BYJU'S Home Learning Program

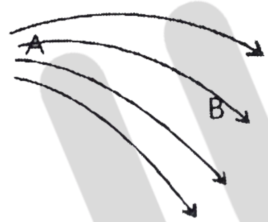
Topic covered:

- **Electrostatics (Session - 2) - NEET**

Daily Practice Problems

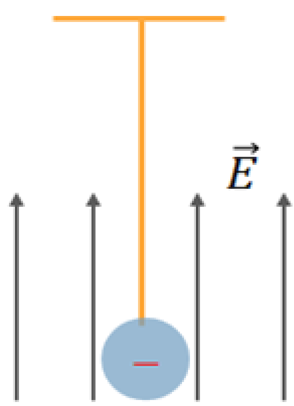
1. A charged oil drop is suspended in a uniform field of $3 \times 10^4\ V/m$ so that it neither falls nor rises. The charge on the drop will be (Take the mass of the charge $= 9.9 \times 10^{-15} kg$ and $g = 10\ m/s^2$)
   a. $1.6 \times 10^{-18} C$
   b. $4.0 \times 10^{-18} C$
   c. $3.3 \times 10^{-18} C$
   d. $4.8 \times 10^{-18} C$

2. Some electric lines of force are shown in figure. For points A and B

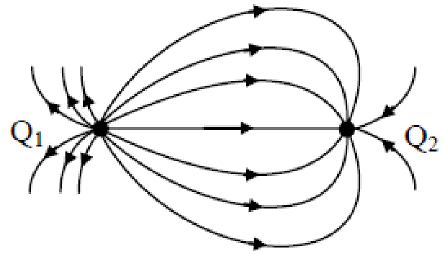


   a. $E_A > E_B$
   b. $E_B > E_A$
   c. $E_A = E_B$
   d. Can't say

3. A simple pendulum of time period T is suspended from roof. An uniform electric field exist in region as shown. If the bob is given some negative charge and displaced slightly, its time period of oscillation will be
   a. >T
   b. <T
   c. T
   d. Proportional to its amplitude

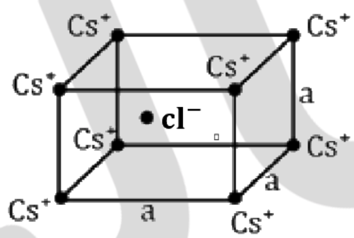


4. A few electric field lines for a system of two charges Q_1 and Q_2 fixed at two different points on the x-axis are shown in the figure. Then $\frac{Q_1}{Q_2}$ might be



a. $\frac{13}{9}$
b. $\frac{9}{13}$
c. 1
d. Can't say

5. In the basic $CsCl$ crystal structure, Cs^+ *and* Cl^- ions are arranged in a BCC configuration as shown in figure. The net electrostatic force exerted by the eight Cs^+ions on the Cl^- ion is



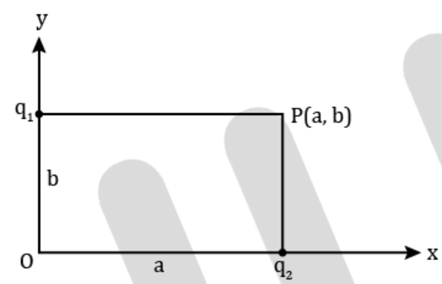
a. $\frac{1}{4\pi\epsilon_0}\frac{4e^2}{3a^2}$
b. $\frac{1}{4\pi\epsilon_0}\frac{16e^2}{3a^2}$
c. $\frac{1}{4\pi\epsilon_0}\frac{32e^2}{3a^2}$
d. Zero

6. Two equal point charges of 1μC each are located at points $(\hat{\imath}+\hat{\jmath}-\hat{k})$ m and $(2\hat{\imath}+3\hat{\jmath}+\hat{k})$ m. What is the magnitude of electrostatic force between them?
a. 10^{-3} N
b. 10^{-6} N
c. 10^{-9} N
d. 10^{-12} N

7. The magnitude of electric field at a distance x from a charge q is E. An identical charge is placed at a distance $2x$ from it. Then the magnitude of the electric force it experiences due to charge q is
a. qE
b. $2\,qE$
c. $\frac{qE}{2}$
d. $\frac{qE}{4}$

