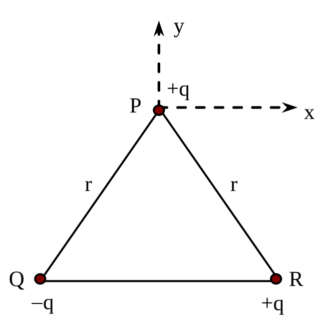
1. Two equal negative charges –q are fixed at points (0, a) and (0, –a) on the y-axis. A positive charge q is released from rest at a point (2a, 0) on the x-axis. The charge Q will
(a) execute simple harmonic motion about the origin
(b) move to the origin and remain at rest there
(c) more to infinity
(d) execute oscillatory but not simple harmonic motion

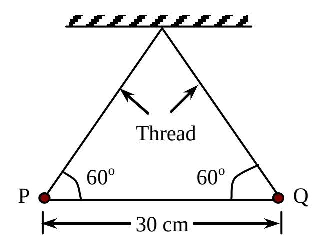
2. Two metallic identical spheres A and B carrying equal positive charge +q are a certain distance apart. The force of repulsion between them is F. A third uncharged sphere of the same size is brought in contact with sphere of the same size is brought in contact with sphere A and removed. It is then brought in contact with sphere B and removed. What is the new force of repulsion between A and B?
(a) F (b) $\frac{3F}{8}$
(c) $\frac{F}{2}$ (d) $\frac{F}{4}$

3. Three point charges +q, –q and +q are placed at the vertices P, Q and R of an equilateral triangle as shown in figure. If F = $\frac{1}{4\pi\varepsilon_0}\frac{q^2}{r^2}$, where r is the side of the triangle, the force on charge at P due to charge at Q and R is



(a) F along positive x-direction
(b) F along negative x-direction
(c) $\sqrt{2}$ F along positive x-direction
(d) $\sqrt{2}$ F along negative x-direction

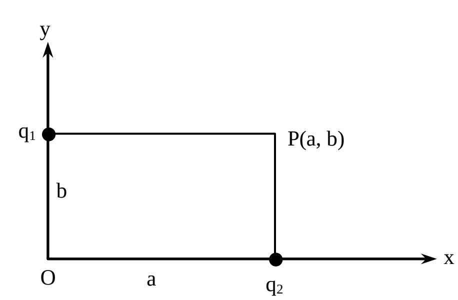
4. Two small identical balls P and Q, each of mass $\sqrt{3}/10$ gram, carry identical charges and are suspended by threads of equal lengths. At equilibrium, they position themselves as shown in figure. What is the charge on each ball. Given $\frac{1}{4\pi\varepsilon_0}$ = 9×10^9 Nm^{2}C^{-2} and take g = 10 ms^{-2}



(a) 10^{-3} C
(b) 10^{-5} C
(c) 10^{-7} C
(d) 10^{-9} C

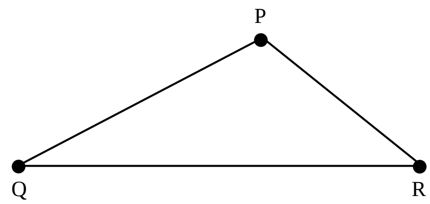
5. Two points charges +4q and +q are placed 30 cm apart. At what point on the line joining them is the electric field zero?
(a) 15 cm from charge 4q
(b) 20 cm from charge 4q
(c) 7.5 cm from charge q
(d) 5 cm from charge q

6. Two point charges q_1 = 2μC and q_2 = 1 μC are placed at distances b = 1 cm and a = 2 cm from the origin on the y and x axes as shown in figure. The electric field vector at a point P(a, b) will subtend an angle θ with the x-axis given by



(a) tan θ = 1
(b) tan θ = 2
(c) tan θ = 3
(d) tan θ = 4

7. Three charges, each of magnitude $q = 2\ \mu C$ are placed at the vertices P, Q and R of the triangle as shown in figure. The sum of the sides PQ and PR is 12 cm and their product is 32 cm^2. The potential at point P would be



(a) 6.00×10^5 V
(b) 6.25×10^5 V
(c) 6.50×10^5 V
(d) 6.75×10^5 V

8. Two tiny spheres carrying charges of 1 μC and 3 μC are placed 8 cm apart in air. What is the electric potential at the mid-point of the line joining the two charges? Given $1/4\pi\varepsilon_0 = 9 \times 10^9$ N m^2 C^{-2}.

