Electrostatics

1. Two conducting solid spheres of radii R and $2R$ are given equal charges $(+Q)$ each. When they are connected by a thin conducting wire, the charges get redistributed. The ratio of charge Q_1 on smaller sphere to charge Q_2 on larger sphere becomes

(a) $\frac{Q_1}{Q_2}=1$ (b) $\frac{Q_1}{Q_2}=2$ (c) $\frac{Q_1}{Q_2}=\frac{1}{2}$ (d) None of these

2. Electric charges of 1 μC, – 1 μC and 2 μC are placed in air at the corners A, B and C respectively of an equilateral triangle ABC having length of each side 10 cm. The resultant force on the charge at C is $\left(\frac{\mu_0}{4\pi}=10^{-7}\,Hm^{-1}\right)$

(a) 0.9 N (b) 1.8 N (c) 2.7 N (d) 3.6 N

3. A solid metallic sphere has a charge + 3Q. Concentric with this sphere is a conducting spherical shell having charge – Q. The radius of the sphere is a and that of the spherical shell is $b(b > a)$. What is the electric field at a distance $R(a<R<b)$ from the centre

(a) $\frac{Q}{2\pi\varepsilon_0 R}$ (b) $\frac{3Q}{2\pi\varepsilon_0 R}$ (c) $\frac{3Q}{4\pi\varepsilon_0 R^2}$ (d) $\frac{4Q}{4\pi\varepsilon_0 R^2}$

4. Electric potential at any point is $V=-5x+3y+\sqrt{15}z$, then the magnitude of the electric field is

(a) $3\sqrt{2}$ (b) $4\sqrt{2}$ (c) $5\sqrt{2}$ (d) 7

5. Two concentric spheres of radii R and r have similar charges with equal surface densities (σ). What is the electric potential at their common centre ?

(a) $\frac{\sigma}{\varepsilon_0}$ (b) $\frac{R\sigma}{r\varepsilon_0}$ (c) $\frac{\sigma}{\varepsilon_0}(R+r)$ (d) $\frac{\sigma}{\varepsilon_0}(R-r)$

6. An elementary particle of mass m and charge $+e$ is projected with velocity v towards a much more massive particle of charge Ze, where $Z > 0$. What is the closest possible approach of the incident particle

(a) $Ze^2/2\pi\varepsilon_0 mv^2$ (b) $Ze^2/4\pi\varepsilon_0 mr_n$ (c) $Ze^2/8\pi\varepsilon_0 r_n$ (d) $-Ze^2/8\pi\varepsilon_0 r_n$

7. A ball of mass 1 g and charge 10^{-8} C moves from a point A. Where potential is 600 $volt$ to the point B where potential is zero. Velocity of the ball at the point B is 20 cm/s. The velocity of the ball at the point A will be

(a) 22.8 cm/s (b) 228 cm/s (c) 16.8 m/s (d) 168 m/s

8. An electron of mass m_e initially at rest moves through a certain distance in a uniform electric field in time t_1. A proton of mass m_p also initially at rest takes time t_2 to move through an equal distance in this uniform electric field. Neglecting the effect of gravity, the ratio of t_2/t_1 is nearly equal to

(a) 1 (b) $(m_p/m_e)^{1/2}$ (c) $(m_e/m_p)^{1/2}$ (d) 1836

9. A parallel plate capacitor has plate area A and separation d. It is charged to a potential difference V_0. The charging battery is disconnected and the plates are pulled apart to three times the initial separation. The work required to separate the plates is

(a) $\frac{3\varepsilon_0 AV_0^2}{d}$ (b) $\frac{\varepsilon_0 AV_0^2}{2d}$ (c) $\frac{\varepsilon_0 AV_0^2}{3d}$ (d) $\frac{\varepsilon_0 AV_0^2}{d}$

10. A charged 100μF capacitor is discharged through a 10 $k\Omega$ resistor. The ratio $\frac{\text{Charge on the capacitor after 1 second}}{\text{Original charge on the capacitor}}$ is

(a) $(1-1/e)$ (b) ln 2 (c) $(1-\ln 2)$ (d) $1/e$

11. The area of the plates of a parallel plate capacitor is A and the distance between the plates is 10 mm. There are two dielectric sheets in it, one of dielectric constant 10 and thickness 6 mm and the other of dielectric constant 5 and thickness 4 mm. The capacity of the condenser is

(a) $\frac{12}{35}\varepsilon_0 A$ (b) $\frac{2}{3}\varepsilon_0 A$ (c) $\frac{5000}{7}\varepsilon_0 A$ (d) 1500 $\varepsilon_0 A$

12. A parallel plate capacitor of capacitance C is connected to a battery and is charged to a potential difference V. Another capacitor of capacitance 2C is connected to another battery and is charged to potential difference 2V. The charging batteries are now disconnected and the capacitors are connected in parallel to each other in such a way that the positive terminal of one is connected to the negative terminal of the other. The final energy of the configuration is

(a) Zero (b) $\frac{25CV^2}{6}$ (c) $\frac{3CV^2}{2}$ (d) $\frac{9CV^2}{2}$

13. Two identical parallel plate capacitors are connected in series to a battery of 100 V. A dielectric slab of dielectric constant 4.0 is inserted between the plates of second capacitor. The potential difference across the capacitor will now be respectively

(a) 50 *V*, 50 *V* (b) 80 *V*, 20 *V* (c) 20 *V*, 80 *V* (d) 75 *V*, 25 *V*

14. How should three charge *q*, 2*q* and 8*q* be arranged on a 9 *cm* long line such that the potential energy of the system is minimum ?

(a) *q* at a distance of 3 *cm* from 2*q* (b) *q* at a distance of 5 *cm* from 2*q*

(c) 2*q* at a distance of 7 *cm* from *q* (d) 2*q* at a distance of 9 *cm* from *q*

15. A proton and an α-particle are situated at *r* distance apart. At very large distance apart when released, the kinetic energy of proton will be

(a) $\frac{2ke^2}{r}$ (b) $\frac{8}{5}\frac{ke^2}{r}$ (c) $\frac{ke^2}{r}$ (d) $\frac{8ke^2}{r}$