Class 12 Physics

Electric Charges And Fields

Ncert Video Solutions - Only On Doubtnut

Download Doubtnut Now

Exercise 1.1

What is the force between two small charged spheres having charges of $2 \times 10^{-7} C$ and $3 \times 10^{-7} C$ placed 30cm apart in air ?

Watch Video Solution On Doubtnut App

Exercise 1.2

The electrostatic force on a small sphere of charge $0.4 \mu C$ due to anther small sphere of charge $-0.8 \mu C$ in air 0.2 N (i) What is the distance between the two spheres? (ii) What is the force on the second sphere due to the first ?

Watch Video Solution On Doubtnut App

Exercise 1.3

Check that the ratio ke2/G memp is dimensionless. Look up a Table of Physical Constants and determine the value of this ratio. What does the ratio signify?

SOLUTION:

The given ratio is $\frac{ke^2}{Gm_e m_p}$

Where,

G = Gravitational constant

Its unit is $Nm^2kg^{?2}$.

m_e and m_p = Masses of electron and proton.

Their unit is kg.

e = Electric charge.

Its unit is C.

k = A constant

$$= \frac{1}{4\pi\varepsilon_0}$$

ε_0 = Permittivity of free space

Its unit is $Nm^2C^{?2}$.

Therefore, unit of the given ratio

$$\frac{ke^2}{Gm_em_p} = \frac{\left[Nm^2C^{-2}\right]\left[C^{-2}\right]}{\left[Nm^2kg^{-2}\right][kg][kg]}$$

$$\frac{\dfrac{ke^2}{Gm_em_p}}{} = \frac{\left[Nm^2C^{-2}\right]\left[C^{-2}\right]}{[Nm^2kg^{-2}][kg][kg]}$$

$$= M^0L^0T^0$$

Hence, the given ratio is dimensionless.

$e = 1.610^{?19}C$

$G = 6.6710^{?11}Nm_2kg^{-2}$

$$G = 6.6710^{?11}Nm_2kg^{-2}$$

$me = 9.110^{?31} kg$

$mp = 1.6610^{?27} kg$

Hence, the numerical value of the given ratio is .

$$\frac{ke^2}{Gm_e m_p} = \frac{9 \times 10^9 \times \left(1.6 \times 10^{-19}\right)^2}{6.67 \times 10^{-11} \times 9.1 \times 10^{-3} \times 1.67 \times 10^{-22}} \approx 2.3 \times 10^3$$

$$\frac{ke^2}{Gm_e m_p}$$

$$= \frac{\begin{array}{l} 9 \times 10^9 \\ \times \left(1.6 \times 10^{-19}\right)^2 \end{array}}{\begin{array}{l} 6.67 \times 10^{-11} \times 9.1 \\ \times 10^{-3} \times 1.67 \\ \times 10^{-22} \end{array}}$$

$$\approx 2.3 \times 10^{39}$$

This is the ratio of electric force to the gravitational force between a proton and an electron, keeping distance between them constant.

View Text Solution On Doubtnut App

Exercise 1.4

(a) Explain the meaning of the statement electric charge of a body is quantised. (b) Why can one ignore quantisation of electric charge when dealing with macroscopic i.e., large scale charges?

Watch Video Solution On Doubtnut App

Exercise 1.5

When a glass rod is rubbed with a silk cloth, charges appear on both. A similar phenomenon is observed with many other pairs of bodies. Explain how this observation is consistent with the law of conservation of charge.

Watch Video Solution On Doubtnut App

Exercise 1.6

Four point charges

$q_A = 2\mu C, q_B = -5\mu C, q_C = 2\mu C$ and $q_D = -5\mu C$
$q_A = 2\mu C, q_B = -5\mu C, q_C$
$= 2\mu C$ and $q_D = -5\mu C$

are located at the corners of a square ABCD of side 10 cm. What is

the force on a charge of $1\mu C$ placed at the center of the square ?

Watch Video Solution On Doubtnut App

Exercise 1.7

(a) An electrostaic field line is a continous curve. That is a field line

cannot have sudden breaks. Why not ?

(b) explain why two filed lines never cross each other at any point.

Watch Video Solution On Doubtnut App

Exercise 1.8

Two point charges $q_A = 3\mu C$ and $q_B = -3\mu C$ are located 20 cm

apart in vaccum (a) what is the electric field at the mid point O of the line AB joining the two charges ? (b) If a negative test charge of magnitude $1.5 \times 10^{-9} C$ is placed at the point, what is the force experienced by the test charge ?

Watch Video Solution On Doubtnut App

Exercise 1.9

A system has two charges

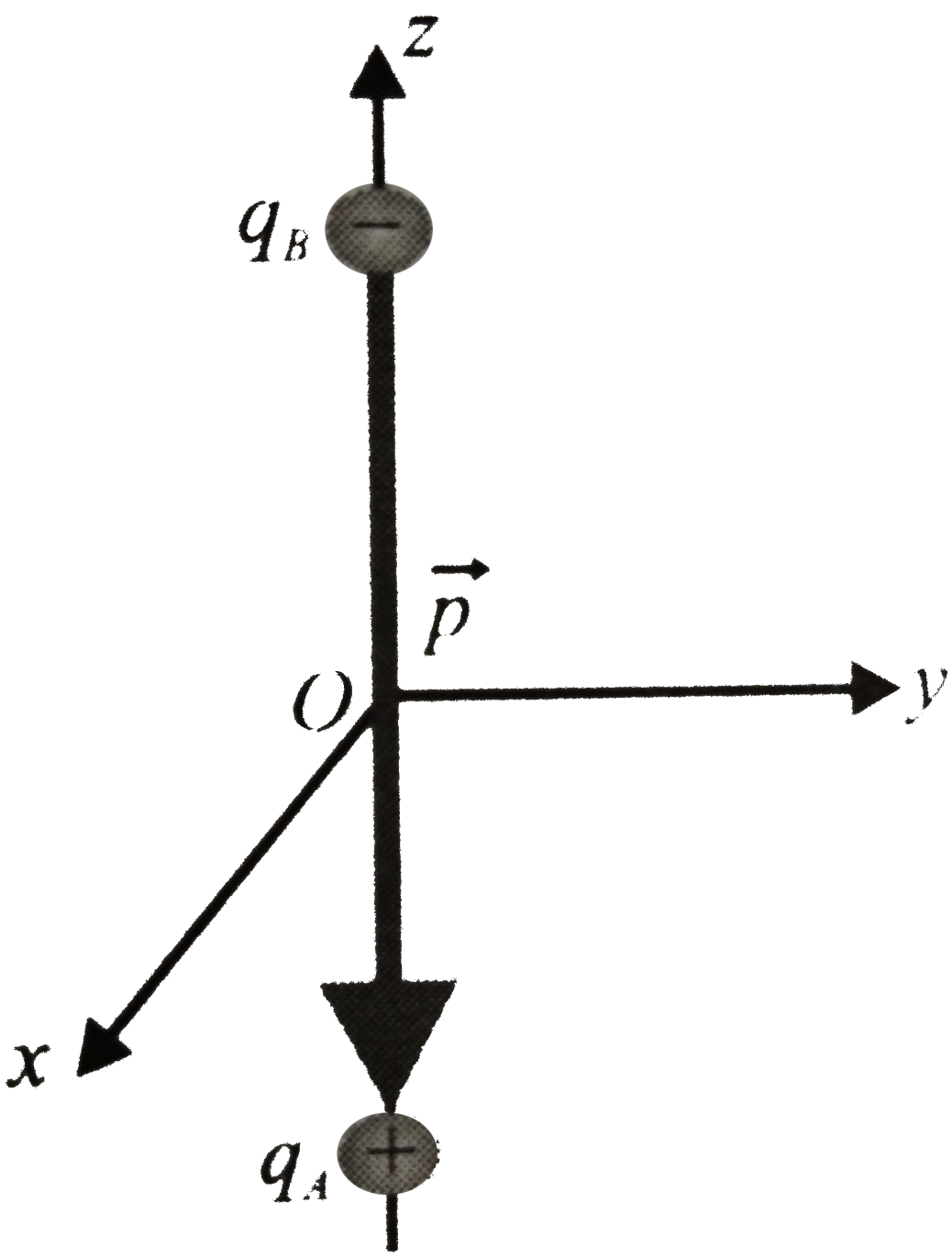
$q_A = +2.5 \times 10^{-7} C$ and $q_B = -2.5 \times 10^{-7} C$

$q_A = +2.5 \times 10^{-7} C$ and

$q_B = -2.5 \times 10^{-7} C$

located at point A: (0,0,-15 cm)and B: (0,0,+15 cm)`, respectively.

