Engineering Daily 28 [Home Practice] EV

Static Electricity

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

MCQ 50 marks

1. Four points A, B, C and D are equally spaced on the circumference of a circle of radius 5 cm. Charges of +4 μC each are placed at A, B and C, and a charge of −4 μC at D. What is the electric field at the centre?

(A) $2.88 \times 10^7\ NC^{-1}$ (B) 0

(C) $1.44 \times 10^7\ NC^{-1}$ (D) $5.76 \times 10^7\ NC^{-1}$

2. Charges +q and +9q are a distance l apart. Where, and with what magnitude, should a third charge be placed so that all three charges are in equilibrium?

(A) $-\frac{4q}{9}$, at $\frac{l}{3}$ from q (B) $+\frac{9q}{16}$, at $\frac{l}{4}$ from q

(C) $-\frac{9q}{16}$, at $\frac{l}{4}$ from q (D) $-\frac{9q}{16}$, at $\frac{3l}{4}$ from q

3. Two parallel plates 5 cm long are 1 cm apart, and the field between them is $910\ NC^{-1}$. An electron enters along the midline, parallel to the plates. What is the minimum speed of the electron so that it leaves without striking a plate? ($m_e = 9.1 \times 10^{-31}$ kg)

(A) $6.32 \times 10^6\ ms^{-1}$ (B) $4.47 \times 10^6\ ms^{-1}$

(C) $3.16 \times 10^6\ ms^{-1}$ (D) $8.94 \times 10^6\ ms^{-1}$

4. A charge of +2 μC is placed at each corner of a square of side 0.2 m. What is the electric field at the midpoint of any side of the square?

(A) 0 (B) $6.44 \times 10^5\ NC^{-1}$

(C) $3.22 \times 10^5\ NC^{-1}$ (D) $7.2 \times 10^5\ NC^{-1}$

5. Two point charges 3 m apart repel each other with a force of 0.1 N. If the sum of the charges is 25 μC, what are the charges?

(A) 20 μC, 5 μC (B) 15 μC, 10 μC

(C) 22 μC, 3 μC (D) 12.5 μC, 12.5 μC

6. The distance from the centre of a regular hexagon to each vertex is r. Charges of +q are placed at five vertices and a charge of −q at the remaining vertex. What is the magnitude of the resultant force on a charge Q placed at the centre?

(A) $\frac{kQq}{r^2}$ (B) 0 (C) $\frac{2kQq}{r^2}$ (D) $\frac{6kQq}{r^2}$

7. Two protons are 10^{-15} m apart. What is the ratio of the electric force to the gravitational force between them? ($m_p = 1.67 \times 10^{-27}$ kg, $G = 6.67 \times 10^{-11}\ Nm^2kg^{-2}$, $e = 1.6 \times 10^{-19}$ C)

(A) 2.27×10^{39} (B) 1.24×10^{30}

(C) 1.24×10^{33} (D) 1.24×10^{36}

8. In outer space (no gravity), two small balls, each carrying 2 μC, are tied to the same point by two threads 0.5 m long. What is the tension in each thread?

(A) 0.144 N (B) 0.072 N (C) 0.018 N (D) 0.036 N

9. The distance between two charges is tripled and they are placed in a medium with K = 3. How many times the original force is the new force?

(A) 1 (B) $\frac{1}{9}$ (C) $\frac{1}{3}$ (D) $\frac{1}{27}$

10. An electron and a proton are released from rest in the same uniform electric field. What is the ratio of the time taken by the proton to the time taken by the electron to cover the same distance?

(A) $\sqrt{\frac{m_e}{m_p}}$ (B) $\sqrt{\frac{m_p}{m_e}}$ (C) $\frac{m_p}{m_e}$ (D) 1

11. At what electric field strength is the weight of an alpha particle balanced by the electric force? ($m_\alpha = 6.64 \times 10^{-27}$ kg)

(A) $1.02 \times 10^{-7}\ NC^{-1}$ (B) $2.03 \times 10^{-7}\ NC^{-1}$

(C) $2.08 \times 10^{-8}\ NC^{-1}$ (D) $4.07 \times 10^{-7}\ NC^{-1}$

12. A charge of 3.542×10^{-10} C is placed at one vertex of a cube. What is the total flux through the cube?

(A) $20\ Nm^2C^{-1}$ (B) $6.67\ Nm^2C^{-1}$

(C) $40\ Nm^2C^{-1}$ (D) $5\ Nm^2C^{-1}$

13. Charges +4 μC and +25 μC are 30 cm apart. At what distance from the 4 μC charge is the electric field zero?

(A) 8.57 cm (B) 10 cm (C) 21.4 cm (D) 12 cm

14. A square of side 20 cm lies in the yz plane in a uniform electric field of $500\ NC^{-1}$ directed along the x-axis. What is the flux through the square?

