BALUNI CLASSES

(CHOICE OF THE GENIUS)
(For IIT-JEE, NEET)

Topic : Electrostatics ***D.P.P.*** ***Batch : IIT-JEE***

Electric Charge and Coulomb's Law

1. Two identical charged spheres suspended from a common point by two massless strings of length l are initially a distance d(d<<l) apart because of their mutual repulsion. The charge begins to leak from both spheres at a constant rate. As a result charges approach each other with a velocity v. Then as a function of distance x between them

(a) $v \propto x^{-1}$ (b) $v \propto x^{1/2}$

(c) $v \propto x^{-1}$ (d) $v \propto x^{-1/2}$

2. Two positive charges of magnitude q are placed at the ends of a side 1 of a square of side 2a. Two negative charges of the same magnitude are kept are the other corners. Starting from rest, if a charge Q moves from the middle of side 1 to the centre of square, its kinetic energy at the centre of square is

(a) $\frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a}\left(1-\frac{1}{\sqrt{5}}\right)$ (b) zero

(c) $\frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a}\left(1+\frac{1}{\sqrt{5}}\right)$ (d) $\frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a}\left(1-\frac{2}{\sqrt{5}}\right)$

3. A charged particle q is shot towards another charged particle Q which is fixed, with a speed v. It approaches Q upto a closest distance *r* and then returns. If q is shot with speed 2*v*, the closest distance of approach would be

(a) $\frac{r}{4}$ (b) $\frac{r}{2}$ (c) $2r$ (d) r

(e) $\frac{3}{2}r$

4. Two conducting spheres of radii 3 *cm* and 1 *cm* are separated by a distance of 10 *cm* in free space. If the spheres are charged to same potential of 10 *V* each, the force of repulsion between them is

(a) $\frac{1}{3}\times10^{-9}N$ (b) $\frac{2}{9}\times10^{-9}N$

(c) $\frac{2}{3}\times10^{-9}N$ (d) $\frac{4}{3}\times10^{-9}N$

(e) $\frac{2}{3}\times10^{-9}N$

5. Four charges equal to –Q are placed at the four corners of a square and a charge q is a *t* its centre. If the system is in equilibrium the value of q is

(a) $-\frac{Q}{4}(1+2\sqrt{2})$ (b) $\frac{Q}{4}(1+2\sqrt{2})$

(c) $-\frac{Q}{2}(1+2\sqrt{2})$ (d) $\frac{Q}{2}(1+2\sqrt{2})$

6. Charges 5 μC and 10μC are placed 1 *m* apart. Work done in bring these charges at a distance 0.5 *m* from each other is

(a) 9×10^4 J (b) 18×10^4 J

(c) 4×10^{-2} J (d) 9×10^4 J

7. Charge q_2 of mass *m* revolves around a stationary charge q_1 in a circular orbit of radius *r*. The orbital periodic time of q_2 would be

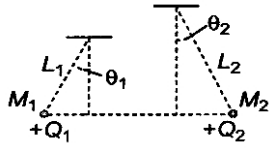
(a) $\left[\frac{4\pi^3mr^2}{kq_1q_2}\right]^{1/2}$ (b) $\left[\frac{kq_1q_2}{4\pi^3mr^2}\right]^{1/2}$

(c) $\left[\frac{4\pi^2mr^4}{kq_1q_2}\right]^{1/2}$ (d) $\left[\frac{4\pi^2mr^2}{kq_1q_2}\right]^{1/2}$

8. Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle of 30° with each other. When suspended in a liquid of density 0.8 gcm^{-3}, the angle remains the same. If density of the material of the sphere is 16 g cm^{-3}, the dielectric constant of the liquid is

(a) 4 (b) 3 (c) 2 (d) 1

9. Two small spheres of masses M_1 and M^2 are suspended by weightless insulating by weightless insulating threads of lengths L_1 and L_2. The spheres carry charges Q_1 and Q_2 respectively. The spheres are suspended such that they are in level with one another and the threads are inclined to the vertical at angles of θ_1 and θ_2 as shown. Which one of the following conditions is essential, if $\theta_1 = \theta_2$?

