Engineering Daily 28 [Set 03] EV

Static Electricity

Total Marks: 50 **Negative Marks:** 0.25 **Time:** 1 Hour

MCQ 50 marks

1. Infinitely many point charges are placed along the x-axis at distances $x = 1\,m, 2\,m, 4\,m, 8\,m, \ldots$, with magnitudes alternating as $+5\,\mu C, -5\,\mu C, +5\,\mu C, -5\,\mu C, \ldots$. What is the magnitude of the electric field at the origin?

(A) $3 \times 10^4\ NC^{-1}$ (B) $6 \times 10^4\ NC^{-1}$
(C) $3.6 \times 10^4\ NC^{-1}$ (D) $4.5 \times 10^4\ NC^{-1}$

2. Two identical point charges of 0.2 C each are placed in air 2 km apart. What is the Coulomb force between them?

(A) 900 N (B) 90 N (C) 180 N (D) 9 N

3. A charge of $+9\,\mu C$ is placed at each end of a straight line and a charge q exactly at the midpoint. If all three charges are in equilibrium, what is q?

(A) $+2.25\,\mu C$ (B) $-4.5\,\mu C$ (C) $-9\,\mu C$ (D) $-2.25\,\mu C$

4. Two identical small charged balls of mass 2 g each are suspended from the same point by two silk threads of length 1 m. In equilibrium the repulsion keeps them 5 cm apart. What is the charge on each ball? ($g = 9.8\ ms^{-2}$)

(A) 5.83×10^{-9} C (B) 1.17×10^{-8} C
(C) 8.25×10^{-9} C (D) 1.65×10^{-8} C

5. Two charges are moved from vacuum into a medium and their separation is reduced to one-third. The force between them becomes one-fourth of its earlier value. What is the dielectric constant of the medium?

(A) $\frac{9}{4}$ (B) 4 (C) 12 (D) 36

6. Charges Q and 9Q are 2 m apart. At what point on the line joining them, measured from the charge Q, is the electric field zero?

(A) 0.25 m (B) 1.5 m (C) 0.5 m (D) $\frac{2}{3}$ m

7. An oil drop of mass 4.9×10^{-15} kg is at rest in a uniform electric field of $3 \times 10^4\ Vm^{-1}$. How many excess electrons does the drop carry?

(A) 8 (B) 10 (C) 16 (D) 5

8. A small object carries a charge Q. A charge $\frac{Q}{4}$ is removed from it and given to another small object, and the two objects are kept at a fixed distance. What is the ratio of the force in this situation to the maximum possible force?

(A) $\frac{1}{2}$ (B) $\frac{1}{4}$ (C) $\frac{9}{16}$ (D) $\frac{3}{4}$

9. Eight identical water droplets carrying equal charges merge to form one large drop (total charge unchanged). How many times is the electric energy of the large drop the total energy of the small drops?

(A) 4 (B) 16 (C) 2 (D) 8

10. A glass rod rubbed with silk acquires a charge of $+4.8 \times 10^{-8}$ C. By how much does the mass of the rod decrease? ($m_e = 9.1 \times 10^{-31}$ kg)

(A) 3×10^{11} kg (B) 5.01×10^{-16} kg
(C) 2.73×10^{-19} kg (D) 0

11. One charge is 4 times another. Placed 3 m apart, they repel each other with a force of 40 N. What is the magnitude of the smaller charge?

(A) 10^{-4} C (B) 10^{-5} C
(C) 2×10^{-4} C (D) 4×10^{-4} C

12. Charges $+2\,\mu C$ and $-2\,\mu C$ are placed at the two ends of the base of an equilateral triangle of side 0.6 m. What is the magnitude of the electric field at the apex?

(A) $10^5\ NC^{-1}$ (B) $5 \times 10^4\ NC^{-1}$
(C) 0 (D) $8.66 \times 10^4\ NC^{-1}$

13. A charge of 2.125×10^{-9} C is placed at the centre of a cube. One face of the cube is divided into two equal halves by joining the midpoints of two opposite sides. What is the electric flux through one half?

(A) $240\ Nm^2C^{-1}$ (B) $20\ Nm^2C^{-1}$
(C) $40\ Nm^2C^{-1}$ (D) $10\ Nm^2C^{-1}$

14. A charge of 1.771×10^{-9} C is placed at the midpoint of an edge of a cube. What is the total electric flux through the cube?

(A) $50\ Nm^2C^{-1}$ (B) $33.3\ Nm^2C^{-1}$
(C) $25\ Nm^2C^{-1}$ (D) $200\ Nm^2C^{-1}$

15. A teacher charges an electrostatic generator to $40\,\mu C$ and carries it into a closed room. What is the net electric flux through the walls of the room? ($\epsilon_0 = 8.854 \times 10^{-12}\ C^2N^{-1}m^{-2}$)

(A) $4.52 \times 10^6\ Nm^2C^{-1}$ (B) 0
(C) $3.6 \times 10^5\ Nm^2C^{-1}$ (D) $4 \times 10^{-5}\ Nm^2C^{-1}$

16. A Gaussian surface encloses a complete electric dipole. What is the total flux through the surface?

(A) 0 (B) $\frac{q}{2\epsilon_0}$ (C) $\frac{2q}{\epsilon_0}$ (D) $\frac{q}{\epsilon_0}$

17. What is the electric field at a distance of 30 cm from an infinite wire with a linear charge density of $2\,\mu C\,m^{-1}$?