What are the total charge and electric dipole moment of the system?



Watch Video Solution On Doubtnut App

Exercise 1.10

An electrtic dipole with dipole moment $4 \times 10^{-9} Cm$ is aligned at 30 with the direction of a uniform electric field of magnitude $5 \times 10^{4} NC^{-1}$. Calculate the magnitude of the torque acting on the dipole .

Watch Video Solution On Doubtnut App

Exercise 1.11

A polythene piece rubbed will wool is found to have a negative charge of $3.0 \times 10^{-7} C$.

(a) Estimate the number of electrons transferred (from which to which)?

(b) Is there a transfer of mass from wool to polythene?

Watch Video Solution On Doubtnut App

Exercise 1.12

(a) Two insulated charged copper spheres A and B have their centers speparated by a distance of 50 cm. What is the mutal force of electrostatic repulsion if the charge on each is $6.5 \times 10^{-7} C$? The radill of A and B are negalible compared to the distance of separation.

(b) What is the force of repulsion if each sphere is charged double

the above amount, and the distance between them is halved ?

Watch Video Solution On Doubtnut App

Exercise 1.13

Suppose the spheres A and B in Exercise 1.12 have identical sizes. A third sphere of the same size but uncharged is brought in contact with the first, then brought in contact with the second, and finally removed from both. What is the new force of repulsion between A and B?

SOLUTION:

Distance between the spheres, A and B, r = 0.5 m

Initially, the charge on each sphere,$q = 6.510^{?7}C$

When sphere A is touched with an uncharged sphere C, $\frac{q}{2}$ amount of charge from A will transfer to sphere C.

Hence, charge on each of the spheres, A and C, is. $\frac{q}{2}$

When sphere C with charge $\frac{q}{2}$ is brought in contact with sphere B with charge q, total charges on the system will divide into two equal halves given as,

$$\frac{\frac{q}{2}+q}{2}=\frac{3q}{4}$$

Each sphere will share each half. Hence, charge on each of the spheres, C and B, is. $\frac{3q}{4}$

Force of repulsion between sphere A having charge $\frac{q}{2}$ and sphere B having charge $\frac{3q}{4}=\frac{\frac{q}{2}\times\frac{3q}{4}}{4\pi\varepsilon_0 r^2}=\frac{3q^2}{8\times 4\pi\varepsilon_0 r^2}$

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

$$=\frac{3q^2}{8\times 4\pi\varepsilon_0 r^2}$$

$$9\times 10^9\times\frac{3\times\left(6.5\times 10^{-7}\right)^2}{8\times(0.5)^2}$$

$$9 \times 10^9 \times \frac{3 \times \left(6.5 \times 10^{-7}\right)^2}{8 \times (0.5)^2}$$

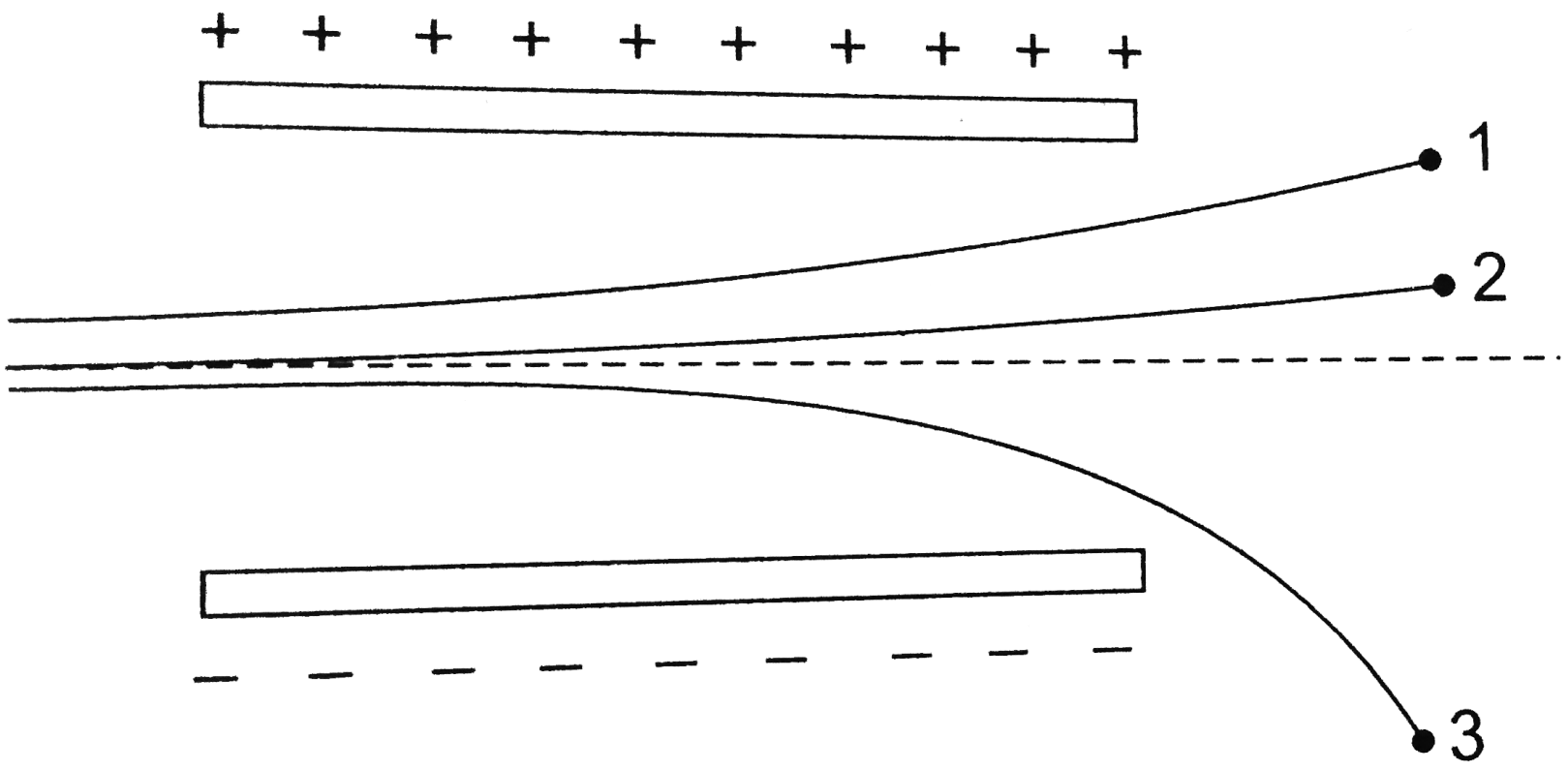
$$= 5.703 \times 10^{-3} N$$

Therefore, the force of attraction between the two spheres is $5.70310^{?3}N$.

View Text Solution On Doubtnut App

Exercise 1.14

Figure shows tracks of three charged particles crossing a uniform electrostatic field with same velocities along horizontal. Give the sign of the three charges. Which particle has the highest charge to mass ratio?



Watch Video Solution On Doubtnut App

Exercise 1.15

Consider a uniform electric field $E = 3 \times 10^3 \hat{i} N/C$. (a) What is the flux of this field through a square of 10 cm on a side whose plane is parallel to the yz plane ? (b) What is the flux through the same square if the normal to its plane makes a 60 angle with the x-axis ?

Watch Video Solution On Doubtnut App

Exercise 1.16

What is the net flux of the uniform electric field of Exercise 1.15 through a cube of side 20 cm oriented so that its faces are parallel to the coordinate planes?