8. Two-point charges q_1 = +9μC and q_2 = (-1)μC are held 10 cm apart. Where should at third charge +Q be placed from q_2 on the line joining them so that charge Q does not experience any net force?
   a. 4 cm
   b. 5 cm
   c. 6 cm
   d. 7 cm

9. Two-point charges q_1 = 2μC and q_2 = 1μC are placed at distances b = 1 cm and a = 2 cm from the origin on the y and x - axes as shown in figure. The electric field vector at point P (a, b) will subtend an angle θ with the x - axis given by
   a. tan θ = 1
   b. tan θ = 2
   c. tan θ = 3
   d. tan θ = 4



10. Two equal negative charges $-q$ are fixed at points $(0, a)$ and $(0, -a)$ on the y-axis. A positive charge Q is released from rest at a point $(2a, 0)$ on the x-axis. The charge q will
   a. execute simple harmonic motion about the origin
   b. move to the origin and remain at rest there
   c. move to infinity
   d. may execute oscillatory but not simple harmonic motion.

Answer Key

Question Number	1	2	3	4	5	6
Answer Key	(c)	(a)	(b)	(a)	(d)	(a)

Question Number	7	8	9	10
Answer Key	(d)	(b)	(b)	(d)

Solutions

1. (c)

$$qE = mg$$

$$\Rightarrow q = \frac{mg}{E} = \frac{9.9 \times 10^{-15} \times 10}{3 \times 10^{4}} = 3.3 \times 10^{-18} C$$

2. (a)

Lines are denser at A. So, $E_A > E_B$ in the direction of electric field.

3. (b)

Effective acceleration due to gravity, $g' = g + \frac{F_e}{m}, F_e \rightarrow$ electrostatic force

$\Rightarrow$ there is an increase in the value of effective acceleration due to gravity.

$\Rightarrow$ T will be reduced as $T \alpha \frac{1}{\sqrt{g}}$. Hence option (b) is correct.

4. (a)

As, $Q \propto$ No. of electric field line going out or coming in.

So, $\frac{Q_1}{Q_2} = \frac{\{no.of\ electric\ field\ line\ going\ out\ \ at\ Q_1\}}{\{no.of\ electric\ field\ line\ coming\ in\ \ at\ Q_2\}} = \frac{13}{9}$

5. (d)

The electrostatic force is F= $\frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2}$

One Cs^+ ion is balanced by diagonally opposite Cs^+ ion. Hence net electrostatic on Cl^- ion due to eight ions is zero.

6. (a)

Position vector of one charge particle w.r.t. other is given by,

r = $(2\hat{\imath} + 3\hat{\jmath} + \hat{k}) - (\hat{\imath} + \hat{\jmath} - \hat{k}) = (\hat{\imath} + 2\hat{\jmath} + 2\hat{k})$ m.

The magnitude of **r** is

r = $\sqrt{1^2 + 2^2 + 2^2}$ = $\sqrt{1 + 4 + 4}$ = 3 m

$F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2} = \frac{9 \times 10^9 \times 10^{-6} \times 10^{-6}}{(3)^2} = 10^{-3}$ N

7. (d)

Given, $E = \frac{q}{4\pi\varepsilon_0 x^2}$.

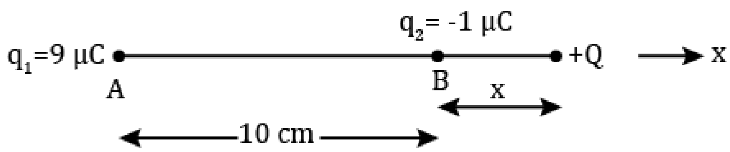
Hence the magnitude of the electric field at a distance $2x$ from charge q is

E' = $\frac{q}{4\pi\varepsilon_0 (2x)^2} = \frac{q}{4\pi\varepsilon_0 x^2} \times \frac{1}{4} = \frac{E}{4}$

Therefore, the force experienced by a similar charge q at a distance $2x$ is

$$F = qE' = \frac{qE}{4}$$

8. (b)
Charge Q will not experience any net force if the force exerted on it by charges q_1 and q_2 are equal and opposite in directions.



