{\left(1+\sqrt{3}\right)}$ then angle $'\alpha'$ with the vertical is:



(A) 60°

(B) 30°

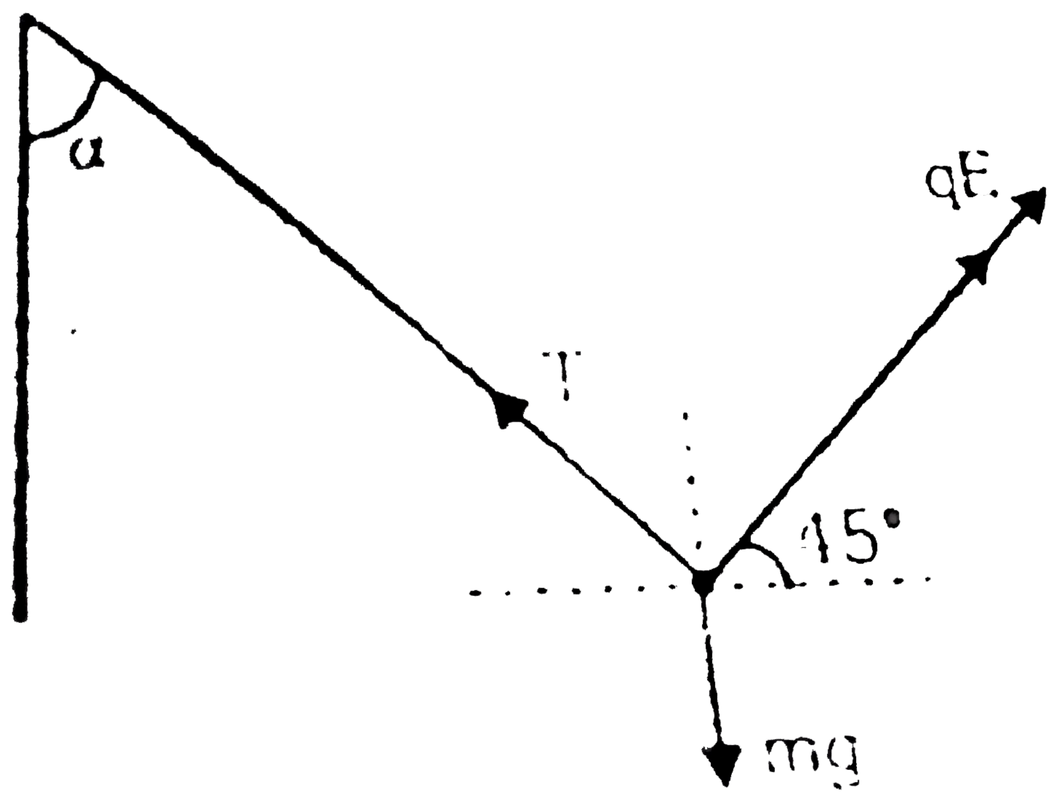
(C) 45°

(D) 18°

CORRECT ANSWER: A::B

SOLUTION:

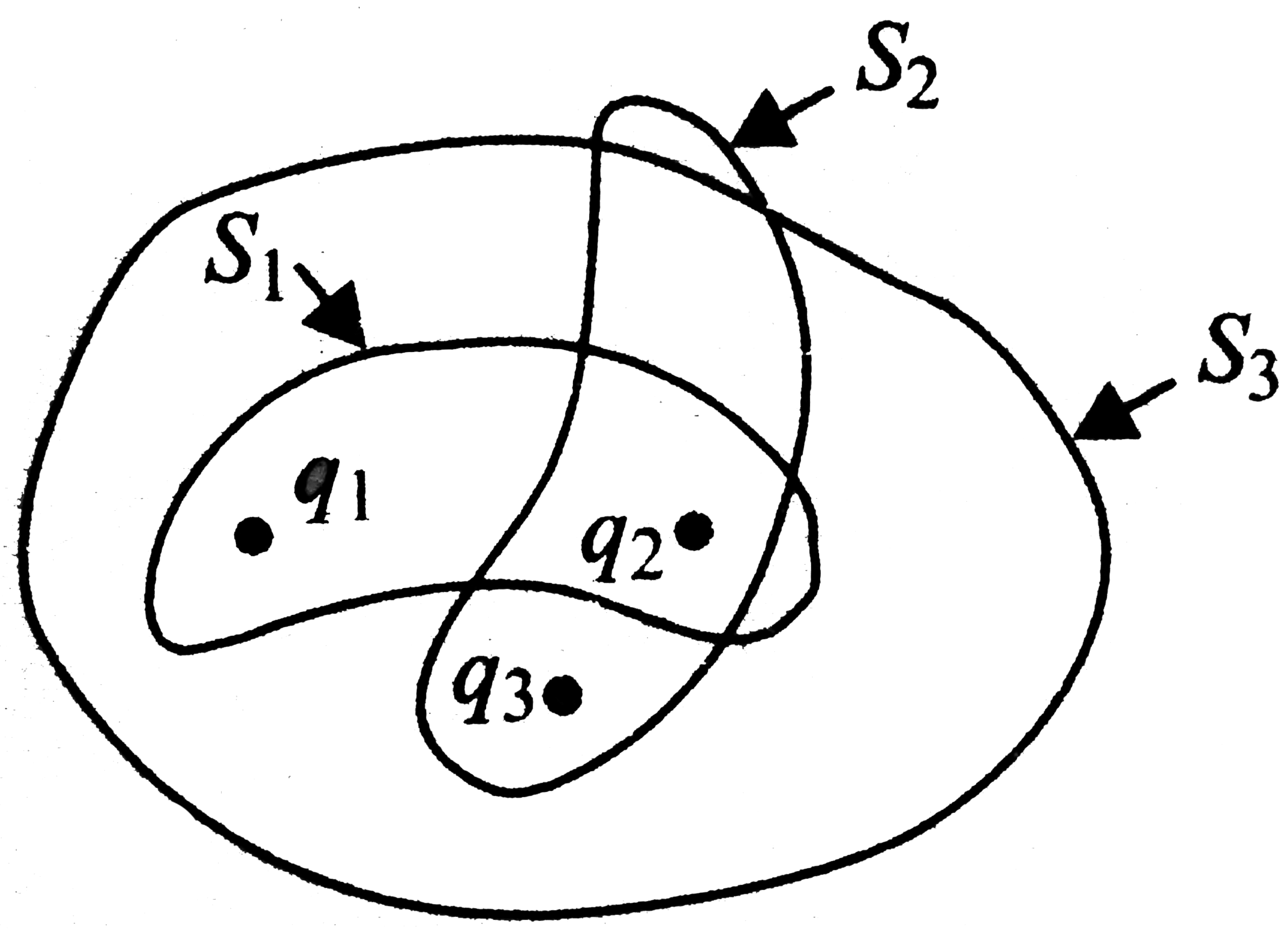
$T\sin\alpha = qE\cos 45$ and
$T\cos\alpha + qE\sin 45$
$= mg$



Q-16 - 11308504

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 figure. Then the net electric flux will be maximum for the surface



(A) S_1

(B) S_2

(C) S_3

(D) same of all three

CORRECT ANSWER: A

SOLUTION:

a. Charge inside S_1 = $q_1 + q_2 = 3 \times 10^{-6} C$

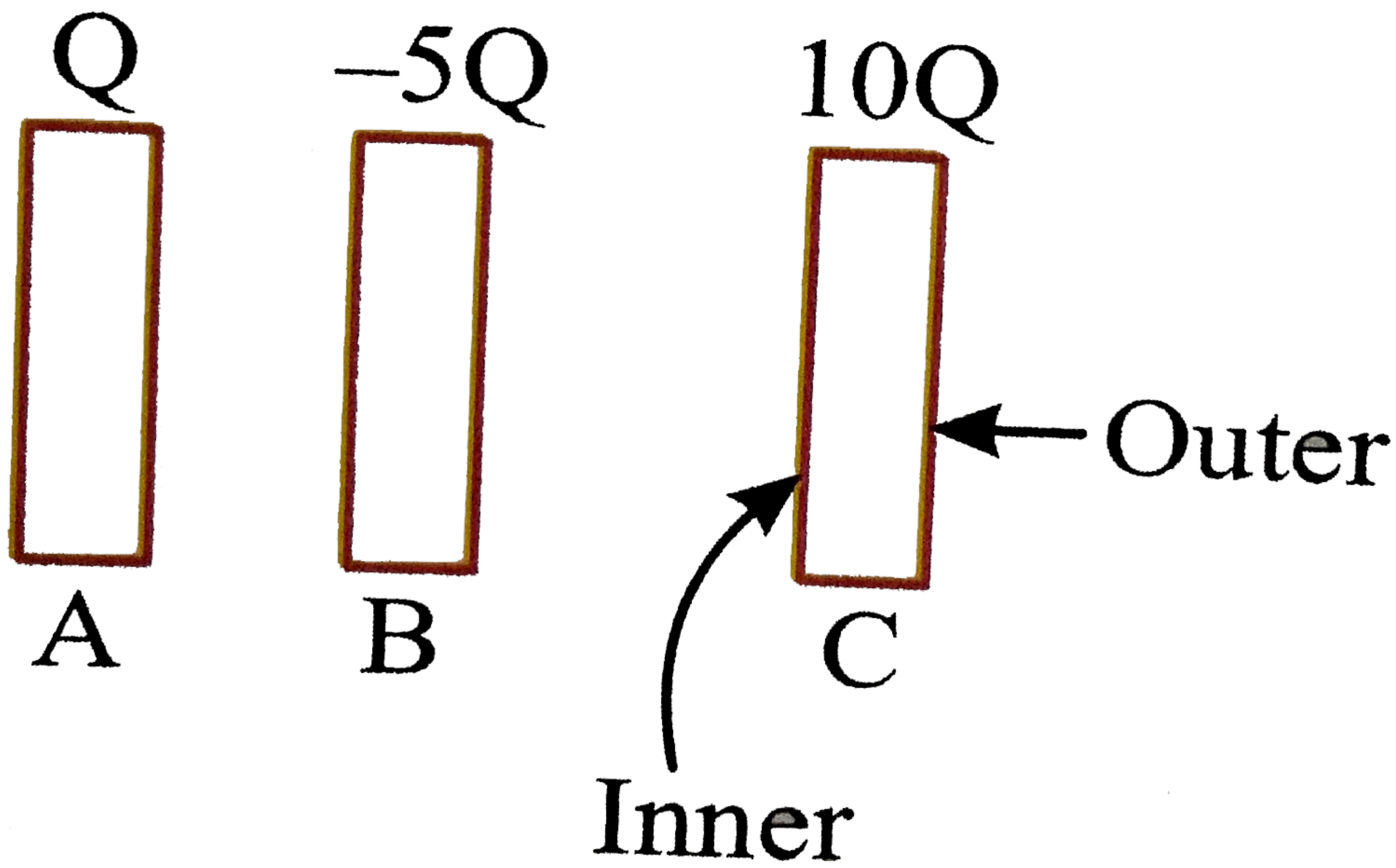
Charge inside S_2 =
$q_2 + q_3 = -1$
$\times 10^{-6} C$

Charge inside S_3 = 0

Charge inside S_1 is greatest. So, flux through S_1 is maximum.

Q-17 - 13656477

Three very large plate are given charges as shown in the figure, if the cross -sectional area of each plate is the same the final charge distribution on plate C is



(A) $+5Q$ on the linear surface ,$+5Q$ on the outer surface

(B) $+6Q$ on the inner surface ,$+4Q$ on the outer surface

(C) $+7Q$ on the inner surface ,+3Q on the outer surface

(D) $+8Q$ on the inner surface ,$+2Q$ on the outer surface

CORRECT ANSWER: 3

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Q-18 - 13157262

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

(A) $A\varepsilon_0 a^2$

(B) $4\pi\varepsilon_0 Aa^2$

(C) $\varepsilon_0 Aa^3$

(D) $4\pi\varepsilon_0 Aa^3$

CORRECT ANSWER: D

SOLUTION:

$$\phi = \frac{q_{in}}{\varepsilon_0}$$

$$(Aa)(4\pi a^2) = \frac{q_{in}}{\varepsilon_0}$$

$$q_{in} = 4\pi\varepsilon_0 A a^3$$

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Q-19 - 14797817

A sphere of radius R contains charge density $\rho(r) = A(R - r)$, for $0 < r < R$. The total electric charge inside the sphere is Q. The electric outside the sphere is $\left(k = \frac{1}{4\pi \in_0}\right)$

(A) $\frac{kQ}{r}$

(B) $\frac{kQ}{r^2}$

(C) $\frac{kQ}{r^2}$

(D) $\frac{kQ^2}{r^2}$

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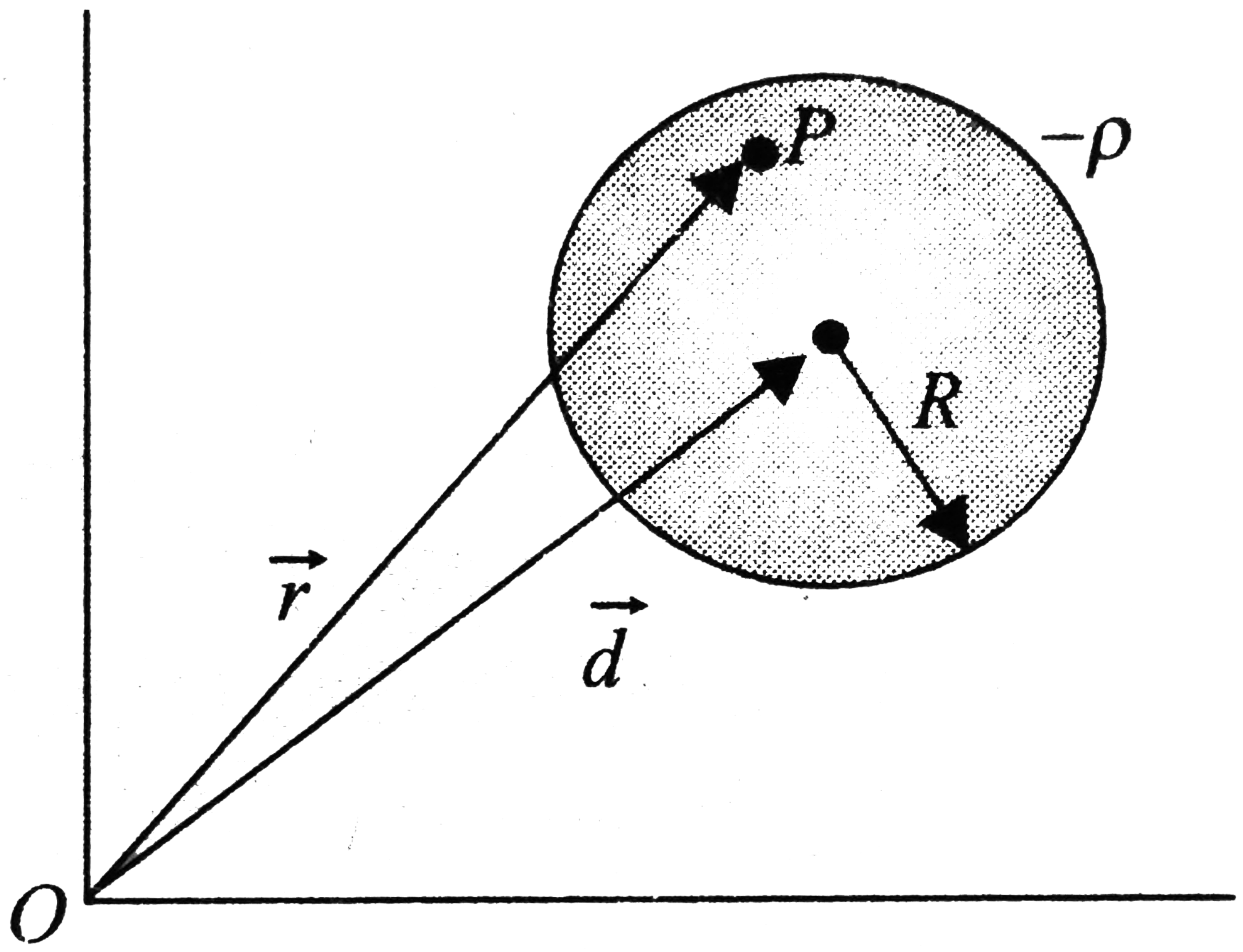
Q-20 - 11308517

A nonconducting sphere of radius R is filled with uniform volume charge density $-\rho$. The center of this sphere is displaced from the origin by $\overrightarrow{d}$. The electric field $\overrightarrow{E}$ at any point P having position vector inside the sphere is



(A) $\dfrac{\rho}{3\varepsilon_0}\overrightarrow{d}$

(B) $\frac{\rho}{3\varepsilon_0}\left(\overrightarrow{r} - \overrightarrow{d}\right)$

(C) $\frac{\rho}{3\varepsilon_0}\left(\overrightarrow{d} - \overrightarrow{r}\right)$

(D) $\frac{\rho}{3\varepsilon_0}\left(\overrightarrow{r}\right)$

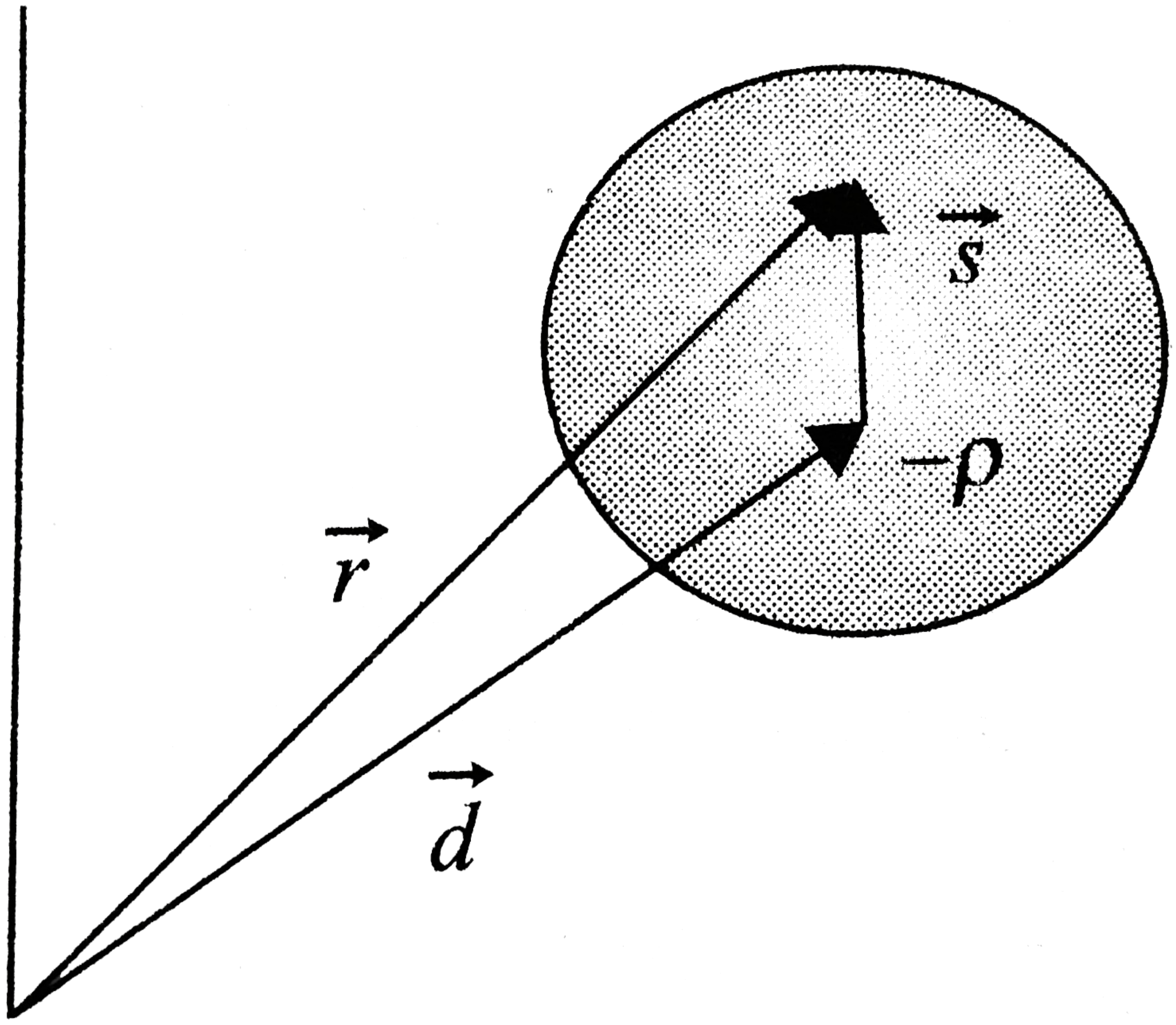
CORRECT ANSWER: C

SOLUTION:

$$\overrightarrow{E_P} = \frac{-\rho}{3\varepsilon_0}\overrightarrow{s} =$$

$$-\frac{\rho}{3\varepsilon_0}\left(\overrightarrow{r} - \overrightarrow{d}\right)$$

$$= \frac{\rho}{3\varepsilon_0}\left(\overrightarrow{d} - \overrightarrow{r}\right)$$



Q-21 - 16113234

The electric field in a region is radially outwards with magnitude $E = \alpha r / \varepsilon_0$. IN a sphere of radius R centered at the origin, calculate the value of charge in coulombs $\alpha = \frac{5}{\pi}$ if V / m^2 and $R = \left(\frac{3}{10}\right)^{1/3} m.$

CORRECT ANSWER: 6

SOLUTION:

$$q = \varepsilon_0 \oint E.\, ds$$

$$= \varepsilon_0 \frac{\alpha r}{\varepsilon_0} 4\pi r^2 = 4\pi r^3 \alpha$$

$$= 6$$

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Q-22 - 13656637

Statement -1:The potential of an unchanged conducting sphere of radius R for a point charge q located at a distance r from its centre $(r > R)$ is $\frac{q}{4\pi\varepsilon_0 r}$ Statement 2: Electric field intensity inside the conductor is zero therefore potential at each point on the conductor is zero.

