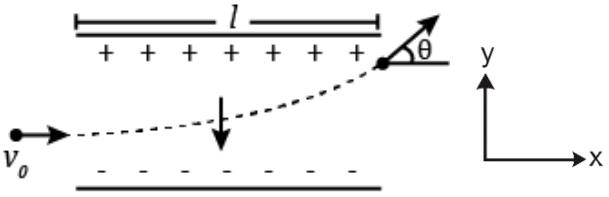
DPP – 2

ELECTRIC FIELD

Q.1 The electric force experienced by a charge of 5×10^{-6}C is 25×10^{-3} N. Find the magnitude of the electric field at that position of the charge due to the source charges.

Q.2 A uniform electric field $E = 91 \times 10^{-6}$ V/m is created between two parallel, charged plates as shown in figure. An electron enters the field symmetrically between the plates with a speed $v_0 = 4 \times 10^3$ m/s. The length of each plate is $\ell = 1$ m. Find the angle of deviation of the path of the electron as it comes out of the field. (Mass of the electron is $m = 9.1 \times 10^{-31}$ kg and its charge is $e = -1.6 \times 10^{-19}$C).



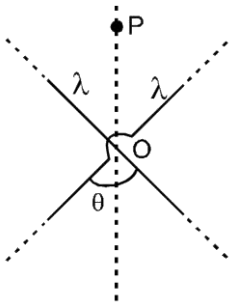
Q.3 Two point particles A and B having charges of 4×10^{-6}C and -64×10^{-6}C respectively are held at a separation of 90 cm. Locate the point(s) on the line AB or on its extension where the electric field is zero

Q.4 Three point charges q_0 are placed at three corners of square of side a. Find out electric field intensity at the fourth corner.

Q.5 Two point charges 3μC and 2.5μC are placed at point A(1,1,2)m and B(0,3, −1)m respectively. Find out electric field intensity at point C(3,3,3)m.

Q.6 (i) Two infinitely long line charges each of linear charge density λ are placed at an angle θ as shown in figure. Find out electric field intensity at a point P, which is at a distance x from point O along angle bisector of line charges.

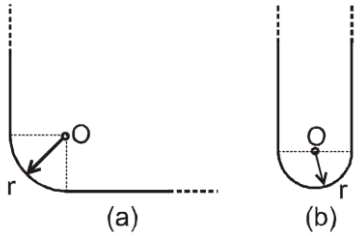
(ii) Repeat the above question if the line charge densities are λ and −λ. as shown in figure.



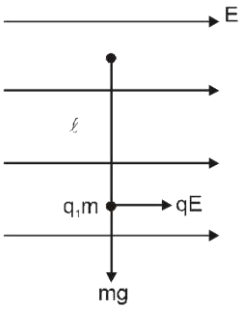
Q.7 The bob of a simple pendulum has a mass of 60 g and a positive charge of 6×10^{-6}C. It makes 30 oscillations in 50 s above earth's surface. A vertical electric field pointing upward and of magnitude 5×10^4 N/C is switched on. How much time will it now take to complete 60 oscillations?

$(g = 10\ m/s^2)$

Q.8 A thread carrying a uniform charge λ per unit length has the configuration shown in figure a and b. Assuming a curvature radius r to be considerably less than the length of the thread, find the magnitude of the electric field strength at the point O.

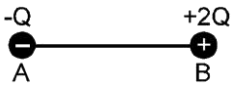


Q.9 A simple pendulum has a length ℓ & mass of bob m. The bob is given a charge q coulomb. The pendulum is suspended in a uniform horizontal electric field of strength E as shown in figure, then calculate the time period of oscillation when the bob is slightly displaced from its mean position.



(A) $2\pi\sqrt{\frac{\ell}{g}}$ (B) $2\pi\sqrt{\left\{\frac{\ell}{g+\frac{qE}{m}}\right\}}$ (C) $2\pi\sqrt{\left\{\frac{\ell}{g-\frac{qE}{m}}\right\}}$ (D) $2\pi\sqrt{\frac{\ell}{\sqrt{g^2+\left(\frac{qE}{m}\right)^2}}}$

Q.10 Charges 2Q and $-Q$ are placed as shown in figure. The point at which electric field intensity is zero will be:



(A) Somewhere between $-Q$ and 2Q

(B) Somewhere on the left of $-Q$

(C) Somewhere on the right of 2Q

(D) Somewhere on the perpendicular bisector of line joining $-Q$ and 2Q

Q.11 The maximum electric field intensity on the axis of a uniformly charged ring of charge q and radius R will be:

(A) $\frac{1}{4\pi\varepsilon_0}\frac{q}{3\sqrt{3}R^2}$ (B) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{3R^2}$ (C) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{3\sqrt{3}R^2}$ (D) $\frac{1}{4\pi\varepsilon_0}\frac{3q}{2\sqrt{3}R^2}$

