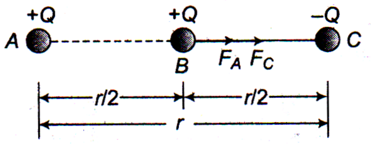
WEEKLY TEST TARGET - JEE - TEST - 20

SOLUTION Date 22-09-2019

[PHYSICS]

1. **(d)** Note that there is no field inside the metallic shell.

2. **(c)** Initially, force between A and C $F = k\dfrac{Q^2}{r^2}$



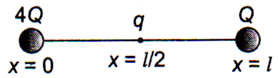
When a similar sphere B having charge $+Q$ is kept at the mid point of line joining A and C, then

Net force on B is $F_{\text{net}} = F_A + F_C = k\dfrac{Q^2}{(r/2)^2} + \dfrac{kQ^2}{(r/2)^2}$.

$= 8\dfrac{kQ^2}{r^2} = 8F.$

(Direction is shown in figure)

3. **(d)** The total force on Q

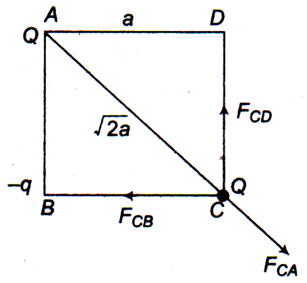


$$\frac{Qq}{4\pi\varepsilon_0\left(\frac{l}{2}\right)^2} + \frac{4Q^2}{4\pi\varepsilon_0 l^2} = 0$$

$$\frac{Qq}{4\pi\varepsilon_0\left(\frac{l}{4}\right)^2} = -\frac{4Q^2}{4\pi\varepsilon_0 l^2} \Rightarrow q = -Q.$$

4. **(a)** In the following figure since $|\vec{F_A}| = |\vec{F_B}| = |\vec{F_C}|$ and they are equally inclined with each other, so their resultant will be zero.

5. **(a)** Different forces on C are shown in figure, a is the side of square.



$$F_{CA} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q^2}{2a^2} \text{ along AC}$$

If the resultant force on C is to be zero, the forces on C due to D and B must be along CD and CB respectively. Thus, q must be negative.

Resultant force, F_{CB} and F_{CD} in the direction of CA is given by

$$\frac{1}{4\pi\varepsilon_0} \cdot \frac{Qq}{a^2} \cdot \frac{1}{\sqrt{2}} + \frac{1}{4\pi\varepsilon_0} \cdot \frac{Qq}{a^2} \cdot \frac{1}{\sqrt{2}} = \sqrt{2} \cdot \frac{1}{4\pi\varepsilon_0} \cdot \frac{Qq}{a^2}$$

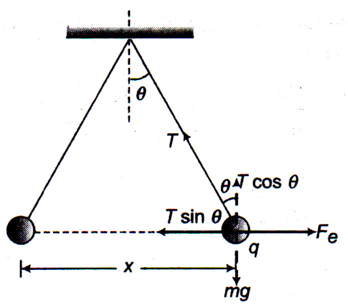
$$\sqrt{2} \cdot \frac{1}{4\pi\varepsilon_0} \frac{qQ}{a^2} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q^2}{2a^2}$$

$$|Q| = 2\sqrt{2}\,|q|$$

As q is negative, $Q = -2\sqrt{2}\,q$

6. **(a)** The negative charge oscillates, the resultant force acts as a restoring force and proportional to displacement. When it reaches the plane xy, the resultant force is zero and the mass moves down due to inertia. Thus oscillation is set.

7. **(a)**



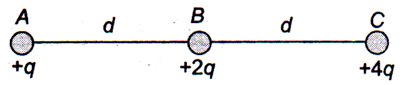
In equilibrium $F_e = T\sin\theta$ ... (i)

$mg = T\cos\theta$ ... (ii)

$$\tan\theta = \frac{F_e}{mg} = \frac{q^2}{4\pi\varepsilon_o x^2 \times mg} \text{ also } \tan\theta \approx \sin\theta = \frac{x/2}{L}$$