CORRECT ANSWER: C

SOLUTION:

Apply the concept of electric image.

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Q-23 - 14797227

For spherical symmetrical charge distribution, variation of electric potential with distance from centre is given in diagram Given that :

$V=\frac{q}{4\pi\varepsilon_0 R_0}$ for $r \leq R_0$ and $V=\frac{q}{4\pi\varepsilon_0 r}$ for $r \geq R_0$

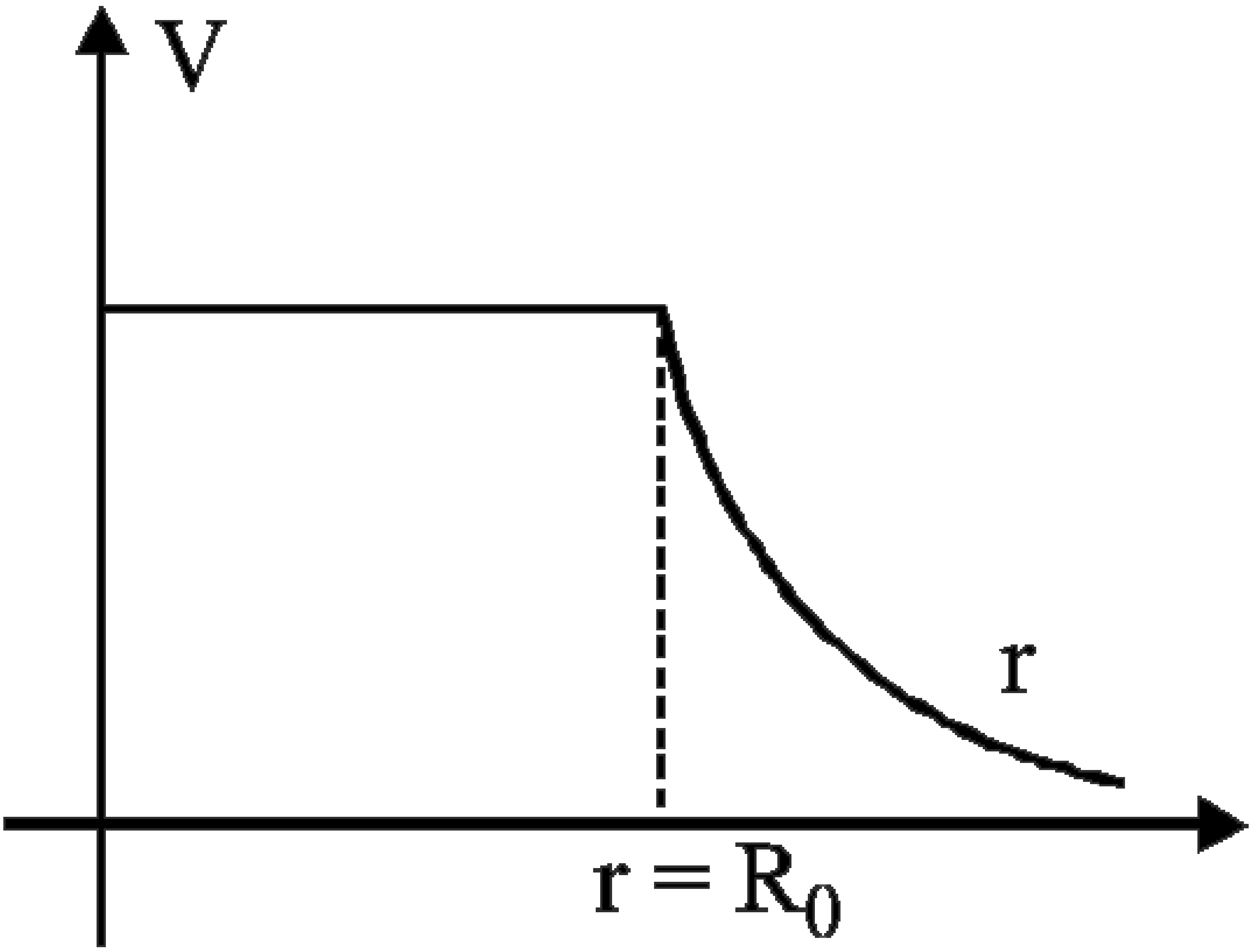
Then which option (s) are correct :

(1) Total charge within $2R_0$ is q

(2) Total electrosstatic energy for $r \leq R_0$ is non-zero

(3) At $r=R_0$ electric field is discontinuous

(4) There will be no charge anywhere except at $r < R_0$



(A) 1,2 and 3 are correct

(B) 1 and 2 are correct

(C) 2 and 4 are correct

(D) 1 and 3 are correct

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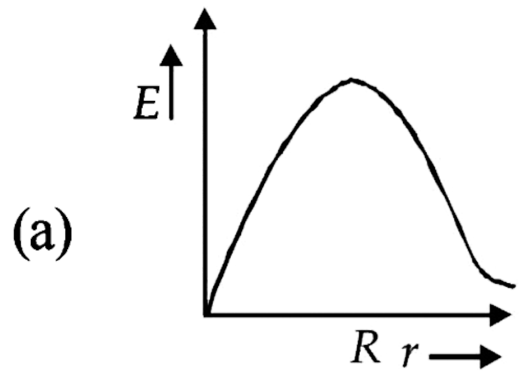
Q-24 - 10059699

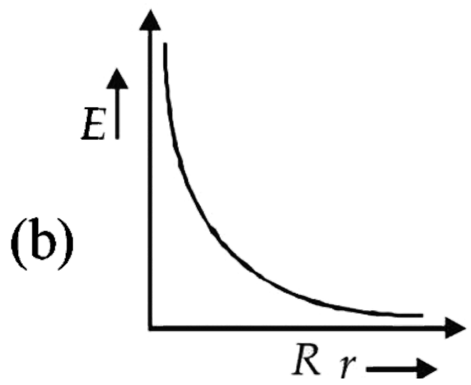
In a uniformly charged sphere of total charge Q and radius R, the electric field E is plotted as function of distance from the centre,

The graph which would correspond to the above will be:

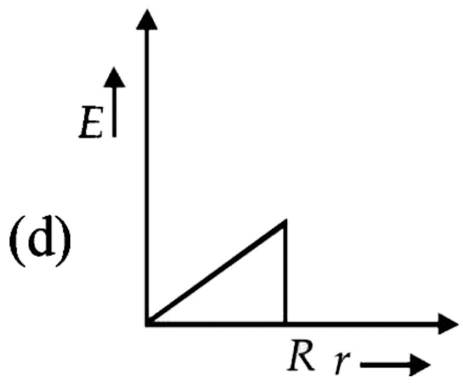
(A) (a)



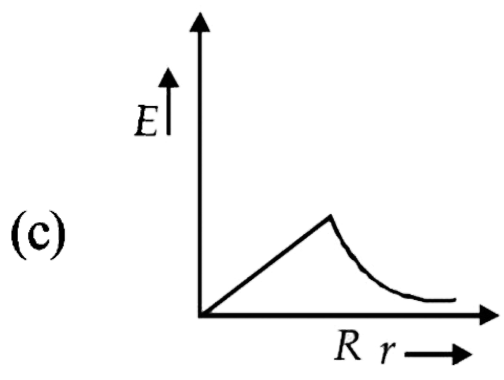
(B) (b)



(C) (c)



(D) (d)



CORRECT ANSWER: C

SOLUTION:

$E_{in} \propto r$

$$E_{out} \propto \frac{1}{r^2}$$

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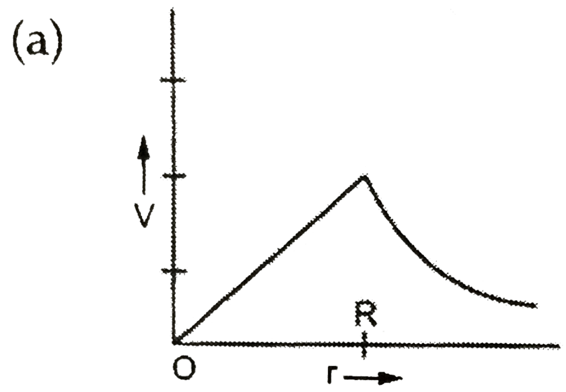
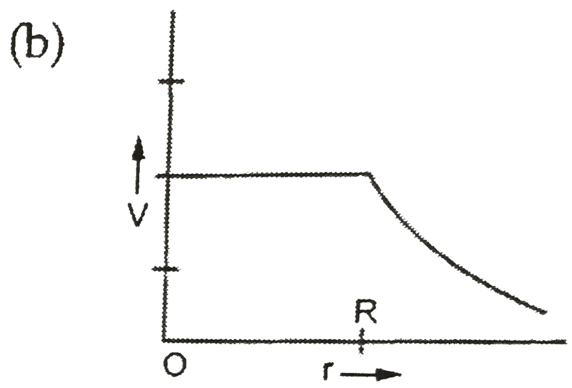
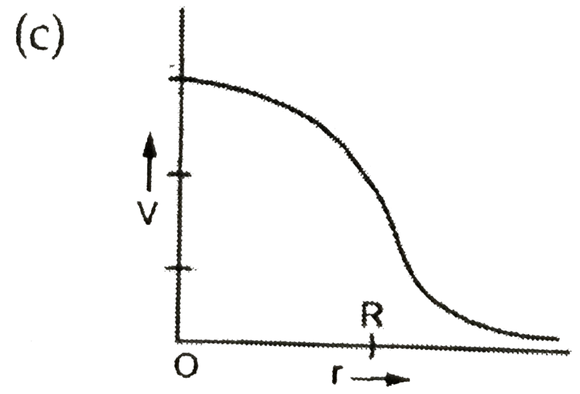
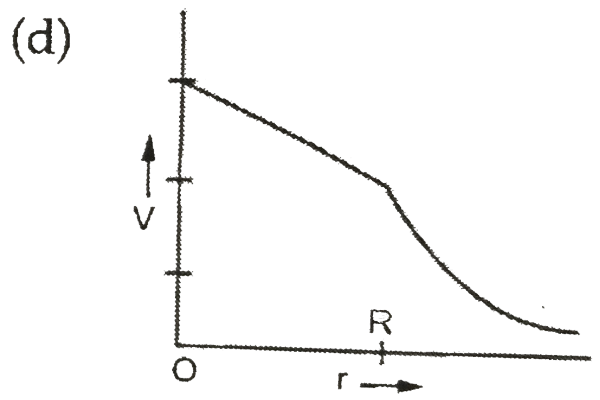
Q-25 - 17244254

A solid sphere of radius R is charged uniformly. The electrostatic potential V is plotted as a function of distance r from the centre of th sphere. Which of the following best represents the resulting curve?

(A) 

(B) 

(C) 

(D) 

CORRECT ANSWER: C

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Q-26 - 10967045

Find the electric field at the centre of a uniformly charged semicircular ring of radius R. Linear charge density is λ

CORRECT ANSWER: A::B::D

SOLUTION:

$$E_{\text{net}} = 2\int_{0}^{90^{\square}} dE\sin\theta$$

$$= 2$$

$$\int_{0}^{90^{\square}} \left(\frac{1}{4\pi\varepsilon_0}\left(\frac{dq}{R^2}\right)\sin\theta\right.$$

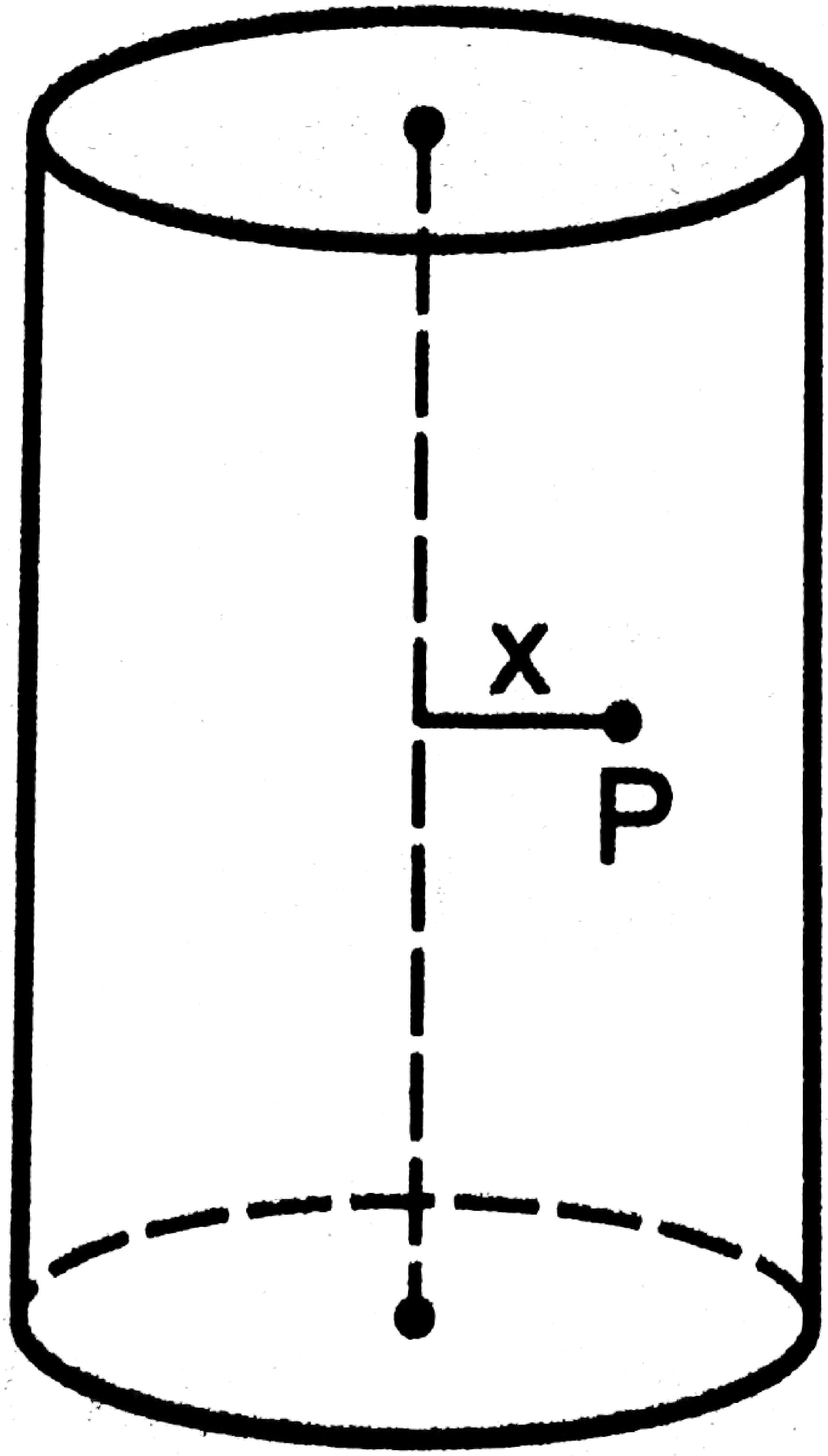
$$2$$

$$\int_{0}^{90^{\square}} \left(\frac{1}{4\pi\varepsilon_0}\right)\left(\frac{\lambda R dth\eta}{R^2}\right.$$

$$\left.\right)\sin\theta = \frac{\lambda}{2\pi\varepsilon_0 R}$$

Q-27 - 9726199

A long cylindrical volume contains a uniformly distributed charge of dendity ρ. Find the electric field at a point P inside the cylindrical volume at a distance x from its axis (figure 30-E5) ,



SOLUTION:

Charge on the cylinder of radius x

$$= \rho\pi\left(x^2\right)h$$

We know,

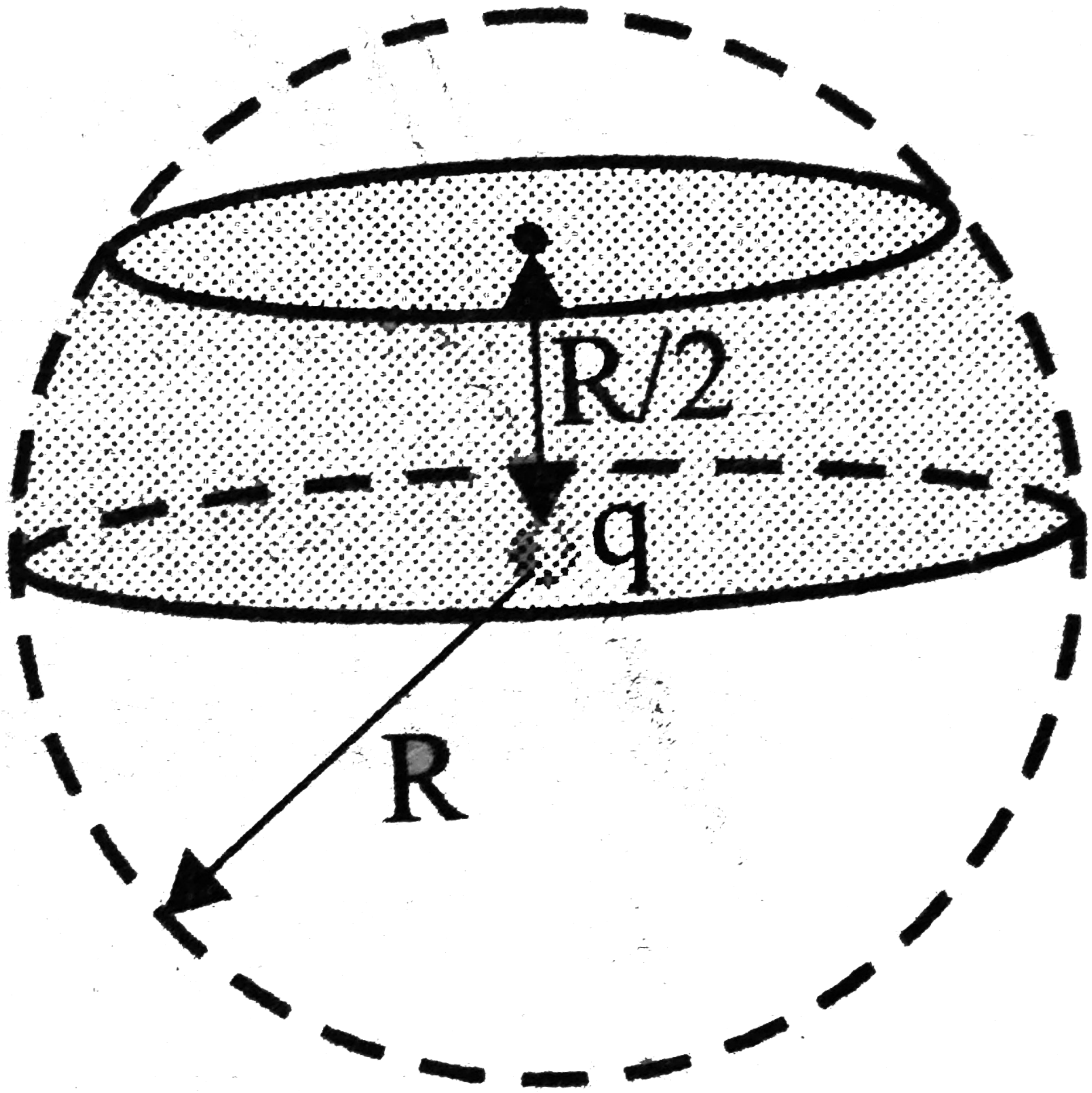
$$\oint E.\,ds = \frac{q}{\varepsilon_0}$$

$$E.2\pi xh = \left(\pi\rho\left(x^2\right)\frac{h}{\varepsilon_0}\right) \text{ or}$$

E= rhox / 2 epsilon_0`.

