Engineering Daily 28 [Set 04] EV

Static Electricity

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

MCQ 50 marks

1. Two equal charges are placed 40 cm apart. At what distance from the midpoint, on the perpendicular bisector of the line joining them, is the force on a test charge maximum?

(A) 10 cm (B) 20 cm (C) 28.3 cm (D) 14.1 cm

2. Two identical conducting balls carry charges of the same kind, and the force between them at a certain distance is F. The balls are touched together and placed at the same distance again, and the force becomes 1.125F. What is the ratio of the larger charge to the smaller charge?

(A) 4 (B) 1.5 (C) 2 (D) 3

3. What is the electric field in air at a distance of 30 cm from a charge of 3×10^{-5} C?

(A) 10^{6} NC^{-1} (B) 9×10^{5} NC^{-1}
(C) 3×10^{6} NC^{-1} (D) 3×10^{5} NC^{-1}

4. Charges of 5 µC and 20 µC are 6 cm apart. What is the electric field at the midpoint of the line joining them?

(A) 2.5×10^{8} NC^{-1} (B) 3.75×10^{7} NC^{-1}
(C) 0 (D) 1.5×10^{8} NC^{-1}

5. What is the force on an alpha particle in a uniform electric field of 5×10^{4} Vm^{-1}?

(A) 3.2×10^{-14} N (B) 1.6×10^{-14} N
(C) 8×10^{-15} N (D) 1.6×10^{-15} N

6. Which of the following charges can exist on an object? ($e = 1.6 \times 10^{-19}$ C)

(A) 4.8×10^{-19} C (B) 5.6×10^{-19} C
(C) 1.2×10^{-19} C (D) 2.4×10^{-19} C

7. Two charges are placed 10 cm apart in air. A dielectric slab of thickness 4 cm and K = 9 is placed between them. How many times the original force is the new force?

(A) $\frac{5}{9}$ (B) $\frac{25}{49}$ (C) $\frac{25}{81}$ (D) $\frac{1}{9}$

8. A charge Q is placed at each of two opposite corners of a square and a charge q at each of the other two corners. If the net force on each q is zero, what is the value of $\frac{Q}{q}$?

(A) $-\frac{1}{\sqrt{2}}$ (B) $-2\sqrt{2}$ (C) $-\frac{1}{2\sqrt{2}}$ (D) $2\sqrt{2}$

9. A pith ball of mass 0.2 g carries a charge of -8×10^{-9} C. How far above the ball should an object carrying $+5 \times 10^{-9}$ C be placed so that the ball stays suspended in air?

(A) 0.958 cm (B) 1.84 cm
(C) 1.36 cm (D) 2.71 cm

10. At what electric field strength does a proton experience an electric force equal to its weight? ($m_p = 1.67 \times 10^{-27}$ kg)

(A) 10^{-6} NC^{-1} (B) 1.02×10^{-8} NC^{-1}
(C) 1.02×10^{-7} NC^{-1} (D) 5.57×10^{-11} NC^{-1}

11. A charge of 1.2×10^{-8} C is placed at the centre of a cube. What is the flux through each face of the cube?

(A) 226 Nm^{2}C^{-1} (B) 1360 Nm^{2}C^{-1}
(C) 169 Nm^{2}C^{-1} (D) 56.5 Nm^{2}C^{-1}

12. A square surface of side 8 mm is placed in a uniform electric field of 2000 NC^{-1}. The field lines make an angle of 30° with the surface. What is the electric flux through the surface?

(A) 0.032 Nm^{2}C^{-1} (B) 0.064 Nm^{2}C^{-1}
(C) 0.128 Nm^{2}C^{-1} (D) 0.111 Nm^{2}C^{-1}

13. A charge of 3 µC is placed at the centre of a sphere of radius 5 m. What is the electric flux through the surface of the sphere?

(A) 1080 Nm^{2}C^{-1} (B) 1.36×10^{4} Nm^{2}C^{-1}
(C) 3.39×10^{5} Nm^{2}C^{-1} (D) 0

14. Charges of +50 µC and −2 µC are 20 cm apart. At what distance from the smaller charge is the electric field zero?

(A) 4 cm (B) 16.7 cm (C) 25 cm (D) 5 cm

15. The electric flux through the entire surface of a closed sphere is 4.5×10^{4} Nm^{2}C^{-1}. What is the charge enclosed by the sphere?

(A) 3.17×10^{-8} C (B) 3.98×10^{-7} C
(C) 5.08×10^{15} C (D) 3.98×10^{-6} C

16. An oil drop is held stationary between two horizontal plates by a potential difference of 800 V. What potential difference is needed to hold stationary, between the same plates, another drop of half the radius (same density) that carries twice the charge?