Q.12 A charged particle of charge q and mass m is released from rest in a uniform electric field E. Neglecting the effect of gravity, the kinetic energy of the charged particle after time ' t ' seconds is

(A) $\frac{Eqm}{t}$ (B) $\frac{E^2q^2t^2}{2m}$ (C) $\frac{2E^2t^2}{mq}$ (D) $\frac{Eq^2m}{2t^2}$

Q.13 A flat circular fixed disc has a charge $+Q$ uniformly distributed on the disc. A charge $+q$ is thrown with kinetic energy K, towards the disc along its axis. The charge q :

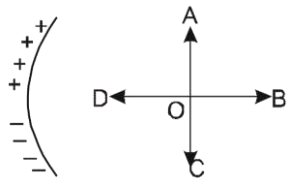
(A) may hit the disc at the centre

(B) may return back along its path after touching the disc

(C) may return back along its path without touching the disc

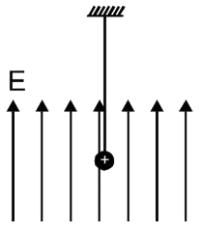
(D) any of the above three situations is possible depending on the magnitude of K

Q.14 The linear charge density on upper half of a segment of ring is λ and at lower half, it is $-\lambda$. The direction of electric field at centre O of ring is :



(A) along OA (B) along OB (C) along OC (D) along OD

Q.15 A positively charged pendulum is oscillating in a uniform electric field as shown in Figure. Its time period of SHM as compared to that when it was uncharged.



(mg > qE)

(A) Will increase (B) Will decrease

(C) Will not change (D) Will first increase then decrease

Q.16 Under the influence of the Coulomb field of charge +Q, a charge −q is moving around it in an elliptical orbit. Find out the correct statement(s). **[JEE 2009, 4/160, -1]**

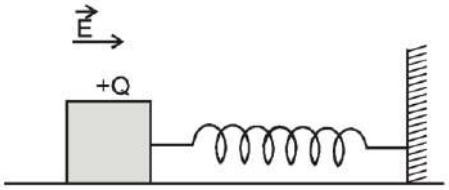
(A) The angular momentum of the charge −q is constant.

(B) The linear momentum of the charge −q is constant.

(C) The angular velocity of the charge −q is constant.

(D) The linear speed of the charge −q is constant.

Q.17 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 E is switched-on as shown, then the SHM of the block will be **[JEE 2011, 3/160, -1]**



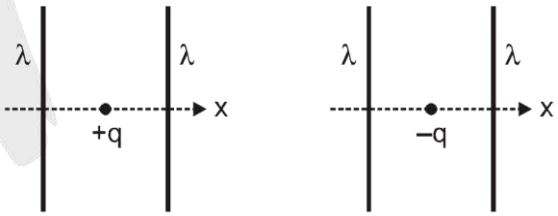
(A) of the same frequency and with shifted mean position.

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

(C) of changed frequency and with shifted mean position.

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

Q.18 The figures below depict two situations in which two infinitely long static line charges of constant positive line charge density λ are kept parallel to each other. In their resulting electric field, point charges q and −q are kept in equilibrium between them. The point charges are confined to move in the x-direction only. If they are given a small displacement about their equilibrium positions, then the correct statement (s) is (are): **[JEE (Advanced) 2015; P − 1 4/88, -2]**



(A) Both charges execute simple harmonic motion.

(B) Both charges will continue moving in the direction of their displacement.

(C) Charge +q executes simple haramonic motion while charge −q continues moving in the direction of its displacement.

(D) Charge −q executes simple haramonic motion while charge +q continues moving in the direction of its displacement.

ANSWER KEY

1. $\frac{F}{q} = 5 \times 10^3$ N/C

2. The electron deviates by an angle $\theta = \tan^{-1}\frac{eE\ell}{mv_0^2}$ (from x axis) $= 45°$

3. 30 cm from A along BA

4. $\left(\sqrt{2}+\frac{1}{2}\right)\frac{Kq_0}{a^2}$

5. $2540\hat{i} + 2000\hat{j} + 1720\hat{k}$N/C

6. (i) $\frac{4K\lambda}{x}$; along OP. (ii) $\frac{4K\lambda}{x}\cot\frac{\theta}{2}$; Perpendicular to OP.

7. $100\sqrt{2} \approx 141$ s

8. (a) $E = \frac{\sqrt{2}\lambda}{4\pi\epsilon_0 r}$ (b) $E = 0$

9. (D)

10. (B)

11. (C)

12. (B)

13. (D)

14. (C)

15. (A)

16. (A)

17. (A)

18. (C)