Q-28 - 11308522

Flux passing through the shaded surface of a sphere when a point charge q is placed at the center is (radius of the sphere is R)



(A) $\frac{q}{\varepsilon_0}$

(B) $\frac{q}{2}\varepsilon_0$

(C) $\frac{q}{4}\varepsilon_0$

(D) zero

CORRECT ANSWER: C

SOLUTION:

c. $\alpha = 60$. Solid angle subtended by BCD is

$\omega = 2\pi(1 - \cos\alpha)$

$= \pi$

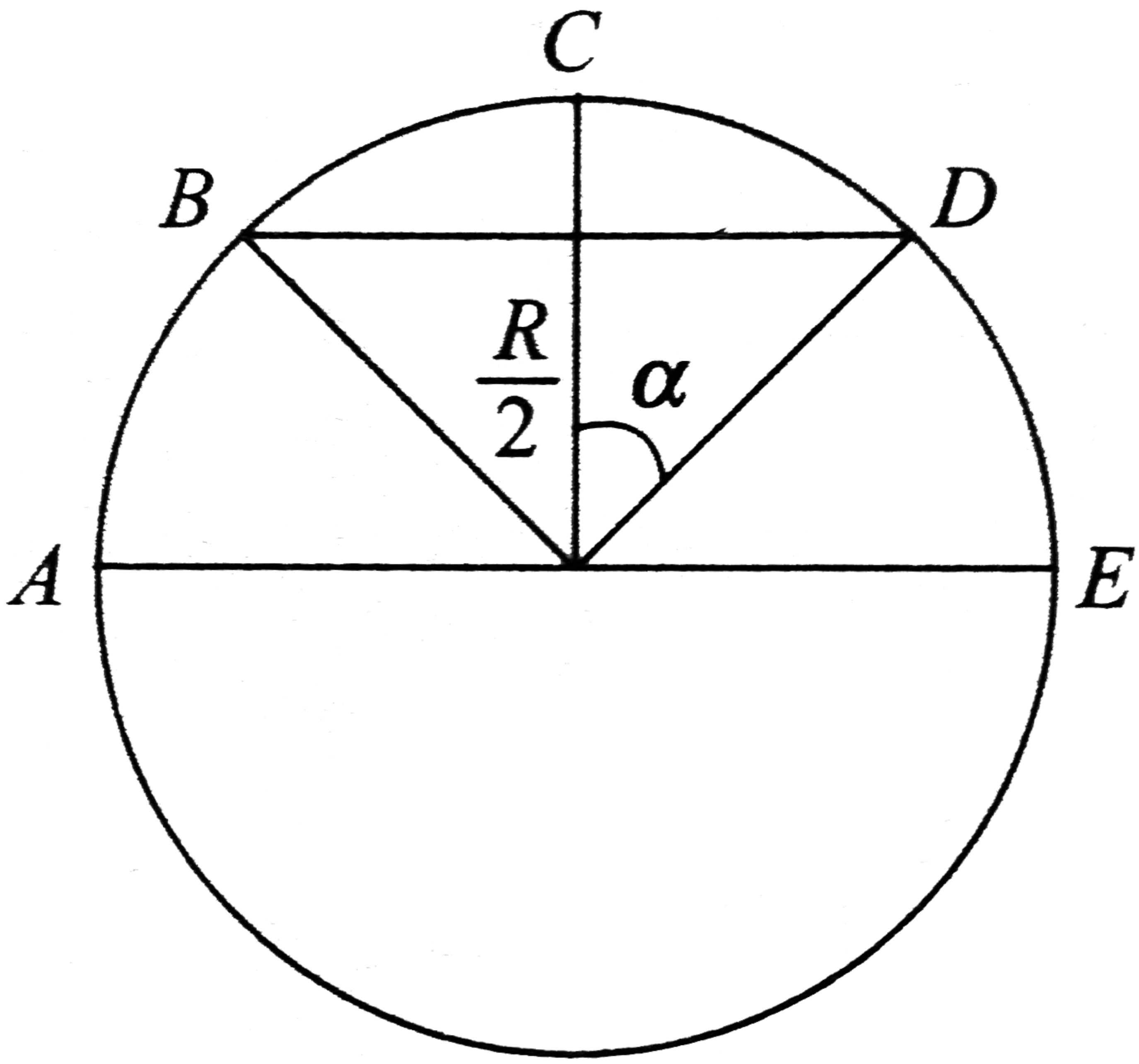
Solid angle subtended by ABDE is

$\omega_{ABCDE} - \omega_{BCD} = 2\pi$

$- \pi = \pi$

Hence, flux through ABDE is

$\phi = \dfrac{q}{\varepsilon_0}\dfrac{\pi}{4\pi} = \dfrac{q}{4\varepsilon_0}$



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Q-29 - 15089032

Statement-1: When a charged particle is placed in the cavity in a conducting sphere, the induced charge on the outer surface of the sphere is found to be uniformly distributed.

Statement-2 : Conducting surface is equipotential surface.

(A) Statement-1 is True, Statement-2 is True, Statement-2 is a cor.

(B) Statement-1 is True, Statement-2 is True, Statement-2 is not a

(C) Statement-1 is False, Statement-2 is True

(D) Statement-1 is True, Statement-2 is False.

CORRECT ANSWER: A

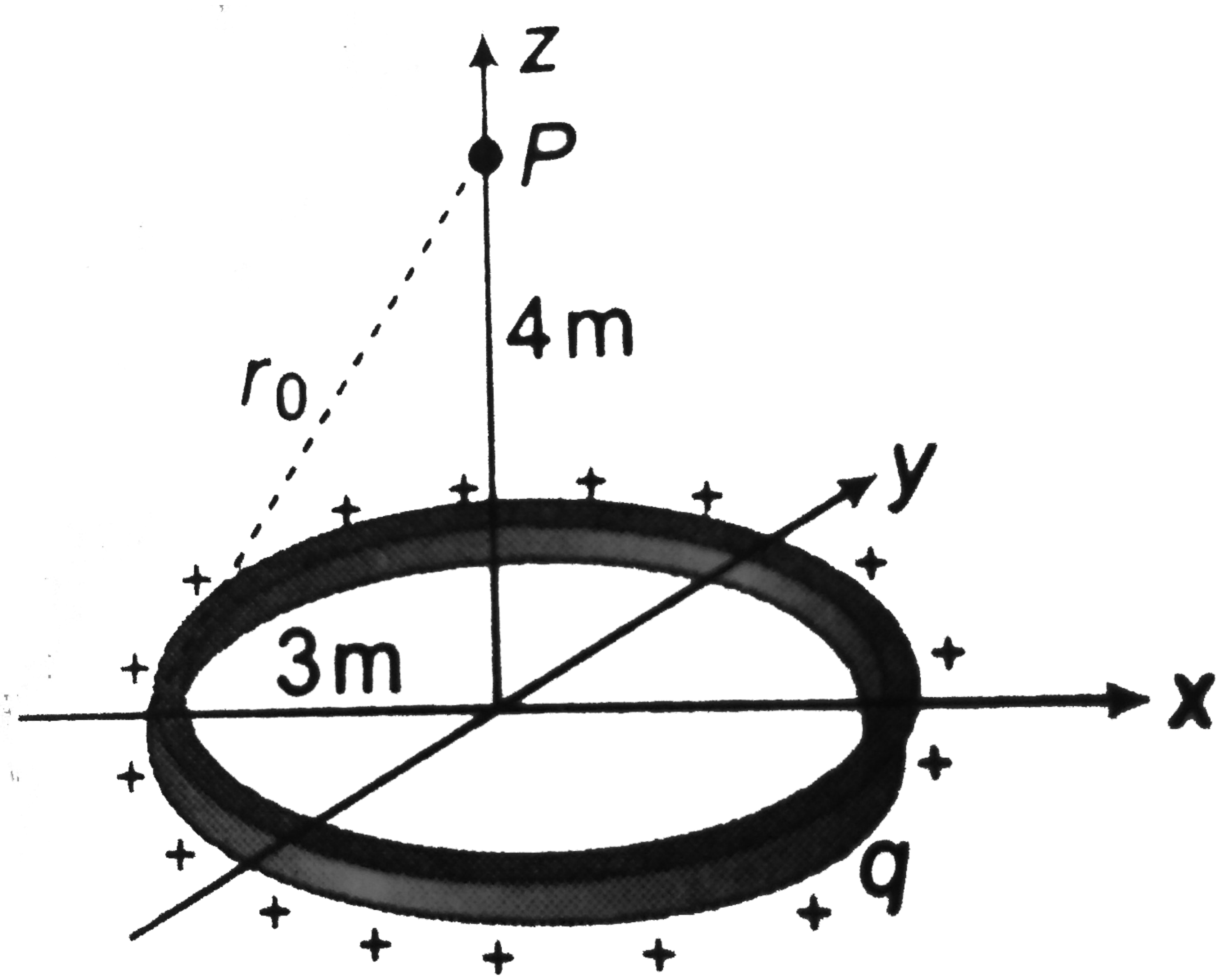
Q-30 - 10966889

A charge $q = 10\mu C$ is distributed uniformly over the circumference of a ring of radius 3m placed on x-y placed with its centre art origin. Find the electric potential at a point $P(0, 0, 4m)$

CORRECT ANSWER: A::D

SOLUTION:

The electric potential at point P would be



$$V=\frac{1}{4\pi\varepsilon_0}.\frac{q}{r_0}$$

Here, $r_0 =$ distance of point P from the circumference

of ring

$$=\sqrt{(3)^2+(4)^2}$$
$$=5m$$

and q=10muC=10^-5C

$Substitut \in gthevalueswehave$

V=((9.0xx10^9)(10^-5))/((5.0))=1.8xx10^4V`

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Q-31 - 12297262

If the electric field is given by $\overrightarrow{E} = 8\hat{i} + 4\hat{j} + 3\hat{k}NC^{-1}$, calculate the electric flux through a surface of area $100m^2$ lying in X-Y plane.

CORRECT ANSWER: $300NM^2C^{-1}$

SOLUTION:

$$\overrightarrow{E} = 8\hat{i} + 4\hat{j} + 3\hat{k}NC^{-1}, \overrightarrow{S} = 100\hat{k}m^2$$

$$\phi_E = \overrightarrow{E} . Vec(S)$$

$$= \left(8\hat{i} + 4\hat{j} + 3\hat{k}\right)$$

$$- \left(100\hat{k}\right)$$

$$= 300 Nm^2 C^{-1}$$

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Q-32 - 19037671

A point charge Q is placed at the centre of a hemisphere. Find the ratio of electric flux passing through curved andplane surface of the hemisphere.

(A) $1:1$

(B) $1:2$

(C) $2\pi:1$

(D) $4\pi:1$

Q-33 - 9726151

A uniform electric field of magnitude $E = 100 NC^{-1}$ exists in the space in x-direction. Calculate the flux of this field through a plane square of edga 10 cm placed in the y-z plane. Take the normal along the positive x-axis to be positive.

SOLUTION:

The Flux $\Phi = \int E \cos \theta dS$. As the normal to the area point along the electric field, $\theta = 0$. Also, E is unifrom, so

$\Phi = E \Delta S$

$= (100 NC^{-1})(0.10m$

$)^2 = 1.0 Nm^2 C^{-1}$

.

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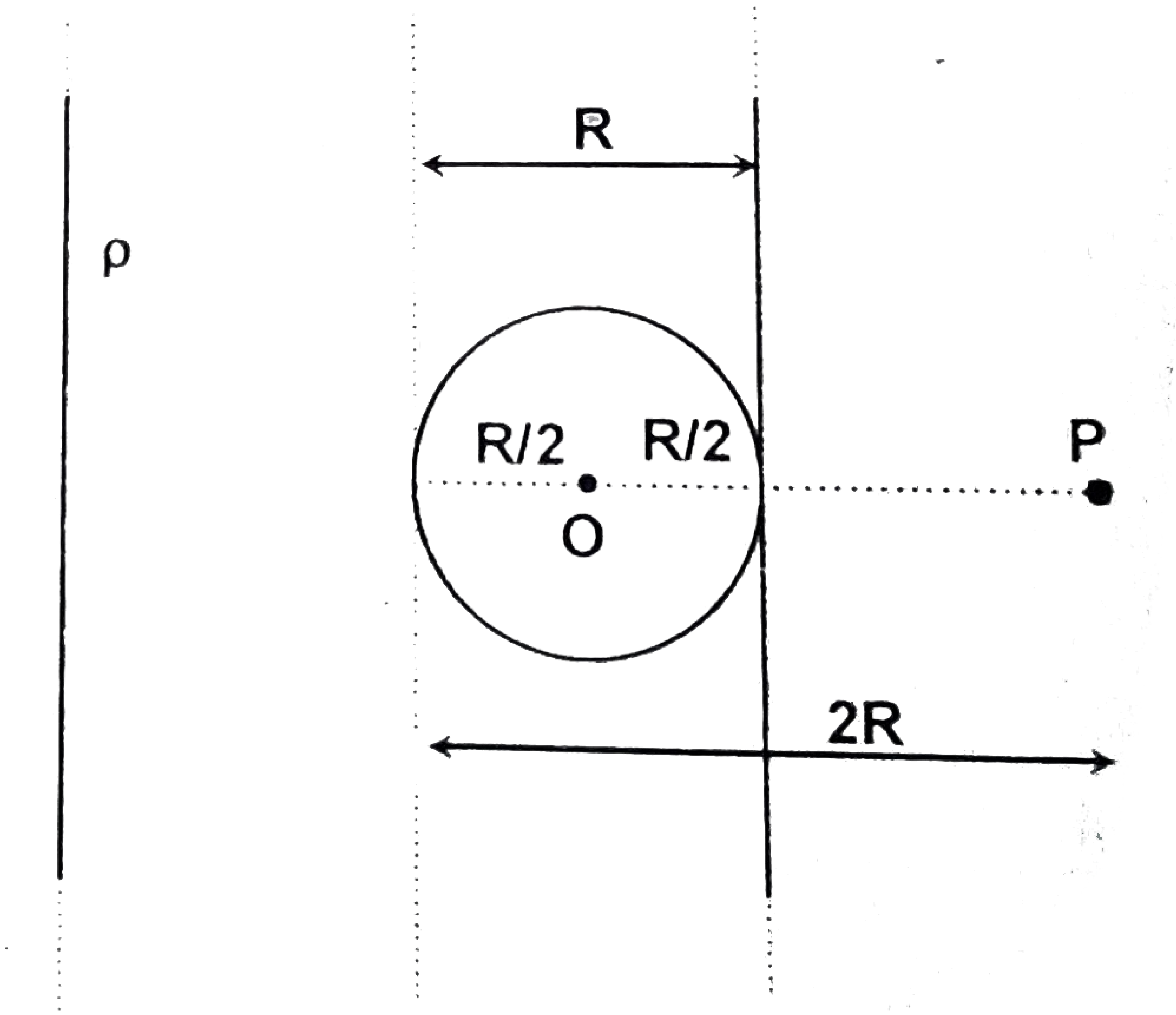
Q-34 - 14278183

Inside a uniformly charged infinitely long cylinder of radius 'R' and volume charge density 'rho' there is a spherical cavity of radius 'R//2'. A point 'P' is located at a dsintance $2R$ from the axis of the cylinder as shown. Then the electric field strength at the point 'P' is



(A) $\dfrac{23rhpR}{54\varepsilon_0}$

(B) $\dfrac{23rhpR}{108\varepsilon_0}$

(C) $\dfrac{25\rho R}{54\varepsilon_0}$

(D) $\dfrac{25\rho R}{108\varepsilon_0}$

CORRECT ANSWER: D

SOLUTION:

The electric field strength at point 'P' is

$$E = E_1 - E_2$$

$$= \frac{\rho R}{4\varepsilon_0} - \frac{\rho R}{54\varepsilon_0}$$

$$E = \frac{25\rho R}{108\varepsilon_0}$$

Q-35 - 16537202

A dielectric slab of thickness d is inserted in a parallel plate capacitor whose negative plate is at $x = 0$ and positive plate is at $x = 3d$. The slab is equidistant from the plates. The capacitor is given some charge. As one goes from 0 to $3d$:

(A) The magnitude of the electric field remains the same

(B) The direction of the electric field remains the same

(C) The electric potential increases continuously

(D) The electric potential increases at first, then decreases and again increases

---

CORRECT ANSWER: B::C

Q-36 - 15088707

An electric field is given by $\overrightarrow{E} = \left(y\hat{i} + x\hat{j}\right)\frac{N}{C}$. Find the work done (in J) in moving a $1C$ charge from $\overrightarrow{r}_A = \left(2\hat{i} + 2\hat{j}\right)$ m to

$\vec{r}_B = \left(4\hat{i} + \hat{j}\right)m.$

CORRECT ANSWER: 0

SOLUTION:

$A = (2, 2)$ and

$B = (4, 1), W_{A \to B}$

$= q(V_B - V_A) = q$

$\int_A^B dV = -\int_A^B q\vec{E} \,.\, d\vec{r}$

$= q$

$\int_A^B$

(yhat(i)+xhat(j)).(dxhat(i)+dyhat(j))=qunderset(A

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Q-37 - 11964090

A hollow metal sphere of radius $5cm$ is charged so that the potential on its surface is $10V$. The potential at the centre of the sphere is

(A) $0V$

(B) $10V$

(C) same as at point $5cm$ away from the surface

(D) same as at point $25cm$ away from the surface

CORRECT ANSWER: B

SOLUTION:

Since potential inside the hollow sphere is same as that on the surface.