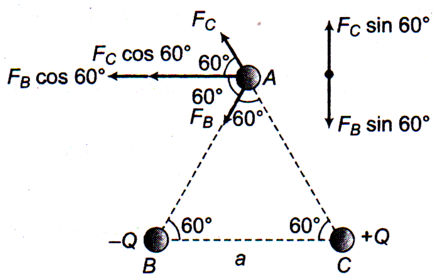
Hence $\frac{x}{2L} = \frac{q^2}{4\pi\varepsilon_o x^2 \times mg}$

$$\Rightarrow x^3 = \frac{2q^2L}{4\pi\varepsilon_o mg} \Rightarrow x = \left(\frac{q^2L}{2\pi\varepsilon_o mg}\right)^{1/3}$$



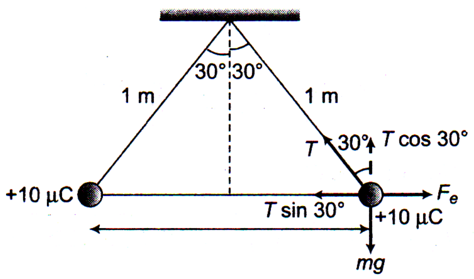
8. **(c)** We put a unit positive charge at O. Resultant force due to the charge placed at A and C is zero and resultant force due to B and D is towards D along the diagonal BD

9. **(c)** $|\vec{F_B}| = |\vec{F_C}| = k.\frac{Q^2}{a^2}$



Hence force experienced by the charge at A in the direction normal to BC is zero.

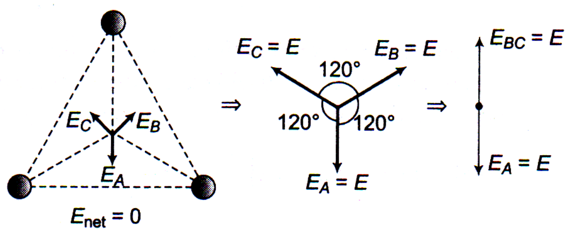
10. **(b)** In the following figure, in equilibrium $F_e = T \sin 30°$, $r = 1$ m



$$\Rightarrow 9\times10^9 . \frac{Q^2}{r^2} = T \times \frac{1}{2}$$

$$\Rightarrow 9\times10^9 . \frac{(10\times10^{-6})^2}{1^2} = T\times\frac{1}{2} \Rightarrow T = 1.8 \text{ N}$$

11. **(c)**



12. **(c)** $E_1 = \dfrac{\eta q}{4\pi\varepsilon_0 a^2}, E_2 = \dfrac{\eta q}{4\pi\varepsilon_0 a^2}$ Therefore $E = \vec{E}_1 + \vec{E}_2$

$= \sqrt{E_1^2 + E_2^2 + 2E_1E_2 \cos 60^\circ} = \dfrac{\sqrt{3}\eta q}{4\pi\varepsilon_0 a^2}.$

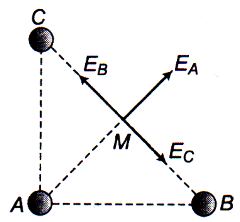
Since $\eta^{-1} < \sqrt{3}, 1 < \sqrt{3}\eta, \sqrt{3}\eta > 1.$

$\Rightarrow \dfrac{\sqrt{3}\eta q}{4\pi\varepsilon_0 a^2} > \dfrac{q}{4\pi\varepsilon_0 a^2} \Rightarrow E_3 > E_0 \left(E_0 = \dfrac{q}{4\pi\varepsilon_0 a^2} \right).$

13. **(b)** E_A = Electric field at M due to charge placed at A

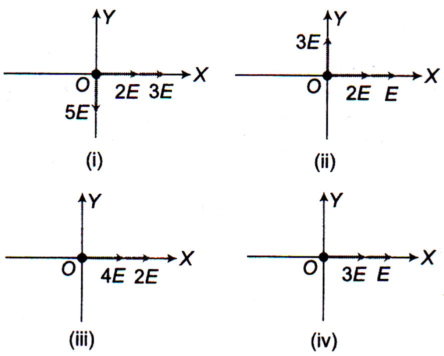
E_B = Electric field at M due to charge placed at B

E_C = Electric field at M due to charge placed at C



As seen from figure $|\vec{E_B}| = |\vec{E_C}|$, so net electric field at M, $E_{net} = E_A$; in the direction of vector 2.