(A) $20\ Nm^2C^{-1}$ (B) $100\ Nm^2C^{-1}$

(C) 0 (D) $2 \times 10^5\ Nm^2C^{-1}$

15. A closed surface encloses charges of +5 μC and −2 μC, and a charge of +7 μC lies outside it. What is the total flux through the surface?

(A) 0 (B) $7.91 \times 10^5\ Nm^2C^{-1}$

(C) $1.13 \times 10^6\ Nm^2C^{-1}$ (D) $3.39 \times 10^5\ Nm^2C^{-1}$

16. At a distance of 5 cm from a uniformly charged wire of infinite length, the electric field is $7.2 \times 10^4\ NC^{-1}$. What is the linear charge density of the wire?

(A) $0.1\ \mu C\ m^{-1}$ (B) $0.02\ \mu C\ m^{-1}$

(C) $0.2\ \mu C\ m^{-1}$ (D) $0.4\ \mu C\ m^{-1}$

17. What is the ratio of the electric fields at distances $\frac{R}{2}$ and 2R from the centre of a uniformly charged non-conducting solid sphere of radius R?

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

18. Charges of 4 nC, −3 nC, 6 nC and −2 nC are placed at different points on the circumference of a circle of radius 0.5 m. What is the potential at the centre?

(A) 270 V (B) 135 V (C) 45 V (D) 90 V

19. A charge $+4q$ is at $x = 0$ and a charge $-q$ is at $x = 30$ cm. From the point on the x-axis where the electric field is zero, what is the distance to the nearest point where the potential is zero?

(A) 40 cm (B) 10 cm (C) 36 cm (D) 20 cm

20. Charges of 6 C, −9 C and 12 C are placed at three corners of a square. What charge must be placed at the fourth corner so that the potential at the centre is zero?

(A) −3 C (B) 9 C (C) −9 C (D) −27 C

21. 125 identical charged mercury drops, each at a potential of 20 V, merge to form one large drop. What is the potential of the large drop?

(A) 2000 V (B) 100 V (C) 500 V (D) 2500 V

22. A nucleus has atomic number 82 and radius 7×10^{-13} cm. What is the electric potential at the surface of the nucleus?

(A) 1.69×10^{7} V (B) 1.69×10^{5} V

(C) 8.43×10^{6} V (D) 1.69×10^{9} V

23. A charge of 5 μC is spread uniformly over a conducting sphere of radius 15 cm. What is the electric field at the surface of the sphere?

(A) 0 (B) $3 \times 10^{5}\ \mathrm{NC^{-1}}$

(C) $2 \times 10^{6}\ \mathrm{NC^{-1}}$ (D) $5 \times 10^{5}\ \mathrm{NC^{-1}}$

24. How much total work is done in bringing a charge of 1 μC to each vertex of an equilateral triangle of side 0.3 m?

(A) 0.06 J (B) 0.18 J (C) 0.03 J (D) 0.09 J

25. Starting from rest, an electron passes through a potential difference of 20 kV and acquires a speed of $8.4 \times 10^{7}\ \mathrm{ms^{-1}}$. What is the specific charge $\frac{e}{m}$ of the electron?

(A) $4200\ \mathrm{Ckg^{-1}}$ (B) $3.53 \times 10^{11}\ \mathrm{Ckg^{-1}}$

(C) $8.82 \times 10^{10}\ \mathrm{Ckg^{-1}}$ (D) $1.76 \times 10^{11}\ \mathrm{Ckg^{-1}}$

26. An electron is brought from a point 30 cm away to a point 10 cm away from a charge of 15 μC. What is the magnitude of the work done by the electric field?

(A) 1.44×10^{-13} J (B) 1.08×10^{-13} J

(C) 4.32×10^{-13} J (D) 7.2×10^{-14} J

27. How many joules of kinetic energy does a proton gain when it is accelerated through a potential difference of 2 kV?

(A) 3.2×10^{-19} J (B) 3.2×10^{-16} J

(C) 2×10^{3} J (D) 1.6×10^{-16} J

28. In an electric field, $V = 12x - x^3$. At which points on the x-axis is the field zero?

(A) $x = 0, \pm 2\sqrt{3}$ (B) $x = \pm 4$

(C) $x = \pm 2$ (D) $x = \pm\sqrt{12}$

29. If the potential at a point is $V = -2x + 3y + 6z$, what is the magnitude of the electric field?

(A) 7 (B) 49 (C) 5 (D) 11

30. In an electric field, $E_x = 2x$ and $E_y = 3$ (SI units). What is the potential difference $V_B - V_A$ from point $A(0, 3)$ to point $B(4, 0)$?

(A) −25 V (B) −7 V (C) 25 V (D) 7 V

31. Two parallel metal plates 5 mm apart have a potential difference of 250 V. What is the electric field in the space between them?

