ASSIGNMENT-3

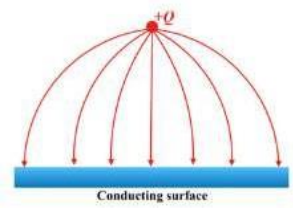
ANSWER KEY

(1 MARK QUESTION)

1. d

2. If two lines of forces intersect, then there would be two tangents and two directions of electric field at the point of intersection, which is impossible.

3. c

4. 

5. Work done by field is negative. Since charge is moved against the force exerted by the field.

6. q_1 and q_2 must be -ve charges. As field lines are pointing towards q_1 and q_2.

7. The electric field due to the system of two charges will be zero at a point to the right of charge.

MCQ Types Question

8. (a) Explanation: Let net electric field due to two given charges be zero at P, where OP = x

$E_{AP} = B_{BP} = K8q/x^2 = K(2q)/(x - L)^2$ or $2/x = 1/x\text{-}L$

Or $2x - 2L = x$

$X = 2L$

Assertion/Reasoning

9. (A) 10. (B) 11. (C) 12.(B) 13. (D) 14.b) $4\pi\epsilon_o Aa^3$

15.a) $\frac{q}{6g_o}$ 16. Gauss' Theorem in electrostatics

17. Flux through each face = $\frac{q}{6g_o}$

Flux through two opposite faces = $\frac{q}{6g_o} + \frac{q}{6g_o} = \frac{q}{3g_o}$

Answer for Two-mark questions

18. Refer from textbook

19. Electric field intensity at a point defined as the electrostatic force per unit test charge acting on a vanishingly small positive test charge placed at that point .

SI unit of intensity is N/C.

Electrostatic force = charge x electric field.

20. E at origin, $E = 9x10^9 [4x10^{-6}/ (1)^2 + 4x10^{-6}/22] + ----$

$= 36x10^3[1+1/22+1/42 +--]$

(Geometric series)

Therefore, Sum = a/1-r

a= first term = 1

r = common ratio = ¼

$E= 36x10^3 x1/ (1-1/4) = 48x10^3$

21. 4th

Explanation: When metallic solid sphere is placed in uniform electric field the electrons of the sphere move against the direction of electric field. Consequently, the left face acquires negative charge while the right face attains +ve charge. The filed lines will terminate at the left face of sphere and restart from right face. The electric field inside the sphere is zero. On the other surface of the sphere, the filed lines are normal at energy point. i.e., directed towards the centre. Therefore, the correct field is represented.

22. Refer from NCERT textbook

23. The total charge enclosed by a surface is zero, it doesn't imply that the electric field everywhere on the surface is zero. As $\oint_s \vec{E} \cdot \vec{dS} = q/\epsilon_o$, therefore, the field may be normal to the surface.

Also, the conversely it does imply that net charge inside is zero if electric field everywhere on the surface is zero.

24. Here, $\lambda = \frac{dq}{dx} = Kx$; ϕ=?

$dq = Kx\, dx$

Total charge on the wire

$q = \int_0^L Kx\, dx = [\frac{Kx^2}{2}] = KL^2/2$

Total electric flux through the Gaussian hollow surface is

$\Phi = q/\epsilon_o = KL^2/2\epsilon_o$

25. (a) d=2.4m r=1.2m

Surface charge density, $\sigma = 180.0\ \mu C/m^2 = 180 \times 10^{-6} C/m^2$

Total charge on surface of sphere,

$Q = \sigma \times 4\pi r^2 = 180 \times 10^{-6} \times 4 \times 3.14 \times (1.2)^2$

$= 3.25 \times 10^{-3}$ C

(a) $\Phi_{Total} = Q/\epsilon_o$

$\Phi_{Total} = \frac{3.25 * 10^{-3}}{8.85 * 10^{-12}} = 3.67 \text{ X } 10^8 \text{ Nm}^2\text{C}^{-1}$

26. Here, q= 17.7 x 10^{-4} C, A= 400 cm^2, E=?, r =10 cm = 10^{-1}m

In case of a large plane sheet, distance of the point (=r) doesn't matter.

$E = \sigma/2\epsilon_o = q/2\epsilon_o A = \frac{17.7 * 10^{-4}}{2 * (8.85 * 10^{-12}) * 400} = 2.5 \text{ x } 10^5$ N/C

27. Here, $\sigma = 5 \text{ x } 10^{-16}$ Cm^{-2}, ϕ=?

r= 1 cm =10^{-2}m, $\theta = 60^o$

$\phi = E(\Delta S)\cos\theta = (\sigma/2\epsilon_o)\,\pi r^2 \cos 60^o$

$= \frac{5 * 10^{-16} * 3.14 * (10^{-4}) * 1/2}{2 * 8.85 * 10^{-12}} = 4.44 \text{ x } 10^{-9} \text{Nm}^2\text{C}^{-1}$.

