PHYSICS

ELECTROSTATICS

41. (3)

Charge density, $\sigma = \frac{\text{charge}}{\text{area}}$

When two conductors are connected by a conducting wire, then they have same potential i.e., $V_1 = V_2$

$$\therefore \frac{1}{4\pi\varepsilon_0}\frac{Q_1}{R_1} = \frac{1}{4\pi\varepsilon_0}\frac{Q_2}{R_2}$$

$$\Rightarrow \frac{1}{4\pi\varepsilon_0}\frac{Q_1}{R_1}\times\frac{R_1}{R_1} = \frac{1}{4\pi\varepsilon_0}\frac{Q_2}{R_2}\times\frac{R_2}{R_2}$$

$$\Rightarrow \frac{Q_1R_1}{4\pi R_1^2} = \frac{Q_2R_2}{4\pi R_2^2\varepsilon_0}$$

$$\therefore \frac{\frac{Q_1}{4\pi R_1^2}}{\frac{Q_2}{4\pi R_2^2}} = \frac{R_2}{R_1} \text{ or } \frac{\sigma_1}{\sigma_2} = \frac{R_2}{R_1}$$

42. (1)

Let charge and radius of smaller drop is q and r respectively and R = radius of bigger drop

For smaller drop, electric potential,

$$V = \frac{kq}{r} = 220 \text{ V}$$

As volume remains the same

$$\left(\frac{4}{3}\pi r^3\right)\times 27 = \frac{4}{3}\pi R^3$$

$$\Rightarrow R = \sqrt[3]{27}r = 3r$$

And from conservation of charge Q = 27q

∴ Potential of bigger drop,

$$V_{\text{big drop}} = \frac{kQ}{R} = \frac{k(27q)}{3r}$$

$$= 9\left(\frac{kq}{r}\right) = 9\times 220 = 1980 \text{ V}$$

43. (1)

Potential in a region is given by

$V = 6xy - y + 2yz$

As we know the relation between electric potential and electric field is

$$\vec{E} = -\left(\frac{\partial V}{\partial x}\hat{i} + \frac{\partial V}{\partial y}\hat{j} + \frac{\partial V}{\partial z}\hat{k}\right)$$

where $V = 6xy - y + 2yz$

$$\vec{E} = -\left[(6y\hat{i} + (6x - 1 + 2z)\hat{j} + (2y)\hat{k}\right]$$

$$\vec{E}_{(1,1,0)} = -\left(6\hat{i} + 5\hat{j} + 2\hat{k}\right)$$

44. (3)

Potential energy of electric dipole in external electric field.

$$U = -\vec{P}\cdot\vec{E} - = -PE\cos\theta = -PE\cos 180°$$

Single angle between $\vec{E}$ and $\vec{P}$ is 180°

∴ U = +PE

On moving towards right electric field strength decrease

∴ U decreases.

Net force on electric dipole is towards right and net torque acting on it is zero so move towards right.

45. (4)

46. (3)

Series: $C_1 = \frac{C}{2}$

Parallel: $C_2 = 2C$

$$\frac{C_1}{C_2} = \frac{\frac{C}{2}}{2C} = 1:4$$

47. (2)

Energy stored in the system initially

$$U_i = \frac{1}{2}CE^2$$

$$U_f = \frac{1}{2}\frac{Q^2}{C_{eq}} = \frac{(CE)^2}{2\times 4C} = \frac{1}{2}\frac{CE^2}{4}$$

[As Q = CE and $C_{eq} = 4C$]

$$\Delta U = \frac{1}{2}CE^2\times\frac{3}{4} = \frac{3}{8}CE^2 = \frac{3}{8}\frac{Q^2}{C}$$

NEET 220 Medical Seats out of 240

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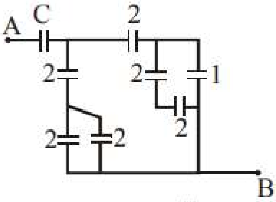
48. (1)

From series combination



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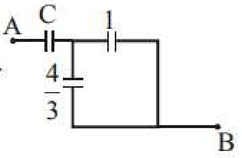

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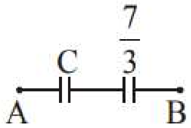
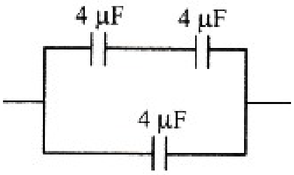


$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} \Rightarrow \frac{\frac{7C}{3}}{\frac{7}{3}+C} = \frac{1}{2}$$

$$\Rightarrow 14C = 7 + 3C \Rightarrow C = \frac{7}{11}\mu F$$

49. (4)

To get effective capacitance of 6 μF two capacitors of 4 μF each connected in series and one of 4 μF capacitor in parallel with them.



Two capacitances in series

$$\therefore \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{4} + \frac{1}{4} = \frac{1}{2}$$

1 capacitor in parallel

$$\therefore C_{eq} = C_3 + C = 4 + 2 = 6\ \mu F$$

50. (2)

As n plates are joined alternately positive plate of all (n – 1) capacitor are connected to one point and negative plate of all (n – 1) capacitors are connected to other point.

It means (n–1) capacitors joined in parallel. Therefore, resultant capacitance = (n – 1)C

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