Watch Video Solution On Doubtnut App

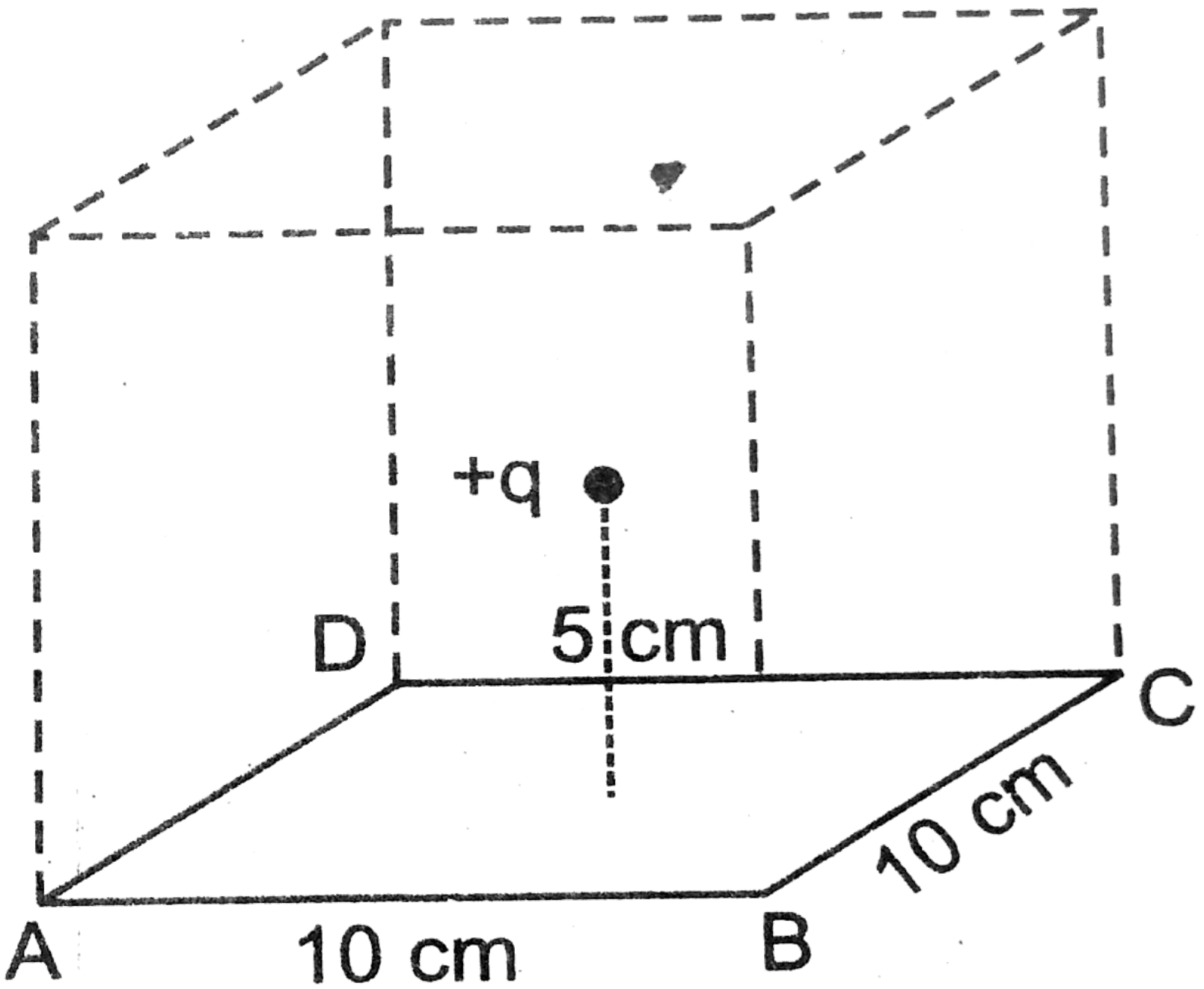
Exercise 1.17

Careful measurement of the electric field at the surface of a black box indicates that the net outward flux through the surface of the box is $8.0 \times 10^3 Nm^2/C$ (a) what is the net charge inside the box ? (b) If the net outward flux through the surface of the box were zero, could you conclude that there were no charges inside the box ? Why or why not?

Watch Video Solution On Doubtnut App

Exercise 1.18

A point charge $+10\mu C$ is at distance of 5cm directly above the center of a square of side 10 cm as shown in Fig. What is the magnitude of the electric flux through the square ? (Hint. Think of the square of the square as one face of a cube with edge 10 cm)



Watch Video Solution On Doubtnut App

Exercise 1.19

A point charge of $2.0\mu C$ is at center of a cublic Gaussian surface 9.0

cm on edge. What is the net electric flux through the surface?

Watch Video Solution On Doubtnut App

Exercise 1.20

A point charge causes an electric flux of $-1.0 \times 10^3 Nm^2/C$ to pass through a spherical Gaussian surface of 10.0 cm radius centred on the charge. (a) If the radius of the Gaussian surface were doubled, how much flux would pass through the surface ? (b) What is the is the value of the point charge ?

Watch Video Solution On Doubtnut App

Exercise 1.21

A conducting sphere fo radius 10 cm has an unknown charge. If the electric field 20 cm from the center of the sphere is $1.5 \times 10^3 N/C$ and points radilly inwards, what is the net charge on the sphere ?

Watch Video Solution On Doubtnut App

Exercise 1.22

A uniformly charged conducting sphere of 2.4m diameter has a surface density of $80.0\mu C/m^2$. (a) Find the charge on the sphere (b) What is the total electric flux leaving the surface of the sphere ?

Watch Video Solution On Doubtnut App

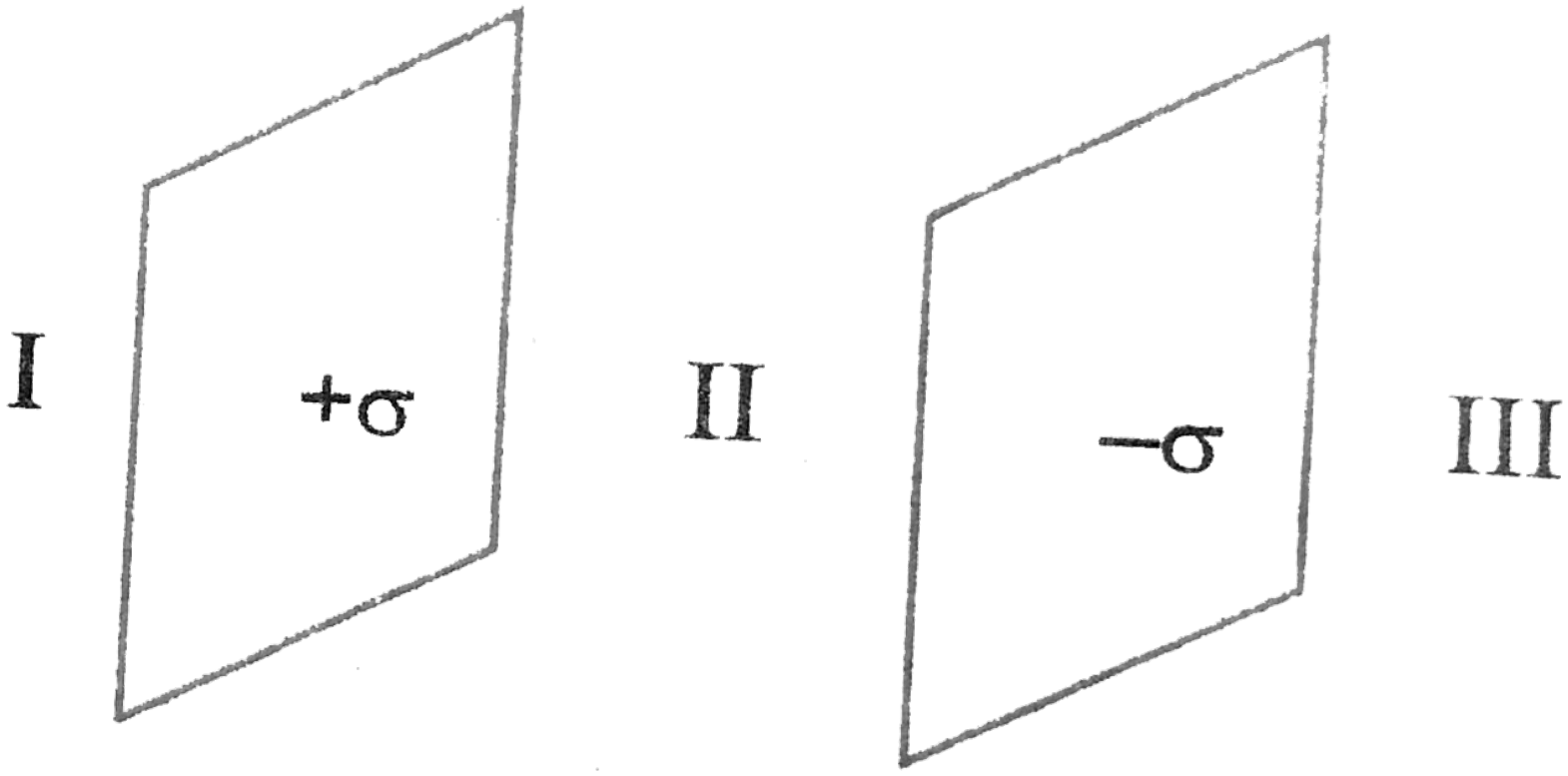
Exercise 1.23

An infinite line charge produces a field of $9 \times 10^{-4} N \quad C^{-1}$ at a distance of 2 cm. calculate the linear charge density.