Answer to Three-mark questions

28. Refer from NCERT textbook

29. For electron

Y_1= 1.5 cm = 1.5 x10^{-2}m

$E_1 = 2x10^4$N/C

q_0 = (-) 1.6x10^{-19} C

$m_1 = 9x10^{-3}$ kg

$Y_1 = u_1 t_1 + \frac{1}{2} a_1 t_1^2$

$= 0 + \frac{1}{2} a_1 t_1^2$

$t_1 = \sqrt{\frac{2y_1}{a_1}} = \sqrt{\frac{2 \times 1 \cdot 5 \times 10^{-2}}{3.55 \times 10^{15}}} = 2.9 \text{ X } 10^{-9}$sec

therefore,

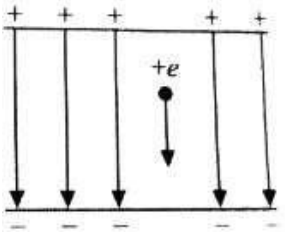
$a_1 = F_1/m_1 = q_0 E_1/m_1$

$a_1 = 1.6 \text{ x } 10^{-19} \text{x } 2 \text{ x } 10^4 / 9 \text{ x } 10^{-37}$

$a_1 = 3.55 \text{ x } 10^{15}$ m/s^2

For proton

When electric field is reversed



$q_0 = +1.6 \times 10^{-19}$C.

$m_2 = 1.67 \times 10^{-27}$kg.

acceleration $a_2 = F_2/m_2 = q_0E/m_2$

a = 1.6 x 10 -19x 2 x 104/ 1.67 x 10-27 = 1.92 x 1012 m/s2

Similarly, $t2 = \sqrt{\frac{2y_2}{a_2}} = \sqrt{\frac{2\times1.5\times10^{-2}}{1.92\times10^{12}}}$

t1/t2 = 2.9 x 10-9/1.25 x 10-7 = 2.3 x 10-2

Observation:

Acceleration of $e^- = 10^{15}$ m/s^2

Acceleration of $p^+ = 10^{12}$ m/s^2

Acceleration of g = 9.8 m/s^2 = 10 m/s^2 (negligible), Effect of gravity can be ignored.

30. a) When we consider the charged particle to be placed at the centre of the cube whose side is 2a, then the charge is equally distributed among 8 cubes. Therefore, the total flux through the faces of the cube=q/8 ϵ_o.

b) When the charge is placed at B, the charge is equally distributed among the 4 cubes. Therefore, the total flux through the four faces is given as = q/4 ϵ_o.

c) When the charge is placed at C, the charge is shared among 2 cubes equally. Therefore, the total flux through these faces is given as = q/2 ϵ_o.

d) When the charge is place at D, the charge is distributed among two cubes and therefore, the total flux is given as = q/2 ϵ_o.

31. Here, $\vec{E} = 30 \times 10^3 \hat{t}$ NC^{-1}

A= 10^{-2} m^2

(a) As normal to the area is in the direction of electric field, therefore $\theta = 0^o$

$\Phi = EA \cos\theta = 30\times10^3\times10^{-2} \cos 0^0$
$= 300 Nm^2C^{-1}$

(b) In this case, $\theta = 60^o$

$\Phi` = EA \cos\theta = 30\times10^3\times10^{-2} \cos 60^0$
$= 150\ Nm^2C^{-1}$.

(c) In this case, $\theta=90^o$

$\Phi= EA \cos\theta= 30x10^3x10^{-2} \cos 90^0$

$= 0\ Nm^2C$

32. Through the left face

$\Phi_1= E_x. A \cos 180^o$

$=500 \times 0.1 \times 10^{-2}(-1) = -0.5$

Through the right face

$\Phi_2= E_x. A \cos 0^o$

$=500 \times 0.2 \times 10^{-2}= 1.0$

$\therefore$ Net flux through the cube

$\Phi=\Phi_1+\Phi_2= 0.5\ Nm^2C^{-1}$

Charge inside the cube $=\epsilon_o\Phi$

$= 8.85 \times 10^{-12} \times 0.5= 4.425 \times 10^{-12}$ C.

Answer to Five-mark questions

Q33. Refer from NCERT textbookQ34. Refer from NCERT textbook

1. b 2. a 3. d 4. a 5. c

Q35. 1. d 2. b 3. d 4. c 5. a