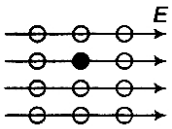


(a) $M_1 \neq M^2$, but Q_1 and Q_2

(b) $M_1 = M_2$

(c) $Q_1 = Q_2$
(d) $L_1 = L_2$

10. There is a uniform electric field of intensity E which is as shown. How many labeled points have the same electric potential as the fully shaded points?



(a) 2 (b) 3 (c) 8 (d) 11

11. Two identical conducting ball A and B have positive charges q_1 and q_2 respectively but $q_1 \neq q_2$. The balls are brought together so that they touch each other and then kept in their original positions. The force between them is
(a) less than that before the balls touched
(b) greater than that before the balls touched
(c) same as that before the balls touched
(d) zero

12. Under the action of a given coulombic force the acceleration of an electron is 2.5×10^{22} m/s^2. Then the magnitude of the acceleration of a proton under the action of same force is nearly
(a) 1.6×10^{-19} m/s^2 (b) 9.1×10^{31} m/s^2
(c) 1.5×10^{19} m/s^2 (d) 1.6×10^{27} m/s^2

13. A conductor has been given a charge -3×10^{-7} C by transferring electrons. Mass increase (in kg) of the conductor and the number of electrons added to the conductor are respectively
(a) 2×10^{-16} and 2×10^{31}
(b) 5×10^{-31} and 5×10^{16}
(c) 3×10^{-19} and 9×10^{16}
(d) 2×10^{-18} and 2×10^{32}

14. What is the total charge in coulomb of 75.0 kg of electrons?
(a) $0.32 \times 10^{13} C$ (b) $3.2 \times 10^{16} C$
(c) $-1.32 \times 10^{13} C$ (d) $+1.32 \times 10^{-13} C$

15. Under the influence of the coulomb field of charge +Q, a charge –q is moving around it in an elliptical orbit. Find out the correct statement(s).
(a) the angular momentum of the charge –q is constant
(b) the linear momentum for the charge –q is constant
(c) the angular velocity of the charge –q is constant
(d) the linear speed of the charge –q is constant

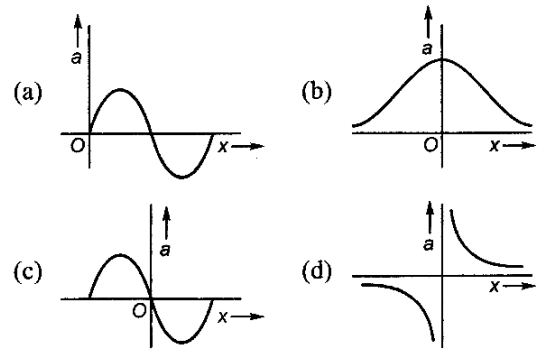
16. A charge Q is placed at each of the opposite corners of a square. A charge q is placed at each of the other two corners. If the net electrical force on Q is zero, then the $\frac{Q}{q}$ equals

(a) $-2\sqrt{2}$ (b) –1 (c) 1 (d) $-\frac{1}{\sqrt{2}}$

17. An object A has a charge of $-2\mu C$ and the object B has a charge of $+6\mu$C. Which statement is true?
(a) $F_{AB} = -3F_{BA}$ (b) $F_{AB} = -F_{BA}$
(c) $3F_{AB} = -F_{BA}$ (d) $F_{AB} = 4F_{BA}$

18. A charge of $1\mu C$ is divided into two parts such that their charges are in the ratio 2 : 3. These two charges are kept at a distance 1 m apart in vacuum. Then, the electric force between them (in N) is
(a) 0.216 (b) 0.00216 (c) 0.0216 (d) 2.16

19. Two identical positive charges are fixed on the y–axis at equal distances from the origin O. A negatively charged particle starts on the x–axis, at a large distance from O, moves along the x–axis, passes through O and moves far away from O. Its acceleration a is taken as positive along its direction of motion. The best graph between the particle's acceleration and its x–coordinate is represented by



20. Two identical metal spheres charged with $+12\mu$F and -8μF are kept at certain distance in air. They are brought into contact and then kept at the same distance. The ratio of the magnitudes of electrostatic forces between them before and after contact is
(a) 12 : 1 (b) 8 : 1 (c) 24 : 1 (d) 4 : 1