14. **(c)** If electric field due to charge $|q|$ at origin is E then electric field due to charges $|2q|, |3q|, |4q|$ and $|5q|$ are respectively $2E, 3E, 4E$ and $5E$



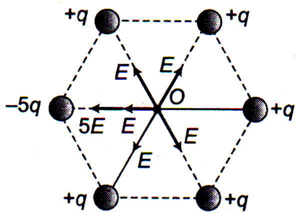
$E_{(i)} = \sqrt{(5E)^2 + (5E)^2} = 5\sqrt{2}E$,

$E_{(ii)} = \sqrt{(3E)^2 + (3E)^2} = 3\sqrt{2}E$,

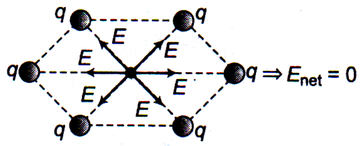
$E_{(iii)} = 4E + 2E = 6E$ and $E_{(iv)} = 3E + E = 4E$

$\Rightarrow E_{(i)} > E_{(iii)} > E_{(ii)} > E_{(iv)}$

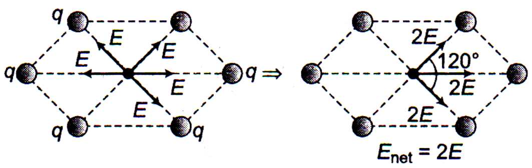
15. **(d)** To obtained net field $6E$ at centre O, the charge to be placed at remaining sixth corner is $-5q$. (see following figure)



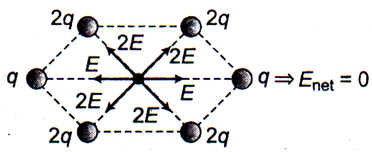
16. **(b)** Electric field at a point due to positive charge acts away from the charge and due to negative charge it act's towards the charge.



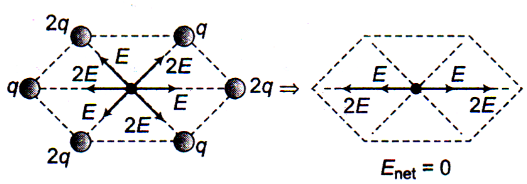
Case(1)



Case(2)



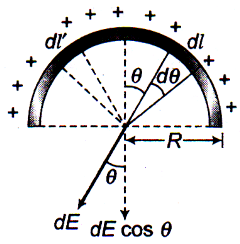
Case(3)



Case(4)

17. **(a)** From figure $dl = R\,d\theta$;

Charge on $dl = \lambda R\,d\theta$ $\left\{\lambda = \frac{q}{\pi R}\right\}$



18. **(d)** Electric field at a point on z-axis distant r from origin is

$$E = \frac{1}{4\pi\varepsilon_0}\left(\frac{Qr}{(r^2+R^2)^{3/2}} - \frac{\sqrt{8}\,Qr}{(r^2+4R^2)^{3/2}}\right) = 0$$

Solving we get $r = \sqrt{2}\,R$

19. **(c)** $E = \frac{1}{4\pi\varepsilon_0}\cdot\frac{ne}{r^2} \Rightarrow n = \frac{Er^2}{e}.4\pi\varepsilon_0$

$$\Rightarrow n = \frac{0.036\times0.1\times0.1}{9\times10^9\times1.6\times10^{-19}} = \frac{360}{144}\times10^5$$

$$= 2.5\times10^5 \text{ N/C.}$$

20. **(a)** Since the lines of forces are terminating on the charges both have to be negative.

21. **(d)** Based on theory

22. **(c)** q is $+ve$ because lines of force emerge from it and $|Q| < |q|$ because more lines emerge from q and less lines terminate at Q.

23. **(a)** In non-uniform electric field. Intensity is more, where the lines are more dense.

24. **(d)** The electric field is always perpendicular to the surface of a conductor. On the surface of a metallic solid sphere, the electrical field is oriented normally (i.e., directed towards the centre of the sphere).