(A) $50\ \mathrm{Vm^{-1}}$ (B) $1.25\ \mathrm{Vm^{-1}}$

(C) $5 \times 10^{4}\ \mathrm{Vm^{-1}}$ (D) $5 \times 10^{3}\ \mathrm{Vm^{-1}}$

32. A dipole consists of two opposite charges of 3 μC separated by 4 cm in vacuum. What is the electric field on its perpendicular bisector at a distance of 60 cm from the centre?

(A) $2500\ \mathrm{NC^{-1}}$ (B) $5000\ \mathrm{NC^{-1}}$

(C) $10^{4}\ \mathrm{NC^{-1}}$ (D) 0

33. A dipole of moment 2×10^{-8} Cm makes an angle of 60° with a field of $5 \times 10^{4}\ \mathrm{NC^{-1}}$. What is its potential energy?

(A) -8.66×10^{-4} J (B) 5×10^{-4} J

(C) -5×10^{-4} J (D) -10^{-3} J

34. Charges $+q$, $-2q$ and $+q$ are placed at three consecutive corners of a square of side a, with the $-2q$ at the middle corner. What is the magnitude of the equivalent dipole moment?

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

35. What acts on a dipole placed in a uniform electric field at an angle to the field?

(A) Both net force and torque zero

(B) Net force zero, torque non-zero

(C) Net force non-zero, torque zero

(D) Both net force and torque non-zero

36. When an uncharged capacitor is fully charged by a battery, what fraction of the energy supplied by the battery is stored in the capacitor?

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

37. How much energy is stored when a 10 μF capacitor is charged by a 15 V battery?

(A) 2.25×10^{-3} J (B) 7.5×10^{-5} J

(C) 1.125×10^{-3} J (D) 1.5×10^{-4} J

38. Capacitors of 2 μF and 6 μF are connected to the same source, first in series and then in parallel. What is the ratio of the energy stored in the series arrangement to that in the parallel arrangement?

(A) $\frac{1}{4}$ (B) $\frac{3}{16}$ (C) $\frac{16}{3}$ (D) $\frac{3}{8}$

39. Two capacitors have an equivalent capacitance of 2.4 μF when connected in series and 10 μF when connected in parallel. What are their values?

(A) 5 μF, 5 μF (B) 6 μF, 4 μF

(C) 7 μF, 3 μF (D) 8 μF, 2 μF

40. Five capacitors of 2 μF each are connected in parallel to a 50 V battery. What is the total energy stored?

(A) 2.5×10^{-3} J (B) 0.0125 J

(C) 0.025 J (D) 5×10^{-4} J

41. An infinite number of capacitors of 1 μF, 2 μF, 4 μF, 8 μF, ... are connected in series. What is the equivalent capacitance?

(A) 0.5 μF (B) 2 μF (C) 1 μF (D) ∞

42. Three capacitors of 2 μF, 3 μF and 6 μF are connected in series across a 60 V source. What is the charge on the 6 μF capacitor?

(A) 360 μC (B) 20 μC (C) 60 μC (D) 120 μC

43. A charged capacitor of capacitance C stores energy U. It is connected in parallel with an uncharged capacitor of capacitance $2C$. What energy is now stored in the first capacitor?

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

44. What is the capacitance of a conducting sphere of radius 18 cm in air?

(A) 2 pF (B) 20 pF (C) 10 pF (D) 200 pF

45. An air-filled parallel-plate capacitor has a capacitance of 2 pF. The distance between the plates is tripled and the space between them is completely filled with wax, which makes the capacitance 4 pF. What is the dielectric constant of the wax?

(A) 1.5 (B) 6 (C) $\frac{2}{3}$ (D) 3

46. An air-filled parallel-plate capacitor has a capacitance of 5 pF. What is its capacitance if the space is filled with a medium of $K = 4$ and the plate separation is tripled?

(A) 3.75 pF (B) 20 pF

(C) 60 pF (D) 6.67 pF

47. Half the thickness of the gap between the plates of a parallel-plate capacitor (over the full plate area) is filled with a dielectric of $K = 3$. How many times the original capacitance does it become?

(A) 1.5 (B) $\frac{4}{3}$ (C) 2 (D) 3

48. Each plate of a parallel-plate capacitor has an area of 0.5 m^2 and the plates are 1 mm apart. If the potential difference is 100 V, what is the charge on each plate?

(A) 4.43×10^{-6} C (B) 2.21×10^{-7} C

(C) 4.43×10^{-9} C (D) 4.43×10^{-7} C

49. A parallel-plate capacitor with plate area 2×10^{-4} m^2 and a medium of $K = 4$ has the same capacitance as a sphere of radius 8 cm placed in air. What is the distance between the plates?

(A) 0.199 mm (B) 7.97 mm

(C) 0.797 mm (D) 1.59 mm

50. If the electric field is $E = cx^2$, what is the potential? (Take the potential to be zero at $x = 0$.)

(A) $-\frac{cx^3}{3}$ (B) $\frac{cx^3}{3}$

(C) $-2cx$ (D) $-cx^3$