(A) 200 V (B) 3200 V (C) 50 V (D) 100 V

17. 125 identical mercury drops carrying equal charges merge into one large drop. What is the ratio of the surface charge density of the large drop to that of a small drop?

(A) 5 : 1 (B) 25 : 1 (C) 125 : 1 (D) 1 : 5

18. Two infinite parallel plates carry charge densities $+\sigma$ and $-\sigma$ respectively, where $\sigma = 1.77 \times 10^{-7}$ Cm^{-2}. What are the electric fields between the plates and outside them, respectively?

(A) 0, 2×10^{4} NC^{-1} (B) 10^{4} NC^{-1}, 0
(C) 2×10^{4} NC^{-1}, 0 (D) 10^{4} NC^{-1}, 10^{4} NC^{-1}

19. Charges of $-10\ \mu C$ and $+40\ \mu C$ are 30 cm apart. At what distance from the $-10\ \mu C$ charge, between the two charges, is the potential zero?

(A) 7.5 cm (B) 6 cm (C) 10 cm (D) 24 cm

20. 64 identical charged mercury drops, each at a potential of 10 V, merge into one large drop. The large drop is then connected by a thin wire to a distant uncharged conducting sphere whose radius is twice that of a small drop. What is the common potential?

(A) 53.3 V (B) 106.7 V (C) 160 V (D) 80 V

21. The force between two charges is 60 N in vacuum and 15 N in a medium at the same separation. What is the dielectric constant of the medium?

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

22. A uniformly charged non-conducting solid sphere of radius 10 cm carries a charge of 2 nC. What is the potential at its centre?

(A) 270 V (B) 180 V (C) 0 (D) 540 V

23. Points A and B lie on the same straight line outward from the surface of a charged conducting sphere of radius 0.5 m, at distances of 0.25 m and 1.0 m from the surface respectively. What is the ratio of the electric field at A to that at B?

(A) 9 : 4 (B) 4 : 1 (C) 16 : 1 (D) 2 : 1

24. A total electric flux of 9000 units (Nm^2C^{-1}) emerges from a point charge. What is the magnitude of the charge?

(A) 79.7 nC (B) 797 nC (C) 1000 nC (D) 39.8 nC

25. Three charges of 4 C each are spread uniformly over the surface of a conducting sphere of radius 30 cm. What is the potential at the centre of the sphere?

(A) 1.2×10^{12} V (B) 0

(C) 1.2×10^{11} V (D) 3.6×10^{11} V

26. A charge q is placed at the midpoint of the line joining two charges +Q separated by a distance d, and all three charges are in equilibrium. What is the total electric potential energy of the system?

(A) $-\frac{kQ^2}{d}$ (B) $-\frac{kQ^2}{4d}$

(C) $\frac{kQ^2}{d}$ (D) 0

27. A particle of charge 20 nC and mass 2 g starts from rest and passes through a potential difference of 400 V. What will its speed be?

(A) $0.0632\ ms^{-1}$ (B) $8 \times 10^{-3}\ ms^{-1}$

(C) $0.126\ ms^{-1}$ (D) $0.0894\ ms^{-1}$

28. The potential difference between two points is 25 V. How much charge must be moved from one point to the other for 0.15 J of work to be done?

(A) 6×10^{-2} C (B) 3.75 C

(C) 6×10^{-3} C (D) 1.67×10^{2} C

29. In an electric field the potential is $V = 3x^2 - x^3$. At which point on the x-axis, other than the origin, is the field zero?

(A) $x = 3$ (B) $x = 2$

(C) $x = \sqrt{3}$ (D) $x = 1$

30. In an electric field the potential is $V = 3x^2 - 2yz + z$. What is the electric field at the point $(1, 2, 1)$?

(A) $-6\hat{i} + 2\hat{j} + 3\hat{k}$ (B) $-6\hat{i} - 4\hat{j} + 3\hat{k}$

(C) $6\hat{i} - 2\hat{j} - 3\hat{k}$ (D) $-6\hat{i} + 2\hat{j} - 3\hat{k}$

31. The potential in a region is $V = 3x + 4y$ (SI). What are the magnitude and the nature of the electric field?

(A) $5\ NC^{-1}$, uniform (B) $25\ NC^{-1}$, uniform

(C) $5\ NC^{-1}$, non-uniform (D) $7\ NC^{-1}$, uniform

32. At some place the electric field is $\vec{E} = (10\hat{i} - 20\hat{j})\ NC^{-1}$. If the potential at the origin is zero, what is the potential at the point $(3, 1)$?

(A) −50 V (B) 10 V (C) 50 V (D) −10 V

33. On the axis of a small dipole, the field at a distance x from the centre is 16 times the field on the perpendicular bisector at a distance y from the centre. What is $\frac{y}{x}$?

