PHYSICS

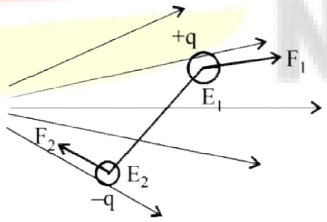
ELECTROSTATICS

11. (4)
Direction of E reverses while magnitude remains same and V remains unchanged.

12. (3)
When the two conducting spheres are connected by a conducting wire, charge will flow from one sphere (having higher potential) to other (having lower potential) till both acquire the same potential.

Therefore, $E = \frac{V}{r} \Rightarrow \frac{E_1}{E_2} = \frac{r_2}{r_1} = \frac{2}{1} = 2:1$

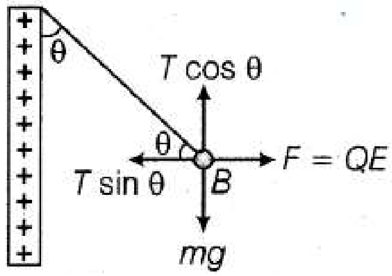
13. (3)
In a non-uniform electric field, the dipole may experience both non-zero torque as well as translational force.
For example, as shown in the figure.



$F_1 \neq F_2$ as E is non-uniform
Torque would also be non-zero.

14. (4)
Electric field due to a charged conducting sheet of surface charge density σ is given by

$$E = \frac{\sigma}{\varepsilon_0 \varepsilon_r}$$



where ε_0 is the permittivity in vacuum and ε_r is the relative permittivity of medium. Here, electrostatic force on B, $QE = \frac{Q\sigma}{\varepsilon_0 \varepsilon_r}$ FBD of B is shown in the figure. In equilibrium, $T\cos\theta = mg$ and

$$T\sin\theta = \frac{Q\sigma}{\varepsilon_0 \varepsilon_r}$$

Thus, $\tan\theta = \frac{Q\sigma}{\varepsilon_0 \varepsilon_r mg} \Rightarrow \tan\theta \propto \sigma$

15. (1)
From Gauss' law,

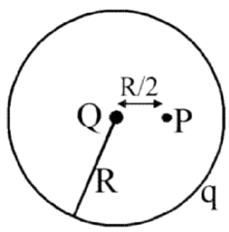
$$\frac{\text{Charged enclosed}}{\varepsilon_0} = \text{Net flux}$$

$$\Rightarrow \frac{q}{\varepsilon_0} = \phi_2 - \phi_1 \text{ or } q = (\phi_2 - \phi_1)\varepsilon_0$$

16. (3)
At P due to shell, potential $V_1 = \frac{q}{4\pi\varepsilon_0 R}$

At P due to Q, potential

$$V_2 = \frac{Q}{4\pi\varepsilon_0 \frac{R}{2}} = \frac{2Q}{4\pi\varepsilon_0 R}$$



Therefore, net potential at P,

$$V = V_1 + V_2 = \frac{q}{4\pi\varepsilon_0 R} + \frac{2Q}{4\pi\varepsilon_0 R}$$

17. (1)

Potential difference between two points in an electric field is $V_A - V_B = \frac{W}{q_0}$

where W is work done by moving charge q_0 from point A to B

Here, $W = 2\text{ J}$, $q_0 = 20\text{ C}$

So, $V_A - V_B = \frac{2}{20} = 0.1\text{ V}$

18. (2)

Electrostatic force, $F_e = eE$ (for both the particles).

But acceleration of electron, $a_e = \frac{F_e}{m_e}$

and acceleration of proton, $a_p = \frac{F_e}{m_p}$

$$S = \frac{1}{2}a_e t_1^2 = \frac{1}{2}a_p t_2^2$$

$$\therefore \frac{t_2}{t_1} = \sqrt{\frac{a_e}{a_p}} = \sqrt{\frac{m_p}{m_e}}$$

19. (1)

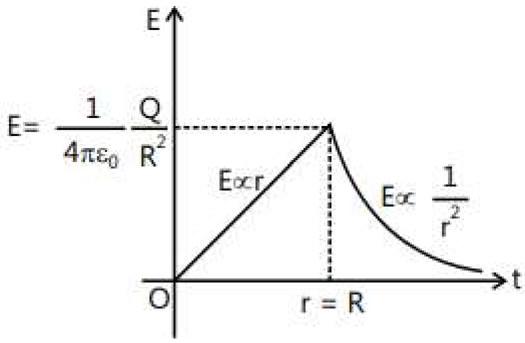
Inside the sphere, $E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R^3}r$

$\Rightarrow E \propto r$ for $r \le R$

i.e., E at centre = 0 as r = 0 and E at surface $= \frac{1}{4\pi\varepsilon_0}\cdot\frac{Q}{R^2}$ as $r = R$

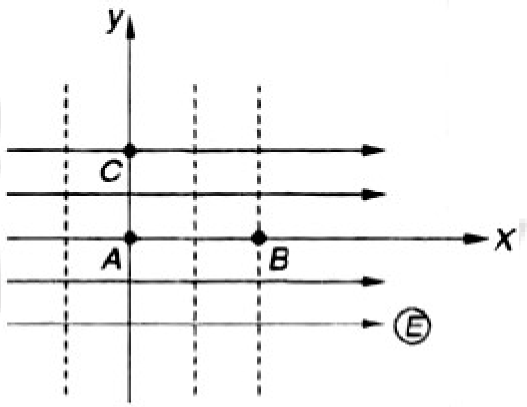
$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2} \text{ for } r \ge R \text{ or } E \propto \frac{1}{r^2}$$

Thus, variation of electric field (E) with distance (r) from the centre will be as shown.



20. (2)

Potential decreases in the direction of electric field. Dotted lines are equipotential lines.



$\therefore V_A = V_C$ and $V_A > V_B$