Watch Video Solution On Doubtnut App

Exercise 1.24

Two large this metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and magnitude $17.0 \times 10^{-22} C/m^2$. What is $\vec{E}$: in the outer region of the first plate. (b) in the outer region of the secound plate, and (c) between the plates ? See Fig.



Watch Video Solution On Doubtnut App

Exercise 1.25

An oil drop of 12 excess electrons is held stationaty under a constant electric field of $2.55 \times 10^4 NC^{-1}$ in Millikan's oil drop experi,ment. The density of the oil is $1.26 gcm^{-3}$. Estimate the

radius of the drop. $\left(g = 9.81ms^{-2}, e = 1.60 \times 10^{19}C\right)$

$\left(g = 9.81ms^{-2}, e = 1.60 \times 10^{19}C\right)$

Watch Video Solution On Doubtnut App

Exercise 1.26

Which of the following curves shown below cannot possibly represent electrostatic field lines?

Watch Video Solution On Doubtnut App

Exercise 1.27

In a certain region of space, electric field is along the z-direction throughout. The magnitude of electric field is , however, not constant but increases uniformly along the positive z-direction. At the rate of $10^5 NC^{-1}m^{-1}$. What are the force and torque

experienced by system having a total dipole moment equal to 10^{-7} Cm in the negative z-direction?

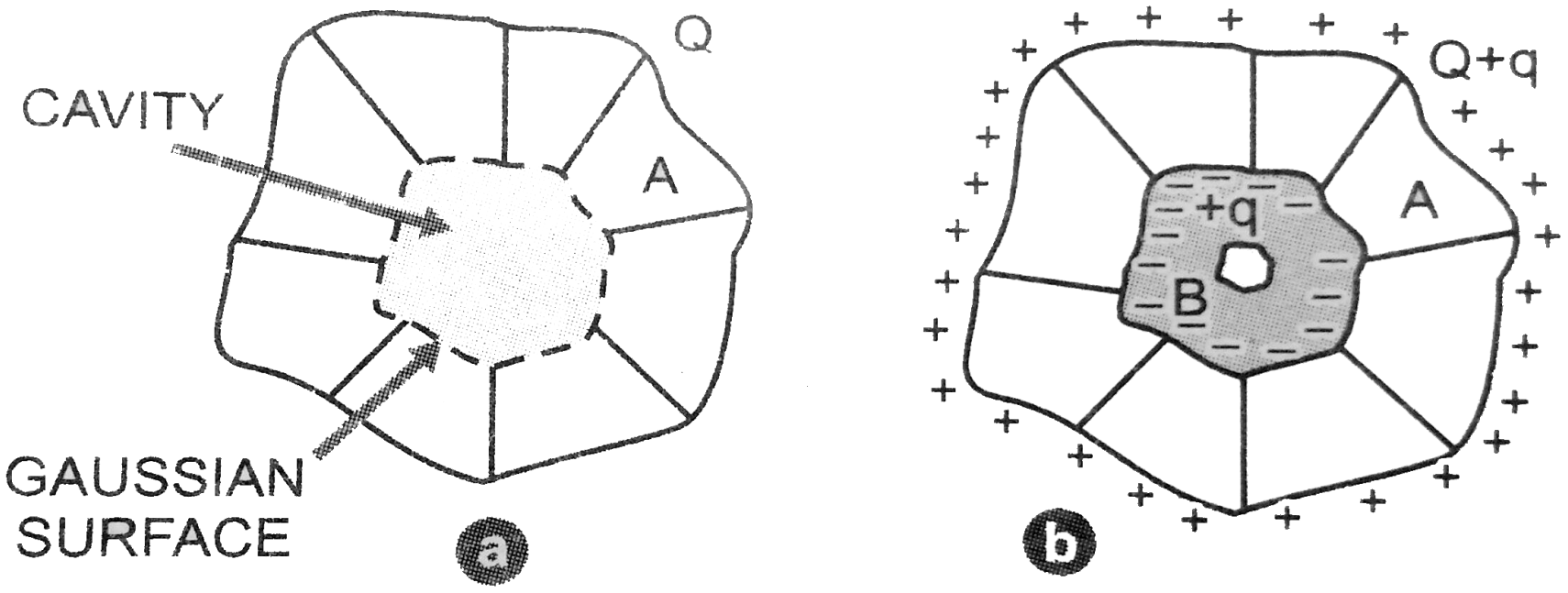
Watch Video Solution On Doubtnut App

Exercise 1.28

(a) A conductor A with a cavity as shown in Fig, is given a charge Q. Show that the entire charge must appear on the outer surface of the conductor.

(b) Another conductor B with charge q is inserted into the cavity keeping B insulated from A. Show that the total charge on the outside surface of A is $(Q + q)$ fig.

(c) A sensitive instrument is to be shielded from the strong electrostatic field in its environment. Suggest a possible way.



Watch Video Solution On Doubtnut App

Exercise 1.29

A hollow charged conductor has a tiny hole cut into its surface. Show that the electric field in the holes is $\left(\sigma/2 \in_0 \hat{n}\right.$, where $\hat{n}$ is the unit vector in the outward normal direction, and σ is the surface charge density near ther hole.

Watch Video Solution On Doubtnut App

Exercise 1.30

Obtain the formula for the electric field due to a long thin wire of

uniform linear charge density λ without using Gauss's law. [Hint.use Coulomb's law directly and evaluate the necessary integral].

Watch Video Solution On Doubtnut App

Exercise 1.31

It is now believed that protons and neutrons (which constitute nuclei of ordinary matter) are themselves built out of more elementary units called quarks. A proton and a neutron consist of three quarks each. Two types of quarks , the so called 'up' quark, (denoted by U) of charge $+(2/3)$ e and the 'down' quark (denoted by d) of charge $(-1/3)$ e together with electrons build up ordinary matter. (Quarks of each other types have also been found which give rise to different unusual varieties of matter). Suggest a possible quark composition of a proton and neutron.

Watch Video Solution On Doubtnut App

Exercise 1.32

(a) Consider an arbitrary electrostatic field configuration. A small test charge is placed at a null point (i.e, where $\vec{E} = 0$) of the configuration. Show that the equilibrium of the test charge is necessarily unstable.

(b) Verify this result for the simple configuration of two charges of the same magnitude and sign placed a certain distance apart.

Watch Video Solution On Doubtnut App

Exercise 1.33

A particle of mass m and charge (q) enters the region between the two charged plates initially moving along x-axis with speed vx (like particle 1 in Fig. 1.33). The length of plate is L and an uniform electric field E is maintained between the plates. Show that the vertical deflection of the particle at the far edge of the plate is

qEL2/(2m vx2). Compare this motion with motion of a projectile in gravitational field discussed in Section 4.10 of Class XI Textbook of Physics.