21. Two identical conducting spheres carrying different charges attract each other with a force f when placed in air medium at a distance d apart. The spheres are brought into contact and then

taken to their original positions. Now the two spheres repel each other with a force whose magnitude is equal to that of the initial attractive force. The ratio between initial charges on the spheres is

(a) $-(3+\sqrt{8})$ only (b) $-3+\sqrt{8}$ only
(c) $-(3+\sqrt{8})$ or $(-3+\sqrt{8})$ (d) $+\sqrt{3}$
(e) $-\sqrt{8}$

22. Two charges +q and –q are kept apart. Then at any point on the right bisector of line joining the two charges
(a) the electric field strength is zero
(b) the electric field potential is zero
(c) both electric potential and electric field strength are zero
(d) both electric potential and electric field strength are non–zero

23. The force of interaction between two charges $q_1 = 6\mu C$ and $q_2 = 2\mu C$ is 12 N. If charge $q = -2\mu C$ is added to each of the charges, then the new force of interaction is
(a) $2 \times 10^{-7}\ N$ (b) zero
(c) $30\ N$ (d) $2 \times 10^{-3}\ N$

24. In nature, the electric charge of any system is always equal to
(a) half integral multiple of the least amount of charge
(b) zero
(c) square of the least amount of charge
(d) integral multiple of the least amount of charge

25. A solid sphere of radius R_1 and volume charge density $\rho = \frac{\rho_0}{r}$ is enclosed by a hollow sphere of radius R_2 with negative surface charge density σ, is a positive constant and r is the distance from the centre of the sphere. The ratio $\frac{R_2}{R_1}$ is

(a) $\frac{\sigma}{\rho_0}$ (b) $\sqrt{2\sigma\rho_0}$ (c) $\sqrt{\rho_0/2\sigma}$ (d) $\frac{\rho_0}{\sigma}$

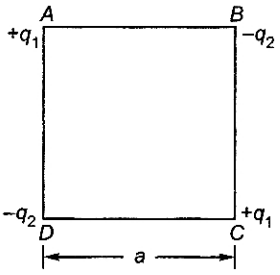
26. A solid sphere conductor of radius R has a spherical cavity of radius a ($a < R$) at its centre. A charge +Q is kept at the centre. The charge at the inner surface, outer surface and at a position r ($a < r < R$) are respectively
(a) +Q, –Q, 0 (b) –Q, +Q, 0
(c) 0, –Q, 0 (d) +Q, 0, 0

27. A comb run through one's dry hair attracts small bits of paper. This is due to
(a) comb is a good conductor
(b) paper is a good conductor
(c) the atoms in the paper get polarized by the charged comb
(d) the comb possesses magnetic properties

28. *A* and *B* are two identical spherical charged bodies which repel each other with force F, kept at a finite distance. A third uncharged sphere of the same size is brought in contact with sphere *B* and removed. It is then kept at mid–point of A and *B*. Find the magnitude of force on C.
(a) F/2 (b) F/8 (c) F (d) zero

29. Two equal charges as separated by a distance d. A third charge placed on a perpendicular bisector at x distance from centre will experience maximum coulomb force, when
(a) $x = d/\sqrt{2}$ (b) $x = d/2$
(c) $x = d/2\sqrt{2}$ (d) $x = d/2\sqrt{3}$

30. Charges are placed at corners of a square of side a as shown in the following figure. The charge A is in equilibrium. The ratio $\frac{q_1}{q_2}$ is



(a) 1 (b) $\sqrt{2}$ (c) $\frac{1}{\sqrt{2}}$ (d) $2\sqrt{2}$

31. Consider a neutral conducting sphere. A positive point charge is placed outside the sphere. The net chare on the sphere is then
(a) negative and distributed uniformly over the surface of the sphere
(b) negative and appears only at the point on the sphere closest to the point charge
(c) negative and distributed non–uniformly over the entire surface of the sphere
(d) zero

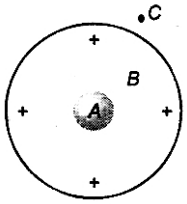
32. A charge Q is divided in two parts q and Q – q. What is value of q for maximum force between them?
(a) $\frac{3Q}{4}$ (b) $\frac{Q}{3}$ (c) Q (d) $\frac{Q}{2}$