(a) 9×10^2 V (b) 9×10^3 V
(c) 9×10^4 V (d) 9×10^5 V

9. A cube of side b has a charge q at each of its vertices. What is the electric potential at the centre of the cube?

(a) $\frac{4q}{\sqrt{3}\pi\varepsilon_0 b}$ (b) $\frac{\sqrt{3}q}{\pi\varepsilon_0 b}$
(c) $\frac{2q}{\pi\varepsilon_0 b}$ (d) zero

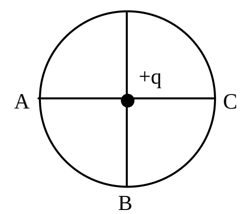
10. Two point charges –q and +q are located at points (0, 0, –a) and (0, 0, a) respectively. What is the electric potential at point (0, 0, z)?

(a) $\frac{qa}{4\pi\varepsilon_0 z^2}$ (b) $\frac{q}{4\pi\varepsilon_0 a}$
(c) $\frac{2qa}{4\pi\varepsilon_0 (z^2 - a^2)}$ (d) $\frac{2qa}{4\pi\varepsilon_0 (z^2 + a^2)}$

11. A neutral hydrogen molecule has two protons and two electrons. If one of the electrons in removed we get a hydrogen molecular ion (H_2^+). In the ground state of H_2^+ the two protons are separated by roughly 1.5 Å and the electron is roughly 1 Å from each proton. What is the potential energy of the system?

(a) –38.4 eV (b) –19.2 eV
(c) –9.6 eV (d) zero

12. A positive charge (+q) is located at the centre of a circle as shown in figure. W_1 is the work done in taking a unit positive charge from a to B and W_2 is the work done in taking the same charge from A to C. Then



(a) $W_1 > W_2$ (b) $W_1 < W_2$
(c) $W_1 = W_2$ (d) $W_1 = W_2 = 0$

13. Two concentric spheres of radii r_1 and r_2 carry charges q_1 and q_2 respectively. If the surface charge density (σ) is the same for both spheres, the electric potential at the common centre will be

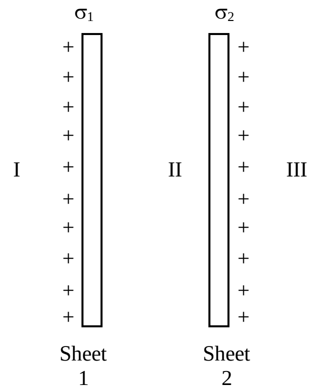
(a) $\frac{\sigma}{\varepsilon_0} \cdot \frac{r_1}{r_2}$

(b) $\frac{\sigma}{\varepsilon_0} \cdot \frac{r_2}{r_1}$

(c) $\frac{\sigma}{\varepsilon_0}(r_1 - r_2)$

(d) $\frac{\sigma}{\varepsilon_0}(r_1 + r_2)$

14. Two parallel plane sheets 1 and 2 carry uniform charge densities σ_1 and σ_2. The electric field in the region marked I is ($\sigma_1 > \sigma_2$)



(a) $-\dfrac{\sigma_1}{2\varepsilon_0}$

(b) $-\dfrac{\sigma_2}{2\varepsilon_0}$

(c) $-\dfrac{(\sigma_1+\sigma_2)}{2\varepsilon_0}$

(d) $-\dfrac{(\sigma_1-\sigma_2)}{2\varepsilon_0}$

15. In Q. 14, what is the electric field in the region marked II?

(a) $\dfrac{\sigma_1}{2\varepsilon_0}$ (b) $\dfrac{\sigma_2}{2\varepsilon_0}$

(c) $\dfrac{(\sigma_1-\sigma_2)}{2\varepsilon_0}$ (d) $\dfrac{(\sigma_1+\sigma_2)}{2\varepsilon_0}$

16. In Q. 14, the electric field in the region marked III is

(a) $-\dfrac{(\sigma_1+\sigma_2)}{2\varepsilon_0}$ (b) $-\dfrac{(\sigma_1-\sigma_2)}{2\varepsilon_0}$

(c) $\dfrac{(\sigma_1+\sigma_2)}{2\varepsilon_0}$ (d) $\dfrac{(\sigma_1-\sigma_2)}{2\varepsilon_0}$

17. A simple pendulum consists of a small sphere of mass m suspended by a thread of length l. The sphere carries a positive charge q. The pendulum is placed in a uniform electric field of strength E directed vertically upwards. With what period will the pendulum oscillate if the electrostatic force acting on the sphere is less that the gravitational force? Assume the oscillations to be small.