SOLUTION:

Charge on a particle of mass m = ? q

Velocity of the particle = V_X

Length of the plates = L

Magnitude of the uniform electric field between the plates = E

Mechanical force, F = Mass (m) $\times$ Acceleration (a)

$$a = \frac{F}{m}$$

However, electric force, $F = qE$

Therefore, acceleration, $a = \frac{qE}{m}$ ...(1)

Time taken by the particle to cross the fields of length L is given by,

$$t = \frac{\text{Length of the plate}}{\text{Velocity of the particle}} = \frac{L}{v_x} \quad ...(2)$$

$$t = \frac{\text{Length of the plate}}{\text{Velocity of the particle}}$$

$$= \frac{L}{v_x} \quad ...(2)$$

In the vertical direction, initial velocity, u = 0

According to the third equation of motion, vertical deflection s of the particle can be obtained as,

$$s = ut + \frac{1}{2}at^2$$

$$s = 0 + \frac{1}{2}\left(\frac{qE}{m}\right)\left(\frac{L}{v_x}\right)^2$$

$$s = 0 + \frac{1}{2}\left(\frac{qE}{m}\right)\left(\frac{L}{v_x}\right)^2$$

$$s = \frac{qEL^2}{2mv_x^2} \quad ...(3)$$

Hence, vertical deflection of the particle at the far edge

of the plate is

$qEL^2/\left(2mv_x^2\right)$. This is similar to the motion of horizontal projectiles under gravity.

View Text Solution On Doubtnut App

Exercise 1.34

Suppose that the particle in Exercise in 1.33 is an electron projected with velocity $vx = 2.0 \times 10^6 ms^1$. If E between the plates separated by $0.5 cmis 9.1 \times 10^2 N/\mathrm{C}$, where will the electron strike the upper plate? $\left(|e| = 1.6 \times 106(19)C, me = 9.1 \times 10^{31} kg\right)$
$\left(|e| = 1.6 \times 106(19)C, me = 9.1 \times 10^{31} kg\right)$

.

SOLUTION:

Velocity of the particle, $V_X = 2.0 \times 10^6 m/s$

Separation of the two plates, d = 0.5 cm = 0.005 m

Electric field between the two plates, E = $9.1 \times 10^2 N/C$

Charge on an electron, q = $1.6 \times 10^{-19} C$

Mass of an electron, $m_e = 9.1 \times 10^{-31}$ kg

Let the electron strike the upper plate at the end of plate

L, when deflection is s.

Therefore,

$$s = \frac{qEL^2}{2mv_x^2}$$

$$L = \sqrt{\frac{2dmv_x^2}{qE}}$$

$$= \sqrt{\frac{2 \times 0.005 \times 9.1 \times 10^{-31} \times \left(2.0 \times 10^6\right)^2}{1.6 \times 10^{-10} \times 9.1 \times 10^2}}$$

$$\frac{2 \times 0.005 \times 9.1 \times 10^{-31} \times \left(2.0 \times 10^6\right)^2}{1.6 \times 10^{-10} \times 9.1 \times 10^2}$$

$= 1.6 \times 10^{-2}$

= 1.6 cm

Therefore, the electron will strike the upper plate after travelling 1.6 cm.

View Text Solution On Doubtnut App

Solved Example 1

How can you charge a metal sphere negatively without touching it?

Watch Video Solution On Doubtnut App

Solved Example 2

If a body gives out 10^9 electrons every second, how much time required to get a total charge of $1C$ from it ?

Watch Video Solution On Doubtnut App

Solved Example 3

How much positive and negative charge is there in a cup of water ?

Watch Video Solution On Doubtnut App

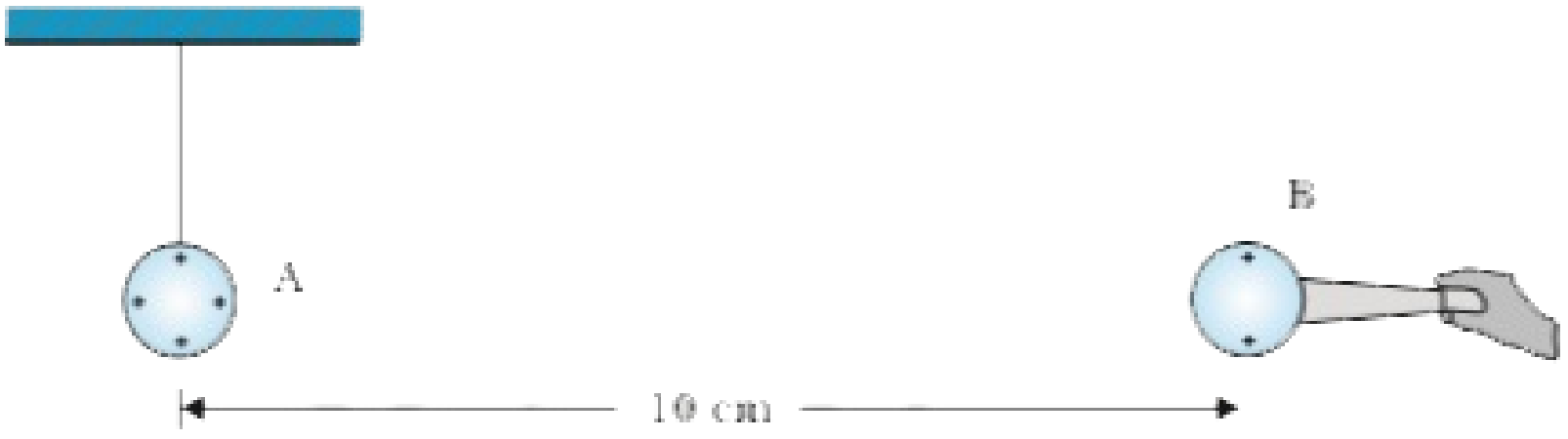
Solved Example 4

Coulomb's law for electrostatic force between two point charges and Newton's law for gravitational force between two stationary point masses, both have inverse square dependence on the distance between the charges/masees (a) compare the strength of these forces by determining the ratio of their maagnitudes (i) for an electron and as proton (ii) for two protons (b) estimate the accelerations for election and proton due to electrical force of their mutal attraction when they are 1 A apart.

Watch Video Solution On Doubtnut App

Solved Example 5

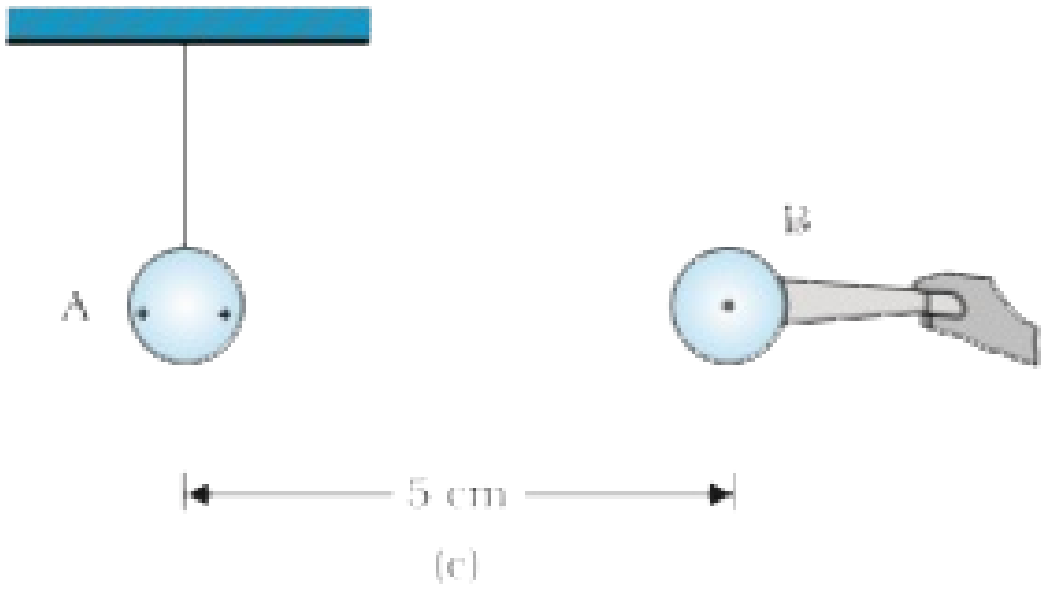
A charged metallic sphere A is suspended by a nylon thread. Another charged metallic sphere B held by an insulating handle is brought close to A such that the distance between their centres is 10 cm, as shown in Fig. 1.7(a). The resulting repulsion of A is noted (for example, by shining a beam of light and measuring the deflection of its shadow on a screen). Spheres A and B are touched by uncharged spheres C and D respectively, as shown in Fig. 1.7(b). C and D are then removed and B is brought closer to A to a distance of 5.0 cm between their centres, as shown in Fig. 1.7(c). What is the expected repulsion of A on the basis of Coulombs law? Spheres A and C and spheres B and D have identical sizes. Ignore the sizes of A and B in comparison to the separation between their centres.