(A) $6 \times 10^4\ NC^{-1}$ (B) $1.2 \times 10^5\ NC^{-1}$
(C) $4 \times 10^5\ NC^{-1}$ (D) $2.4 \times 10^5\ NC^{-1}$

18. Two electrons are 1 Å apart. What is the electric potential energy of the system?

(A) 2.3×10^{-18} J (B) -2.3×10^{-18} J
(C) 2.3×10^{-8} J (D) 4.61×10^{-18} J

19. An infinite plane sheet has a surface charge density of $8.854 \times 10^{-6}\ \text{Cm}^{-2}$. What is the electric field near the sheet?

(A) $2.5 \times 10^{5}\ \text{NC}^{-1}$ (B) $5 \times 10^{5}\ \text{NC}^{-1}$

(C) $10^{6}\ \text{NC}^{-1}$ (D) $5 \times 10^{4}\ \text{NC}^{-1}$

20. Two small spheres A and B of equal radius are 40 cm apart in vacuum. A carries $+5 \times 10^{-12}$ C and B carries -8×10^{-12} C. What is the potential at the point between A and B on the line AB that is 10 cm from A?

(A) 0.306 V (B) 0.21 V

(C) 0.69 V (D) −0.135 V

21. Two conducting spheres of radii 0.2 m and 0.3 m are charged to potentials of 9 V and 4 V respectively. If the distance between their centres is 1.5 m, at what distance from the centre of the first sphere, along the line joining them, is the electric field zero?

(A) 0.75 m (B) 0.674 m

(C) 0.826 m (D) 0.9 m

22. A charge of 2 nC is placed at each corner of a square of side 0.2 m. What is the electric potential at the centre?

(A) 0 (B) 255 V (C) 360 V (D) 509 V

23. A charge of +4 nC is placed at each corner of an equilateral triangle of side 0.2 m. What is the potential at the midpoint of any side?

(A) 935 V (B) 1080 V (C) 928 V (D) 720 V

24. Which of the following describes the graph of potential V versus distance r for a charged conducting sphere?

(A) $V \propto \frac{1}{r^2}$ everywhere

(B) 0 for $r \le R$; $V \propto \frac{1}{r}$ for $r > R$

(C) Constant for $r \le R$; $V \propto \frac{1}{r}$ for $r > R$

(D) $V \propto r$ for $r \le R$; constant for $r > R$

25. Two spheres of radii 4 cm and 6 cm are given charges of 16 and 27 units respectively. What is the ratio of their surface charge densities?

(A) 8 : 9 (B) 3 : 4

(C) 4 : 3 (D) 16 : 27

26. Eight charges of 5 C each are spread uniformly over the surface of a conducting sphere of radius 20 cm. What is the potential at a point 10 cm from the centre of the sphere?

(A) 3.6×10^{12} V (B) 2.25×10^{11} V

(C) 1.8×10^{12} V (D) 0

27. How much work must be done to bring charges of 4 μC and 5 μC from a separation of 30 cm to a separation of 10 cm?

(A) 1.2 J (B) 0.9 J (C) 16 J (D) 1.8 J

28. An electron starting from rest is accelerated through a potential difference of 405 V. What is its final speed? ($m_e = 9 \times 10^{-31}$ kg)

(A) $6 \times 10^{6}\ \text{ms}^{-1}$ (B) $1.2 \times 10^{7}\ \text{ms}^{-1}$

(C) $8.5 \times 10^{6}\ \text{ms}^{-1}$ (D) $1.44 \times 10^{14}\ \text{ms}^{-1}$

29. During a lightning strike, a charge of 25 C is discharged through a potential difference of 1.2×10^{9} V in 0.05 s. What is the average power during this time?

(A) 3×10^{10} W (B) 6×10^{11} W

(C) 2.4×10^{10} W (D) 1.5×10^{9} W

30. An electron released from rest in a uniform electric field travels 30 cm in 0.1 s. What is the potential difference between these two points? ($m_e = 9.1 \times 10^{-31}$ kg)

(A) 102 pV (B) 11.375 pV

(C) 34.1 pV (D) 51.2 pV

31. If $V = x^2 - 2y^2 + 3z$, what is the magnitude of the electric field at the point (1, 1, 2)?

(A) 29 (B) $\sqrt{21}$ (C) $\sqrt{17}$ (D) $\sqrt{29}$

32. The field at a distance x from the source of a static electric field is $E = \frac{8}{x^3}$ (SI). For points A and B at 1 m and 2 m from the source, what is $V_B - V_A$?

(A) 3 V (B) −4 V (C) −6 V (D) −3 V

33. A dipole has charges of ±8 μC separated by 0.6 cm. What is the electric field on the axis of the dipole at a distance of 20 cm from its centre?