25. **(c)** At A and C, electric lines are equally spaced and dense that's why $E_A = E_C > E_B$

26. **(a)** When the point is situated at a point on diameter away from the centre of hemisphere charged uniformly

27. **(c)** No field inside the hollow conducting sphere.

28. **(a)** Since $qE = mg$ or $E = \frac{mg}{q} = \frac{1.7\times10^{-27}\times9.8}{1.6\times10^{-19}}$

$= 10.0 \times 10^{-8} = 1 \times 10^{-7}$ V/m

29. **(a)** Electric field inside a conductor is zero.

30. **(c)** The time required to fall through distance d is

$$d = \frac{1}{2}\left(\frac{qE}{m}\right)t^2 \text{ or } t = \sqrt{\frac{2dm}{qE}}$$

Since $t^2 \propto m$, a proton takes more time.

[CHEMISTRY]

31. **(b)** $K = \kappa R = (6.67 \times 10^{-3}\ \Omega^{-1}\ cm^{-1})\ (243\ \Omega) = 1.62\ cm^{-1}$.

32. **(c)** $\lambda^{\infty}BaCl_2 = \frac{1}{2}\lambda^{\infty}Ba^{2+} + \lambda^{\infty}Cl^-$

$= \frac{127}{2} + 76 = 139.5\ ohm^{-1}cm^{-1}\ eq^{-1}$

33. **(d)** Molar conductivity $\propto$ no. of ions per mole of electrolyte.

34. **(d)** $1.53 = \frac{1000 \times 3.06 \times 10^{-6}}{\text{Normality}}$

Normality $= 2 \times 10^{-3}$ N

Molarity $= \frac{2 \times 10^{-3}}{2} = 10^{-3}$ M

$K_{sp} = 10^{-6}$ M

35. **(a)** For strong electrolyte

$\lambda^{\circ}_M = \lambda^{\infty}_M = b\sqrt{C}$

36. **(a)** $CuSO_4 + 2e^- \longrightarrow Cu + SO_4^-$

$Bi_2(SO_4)_3 + 6e^- \longrightarrow 2Bi + 3SO_4^-$

$AlCl_3 + 3e^- \longrightarrow Al + 3Cl^-$

$AgNO_3 + e^- \longrightarrow Ag + NO_3^-$

37. **(c)** $\kappa = \Lambda_c = (200\ S\ cm^2\ mol^{-1})\ (0.05 \times 10^{-3}\ mol\ cm^{-1})$

$= 0.01\ S\ cm^{-1}$

$$R = \frac{1}{\kappa}\left(\frac{\ell}{A}\right) = \frac{1}{(0.01\ S\ cm^{-1})}\left(\frac{1}{3}cm^{-1}\right) = 33.33\ \Omega$$

38. **(a)** $50 = \frac{1}{\Lambda_{eq}} \times \frac{1.5}{10/2} \times \frac{1000}{0.05} \Rightarrow 120\ S\ cm^2\ eq^{-1}$

39. **(b)** At anode $2H_2O \longrightarrow O_2 + 4H^+ + 4e^-$

At cathode $Ag^+ + e^- \longrightarrow Ag$

40. **(d)** Since $Ag^+ + e^- \to Ag$, $Cu^{2+} + 2e^- \to Cu$, $Au^{3+} + 3e^- \to Au$, 3 F of electricity will deposit 3 moles of Ag, 1.5 moles of copper, and 1 mole of gold. Therefore, the molar ratio is 3 : 1.5 : 1 or 6 : 3 : 2.

41. **(c)** $\frac{\text{Weight of Cu}}{\text{Weight of } H_2} = \frac{\text{Eq. weight of Cu}}{\text{Eq. weight. of H}}$

$\frac{\text{Weight of Cu}}{0.50} = \frac{63.6/2}{1}$

Weight of Cu = 15.9 g

42. **(c)** $2O^{2-} \longrightarrow O_2 + 4e$

$$\text{Mole of } e = \frac{0.75 \times 10 \times 60}{96500}$$

$$\text{Mole of } O_2 = \frac{4.66 \times 10^{-3}}{4} = 0.0261 \text{ L}$$

43. **(a)** In galvanic cell/electrochemical cell electrical energy is produced due to some chemical reaction.