Q-38 - 14528147

Time constant of a C-R circuit is $\frac{2}{\ln(2)}$ second. Capacitor is discharged at time $t = 0$. The ratio of charge on the capacitor at time $t = 2s$ and $t = 6s$ is

(A) $3:1$

(B) $8:1$

(C) $4:1$

(D) $2:1$

CORRECT ANSWER: C

SOLUTION:

$q = q_0 e^{-t/c}$

at

$t = 2\sec \Rightarrow q_1$

$= q_0 e^{\frac{2}{2/\ln^2}} = \frac{q_0}{2}$

at t=6 sec

$$\Rightarrow q_1 q_0 e^{\frac{2}{2/\ln^2}} e^{\frac{6}{2/\ln^2}}$$

$$= \frac{q_0}{8} \Rightarrow q_1 : q_2 : : 4 : 1$$

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Q-39 - 10967264

A capacitor of capacitance C is given a charge go. At time $t = 0$, it is connected to a battery of emf E through a resistance R. Find the charge on the capacitor at time t.

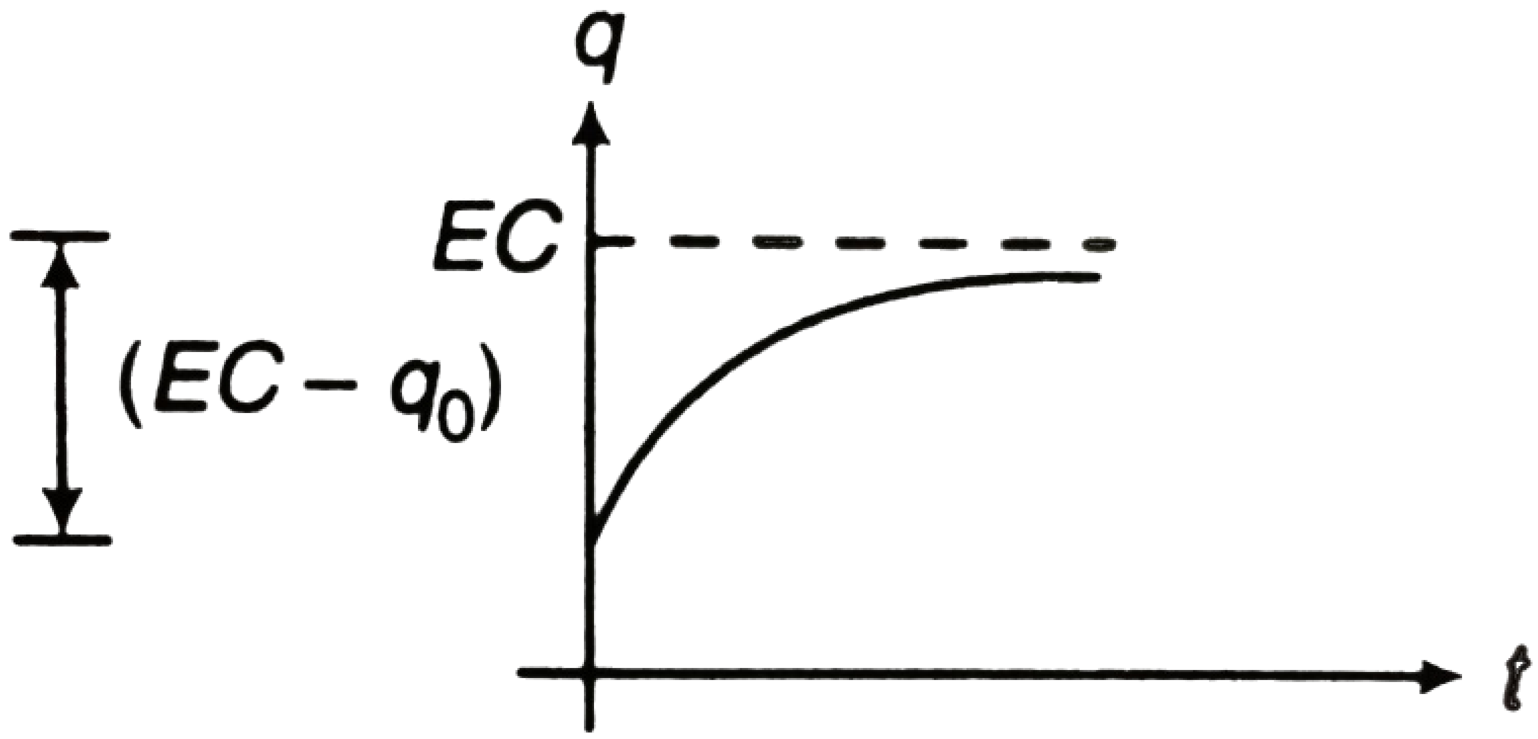
CORRECT ANSWER: C

SOLUTION:

$q_i = q_0$

$q_f = EC$

Now, charge on capacitor change from q_i to q_f exponentially.



$$\therefore q = q_0 + (EC - q_0)\left(1 - e^{-\frac{1}{\tau_C}}\right)$$

$$= EC\left(1 - e^{-\frac{t}{\tau_C}} + q_0 e^{-\frac{t}{\tau_C}}\right)$$

Here $\tau_C = CR$

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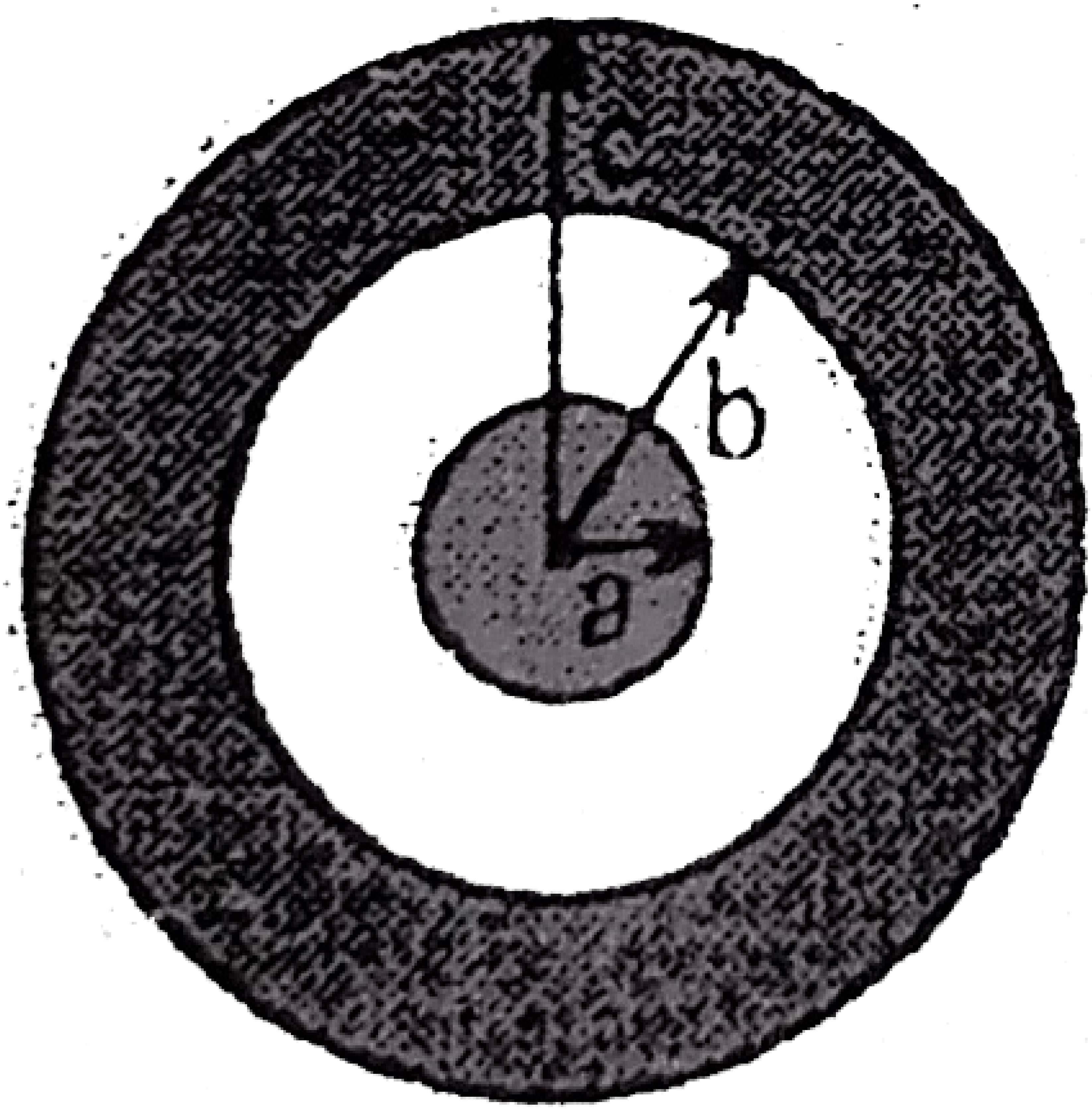
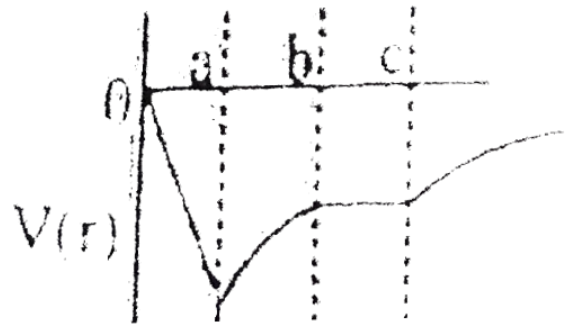
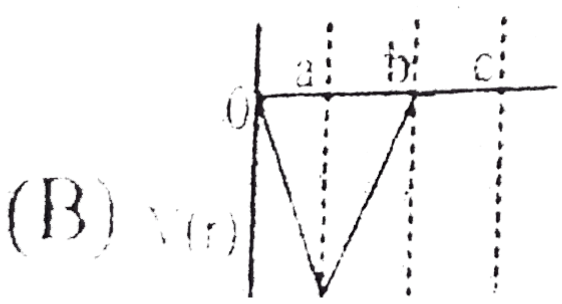
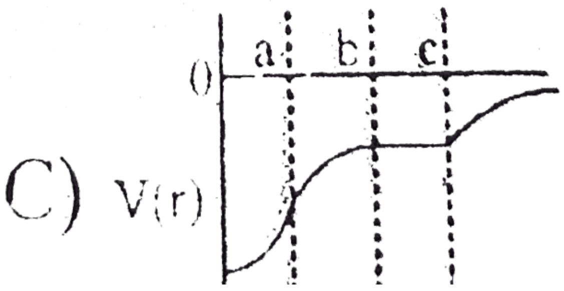
Q-40 - 15511435

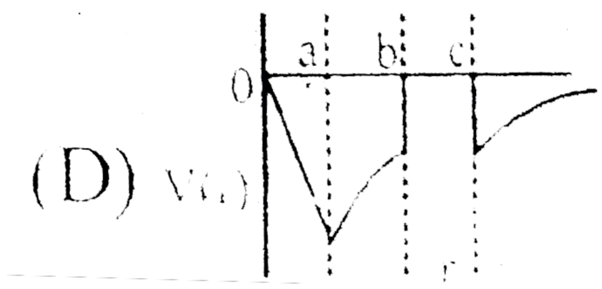
A nonconducting sphere with radius a is concentric with and surrounded by a conducting spherical shell with inner radius b and outer radius c. The inner sphere has a negative charge uniformly distributed throughout its volume, while the spherical shell has no net charge. The potential V (r) as a function of distance from the center is given by



(A) 

(B) 

(C) 

(D) 

CORRECT ANSWER: C

SOLUTION:

for $r \leq a$

$$V = \frac{KQ\left(3a^2 - r^2\right)}{2a^3}$$

$$+ \frac{K(-Q)}{b} + \frac{KQ}{c}$$

$f \text{ or } a \le r \le b$

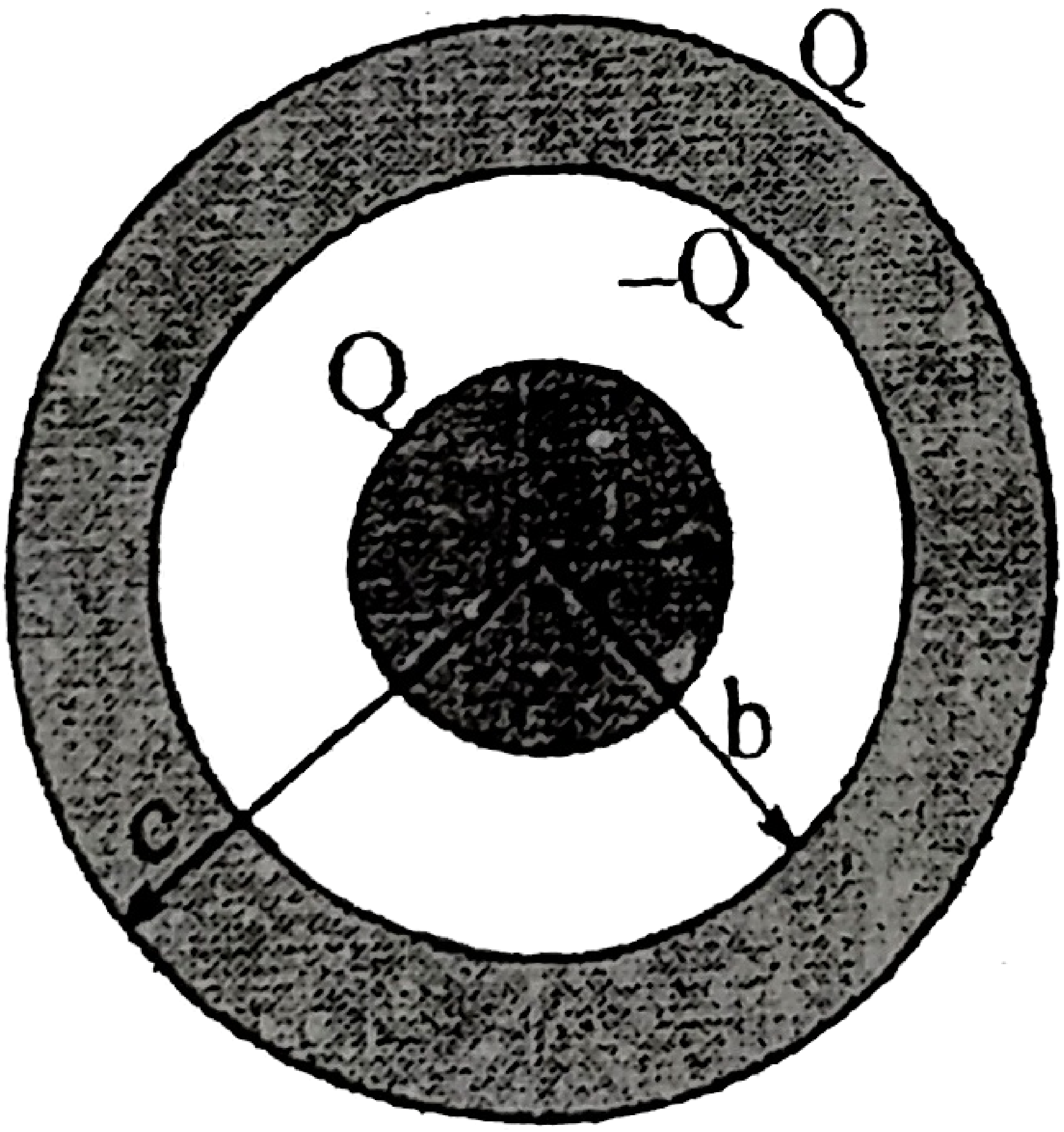
$$V = \frac{KQ}{r} + \frac{K(-Q)}{b} + \frac{KQ}{c}$$

$f \text{ or } b \le r \le c$

$$V = \frac{KQ}{r} + \frac{K(-Q)}{b} + \frac{KQ}{c} = \frac{KQ}{c}$$

$f \text{ or } r \le c$

$$V = \frac{KQ}{r} + \frac{k(-Q)}{r} + \frac{kQ}{r} = \frac{kQ}{r}$$



Q-41 - 14528812

A solid conducting sphere of radius a is enclosed in a concentric shell of radius $b > a$. The charge on the inner sphere is $3\mu C$ and on the conducting shell is $-10\mu C$. The potential difference between the conductors is V. If $+10\mu C$ additional charge is given to the outer shell, the new potential difference is

(A) V

(B) V/2

(C) 2V

(D) zero

CORRECT ANSWER: A

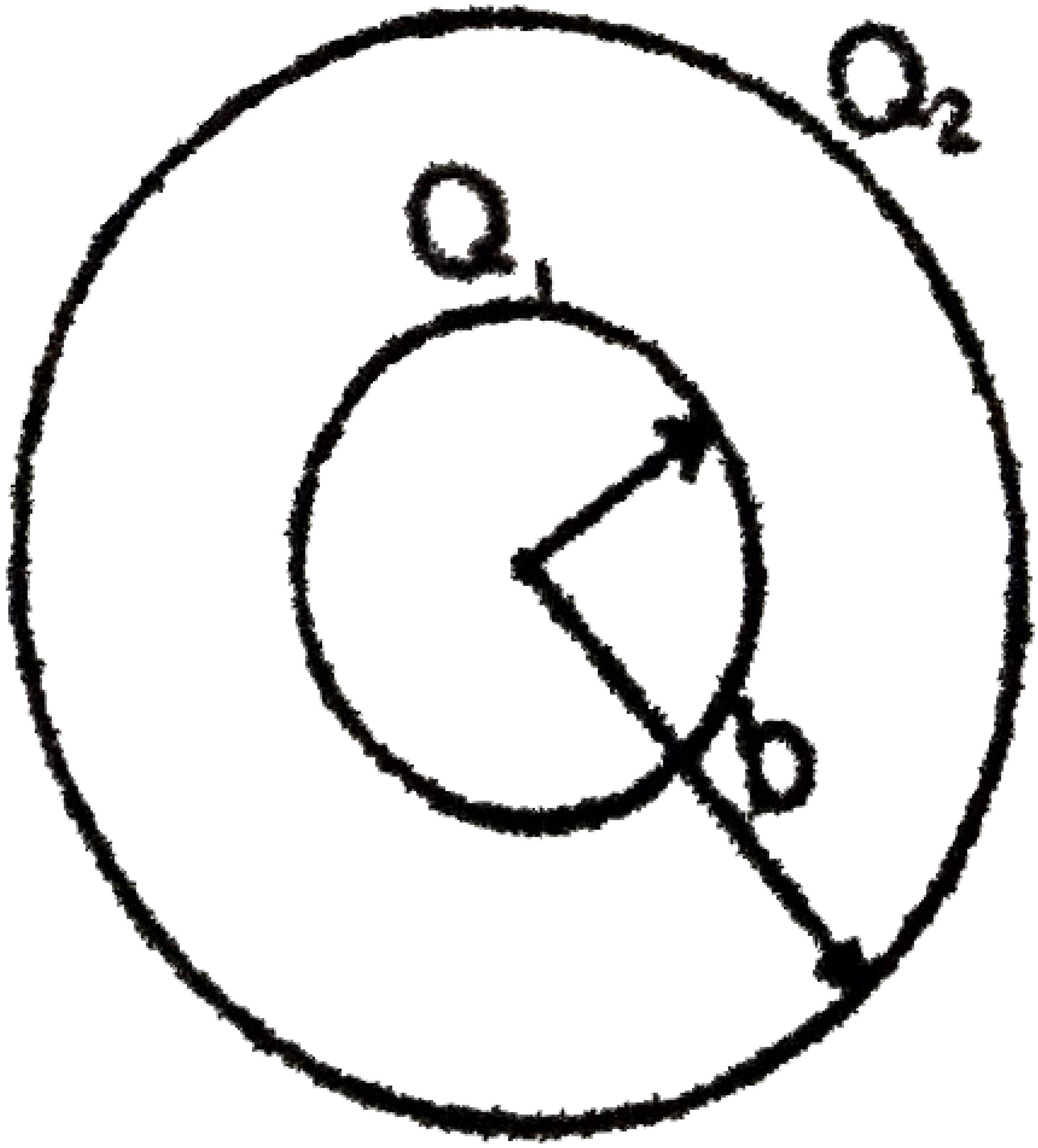
SOLUTION:

The potential difference between and the two conductors

$$\Delta V = \frac{Q_1}{4\pi\varepsilon_0}\left(\frac{1}{a} - \frac{1}{b}\right)$$

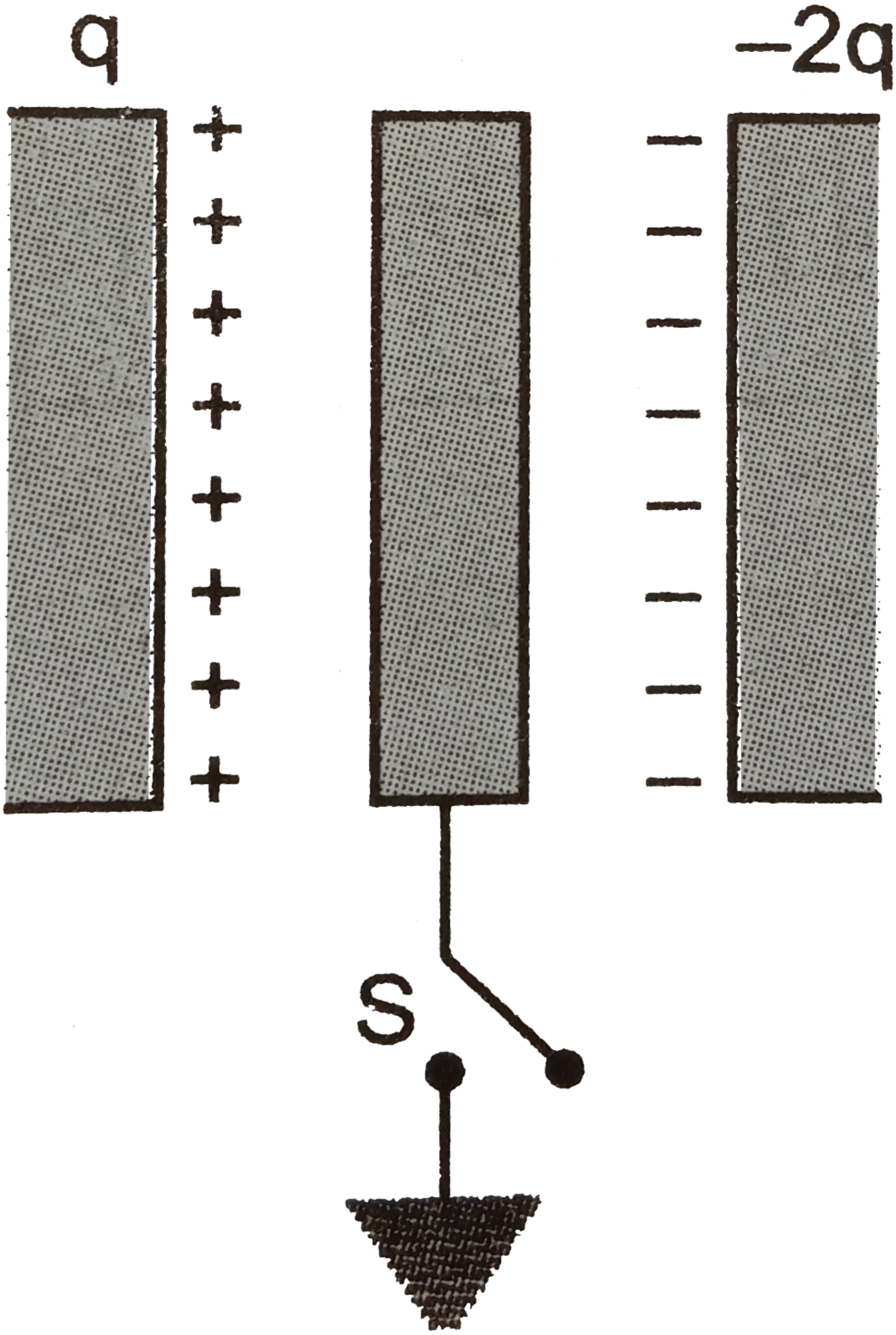
is independent of the charge on the outer shell.

$\therefore$ potential difference will remain same.



Q-42 - 12297518

The metal plate on the left in Fig, carries a charge $+q$. The metal plate on the right has a charge of $-2q$. What charge will flow through S when it is closed if the central plate is initially neutral ?



(A) zero

(B) $-q$

(C) $+q$

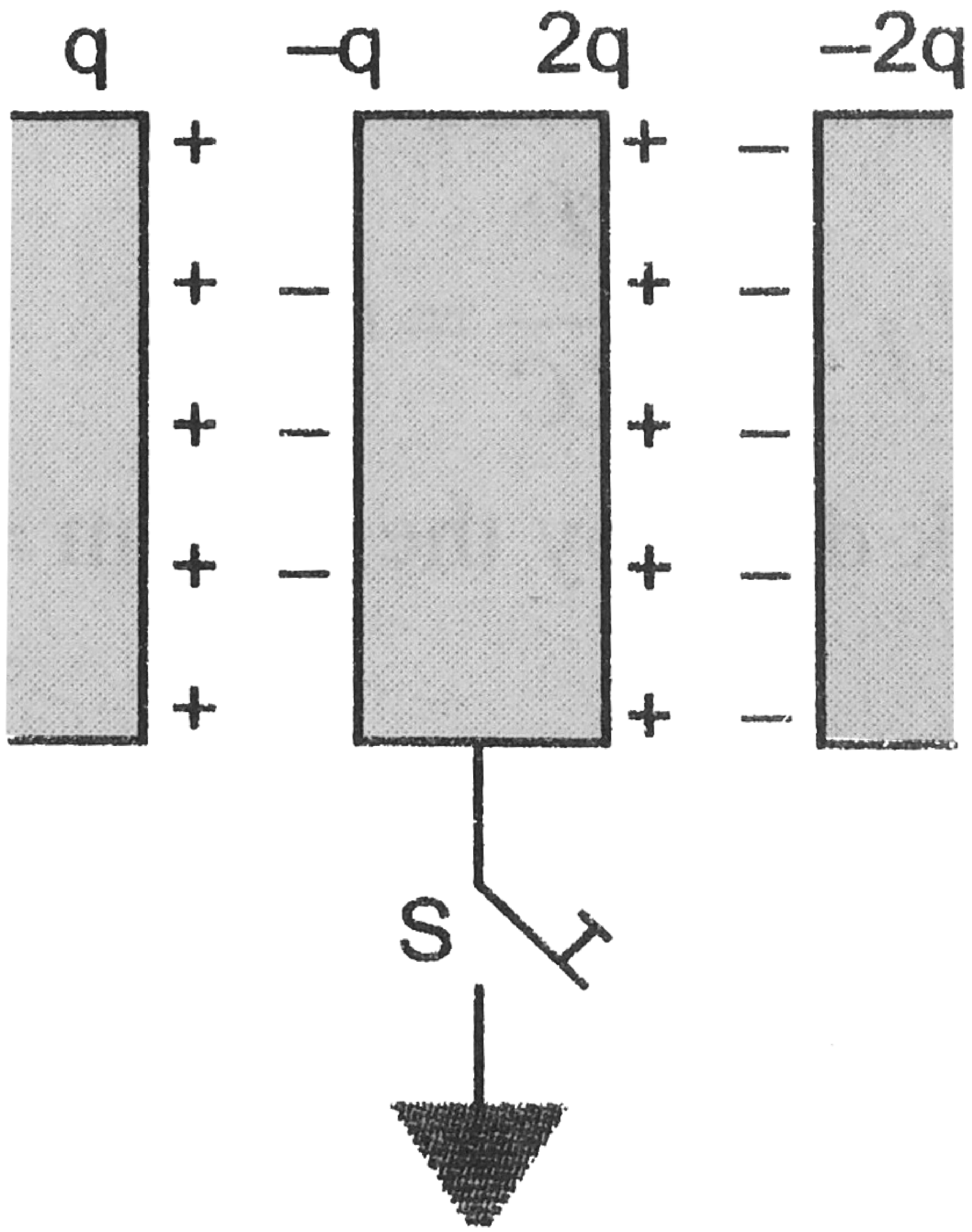
(D) $-2q$

CORRECT ANSWER: C

SOLUTION:

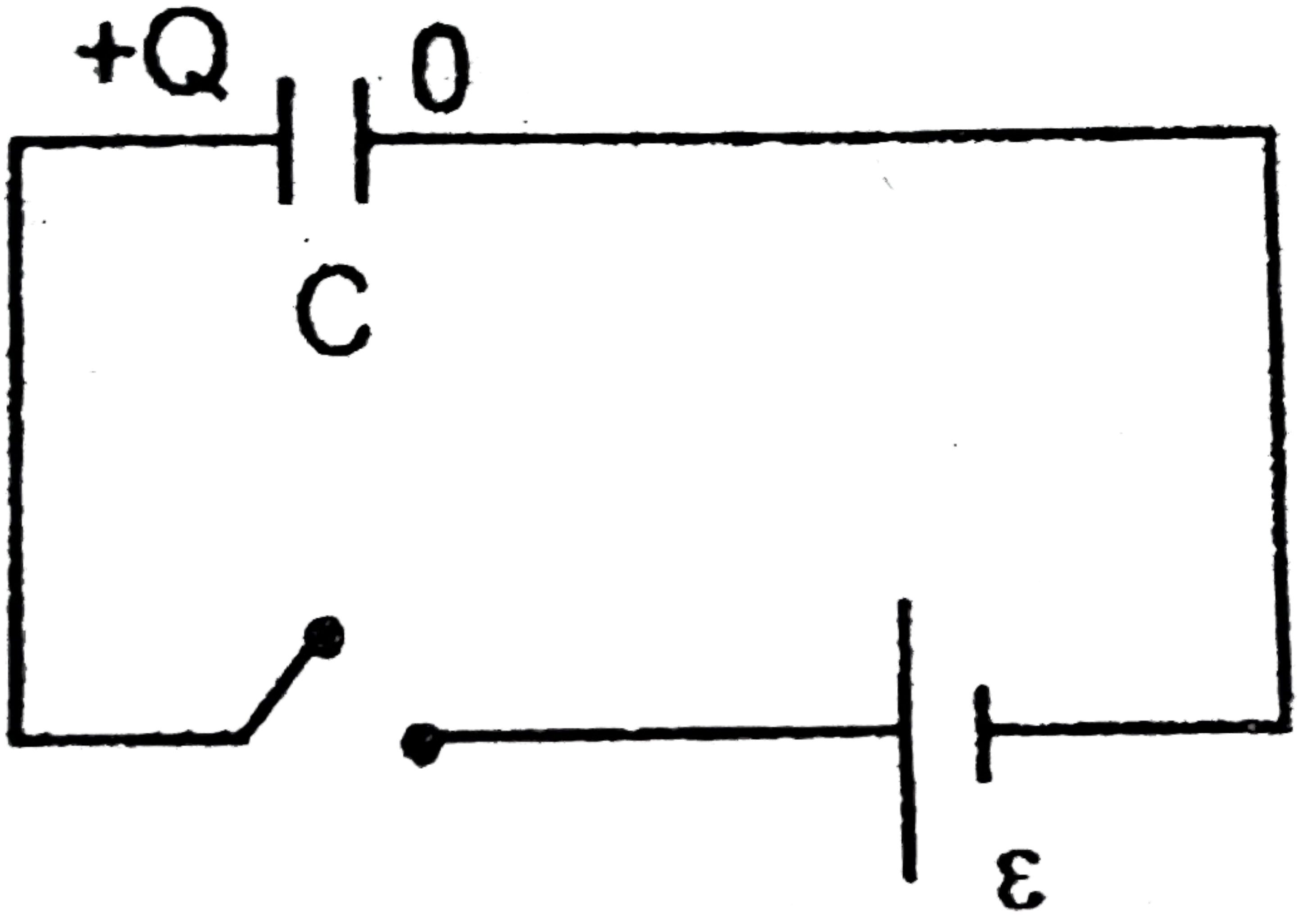
In Fig, $-q$ charge is induced on left face and $+2q$ charge is induced on right face of central plate.

Therefore, when switch S is closed, charge that flows through S to earth $=(+2q-q)=+q$.



Q-43 - 16112570

The left plate of the capacitor shown in the figure above carries a charge $+Q$ while the right plate is uncharged at $t=0$. The total charge on the right plate after closing the switch will be:



(A) $\frac{Q}{2}+C\varepsilon$

(B) $\frac{Q}{2}-C\varepsilon$

(C) $-\frac{Q}{2}$

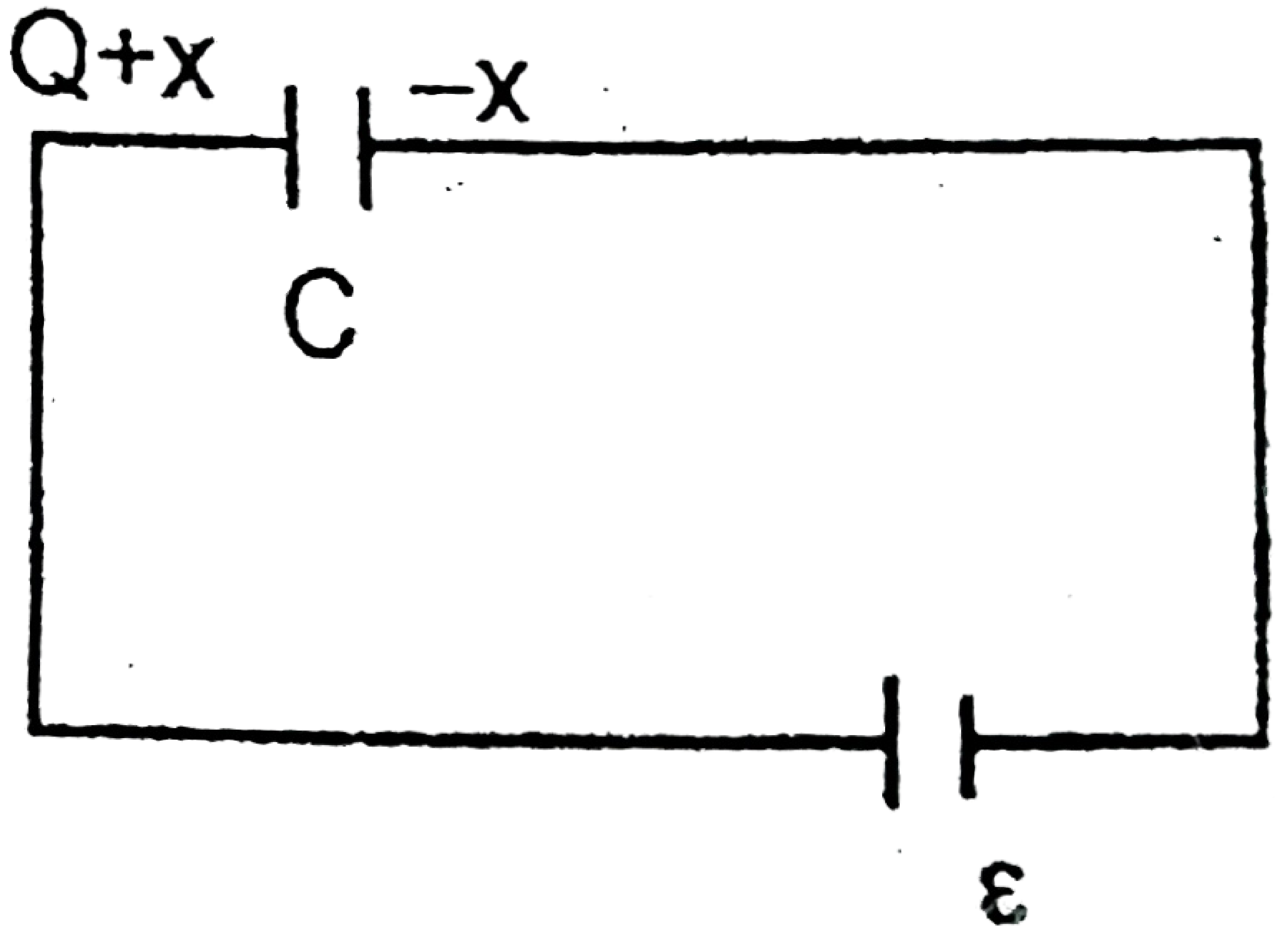
(D) $-C\varepsilon$

CORRECT ANSWER: B

SOLUTION:

Electric field between the capacitor plates

$$\frac{\sigma_1}{2\varepsilon_0} + \frac{(-\sigma_2)}{2\varepsilon_0}$$



$$E = \frac{Q+x}{2A\varepsilon_0} + \frac{x}{2A\varepsilon_0}$$

$$= \frac{1}{2A\varepsilon_0}[Q+2x]$$

$\Rightarrow$ Potential different

$$Ed = \frac{d}{2As\varepsilon_0}[Q+2x]$$

$$= \varepsilon$$

$$\Rightarrow \varepsilon = \frac{Q+2x}{2C} =$$

$$-x = \frac{Q}{2} - C\varepsilon$$

Q-44 - 14799589

A spherical charged conductor has σ as the surface density of charge. The electric field on its surface is E. If the radius of the sphere is doubled keeping the surface density of charge unchanged, what will be the electric field on the surface of the new sphere -

(A) $\frac{E}{4}$

(B) $\frac{E}{2}$

(C) E

(D) $2E$

CORRECT ANSWER: C

Q-45 - 11964116

A spherical conductor of radius $2m$ is charged to a potential of $120V$. It is now placed inside another hollow spherical conductor of radius $6m$. Calculate the potential to which the bigger sphere would be raised

(A) $20V$

(B) $60V$

(C) $80V$

(D) $40V$

CORRECT ANSWER: D

SOLUTION:

If charge acquired by the smaller sphere is Q then its potential $120 = \frac{kQ}{2}$ ..(i)

Also potential of the outer sphere

$$V = \frac{kQ}{6} \text{ ..(ii)}$$

From equations (i) and (ii) $V = 40$ volts

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Q-46 - 17244341

A positive charge is fixed at the origin of coordinates. An electri dipole which is free to move and rotate is placed on the positive x-axis. Its moment is directed away from the origin. The dipole will

(A) move towards the origin

(B) move away from the origin

(C) rotate by $\pi / 2$

(D) rotate by π

CORRECT ANSWER: A

Q-47 - 16464239

A charge +q is placed somewhere inside the cavity of a thick conducting spherical shell of inner radius R_1 and outer radius R_2. A charge Q is placed at a distance $r > R_2$ from the centre of the shell. Then the electric field in the hollow cavity-

(A) depends on both +q and � Q

(B) is zero

(C) is only that due to -Q

(D) is only that due to +q

CORRECT ANSWER: D

Q-48 - 11308822

A solid conducting spere of radius $10 cm$ is enclosed by a thin metallic sheel of radius $20 cm$. A charge $q = 20 \mu C$ is given to the inner spere. Find the heat generated in the process. The inner sphere is connected to the shell by a conducting wire.