(A) $5.4 \times 10^{4}\ \text{NC}^{-1}$ (B) $1.08 \times 10^{4}\ \text{NC}^{-1}$

(C) $2.16 \times 10^{5}\ \text{NC}^{-1}$ (D) $1.08 \times 10^{5}\ \text{NC}^{-1}$

34. At a point $r = \sqrt{7}$ m from a small dipole at the origin, the electric field and the potential are numerically equal. What is the acute angle between the position vector of the point and the dipole axis?

(A) 45° (B) 30° (C) 90° (D) 60°

35. A dipole is formed by placing charges +2 μC and −2 μC 4 cm apart. What is the potential on the axis at a distance of 10 cm from the centre, on the side of the positive charge?

(A) 0 (B) 7.2×10^{4} V

(C) 7.5×10^{4} V (D) -7.5×10^{4} V

36. An equilateral triangle of side a has a charge $+2q$ at one vertex and a charge $-q$ at each of the other two vertices. What is the magnitude of the equivalent dipole moment?

(A) $\sqrt{2}\,qa$ (B) $\sqrt{3}\,qa$ (C) $2qa$ (D) qa

37. Increasing the charge on a capacitor by 3 C increases the stored energy by 44%. What was the initial charge on the capacitor?

(A) 7.5 C (B) 20 C (C) 15 C (D) 12 C

38. A dipole is formed by placing charges +50 nC and −50 nC 20 µm apart. It is placed parallel to a field of $5\ \text{kVm}^{-1}$ and rotated through 60°. How much work is done?

Ⓐ 4.33×10^{-9} J Ⓑ 5×10^{-9} J

Ⓒ 2.5×10^{-9} J Ⓓ 1.25×10^{-9} J

39. At what distance from the centre, on the axis of an electric dipole of length 2 cm, is the exact electric field twice the approximate value obtained by assuming $l \ll r$?

Ⓐ 2 cm Ⓑ 2.61 cm

Ⓒ 1.41 cm Ⓓ 1.85 cm

40. A 4.7 µF capacitor has a potential difference of 9 V across it. How much additional charge is needed to raise the potential difference to 21 V?

Ⓐ 56.4 µC Ⓑ 42.3 µC

Ⓒ 98.7 µC Ⓓ 141 µC

41. Two capacitors of 3 µF and 6 µF are connected in series across a 600 V source. What is the total energy stored?

Ⓐ 0.72 J Ⓑ 0.36 J Ⓒ 1.62 J Ⓓ 0.18 J

42. Capacitors of 6 µF and 3 µF are connected in series, and a 4 µF capacitor is connected in parallel with this combination. What is the equivalent capacitance?

Ⓐ 6 µF Ⓑ 13 µF

Ⓒ 1.33 µF Ⓓ 2.4 µF

43. Three capacitors of 3 µF, 6 µF and 9 µF are connected in series. What is the equivalent capacitance?

Ⓐ $\frac{18}{11}$ µF Ⓑ 2 µF

Ⓒ $\frac{11}{18}$ µF Ⓓ 18 µF

44. Two capacitors of 10 µF and 15 µF are connected in series with a 50 V battery. What is the charge on each capacitor?

Ⓐ 500 µC Ⓑ 1250 µC

Ⓒ 750 µC Ⓓ 300 µC

45. A charged capacitor storing energy U is connected in parallel with an uncharged capacitor of the same capacitance. What is the total energy of the system?

Ⓐ $\frac{U}{2}$ Ⓑ $\frac{U}{4}$ Ⓒ U Ⓓ 2U

46. A charged parallel-plate capacitor is disconnected from the battery and the distance between its plates is doubled. How does the stored energy change?

Ⓐ It becomes four times Ⓑ It remains unchanged

Ⓒ It is halved Ⓓ It is doubled

47. Filling the space between the plates of a parallel-plate capacitor with a dielectric raises its capacitance from 8 µF to 36 µF. What is the dielectric constant?

Ⓐ $\frac{2}{9}$ Ⓑ 44 Ⓒ 4.5 Ⓓ 28

48. What is the energy stored per unit volume in air in an electric field of $3 \times 10^{6}\ \text{Vm}^{-1}$?

Ⓐ $39.8\ \text{Jm}^{-3}$ Ⓑ $1.33 \times 10^{-5}\ \text{Jm}^{-3}$

Ⓒ $79.7\ \text{Jm}^{-3}$ Ⓓ $2.66 \times 10^{-5}\ \text{Jm}^{-3}$

49. Each plate of a parallel-plate capacitor has an area of $0.2\ \text{m}^2$ and the plates are 0.1 mm apart. If the potential difference between the plates is 12 V, what is the stored energy?

Ⓐ 2.55×10^{-6} J Ⓑ 6.37×10^{-7} J

Ⓒ 1.06×10^{-7} J Ⓓ 1.27×10^{-6} J

50. What is the electric field intensity at a point inside a charged hollow spherical conductor?

Ⓐ $\frac{1}{4\pi\varepsilon_0}\frac{q}{R^2}$ Ⓑ 0

Ⓒ $\frac{1}{4\pi\varepsilon_0}\frac{q}{R}$ Ⓓ ∞