Electric Charges and Fields- Problems for NEET

1. Two identical conducting spheres carrying charges Q_1 and Q_2 ($< Q_1$) attract each other with a force F. If they are connected by a thin wire, they repel each other with a force F/3. Then Q_1/Q_2 is:
   (a) 1.5 **(b)** 3 (c) 4.5 (d) 6
2. An infinite number of charges, each equal to 4 μC are placed along the x-axis at x = 1m, 2m, 4 m, 8 m, ... and so on. The electric field at the origin due to this set of charges in N/C is:
   (a) 1.2×10^4 (b) 3.0×10^4 (c) 3.6×10^4 **(d)** 4.8×10^4
3. Three points charges, each +q, placed at three of the vertices of a square and a charge − Q, placed at the centre, are in equilibrium. The ratio q/Q is:
   (a) 2 **(b)** √2 (c) 2√2 (d) 1
4. Two small spherical balls each carrying a charge Q = 10 μC are suspended by two insulating threads of equal lengths L m each, from a point fixed in the ceiling. It is found that in equilibrium threads are separated by an angle 60° between them. What is the tension in the threads?
   (a) 18 N **(b)** 1.8 N (c) 0.18 N (d) (d) None of the these
5. Two equal positive charges are fixed at points A and B. A third charge q is placed at the midpoint of AB. Then:
   (a) if q is positive, it will execute oscillation when displaced slightly along AB (b) if q is positive, it will execute oscillation when displaced slightly perpendicular to AB (c) if q is negative, it will execute oscillation when displaced slightly along AB **(d)** if q is negative, it will execute oscillation when displaced slightly perpendicular to AB
6. A particle of mass m and carrying charge $-q_1$ is moving around a charge $+q_2$ along a circular path of radius r. The period of revolution of the charge $-q_1$ about $+q_2$:
   (a) $\sqrt{\frac{8\pi^3\varepsilon_0 mr^3}{q_1 q_2}}$ **(b)** $\sqrt{\frac{16\pi^3\varepsilon_0 mr^3}{q_1 q_2}}$ (c) $\sqrt{\frac{q_1 q_2}{8\pi^3\varepsilon_0 mr^3}}$ (d) None of these
7. A bob of mass 5 g, carrying a positive charge of 5×10^{-8} C, is suspended by a nonconducting string 0.9 m long from a point in an electric field of 9.8×10^5 V/m, directed vertically downwards. The time period its small oscillations of the bob, about its equilibrium position, in seconds, is:
   (a) 3π/14 (b) 2π/7 **(c)** 3π/7 (d) 6π/7
8. In a regular polygon of n sides, each corner is at a distance r from the center. Identical charges of magnitude q are placed at (n -1) corners. The field at the center is:
   (a) $k\frac{q}{r^2}$ (b) $nk\frac{q}{r^2}$ (c) $(n-1)k\frac{q}{r^2}$ (d) $\left(\frac{n}{n+1}\right)k\frac{q}{r^2}$
9. The electric field at any point on the axis of a charged rod of length L and linear charge density λ at a point separated from the nearer end by d is:
   (a) $\frac{\lambda}{2\pi\varepsilon_0}\left(\frac{1}{L}-\frac{1}{L+d}\right)$ (b) $\frac{\lambda}{2\pi\varepsilon_0}\left(\frac{1}{d}-\frac{1}{L+d}\right)$ (c) $\frac{\lambda}{4\pi\varepsilon_0}\left(\frac{1}{d}-\frac{1}{L+d}\right)$ (d) $\frac{\lambda}{4\pi\varepsilon_0}\left(\frac{1}{L}-\frac{1}{d}\right)$
10. Two point charges + q and − q are held fixed at (− d, 0) and (d, 0) respectively of a X-Y coordinate system. Then:
    (a) the electric field E at all points on the X-axis has the same direction **(b)** the electric field E at all points on the Y-axis is along x-axis (c) work has to be done in bringing a test charge from infinity to the origin (d) the dipole moment is 2qd directed along x-axis
11. A charge Q is enclosed by a Gaussian spherical surface of radius R. If the radius is doubled, then the outward electric flux will:
    (a) be doubled. (b) increase four times. (c) be reduced to half. **(d)** remain the same.