44. **(a)** $E^o_{cell} = E^o_{OP_L} + E^o_{RP_R} = -\Phi_L + \Phi_R$

45. **(b)** $Ag|Ag^+||AgI|Ag$

$$E_{cell} = E^o_{Ag/Ag^+} + E^o_{I^-/AgI(s)/Ag}$$

$$= -0.799 - 0.151 = -0.950 \text{ V}$$

46. **(a)** More is E^o_{RP}, more is oxidizing power or lesser is reducing power.

47. **(a)** $Cu^{2+} + 1e^- \longrightarrow Cu^+$ $\quad E_1 = 0.15$ ...(i)

$Cu^+ + 1e^- \longrightarrow Cu$ $\quad E_2 = 0.50$ ...(ii)

$Cu^{2+} + 2e^- \longrightarrow Cu$ $\quad E_3 = ?$ ...(iii)

Clearly (iii) = (i) + (ii)

$$-\Delta G^0_3 = -\Delta G^0_1 + (-\Delta G^0_2)$$

$$2 \times F \times E_3 = 1 \times F \times E_1 + 1 \times F \times E_2$$

$$E_3 = \frac{0.65}{2} = 0.325 \text{ V}$$

48. **(c)** $E^o_{cell} = E^o_{OPSn/Sn^{2+}} + E^o_{RPFe^{3+}/Fe^{2+}}$

$= 0.14 + 0.77 = 0.91$ V

49. **(b)** The electrode with more negative reduction potential constitutes the anode.

50. **(c)** Lowest SRP, highest reducing power.

51. **(c)** Lower SRP containing ion can displace higher SRP containing ion.

52. **(b)** Negative electrode potential (reduction potential) indicates lesser tendency for the reduction. Hence A is readily oxidized.

53. **(a)** More negative the standard potential, least the reduction tendency of the ion. The corresponding atom has largest oxidation tendency and thus is a strong reducing agent. Zn is the strongest reducing agent.

54. **(d)** Higher the SRP (Standard Reduction Potential) stronger is the oxidizing agent. Among the given electrode potentials,

$E^o_{MnO_4^-/Mn^{2+}}$ is highest.

Hence, MnO_4^- is the strongest oxidizing agent.

55. **(b)** $\Delta G^\circ = -nFE^\circ$ cell if E°_{cell} is positive, then ΔG° will be –ve showing that cell reaction is spontaneous.

56. **(a)** Al is above hydrogen in the electrochemical series, therefore Al^{3+} has lesser reduction tendency as compared with H^+. Hence, hydrogen electrode acts as anode when coupled with aluminium electrode.

$$E^\circ_{cell} = E^\circ_{H^+/H_2} - E^\circ_{Al^{3+}/Al}$$

$$\therefore \quad 1.66\text{V} = 0.0\text{V} - E^\circ_{Al^{3+}/Al}$$

$$E^\circ_{Al^{3+}/Al} = -1.66\text{ V.}$$

57. **(b)** More the negative E° value, larger the reducing power of the metal.

58. **(c)** $Fe^{+2} + Zn \rightarrow Zn^{2+} + Fe$ (Oxidation: $Zn \rightarrow Zn^{2+}$; Reduction: $Fe^{+2} \rightarrow Fe$)

EMF = $E_{cathode} - E_{anode} = 0.44 - (0.76) = +0.32$ V

59. **(d)** The tendency to gain electron is in the order

$Z > Y > X$

Thus $Y + e \rightarrow Y^-$; $X \rightarrow X^+ + e$

60 . **(c)** $\frac{2}{3}Al_2O_3 \longrightarrow \frac{4}{3}Al + O_2$

Thus, $\frac{2}{3} \times 3\,(O^{2-})$

i.e., $2O^{2-} \longrightarrow O_2 + 4e^-$ $\quad [\because n = 4]$

$\Delta G = +966$ kJ mol^{-1} = 966×10^3 J mol^{-1}

$G = -nFE_{cell}$

$966 \times 10^3 = -4 \times 96500 \times E_{cell}$

$E_{cell} = 2.5$ V