33. Two identical charges repel each other with a force equal to 10 mg wt when they are 0.6 *m*

apart in air (g = 10 ms^{-2}). The value of each charge is
(a) 2 mC (b) 2×10^{-7} C
(c) 2 nC (d) 2μC

34. Two unit negative charges are placed on a straight line. A positive charge q is placed exactly at the mid–point between these unit charges. If the system of these three charges is in equilibrium, the value of q (in C) is
(a) 1.0 (b) 0.75 (c) 0.5 (d) 0.25

35. Two equal metal balls are charged to 10 and –20 units of electricity. Then the are brought in contact with each other and then again separated to the original distance. The ratio of magnitudes of the force between the two balls before and after contact is



(a) 8 : 1 (b) 1 : 8 (c) 2 : 1 (d) 1 : 2

36. Two spherical conductors B and C having equal radii and carrying equal charges in them repel each other with a force F when kept apart at some distance. A third spherical conductor having same radius as that of B but uncharged, is brought in contact with B, then brought in contact with C and finally removed away from both. The new force of repulsion between B and C is
(a) $\frac{F}{4}$ (b) $\frac{3F}{4}$ (c) $\frac{F}{8}$ (d) $\frac{3F}{8}$

37. Three charges $1\mu C$, $1\mu C$ and $2\mu C$ are kept at vertices of A, B and C of an equilateral triangle ABC of 10 cm side respectively. The resultant force on the charge at C is
(a) 0.9 N (b) 1.8 N
(c) 2.72 N (d) 3.12 N

38. Force between two identical charges placed at a distance of r in vacuum is F. Now a slab of dielectric of dielectric constant 4 is inserted between these two charges. If the thickness of the slab is r/2, then the force between the charges will become
(a) F (b) $\frac{3}{5}F$ (c) $\frac{4}{9}F$ (d) $\frac{F}{4}$ (e) $\frac{F}{2}$

39. The bob of simple pendulum is hanging vertically down from a fixed identical bob by means of a string of length l. If both bobs are charged with a charge q each, time period of the pendulum is (ignore the radii of the bobs)
(a) $2\pi\sqrt{\frac{l}{g+\left(\frac{q^2}{l^2m}\right)}}$ (b) $2\pi\sqrt{\frac{l}{g-\left(\frac{q^2}{l^2m}\right)}}$
(c) $2\pi\sqrt{\frac{l}{g}}$ (d) $2\pi\sqrt{\frac{l}{g-\left(\frac{q^2}{l^2m}\right)}}$

40. A pendulum bob carries a negative charge –q. A positive charge +q is held at the point of support. Then, the time period of the bob is
(a) greater than $2\pi\sqrt{\frac{L}{g}}$
(b) less than $2\pi\sqrt{\frac{L}{g}}$
(c) equal to $2\pi\sqrt{\frac{L}{g}}$
(d) equal to $2\pi\sqrt{\frac{2L}{g}}$

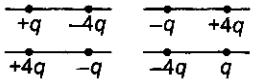
41. Two identical sphere with charges 4q, –2q kept some distance apart exert a force F on each other. If they are made to touch each other and replaced at their old positions, the force between them will be:
(a) $\frac{1}{9}F$ (b) $\frac{1}{8}F$ (c) $\frac{9}{8}F$ (d) $\frac{8}{9}F$

42. Identify the wrong statement in the following Coulomb's law correctly described the electric force that
(a) binds the electrons of an atom to its nucleus
(b) binds the protons and neutrons in the nucleus of an atom
(c) binds atoms together to form molecules
(d) binds atoms and molecules to form solids

43. Four metal conductors having different shapes
1. a sphere 2. cylinder 3. pear
4. lighting conductor
are mounted on insulating stands and charged. The one which is best suited to retain the charges for a longer time is
(a) 1 (b) 2 (c) 3 (d) 4

44. The figure shows four situations in which charges as indicated (q > 0) are fixed on an axis. In which situation is there a point to the left of the charges where an electron would be in

equilibrium?