SOLUTION:

Before connection with the wire, the total electrical energy is $U_i = q^2 / 8\pi\varepsilon_0 a$, after connection with the wire, all charges are transferred to the outer sphere. So

$$U_f = \frac{q^2}{8\pi\varepsilon_0 b}$$

$$\therefore \Delta H = U_i - U_f$$

$$= \frac{q^2}{8\pi\varepsilon_0}\left(\frac{1}{a} - \frac{1}{b}\right)$$

$$= \frac{\left(20 \times 10^{-6}\right)^2 \times 9 \times 10^9}{9} \times \left(\frac{1}{10 \times 10^{-2}} - \frac{1}{20 \times 10^2}\right)$$

$$= 9J$$

Q-49 - 12306748

A capacitor with capacitance $C = 400 pF$ is connected via a resistance $R = 650 \Omega$ to a source of voltage V_0. How soon will the voltage developed across the capacitor reach a value $V = 0.90 V_0$?

SOLUTION:

The formula is,

$$q = CV_0\left(1 - e^{-1/RC}\right)$$

or,

$$V = \frac{q}{C} = V_0\left(1 - e^{-1/RC}\right)$$

or , $\frac{V}{V_0} = 1 - e^{-1/RC}$

or,

$$e^{-1/RC} = 1 - \frac{V}{V_0} = \frac{V_0 - V}{V_0}$$

Hence, $t = RC$ In $\frac{V_0}{V_0 - V} = RC$ In 10, if

$V = 0.9V_0$

Thus $t = 0.6\mu S$.

Q-50 - 11964524

A parallel plate air capacitor has capcity C distance of separtion between plates is d and potential difference V is applied between the plates force of attraction between the plates of the parallel plate air capacitor is

(A) $\dfrac{C^2V^2}{2d^2}$

(B) $\dfrac{C^2V^2}{2d}$

(C) $\dfrac{CV^2}{2d}$

(D) $\dfrac{CV^2}{d}$

CORRECT ANSWER: C

SOLUTION:

$$F=\frac{Q^2}{2\varepsilon_0 A}$$

$$\therefore Q=CV \text{ and } C=\frac{\varepsilon_0 A}{d} \Rightarrow \varepsilon_A = Cd$$

$$\text{So } F=\frac{C^2V^2}{2Cd}=\frac{CV^2}{2d}$$

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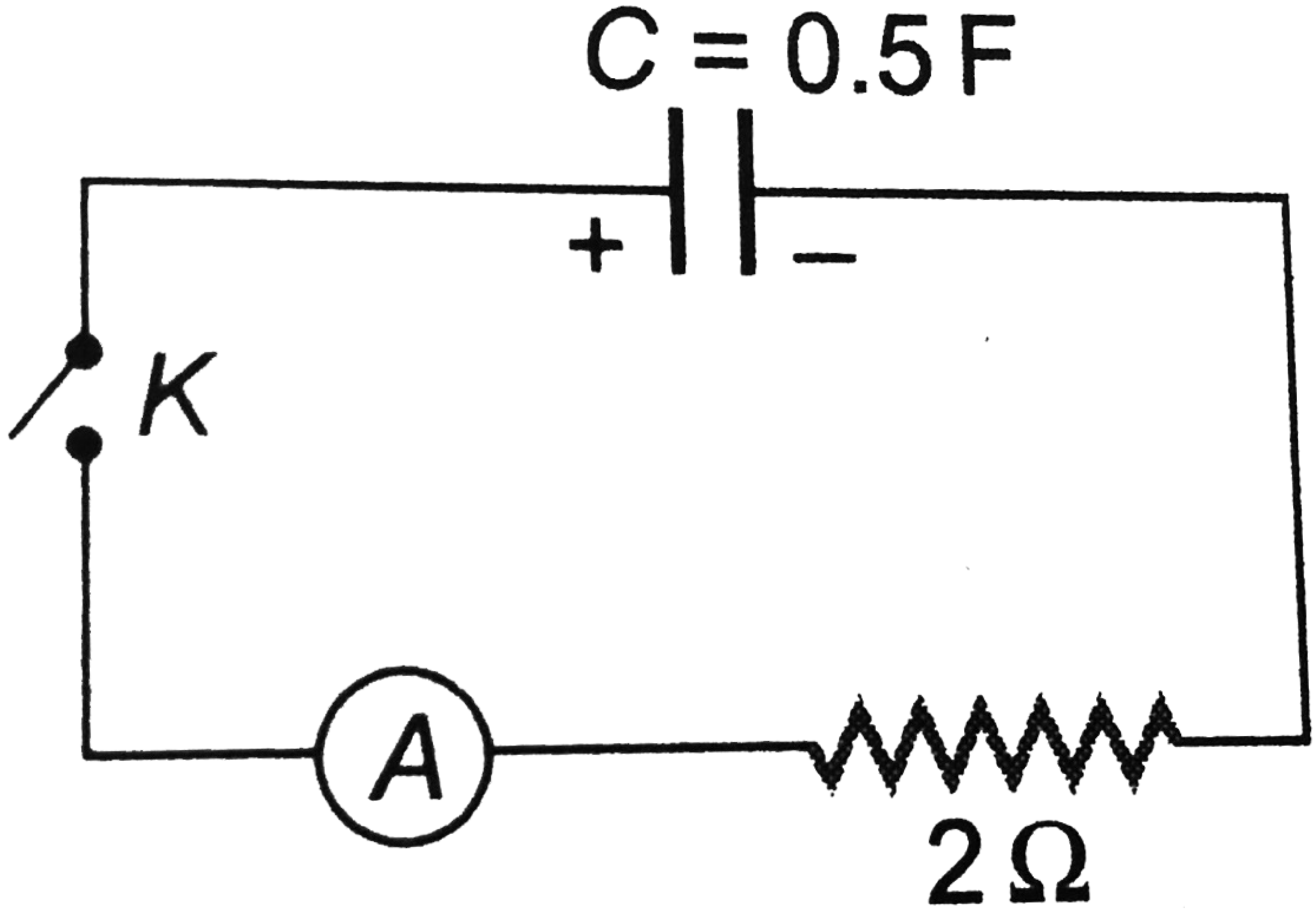
Q-51 - 10967322

A charged capacitor is allowed to dischare through a resistor by closing the key at the instant $t=0$. At the instant $t=(\ln 4)\mu s$, the reading of the ammeter falls half the initial vaslue. The resistance of the ammeter is equal to



(A) 0.5Ω

(B) 1Ω

(C) 2Ω

(D) 4Ω

CORRECT ANSWER: C

SOLUTION:

The given time is the half life time of the exponentially decreasig eqution.

$$\therefore t = t_{\frac{1}{2}} = (\ln 2)\tau_C$$
$$= (\ln 2)CR_{net}$$

$$\therefore R_{net} = \frac{t}{(\ln 2)C}$$
$$= \frac{2(\ln 2)\mu s}{(\ln 2)(0.5\mu F)} = 4$$
Ω

$\therefore$ Resistance of ammeter $= 2\Omega$

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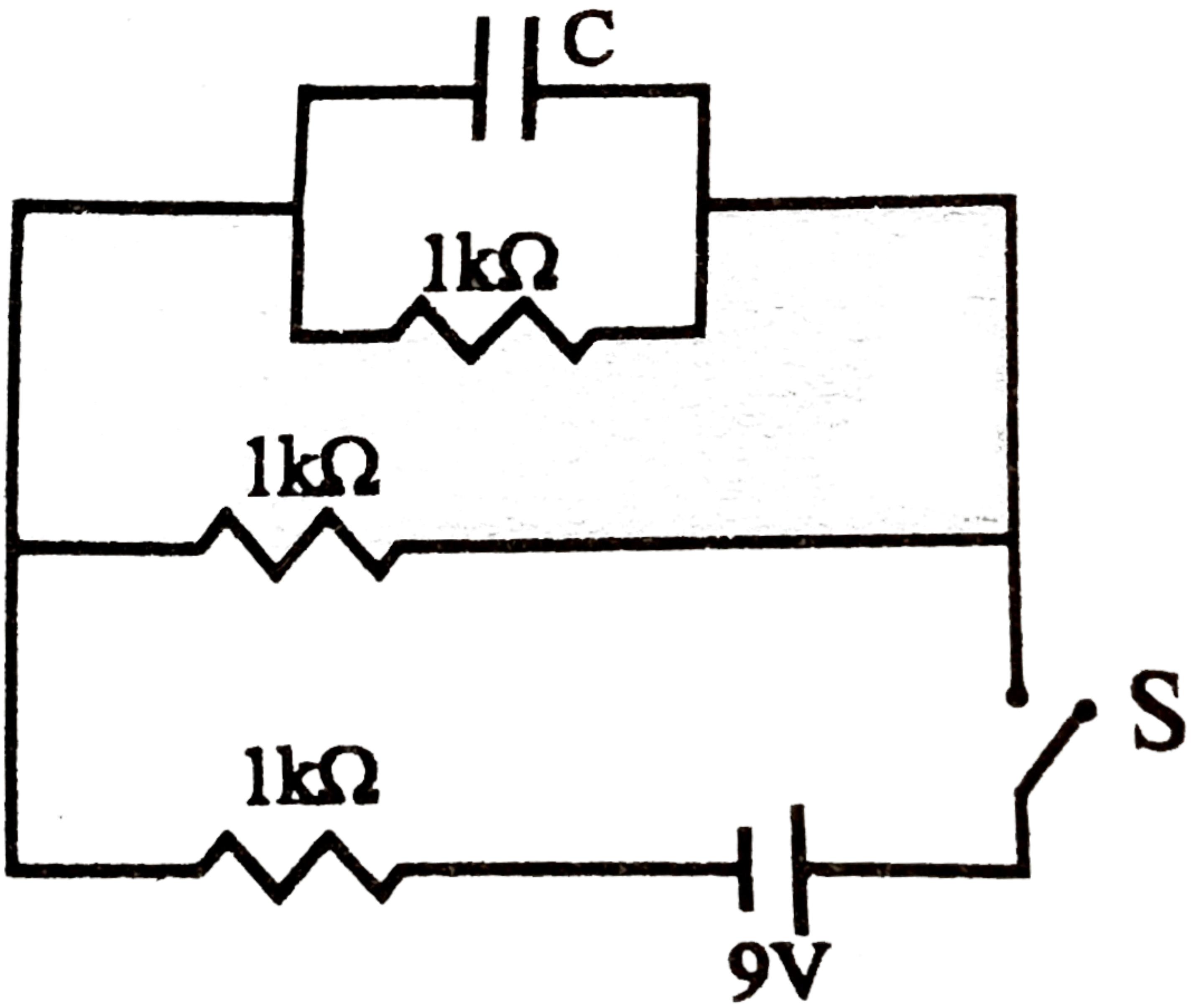
Q-52 - 12228597

A capacitor $C = 100\mu F$ is connected to three resistor each of resistance $1k\Omega$ and a battery of $emf 9V$.



The switch S has been closed for long time so as to charge the capacitor. When switch S is opened, the capacitor discharges with time constant

(A) $33ms$

(B) $5ms$

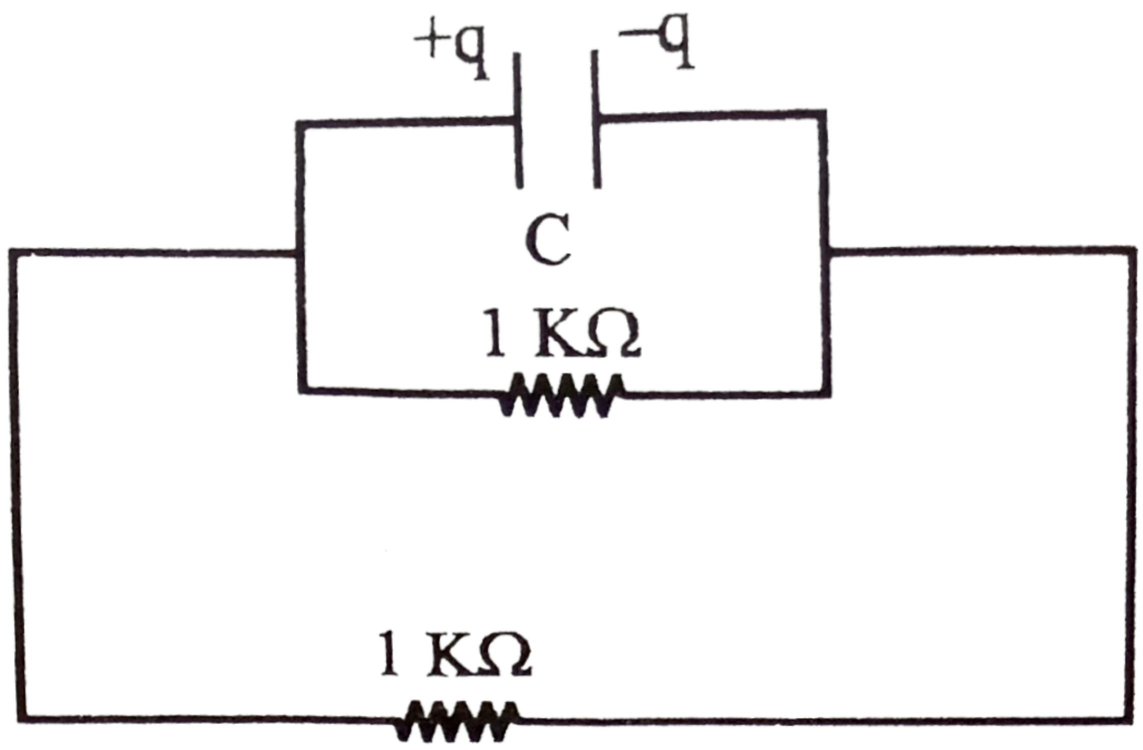
(C) $3.3ms$

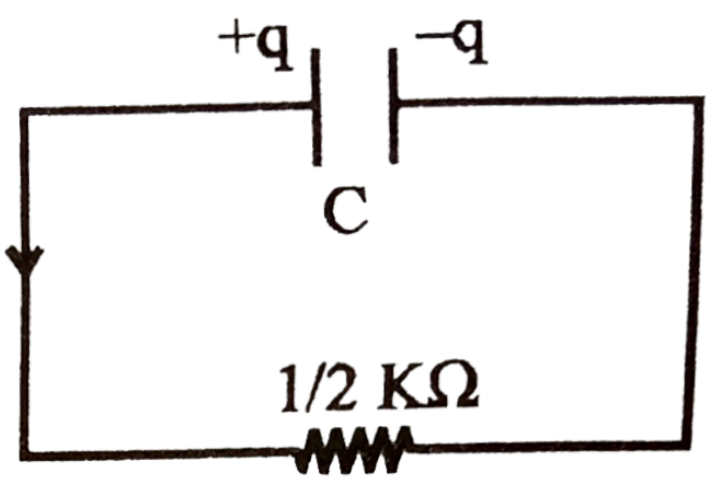
(D) $50ms$

CORRECT ANSWER: D

SOLUTION:

31.[D]





$$\tau = RC = 500\Omega \times 100 \times 10^{-6} F$$

$$= 5 \times 10^{-2} \text{ sec.} = 50 ms$$

Q-53 - 11309011

Each plate of a parallel plate air capacitor has area $S = 5 \times 10^{-3} m^2$ and the distance between the plates is $d = 8.80 mm$.Plate A has positive charge $q_1 = +10^{-10} C$, and plate B has charge $q_2 = +2 \times 10^{-10} C$. A battery of emf $E = 10 V$ has its positive terminal connected to plate A and the negative terminal to plate B. (Given $\varepsilon_0 = 8.8 \times^{12} Nm^2 C^{-2}$).

Charge supplied by time the battery is .