(A) 4 (B) $2^{\frac{1}{3}}$ (C) 2 (D) 8

34. What is the minimum distance from a small dipole at which the electric field and the potential can be numerically equal? (SI)

(A) 2 m (B) 1 m (C) $\sqrt{2}$ m (D) $\sqrt{3}$ m

35. A dipole of moment of inertia $2 \times 10^{-6}\ kg\ m^2$ and dipole moment 2×10^{-7} Cm oscillates with small angular displacements in a field of $100\ NC^{-1}$. What is its time period?

(A) 3.97 s (B) 1.99 s

(C) 0.628 s (D) 0.316 s

36. A dipole of charge 5 nC and length 2 mm makes an angle of 30° with an electric field of $4 \times 10^5\ NC^{-1}$. What is the torque on the dipole?

(A) 2×10^{-6} Nm (B) 4×10^{-6} Nm

(C) 3.46×10^{-6} Nm (D) 0

37. A dipole with charges of 4 μC each and length 12 mm is aligned along a field of $7 \times 10^4\ NC^{-1}$. How much work is needed to turn it to the opposite direction?

(A) 6.72×10^{-3} J (B) 0.0134 J

(C) 0 (D) 3.36×10^{-3} J

38. A capacitor of capacitance 50 pF has a charge of 40 nC on each plate. What is the stored energy?

(A) 4×10^{-8} J (B) 3.2×10^{-5} J

(C) 8×10^{-7} J (D) 1.6×10^{-5} J

39. The potential difference across a capacitor falls to one-third of its earlier value. What fraction of the stored energy is lost?

(A) $\frac{1}{3}$ (B) $\frac{8}{9}$ (C) $\frac{1}{9}$ (D) $\frac{2}{3}$

40. Capacitors of 4 µF and 12 µF are connected in series across a 400 V source. What is the energy stored in the 12 µF capacitor?

(A) 0.06 J (B) 0.96 J (C) 0.18 J (D) 0.24 J

41. Capacitors of 8 µF and 4 µF are connected in parallel across 18 V. What are the equivalent capacitance and the total charge?

(A) 12 µF, 72 µC (B) 12 µF, 216 µC

(C) 32 µF, 576 µC (D) 2.67 µF, 48 µC

42. Three capacitors connected in series have a total capacitance of 1.2 µF. If two of them are 2 µF and 4 µF, what is the value of the third?

(A) 12 µF (B) 6 µF

(C) 4.8 µF (D) 0.83 µF

43. Five identical capacitors are connected in series to a battery. If a total charge Q flows from the battery, what is the charge on each capacitor?

(A) $\frac{Q}{25}$ (B) $\frac{Q}{5}$ (C) 5Q (D) Q

44. Capacitors of 2 µF and 8 µF are connected in series across a 20 V source. What is the potential difference across the 2 µF capacitor?

(A) 20 V (B) 10 V (C) 16 V (D) 4 V

45. Three identical capacitors are connected in parallel. How many times is the equivalent capacitance compared with that of the series connection?

(A) 3 (B) 9 (C) $\frac{1}{9}$ (D) 6

46. A parallel-plate capacitor is charged and then disconnected from the battery. The space between the plates is then filled with a dielectric, and the stored energy becomes one-fourth of its earlier value. What is the dielectric constant?

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

47. While connected to a battery, a parallel-plate capacitor has the space between its plates filled with a dielectric, and its charge becomes 3 times. What happens to the field between the plates, and what is the dielectric constant?

(A) Field unchanged, $K = 3$

(B) Field becomes 3 times, $K = 3$

(C) Field becomes $\frac{1}{3}$ of its value, $K = 3$

(D) Field unchanged, $K = 9$

48. A dielectric with $K = 3$ is placed over half the area of the plates (through the full thickness) of a parallel-plate capacitor. How many times the original capacitance does it become?

(A) 3 (B) 2 (C) 1.5 (D) 4

49. 9 metal plates of equal area are arranged parallel to one another at equal spacings and connected alternately (plates 1, 3, 5, ... together and plates 2, 4, ... together). If the capacitance of the capacitor formed by two adjacent plates is C_0, what is the total capacitance?

(A) $4.5C_0$ (B) $8C_0$ (C) $9C_0$ (D) $\frac{C_0}{8}$

50. Two circular plates of radius 0.1 m are placed 5 mm apart in air and a potential difference of 200 V is applied between them. What is the stored energy?

(A) 5.56×10^{-9} J (B) 4.45×10^{-6} J

(C) 2.23×10^{-6} J (D) 1.11×10^{-6} J