Solution

HPC-ONLINE-A22+B22

Class 12 - Physics

1. **(b)** $\sqrt{3}\frac{a\lambda}{\epsilon_0}$

   Explanation: The maximum length of string that can be fit into cube is $\sqrt{3}a$ which is equal to the length of body diagonal. So, the charge inside the cube is $\sqrt{3}\ \lambda a$

   So, flux $\phi = \frac{q}{\in_0} = \frac{\sqrt{3}\ \lambda a}{\in_0}$

2. **(b)** Zero

   Explanation: By the symmetry, electric field at center due to each elements will cancel out each other and hence net electric field at center will be zero.

3. **(d)** rubbing

   Explanation: The triboelectric effect is a type of contact electrification on which certain materials become electrically charged after they come into frictional contact with a different material.

   Or by rubbing the body having the lower work function loses the electron and becomes positive and another body gains the electron becomes negative.

4. **(d)** None of the above.

   Explanation: F = $\frac{1}{4\pi\varepsilon_0} \cdot \frac{q_1 q_2}{r^2}$

   F' = $\frac{1}{4\pi\varepsilon_0} \cdot \frac{2q_1 \times 2q_2}{(r/2)^2}$ = 16 F

   ∴ n = 16

5. **(d)** **E** on the LHS of the above equation will have a contribution from all charges while **q** on the RHS will have a contribution from q_2 and q_4 only.

   Explanation: According to the Gauss' theorem, the term q on the right side of the equation includes the sum of all charges enclosed by the surface (irrespective of the position of the charges inside the surface).

   If the surface is so chosen that there are some charges inside and some outside, the electric field on the left side of the equation will be due to all charges (both inside as well as outside)

   Hence, **E** on LHS of the above equation will have a contribution from all charges while q on the RHS will have a contribution from charges q_2 and q_4 only.

   Hence option (a) is correct.

6. **(c)** Zero

   Explanation: Electric field is zero at all points inside a hollow charged conducting sphere.

7. **(b)** Electrons flow from the conductor to the earth

   Explanation: After earthing a positively charged conductor electrons flow from earth to conductor and if a negatively charged conductor is earthed then electrons flows from conductor to earth.

   

8. **(c)** q Ey

   Explanation: Increase in K.E. of the charged particle = Work down on the particle by the electric field

   = qE $\times$ y = q Ey

9. **(c)** 4 $\times$ 10^{-7} Nm

   Explanation: τ_{max} = pE = q $\times$ 2a $\times$ E

   = 2 $\times$ 10^{-10} $\times$ 1 $\times$ 10^{-2} $\times$ 2 $\times$ 10^{5} Nm

   = 4 $\times$ 10^{-7} Nm

10. **(a)** $\frac{F}{2}$

    Explanation: F_{liq} = $\frac{F_{\text{air}}}{\kappa} = \frac{F}{2}$

11. **(a)** Coulomb's law

Explanation: Coulomb's law states that, the magnitude of the electrostatic force of attraction or repulsion between two point charges is directly proportional to the product of the magnitudes of charges and inversely proportional to the square of the distances between them. The force acts always along the line joining the two charges.

12. **(d)** Zero

Explanation: On all the dipoles, net charge = 0. Hence net charge enclosed within the surface = 0. So the total electric flux coming out of the surface, $\phi = \frac{q_{net}}{\varepsilon_0} = 0$

13. **(b)** $\frac{kQ}{r^2}$

Explanation: If the same charges are placed at all corners on polygon than the electric field at centre will be zero. But in the given situation, one charge is missing, so the field at the centre now becomes non zero and the net field at centre must be equal to the field which the missing charge exerts such that the total field become zero.

So, now the field at centre = field due to missing charge = $\frac{Q}{4\pi\epsilon_0 r^2} = k\frac{Q}{r^2}$

14. **(b)** $\frac{Q}{6\varepsilon_0}$

Explanation: When a charge Q is placed at one corner of the cube, only one-eighth of the flux emerging from charge Q passes through all the six faces of the cube.