(a)



(b)



(c)

Watch Video Solution On Doubtnut App

Solved Example 6

Consider three charges q_1, q_2 and q_3 each equal to q, at the vertices

of an equilateral triangle of side l. What is the force on a charge Q placed at the centroid of the triangle?

Watch Video Solution On Doubtnut App

Solved Example 7

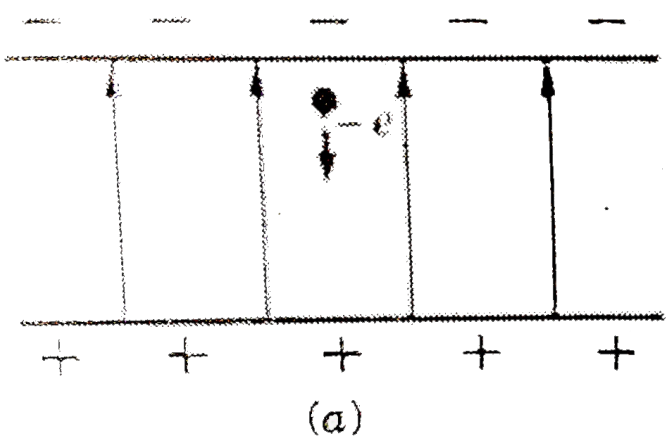
Consider the charges q,q and -q placed at the vertices of an equilateral triangle of each side l. What is the force on each charge ?

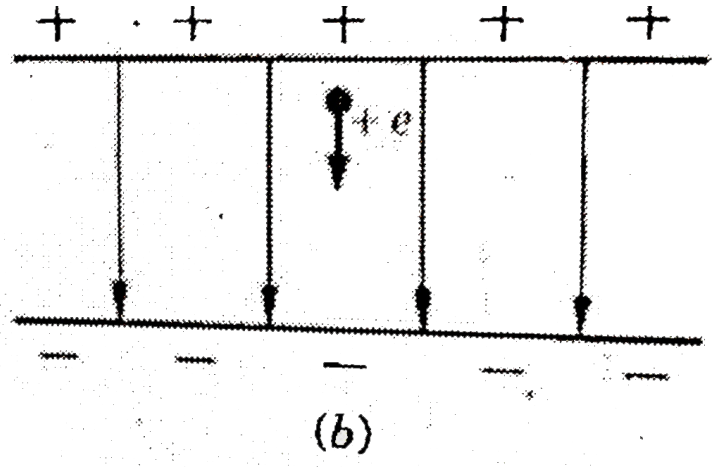
Watch Video Solution On Doubtnut App

Solved Example 8

An electron falls through a distance of 1.5 cm in a uniform electric field of magnitude $2.4 \times 10^4 NC^{-1}$ [Fig.1.12 (a)]`. The direction of the field is reversed keeping its magnitude unchagned and a proton falls through the same distance [Fig. 1.12 (b)]. Complute the time of fall in each case. Contrast the situation (a) with that of free fall

under gravity.