It follows from figure, that charge Q will not experience forces in opposite direction if it lies at any point between AB. Let x be the distance of Q from q_2. Then forces exerted on Q by q_1 and q_2 respectively are

$$F_1 = \frac{q_1 Q\hat{\imath}}{4\pi\varepsilon_0(0.1+x)^2} = \frac{9\times10^{-6}Q\hat{\imath}}{4\pi\varepsilon_0(0.1+x)^2}$$

and $$F_2 = -\frac{q_2 Q\hat{\imath}}{4\pi\varepsilon_0 x^2} = -\frac{1\times10^{-6}Q\hat{\imath}}{4\pi\varepsilon_0 x^2}$$

Net force on Q = $F_1 + F_2$
Net force on Q is zero if $F_1 + F_2 = 0$

$$\Rightarrow \quad \frac{9\times10^{-6}Q\hat{\imath}}{4\pi\varepsilon_0(0.1+x)^2} - \frac{1\times10^{-6}Q\hat{\imath}}{4\pi\varepsilon_0 x^2} = 0$$

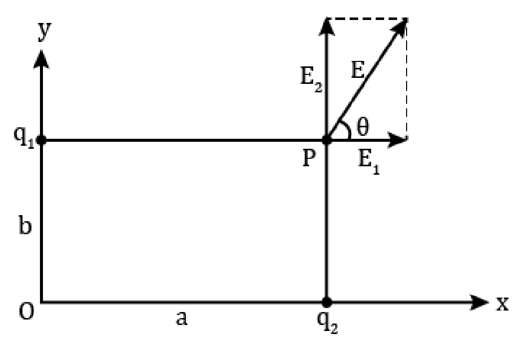
$$\Rightarrow \quad 9 = \frac{(0.1+x)^2}{x^2}$$

$\Rightarrow \quad 3 = \frac{0.1+x}{x}$ (ignore negative sign, as we get negative value of x)

$\Rightarrow \quad$ x = 0.05 m = 5 cm

9. (b)
The electric field E_1 at P due to q_1 has a magnitude

$$E_1 = \frac{1}{4\pi\varepsilon_0}\cdot\frac{q_1}{a^2}$$



and is directed along + x-axis.
The electric field E_2 at P due to q_2 has a magnitude.

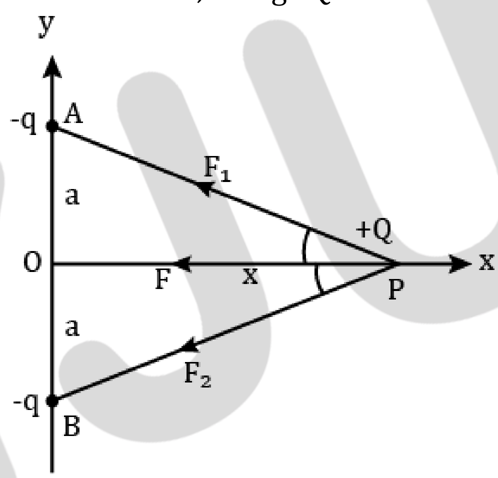
$$E_2 = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q_2}{b^2}$$

and is directed along + y-axis.
The angle θ subtended by the resultant field E with the x-axis is given by

$$\tan\theta = \frac{E_2}{E_1} = \frac{q_2}{q_1} \cdot \frac{a^2}{b^2} = \frac{1}{2} \times \left(\frac{2}{1}\right)^2 = 2$$

Hence the correct choice is (b).

10. (d)
Let the charge Q be at P, with $OP = x$. The resultant force F is along the x-axis directed towards the origin. The charge Q moves to O, and acquires kinetic energy. It will cross O and move to $-ve$ x-axis until it comes to rest. It is again attracted towards O and crosses it and this process continues. Therefore, charge Q executes oscillatory motion.



Let AP = BP = r. Then

$$F_1 = F_2 = \frac{qQ}{4\pi\varepsilon_0 r^2}$$

The resultant force on Q is

$$F = F_1 \cos\theta + F_2 \cos\theta = \frac{2qQ}{4\pi\varepsilon_0 r^2}\cos\theta$$

$$F = \frac{2qQ}{4\pi\varepsilon_0 r^2} = \frac{2qQ}{4\pi\varepsilon_0}\frac{x}{(a^2+x^2)^2}$$

Thus, F is not of the form $F = kx$ (where k = constant) and hence the motion is not simple harmonic.
Hence the correct choice is (d).