12. A hollow cylinder has a charge q coulomb within it. If ϕ is the electric flux in units of V m associated with the curve surface, the flux linked with one of the plane surfaces in units of V m is:
    (a) $\frac{q}{2\varepsilon_0}$ (b) $\frac{\phi}{3}$ (c) $\frac{q}{\varepsilon_0} - \phi$ **(d)** $\frac{1}{2}\left(\frac{q}{\varepsilon_0} - \phi\right)$
13. Charges Q_1 and Q_2 lie inside and outside, respectively, of a closed surface S. Let E be the field at any point on S and ϕ be the flux of E over S, then
    I. If Q_1 changes, both E and ϕ will not change.
    II. If Q_2 changes, E will change but ϕ will not change.
    III. If $Q_1 = 0$ and $Q_2 \neq 0$, then $E = 0$ but $\neq 0$.
    IV. If $Q_1 \neq 0$ and $Q_2 = 0$, then $E = 0$ but $\phi \neq 0$.
    Which of the above statement(s) is/are correct?
    (a) III only (b) II, III and IV **(c)** I, II and III (d) All of these
14. A non-conducting solid sphere of radius R is uniformly charged. The magnitude of the electric field due to the sphere at a distance r from its centre:
    (a) increases as r increases, for $r < R$ (b) decreases as r increases, for $0 < r < \infty$ (c) decreases as r increases, for $R < r < \infty$ (d) is continuous at $r = R$
15. A charge q is placed at the middle point of the line joining two equal charges + Q. The system of the three charges will be in equilibrium if q is equal to:
    (a) $-Q/2$ **(b)** $-Q/4$ (c) $+Q/4$ (d) $+Q/2$
16. A thin half-ring of radius R is uniformly charged with a total charge q. Find the magnitude of the electric field strength at the center of this half ring:
    (a) $\frac{2q}{4\pi^2\varepsilon_0 R^2}$ (b) $\frac{2q}{\pi^2\varepsilon_0 R^2}$ (c) $\frac{q}{4\pi^2\varepsilon_0 R^2}$ (d) $\frac{q}{\pi^2\varepsilon_0 R^2}$
17. A charge Q is placed at each of the opposite corners of a square and a charge q is placed at each of the other two corners. If the net electrical force on Q is zero, then Q/q equals to:
    (a) $-2\sqrt{2}$ (b) -1 (c) 1 (d) $-1/2$.
18. Three concentric metallic spherical shells of radii R, 2R, and 3R are given charges Q_1, Q_2, and Q_3, respectively (as shown in the figure). It is found that the surface charge densities on the outer surfaces of the shells are equal. Then, the ratio of the charges given to the shells Q_1: Q_2: Q_3 is:
    (a) 1 :2 :3 (b) 1 :4 :9 **(c)** 1:3:5 (d) 1: 8: 18
19. A conducting sphere of radius 10 cm is charged with 10 μC. Another uncharged sphere of radius 20 cm is allowed to touch it for some time. After that, if the spheres are separated, then the surface density of charges on the spheres will be in the ratio of:
    (a) 1: 4 (b) 1 :3 **(c)** 1 : 2 (d) 1 :1
20. Two equally charged, identical metal spheres A and B repel each other with a force F. The spheres are kept fixed with a distance r between them. A third identical, but uncharged sphere C is brought in contact with A and then placed at the midpoint of the line joining A and B. The magnitude of the net electric force on C is:
    (a) F (b) F/2 (b) 3F/4 (d) 3F/8
21. A long string with a charge of λ per unit length passes through an imaginary cube of edge L. The maximum flux of the electric field through the cube is:
    (a) $\frac{\lambda L}{\varepsilon_0}$ (b) $\sqrt{\frac{\lambda L}{\varepsilon_0}}$ (c) $\sqrt{\frac{2\lambda L}{\varepsilon_0}}$ **(d)** $\frac{\sqrt{3}\lambda L}{\varepsilon_0}$

22. Electric field due to a uniformly charged infinite non-conducting sheet of charge having surface density σ is E. Electric field due to an infinite conducing sheet of same surface density of charge is:
    (a) E/2 **(b)** 2E (c) E (d) 4E
23. Positive charge Q is distributed uniformly over a circular ring of radius R. A particle having a mass m and a negative charge q, is placed on its axis at a distance x from the center. Assuming x « R, find the time period of oscillations of the particle if it is released from there. (Given: $m\pi^2R^2 = 4kQq$). All the values are in SI system.
    (a) 1 s (b) 2 s (c) 3 s **(d)** 4 s
24. Three charges 4q, Q, and q are placed in a straight line of length L at point 0, L/2, and L respectively. What should be Q so as to make the force on q zero?
    (a) -q/2 (b) -2q **(c)** -q (d) -4q
25. Two long, thin and charged rods, each with charge density λ, are placed parallel to each other at a distance d apart. The force per unit length exerted on one rod by the other is ($k = 1/4\pi\varepsilon_0$)
    (a) $k\frac{\lambda}{d}$ (b) $k\frac{2\lambda^2}{d^2}$ (c) $k\frac{2\lambda}{d^2}$ **(d)** $k\frac{2\lambda^2}{d}$
26. An electric dipole made up of a positive charge and a negative charge, each 1 mC placed 2 cm apart. If the dipole is held in an electric field of 105 N/C, then what is the maximum torque the field exerts on the dipole, while turning from a position $\theta = 0°$ to $\theta = 180°$?
    (a) 3 N m **(b)** 2 N m (c) 4 N m (d) 1 N m
27. Three charged particles are in equilibrium under their electrostatic forces only.
    I. The particles must be collinear.
    II. All the charges cannot have the same magnitude.
    III. All the charges cannot have the same sign.
    IV. The equilibrium is unstable.
    Which of the above statement(s) is/are correct?
    (a) III only (b) II, III and IV (c) I, II and IV **(d)** All of these
28. A, B, and C are three concentric metallic shells. Shell A is the innermost and shell C is the outermost. If shell A is given some charge, then
    I. the inner surface of B and C will have the same charge.
    II. the inner surface of B and C will have the same charge density.
    III. the outer surface of A, B, and C will have the same charge.
    IV. the outer surface of A, B, and C will have the same charge density.
    Which of the above statement(s) is/are correct?
    (a) II and III (c) I, II and III (b) II, III and IV (d) None of these