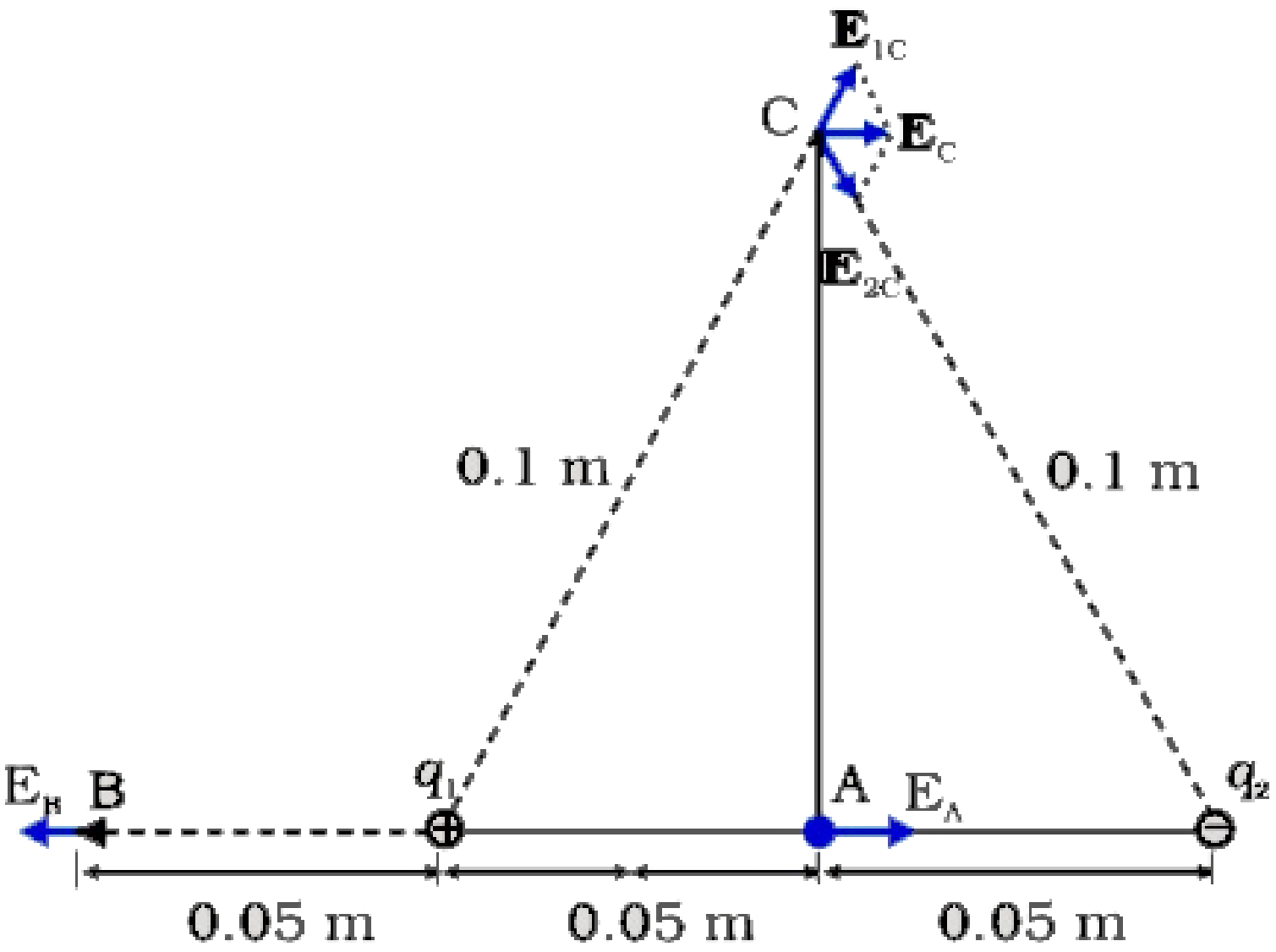




Watch Video Solution On Doubtnut App

Solved Example 9

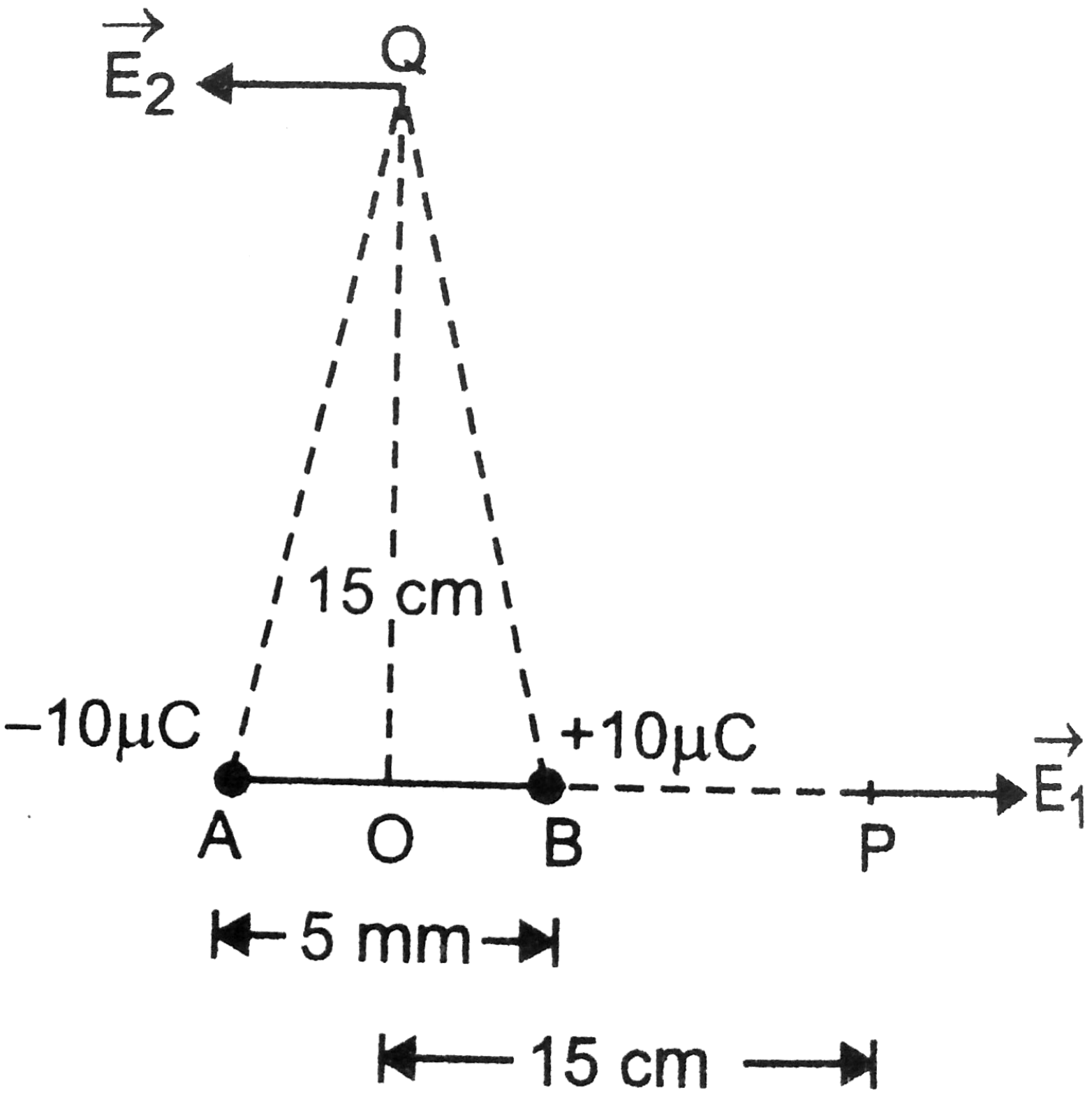
Two point charges q_1 and q_2, of magnitude $+10^8 C$ and $10^8 C$, respectively, are placed 0.1 m apart. Calculate the electric fields at points A, B and C shown in Fig. 1.14.



Watch Video Solution On Doubtnut App

Solved Example 10

Two charges $\pm 10\mu C$ are placed $5 \cdot 0mm$ apart. Determine the electric field at (a) point P on the axis of dipole $15cm$ away from its center on the side of the positive charge. As shown in Figure and at (b) a point Q. $15cm$ away form O on a line passing through O and a line passing through O and normal to the axis of the dipole as shown in Fig.



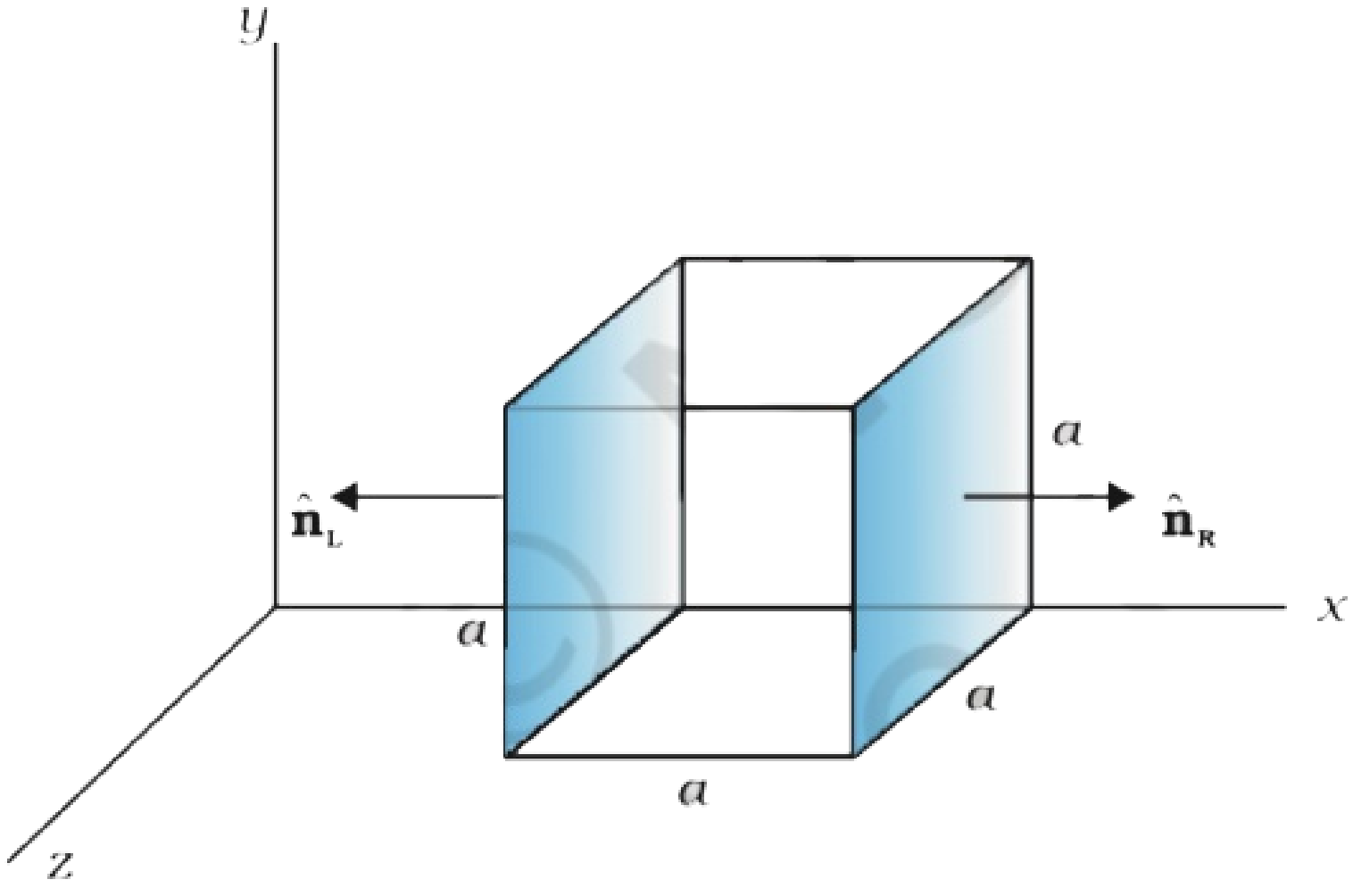
Watch Video Solution On Doubtnut App

Solved Example 11

The electric field components in Fig. 1.27 are

$E_x = \alpha x^{1/2}, E_y = E_z = 0,$ in which $\alpha = 800 N/Cm^{1/2}$. Calculate (a) the flux through the cube, and (b) the charge withing the cube.

Assume that $\alpha = 0.1m$.



Watch Video Solution On Doubtnut App

Solved Example 12

An electric field is uniform, and in the positive x-direction for positive x, and uniform with the same magnitude , but in the negative x-direction for negative x. It is given that $\vec{E} = 200\hat{i}N/Cf$ or $x > 0$ and $\vec{E} = -200\hat{i}N/C$ for x gt 0. A right circular cylinder of length 20 cm and raidus 5cm has its center at the origin and its axis along the x-axis so that one face is at $x = +10cm$ and the other is at $x = -10cm$.