$\therefore \phi_E = \frac{Q}{6\varepsilon_0}$

15. **(d)** +1.6 C

Explanation: q = ne = $10^{19} \times 1.6 \times 10^{-19}$ C = +1.6 C

16. **(a)** $\frac{\rho r}{3\varepsilon_0}$

Explanation: Electric field inside a uniformly charged sphere (r < R),

E = $\frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{R^3} r$

But q = $\frac{4}{3}\pi R^3 \rho$

$\therefore$ E = $\frac{\rho r}{3\varepsilon_0}$

17. **(b)** $\frac{Q}{2\epsilon_0}$

Explanation: If Q is the charge enclosed by conical flask than the flux is given by $\phi = \frac{Q}{\epsilon_0}$

But the charge is placed at the mouth of flask, so if we draw another imaginary flask over it, the charge is surrounded by two flasks now, so the charge through the flask now half of the previous value (shared by two flask).

So, the flux is given by $\phi = \frac{Q}{2\epsilon_0}$

18. **(d)** decreases κ times

Explanation: $F_{med} = \frac{F_{air}}{\kappa}$

19. **(b)** -q

Explanation: Force on q due to 4q,

$F_1 = \frac{1}{4\pi\varepsilon_o}\frac{4q^2}{d^2}$

Force on q due to Q,

$F_2 = \frac{1}{4\pi\varepsilon_o}\frac{Qq}{d^2/4} = \frac{1}{4\pi\varepsilon_o}\frac{4Qq}{d^2}$

For equilibrium, $F_1 + F_2 = 0$ (resultant force is 0)

$\frac{1}{4\pi\varepsilon_o}\frac{4Qq}{d^2} + \frac{1}{4\pi\varepsilon_o}\frac{4q^2}{d^2} = 0$

Hence on solving we get, Q = -q

20. **(a)** electric field intensity

Explanation: The relation between E, σ and E is E = $\frac{\sigma}{\varepsilon}$

21. **(a)** 2

Explanation: F = $\frac{1}{4\pi\varepsilon_0}\frac{q(Q-q)}{x^2}$

x is constant. For maximum force,

$\frac{dF}{dq}$ = 0

$\Rightarrow \frac{d}{dq}$ (qQ - q^2) = 0

$\therefore$ Q - 2q = 0 $\Rightarrow$ $\frac{Q}{q}$ = 2

22. **(d)** Zero

Explanation: If a charge +q is placed outside, then the electric field lines incident on the conducting sphere induces -q charge on one surface whereas the opposite surface becomes oppositely charged (i.e. +q) and the total charge becomes zero.

23. **(c)** any closed surface

Explanation: Gauss's law is valid for any closed surface.

24. **(c)** $E_1 = 2E_2$

Explanation: The electric field at any axial point is twice the electric field at any equatorial point of the dipole at the same distance. $E_1 = 2E_2$

25. **(b)** is the same for all the figures

Explanation: According to the Gauss theorem, the net electric flux through any closed surface S is $\frac{1}{\epsilon_0}$ times the total charge enclosed by S (Irrespective of shape and size of the surface).

All the figures given in the questions have the same charge i.e., +q. So, the electric flux through the surfaces is the same for all the figures.

26. **(a)** 6.25×10^{18}

Explanation: n = $\frac{q}{e} = \frac{1\text{C}}{1.6\times10^{-19}\text{C}}$

= 6.25×10^{18}

27. **(b)** $\frac{q}{8\varepsilon_0}$

Explanation: When the charge q is placed at one corner of the cube, only one-eighth of the flux emerging from the charge q passes through the cube.

$\therefore \phi_E = \frac{q}{8\varepsilon_0}$

28. **(b)** $E_a = 2E_q$

Explanation: Electric field at any axial point is twice the electric field at the same distance along the equatorial line

$\therefore E_a = 2E_q$

29. **(d)** They form closed loops

Explanation: Electric field lines may not always form closed loops.

30. **(c)** $30\text{Nm}^2/\text{C}$

Explanation: Magnitude of electric field intensity, = 3×10^3 N/C

Side of the square, s = 10 cm = 0.1 m

Area of the square, A = s^2 = 0.01 m^2

The plane of the square is parallel to the y-z plane.

Hence, angle between the unit vector normal to the plane and electric field, θ = 0°

Flux (ϕ) through the plane is given by the relation,

ϕ = $\vec{E}.\vec{A} = EA\ cos\theta$ = $3 \times 10^3 \times 0.01 \times$ cos0° = 30 Nm^2/C