(a) 1 and 2 (b) 2 and 4
(c) 3 and 4 (d) 1 and 3

45. If a conducting medium is placed between two charges, then the electric force between them will become
(a) zero (b) infinity
(c) 1 *N* (d) 1 dyne

46. A charge q is placed at the centre of the line joining two equal point charges each equal to Q. The system of three charges will be in equilibrium if q is equal to
(a) +Q/4 (b) –Q/2 (c) +Q/2 (d) –Q/4

47. Four charges equal to –Q are placed at the four corners of a square and a charge q is at its centre. If the system is in equilibrium, the value of q is
(a) $-\frac{Q}{4}(1+2\sqrt{2})$ (b) $\frac{Q}{4}(1+2\sqrt{2})$
(c) $-\frac{Q}{2}(1+2\sqrt{2})$ (d) $\frac{Q}{2}(1+2\sqrt{2})$

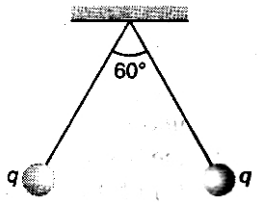
48. Two long conductors, separated by a distance *D* carry currents I_1 and I_2 in the same direction. They exert a force F on each other. Now the current in one of them is increased to two times and its direction is reversed. The distance is also increased to 3d. The new value of the force between them is
(a) –2F (b) F/3 (c) –2 F/3 (d) –F/3

49. An infinite number of charges, each of charge 1μ*C*, are placed on the x–axis with co–ordinates x = 1, 2, 4, 8, …. ∞. If a charge of 1*C* is kept at the origin, then what is the net force acting on 1*C* charge?
(a) 9000 *N* (b) 12000 *N*
(c) 24000 *N* (d) 36000 *N*

50. Two charges of equal magnitudes and at a distance *r* exert a force F on each other. If the charges are halved and distance between them is doubled, then the new force acting on each charge is
(a) F/8 (b) F/4 (c) 4F (d) F/16

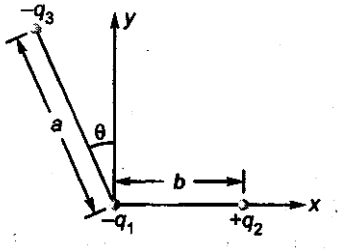
51. When a body is earth connected, electrons from the earth flow into the body. This means the body is
(a) charged negatively (b) an insulator
(c) uncharged (d) charged positively

52. Two small sphere balls each carrying charge q = 10 μ *C* suspended by two insulated threads of equal length 1*m* each, from a point fixed in the ceiling. It is found that in equilibrium, threads are separated by an angle 60° between them as shown in figure, the tension in the thread is



(a) 0.18 *N* (b) 18 *N*
(c) 1.8 *N* (d) none of the above

53. Three charges $-q_1$, $+q_2$ and $-q_3$ are placed as shown in the figure. The x–component of the force on $-q_1$ is proportional to



(a) $\frac{q_2}{b^2}-\frac{q_1}{a^2}\cos\vartheta$ (b) $\frac{q_2}{b^2}+\frac{q_3}{a^2}\sin\vartheta$
(c) $\frac{q_2}{b^2}+\frac{q_1}{a^2}\cos\vartheta$ (d) $\frac{q_2}{b^2}-\frac{q_3}{a^2}\sin\vartheta$

54. The charge on two identical metallic balls are +40μ*C* and –10μ*C* respectively and they are separated at 2.0 m. How much and nature of force will act between them?
(a) 2.9 *N*, repulsive (b) 1.9 *N*, attractive
(c) 1.2 *N*, repulsive (d) 0.9 *N*, attractive

Answer Key

1. (d)	6. (d)	11. (b)	16. (a)	21. (c)	26. (b)	31. (d)	36. (d)	41. (b)	46. (d)	51. (d)
2. (a)	7. (a)	12. (c)	17. (b)	22. (b)	27. (c)	32. (d)	37. (d)	42. (b)	47. (b)	52. (c)
3. (a)	8. (c)	13. (d)	18. (b)	23. (b)	28. (c)	33. (d)	38. (d)	43. (a)	48. (c)	53. (b)
4. (a)	9. (b)	14. (c)	19. (c)	24. (d)	29. (c)	34. (d)	39. (c)	44. (a)	49. (b)	54. (a)
5. (b)	10. (a)	15. (b)	20. (c)	25. (c)	30. (b)	35. (a)	40. (c)	45. (a)	50. (d)	