(A) $120 pC$

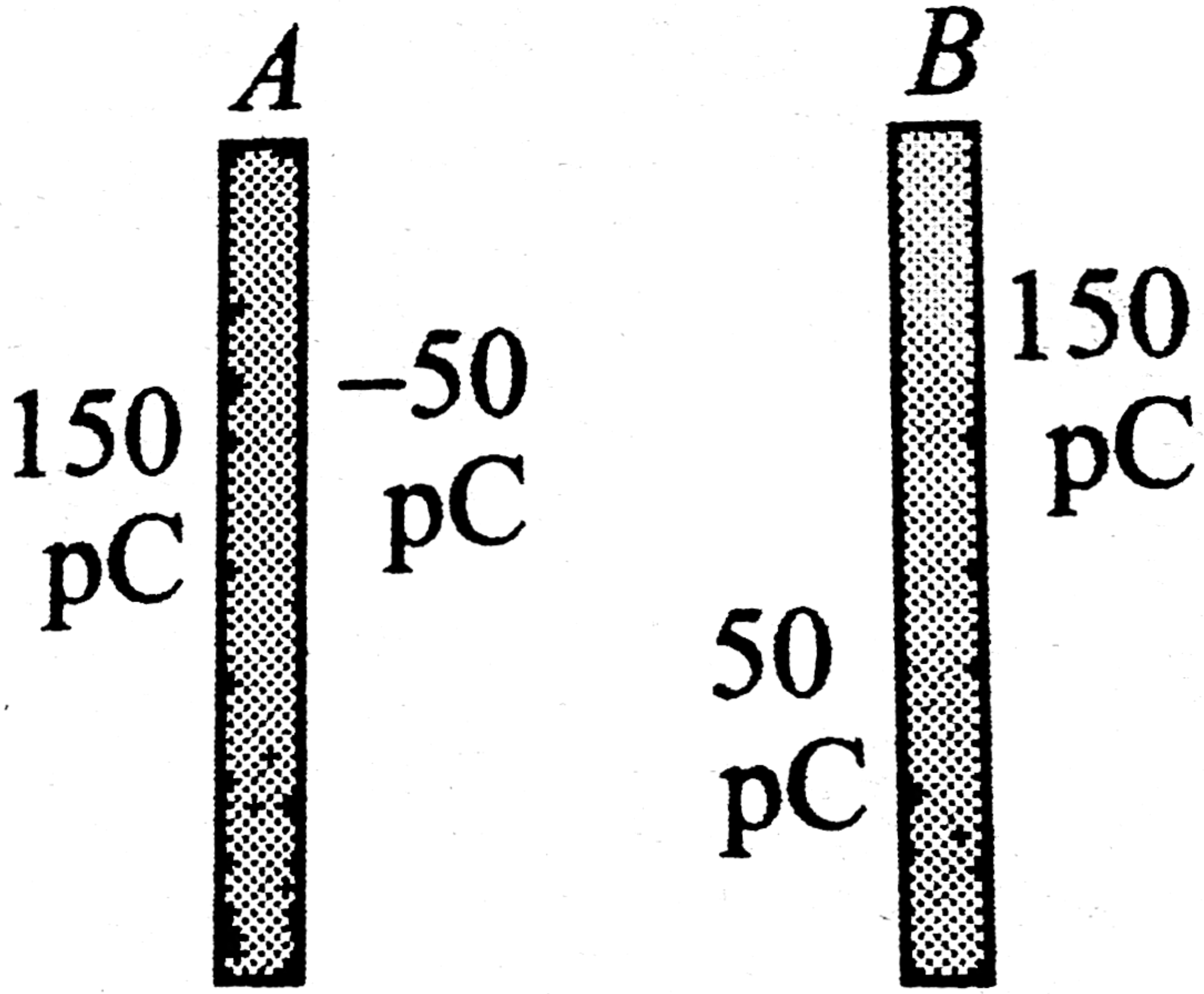
(B) $100 pC$

(C) $60 pC$

(D) $50 pC$

CORRECT ANSWER: B

SOLUTION:



(i)

$$C = \frac{\varepsilon_0 A}{d}$$

$$= \frac{8.8 \times 10^{-12} \times 5 \times 10^{-3}}{8.8 \times 10^{-3}}$$

$$= 5 \times 10^{-12} F$$

Charge on the plate after connection with the battery is

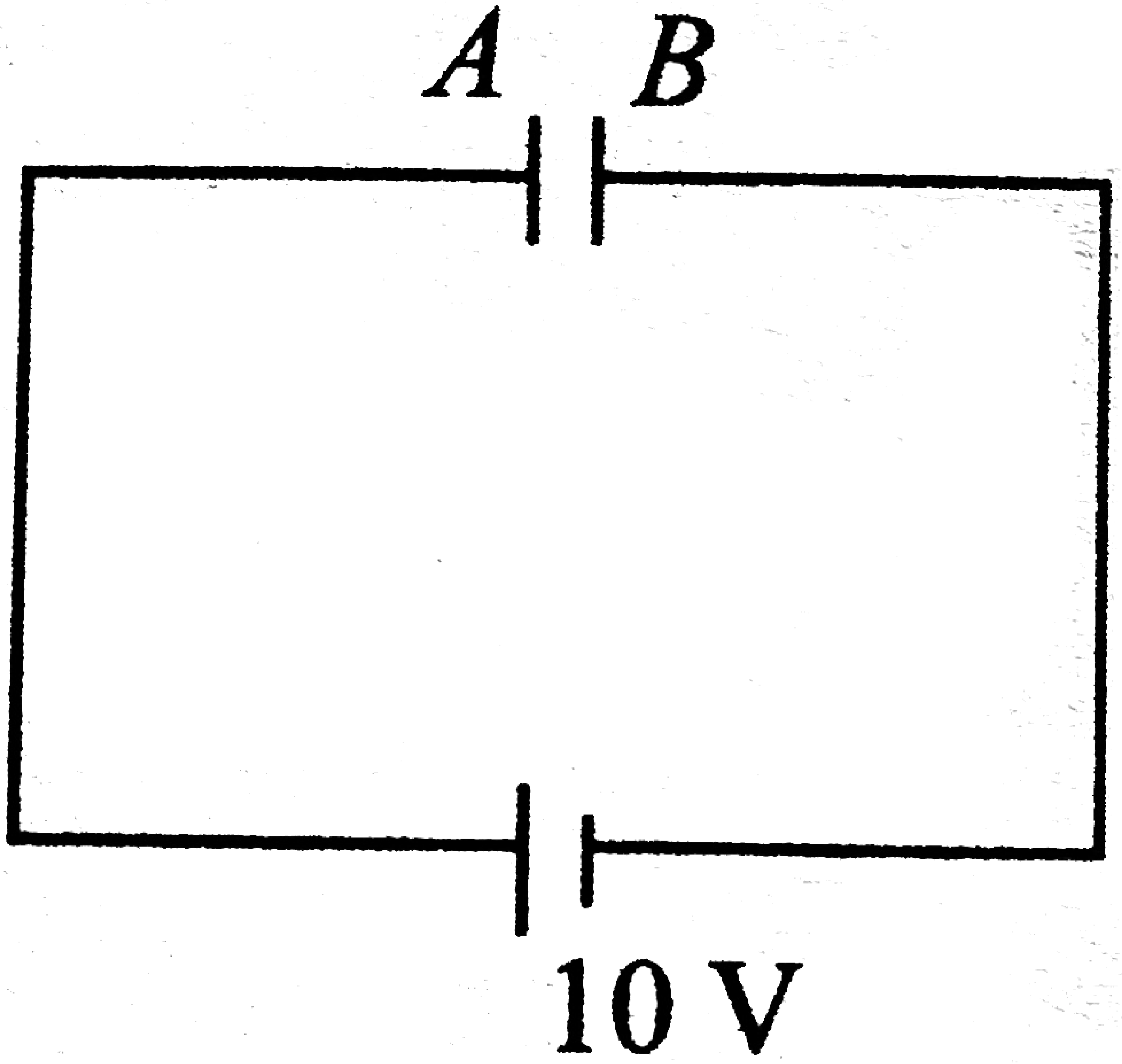


Fig. S4.90

$q = CV = 5 \times 10^{-12}$
$\times 10 = 50pC$

Charge supplied by the battery is

$\Delta q = (50 + 50)pC$
$= 100pC$

Energy supplied by the battery is

(ii)

$$U_{\text{battery}} = \Delta qV = 100 \times 10 = 1000 pJ$$

.

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Q-54 - 11963941

A charge q is placed at the some distance along the axis of a uniformly charged disc of surface cahrge density σ. The flux due to the charge q through the disc is ϕ. The electric force on charge q exerted by the disc is

(A) $\sigma\phi$

(B) $\dfrac{\sigma\phi}{4\pi}$

(C) $\dfrac{\sigma\phi}{2\pi}$

(D) $\dfrac{\sigma\phi}{3\pi}$

CORRECT ANSWER: A

SOLUTION:

We know that if a point charge subtends a half-angle α on the circular cross-section of a disc, then flux passing through the disc is :

$$\phi = \frac{q}{2\varepsilon_0}(1 - \cos\alpha)$$

Also, if a point charge q lies on the axis of a charged disc of charge density σ and subtends a half-anlge α, then it experiences a force

$$F = \frac{q\sigma}{2\varepsilon_0}(1 - \cos\alpha)$$

$$= \sigma\phi$$

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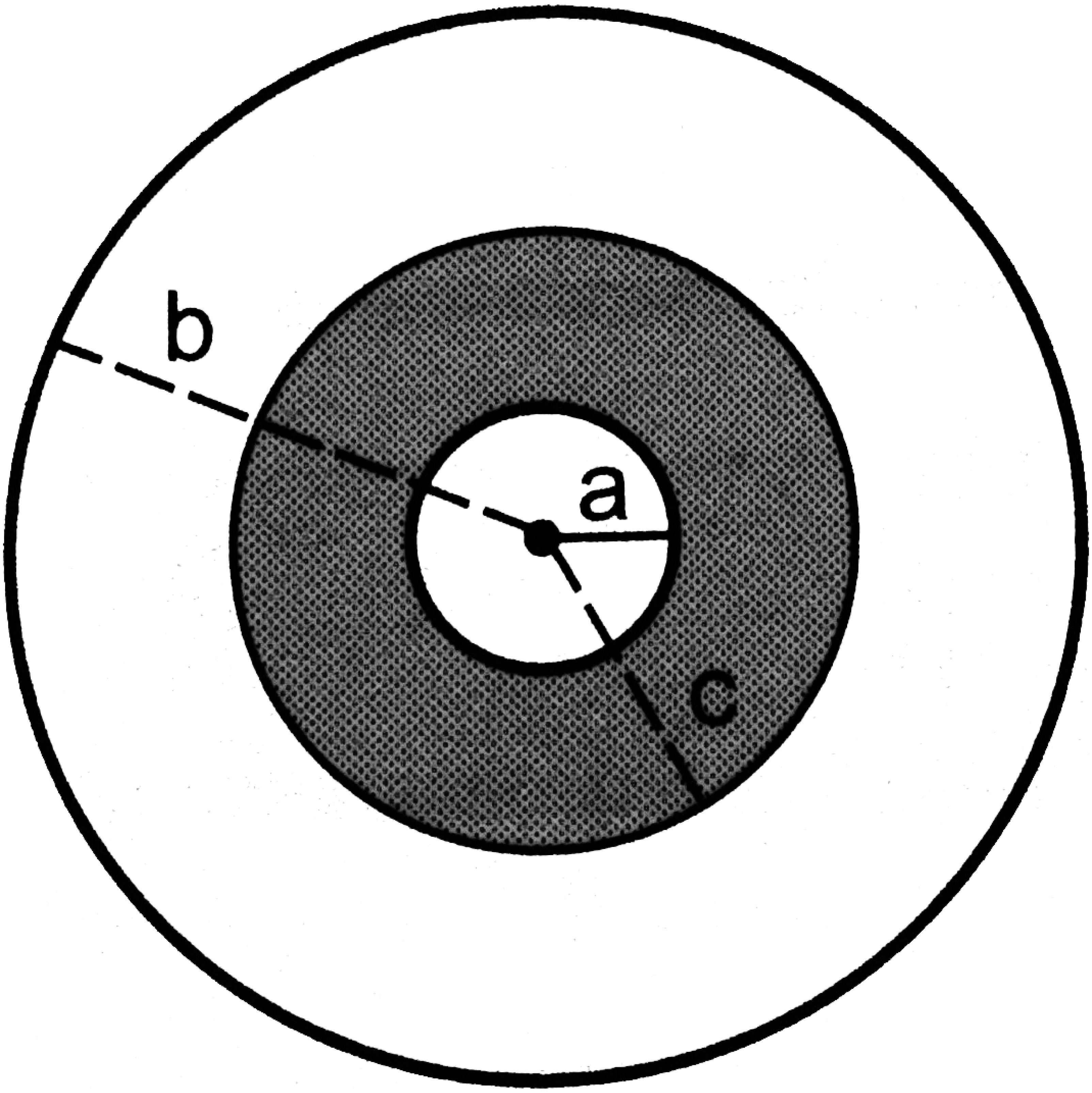
Q-55 - 9726336

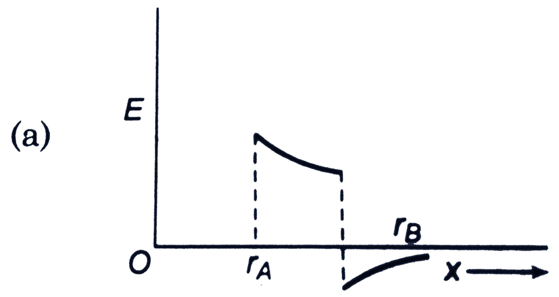
A sphercial capacitor is made of two conducting spherical shells of radii a and b.The space between the shells is filled with a dielectric constant K up to a radius c as shown in figure. Calculate the capacitance .

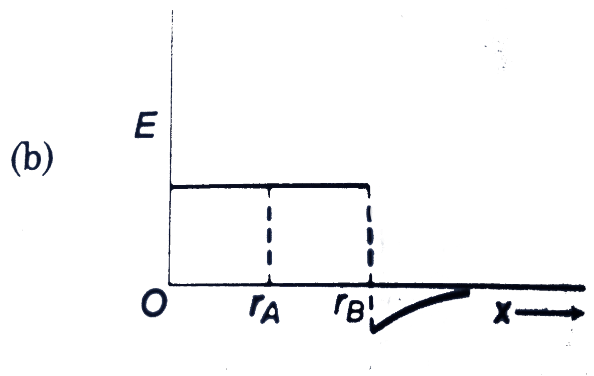


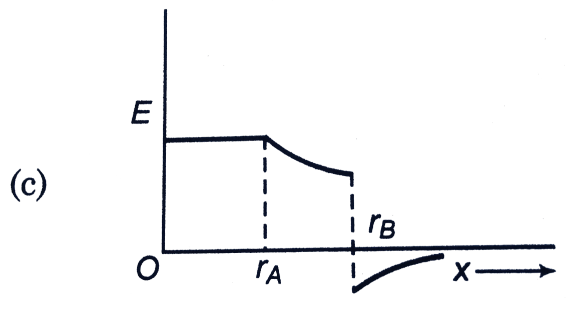
Q-56 - 10967120

Two concentric coducting thin spherical shells A and B having radii r_A and $r_B (r_B > r_A)$ are charged to Q_A and $-Q_B (|Q_B| > |Q_A|)$.

The electrical field along a line passing through the centre is

(A) 

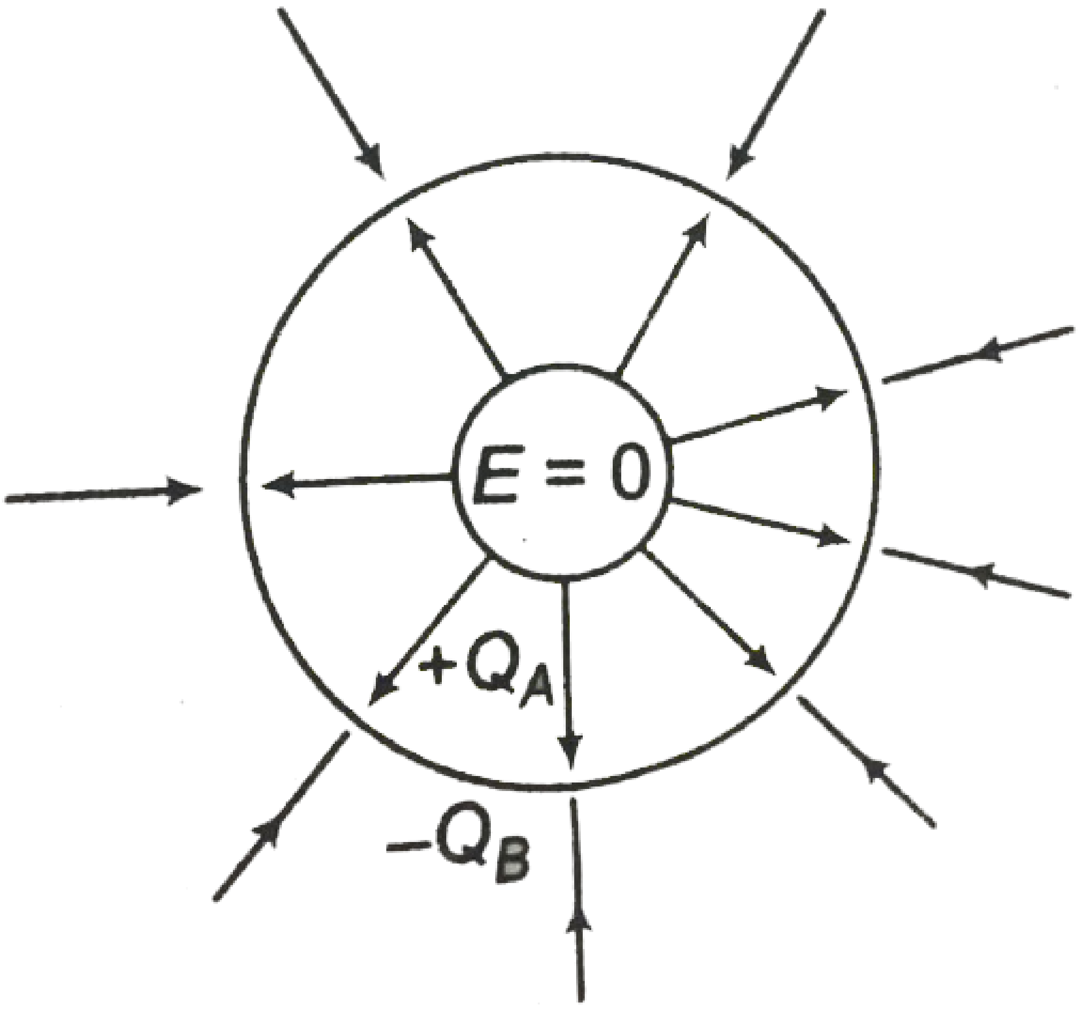
(B) 

(C) 

(D) none of these

CORRECT ANSWER: A

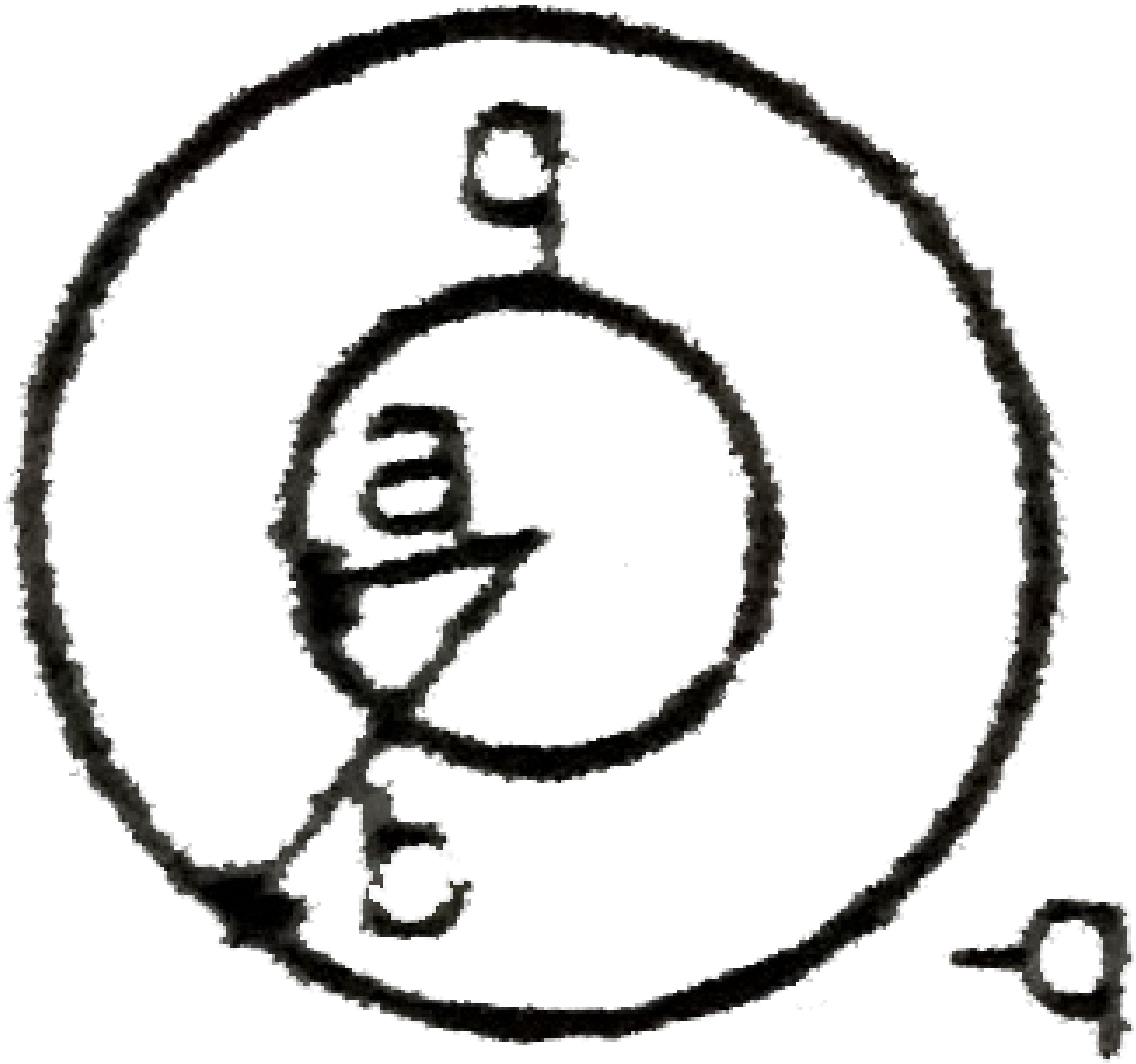
SOLUTION:

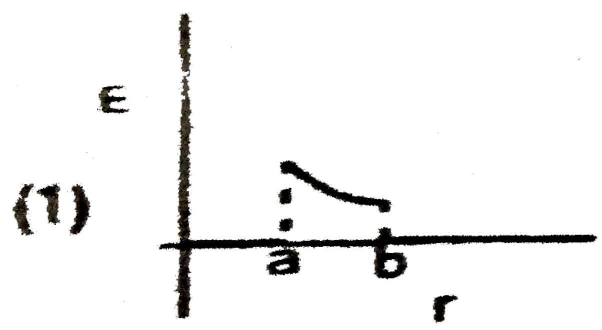


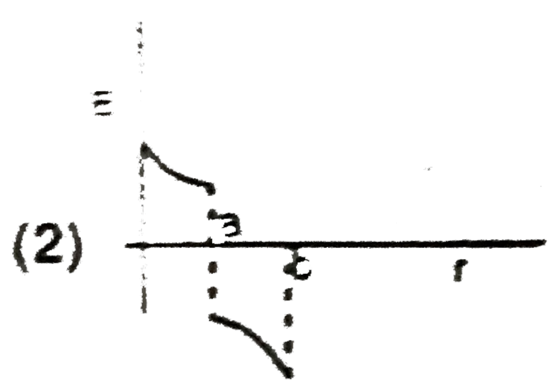
Since $|Q_B| > Q_A$, electric field outside sphere B is inwards (say negative). From A to B enclosed charge is positive. Hence, electic field is radialy outwards (positive)

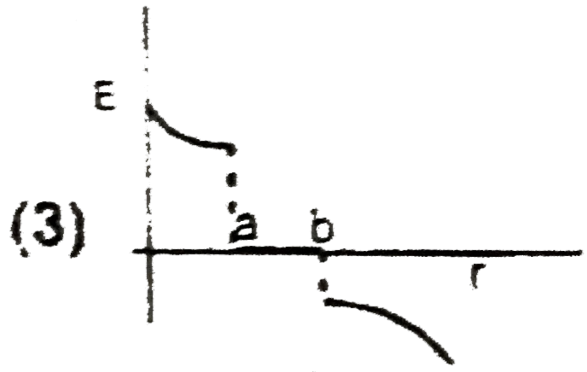
Q-57 - 14528679

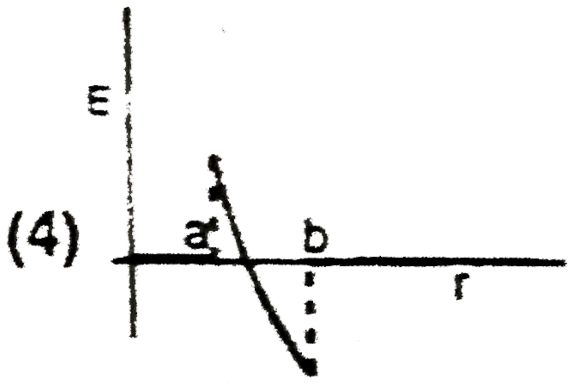
Figure shows two concentric shells of radii a and b uniformly distributed charges q and -q. Which of the following graphs gives correct variation of electric field intensity E with the distance r from the centre?



(A) 

(B) 

(C) 

(D) 

CORRECT ANSWER: A

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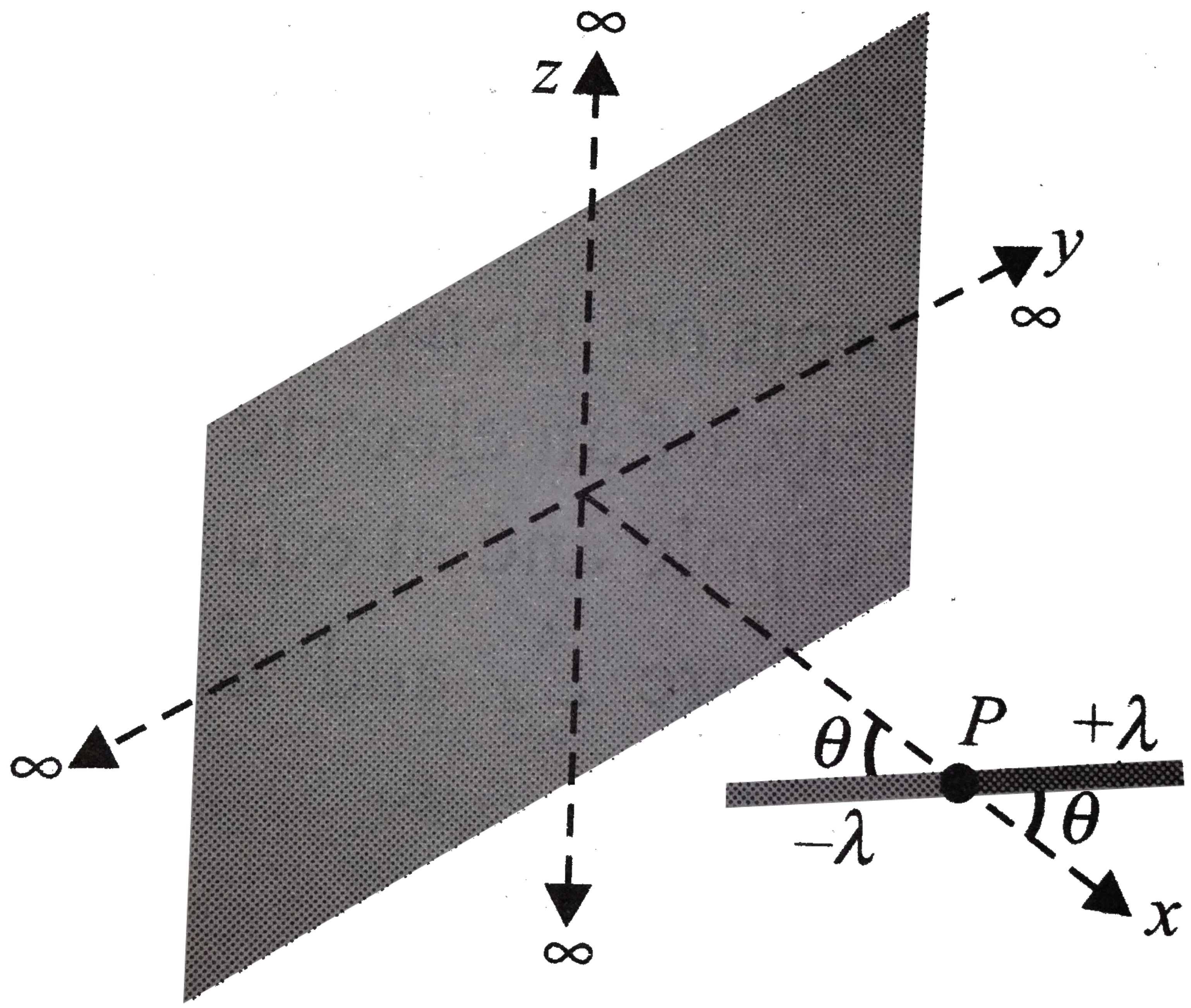
Q-58 - 11308374

A large sheet carries uniform surface charge density σ . A rod of length 2l has a linear charge density $lamba$ on one half and $-\lambda$ on the second half. The rod is hinged at the midpoint O and makes an angle θ with the normal to the sheet. The torque experience by the rod is



(A) 0

(B) $\dfrac{\sigma\lambda l^2}{2\varepsilon_0}\sin\theta$

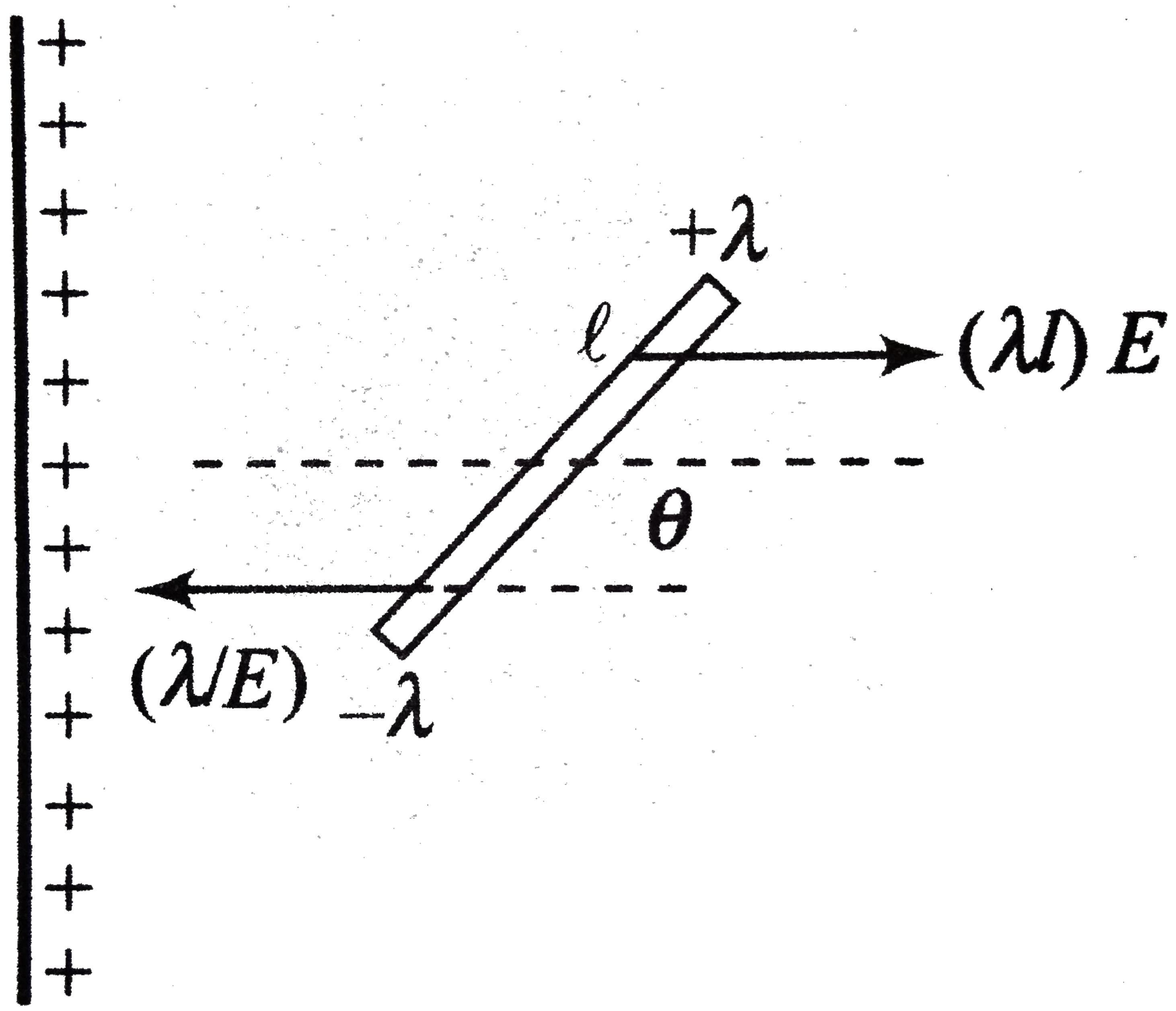
(C) $\dfrac{\sigma\lambda l^2}{\varepsilon_0}\sin\theta$

(D) $\dfrac{\sigma\lambda l}{2\varepsilon_0}$

CORRECT ANSWER: B

SOLUTION:

$$\tau = (\lambda l E) l \sin\theta$$
$$= \lambda l^2 \frac{\sigma}{2\varepsilon_0}$$
$$= \frac{\sigma \lambda l^2}{2\varepsilon} \sin\theta$$



Q-59 - 11963912

A particle of mass m and carrying charge $-q_1$ is moving around a charge $+q_2$ along a circular path of radius r period of revolution of the charge $-q_1$ about $+q_2$ is

(A) $4\sqrt{\frac{\pi^3\varepsilon_0 m r^3}{q_1 q_2}}$

(B) $\sqrt{\frac{\pi^3\varepsilon_0 m r^3}{q_1 q_2}}$

(C) $2\sqrt{\frac{\pi^3\varepsilon_0 m r^3}{q_1 q_2}}$

(D) $3\sqrt{\frac{\pi^3\varepsilon_0 m r^3}{q_1 q_2}}$

CORRECT ANSWER: A

SOLUTION:

Suppose that the charge $-q_1$ moves around the charge q_2 along a circular path of radius r with spedd v.

The necessary centripetal force is provided by the electronic force of attraction between the two charges i.e.,

$$\frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 \times q_2}{r^2}$$
$$= \frac{mv^2}{r}$$

Or

$$v = \left(\frac{1}{4\pi\varepsilon_0}\right.$$
$$\left. \cdot \frac{q_1 \times q_2}{mr}\right)^{1/2}$$

If T is period of revolution of the charge $-q_1$ about q_2

then

$$T = \frac{2\pi r}{v}$$

Subsituting for v we get $T = \sqrt{\frac{16\pi^3\varepsilon_0 m r^3}{q_1 q_2}}$

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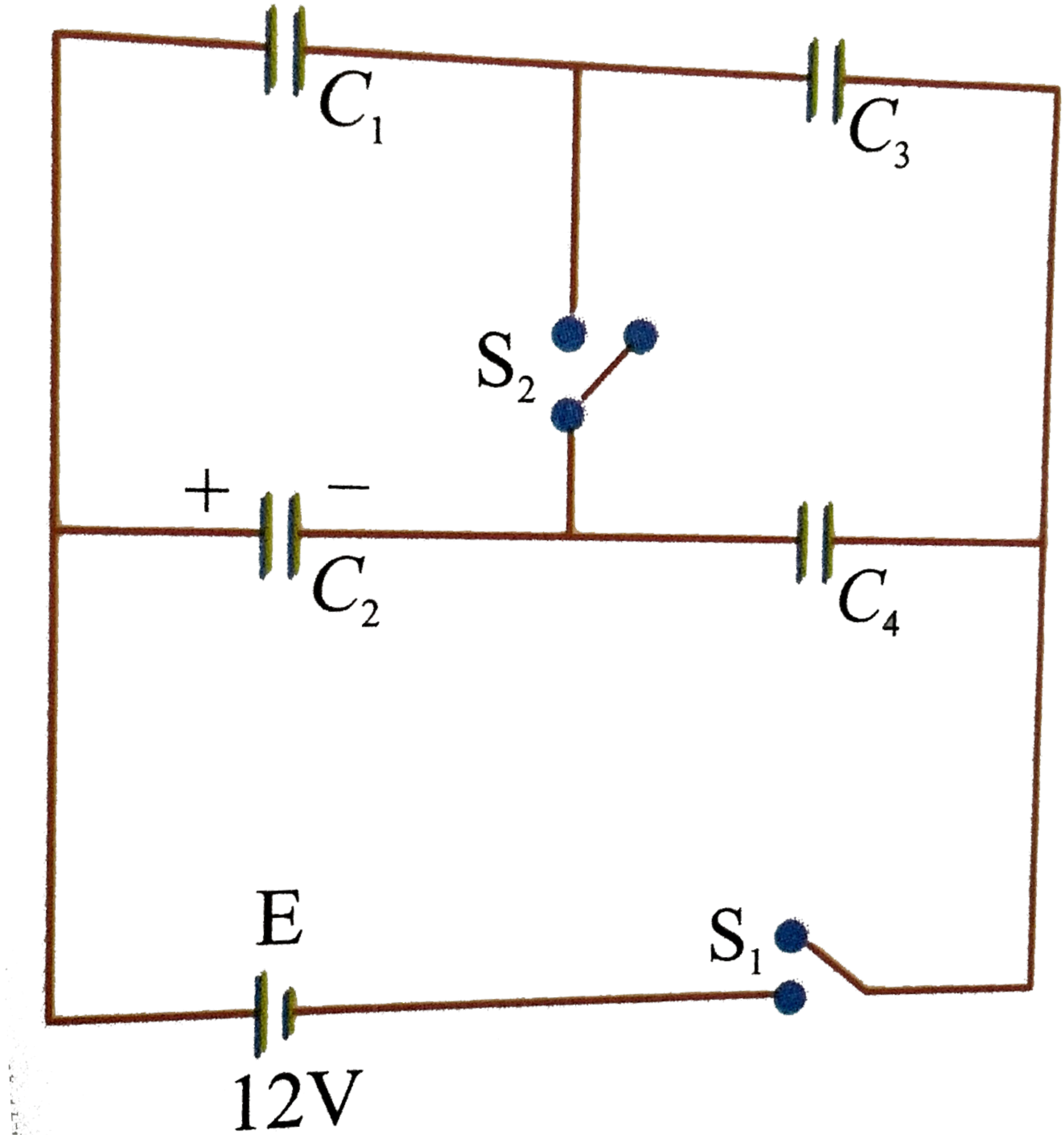
Q-60 - 13079604

Four capacitors

$C_1(= 1\mu F), C_2(= 2\mu F),$
$C_3(= 3\mu F)$

and $C_4(= 4\mu F)$ are connected in a network as shown in the diagram. The emf of the battery is $E = 12V$ and its internal resistance is negligible. The keys S_1 and S_2 can be independetly put on or off. Indicate the charge on the capacitors by q_1, q_2, q_3 and q_4 respectively and the potential drops across them by V_1, V_2, V_3 and V_4 respectively.



Initially both the keys are open. Then the key S_1 is closed. Then the charges on the capacitors are.

(A)
$q_1 = q_2 = 16\mu C, q_3 = q_4 = 9\mu C$

(B)

$q_1 = q_3 = 16\mu C, q_2$
$= q_4 = 9\mu C$

(C)

$q_1 = q_4 = 9\mu C, q_2$
$= q_3 = 16\mu C$

(D)

$q_1 = q_3 = 9\mu C, q_2$
$= q_4 = 16\mu C$

CORRECT ANSWER: D

SOLUTION:

Refer to the circuit network in the problem.

With both keys S_1 and S_2 initially open, it now S_1 is closed, the capacitance C_1 and C_3 are in series as also the capacitors C_2 and C_4

Hence

$$q_1 = q_3 = \frac{VC_1C_3}{C_1 + C_3}$$
$$= \frac{12 \times 1 \times 3}{(1+3)} = 9\mu C$$

Also

$$q_2 = q_4 = \frac{VC_2C_4}{C_2 + C_4}$$

$$= \frac{12 \times 2 \times 4}{(2+4)}$$

$$= 16\mu C$$

.