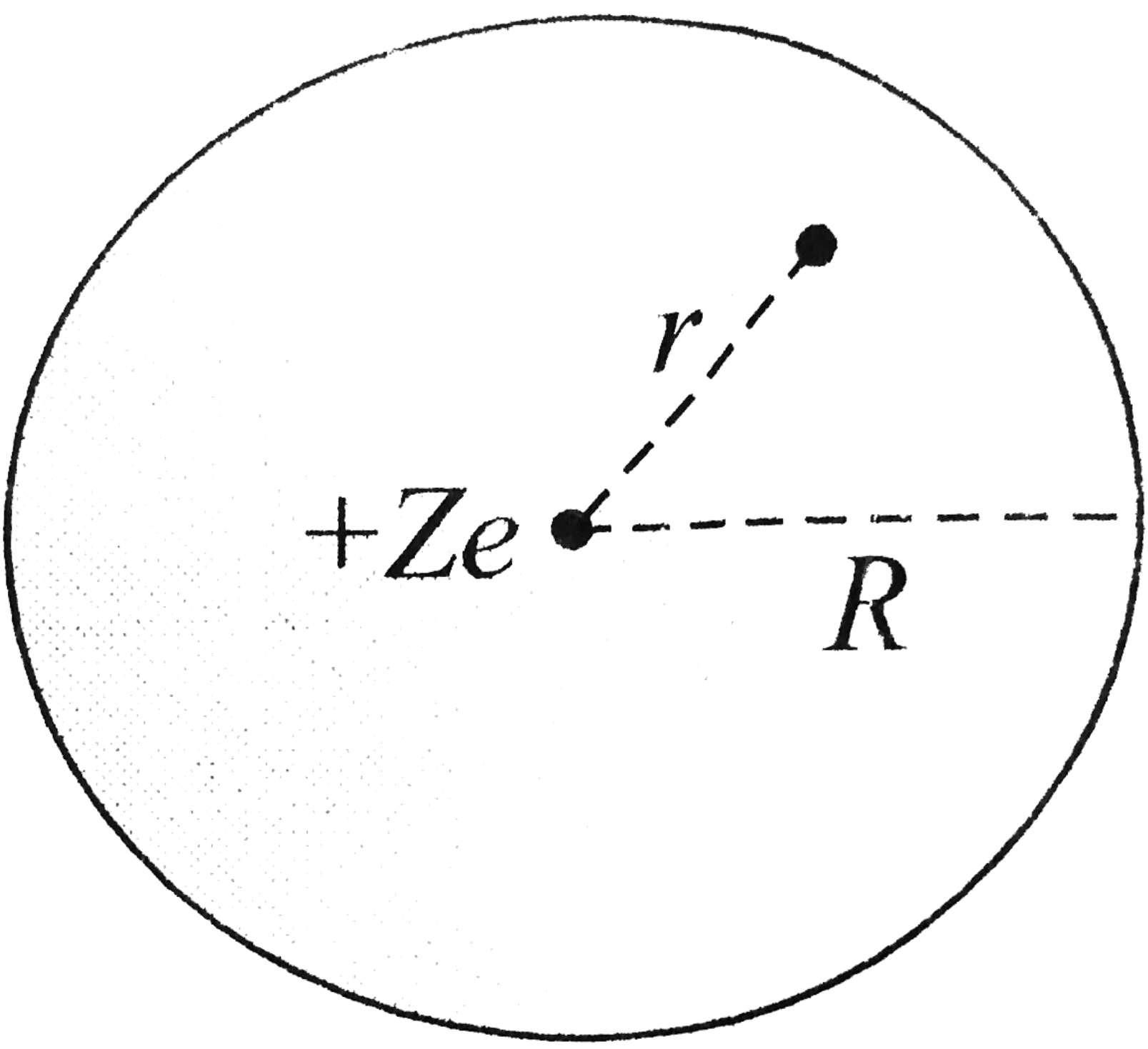
(a) What is the net outward flux through the side of the cylinder ?

(b) What is the net outward flux through the cyclinder ? (c) what is net charge inside the cylinder ?

Watch Video Solution On Doubtnut App

Solved Example 13

According to early model of an atom,the atom is considered it to have a positively charged point nucleus of charge Ze surrounded by a uniform density of negative charge up to a radius R. The atom as a whole is neutral. The electric field at a distance$r$ from the nucleus is $(r < R)$



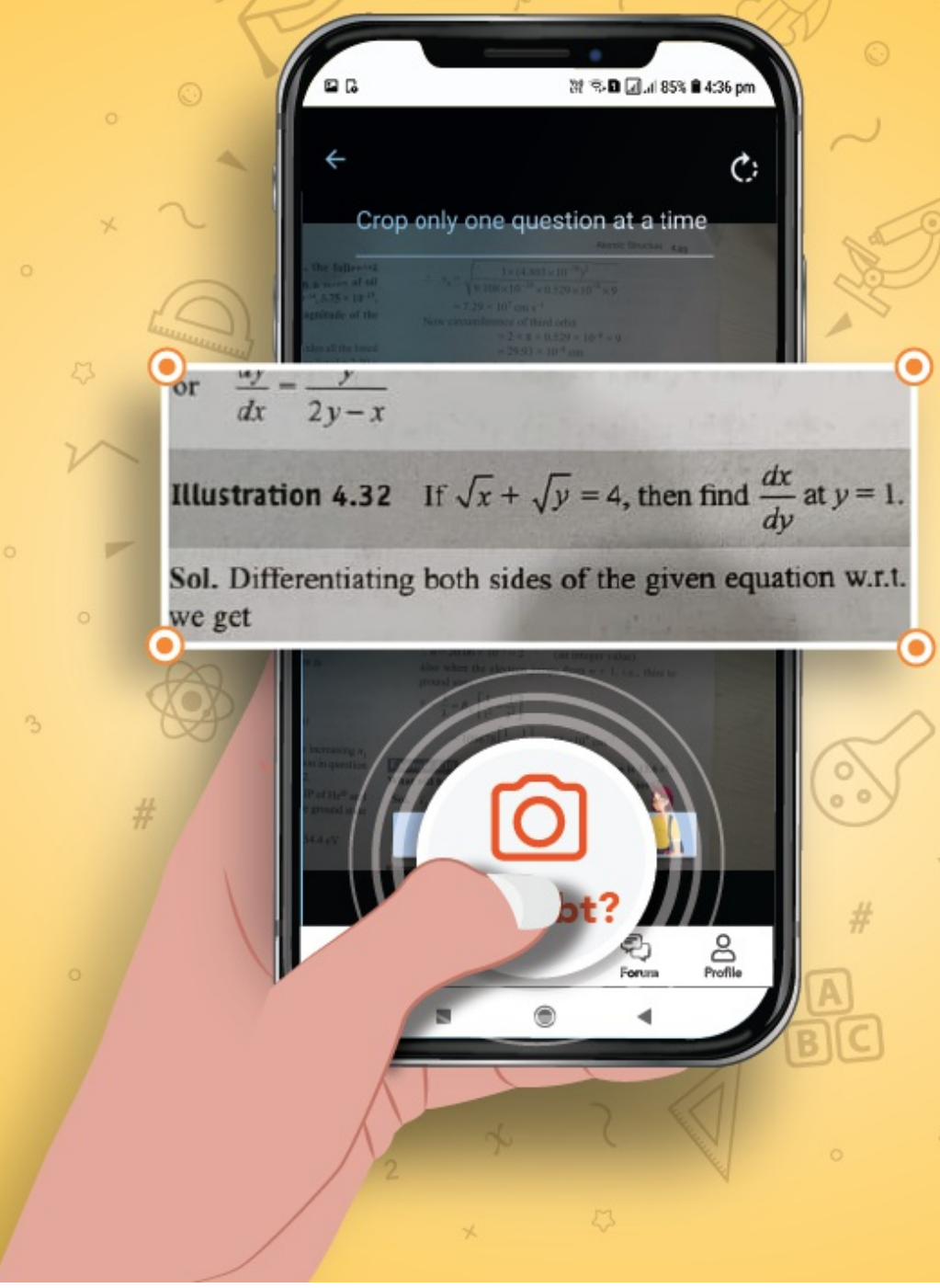
Watch Video Solution On Doubtnut App

Apne doubts ka Instant video solution paayein

Abhi Doubtnut try karein!

GET IT ON Google Play

Whatsapp your doubts on 8400400400



doubtnut