(a) $T = 2\pi\left(\dfrac{l}{g}\right)^{1/2}$ (b) $T = 2\pi\left(\dfrac{ml}{qE}\right)^{1/2}$

(c) $T = 2\pi\left[\dfrac{l}{\left(g-\dfrac{qE}{m}\right)}\right]^{1/2}$ (d) $T = 2\pi\left[\dfrac{l}{\left(g+\dfrac{qE}{m}\right)}\right]^{1/2}$

18. Two equal negative charges –q are fixed at points (0, a) and (0, –a). A positive charge +Q is released from rest at the point (2a, 0) on the x-axis. The charge Q will

(a) execute SHM about the origin

(b) move to the origin and remain at rest there

(c) move to infinity

(d) execute oscillations but not SHM

19. Particle A has a charge +q and particle B has a charge +4q, each having the same mass m. When allowed to fall from rest through the same potential difference, the ratio of their speeds v_A/v_B will be

(a) 2 : 1

(b) 1 : 2

(c) 1 : 4

(d) 4 : 1

20. A point charge +q is placed at the mid point of a cube of side L. The electric flux emerging from the cube is

(a) $\dfrac{q}{\varepsilon_0}$ (b) zero

(c) $\dfrac{6qL^2}{\varepsilon_0}$ (d) $\dfrac{q}{6L^2\varepsilon_0}$

21. The electric potential at the surface of an atomic nucleus (Z = 50) of radius 9.0×10^{-13} cm is

(a) 80 V

(b) 8×10^6 V

(c) 9 V

(d) 9×10^5 V

22. Two identical thin rings, each of radius R are coaxially placed a distance R apart. If Q_1 and Q_2 are respectively the charge uniformly spread on the two rings, the work done in moving a charge q from the centre of one ring to the centre of the other is

(a) zero

(b) $\frac{q}{4\pi\varepsilon_0 \sqrt{2}R}(Q_1 - Q_2)(\sqrt{2} - 1)$

(c) $\frac{q\sqrt{2}}{4\pi\varepsilon_0 R}(Q_1 + Q_2)$

(d) $\frac{(\sqrt{2}+1)q(Q_1+Q_2)}{\sqrt{2}\,4\pi\varepsilon_0 R}$

23. A non conducting ring of radius 0.5 m carries a total charge of 1.11×10^{-10} C distributed non-uniformly on its circumference producing an electric field E everywhere in space. The value of the line integral $\int_{l=\infty}^{l=0} -E \cdot dl$(l = 0 being centre of the ring) in volts is

(a) +2 (b) –1

(c) –2 (d) zero

24. A charge +q is fixed at each of the points $x = x_0$, $x = 3x_0$, $x = 5x_0$.... Upto infinity and a charge –q is fixed at each of the points $x = 2x_0$, $x = 4x_0$, $x = 6x_0$ .....upto infinity. Here x_0 is a positive constant. The potential at the origin to this system of charges is

(a) zero (b) $\frac{q}{4\pi\varepsilon_0 x_0 \ln(2)}$

(c) infinity (d) $\frac{q\ln(2)}{4\pi\varepsilon_0 x_0}$

25. A particle of mass m and charge q is released from rest in a uniform electric field E. The kinetic energy attained by the particle after moving a distance x is

(a) qEx^2 (b) qE^2x

(c) qEx (d) q^2Ex

26. There is a uniform field of strength 10^3 Vm^{-1} along the y-axis. A body of mass 1 g and charge 10^{-6} C is projected into the field from the origin along the positive x-axis with a velocity of 10 ms^{-1}. Its speed (in ms^{-1}) after 10 second will be (neglect gravitation)

(a) 10 (b) $5\sqrt{2}$

(c) $10\sqrt{2}$ (d) 20

27. Eight charged water drops each with a radius of 1 mm and a charge of 10^{-10} C coalesce to form a single drop. What is the potential of the big drop?

(a) 36 V (b) 360 V

(c) 3600 V (d) 36000 V

28. A charge having magnitude q is divided into two parts q and (Q – q) which are held a certain distance r apart. The force of repulsion between the two parts will be maximum if the ratio q/Q is

(a) $\frac{1}{2}$ (b) $\frac{1}{3}$

(c) $\frac{1}{4}$ (d) $\frac{1}{5}$

29. Two spheres of radii r and R carry charges q and Q respectively. When they are connected by a wire, there be no loss of energy of the system if

(a) qr = QR (b) qR = Qr

(c) $qr^2 = QR^2$ (d) $qR^2 = Qr^2$

30. A uniform electric field pointing in positive x-direction exists in a region. Let A be the origin, B be the point on the x-axis at x = +1 cm and C be the point on the y-axis at y = +1 cm. Then the potentials at the points A, B and C satisfy:

(a) $V_A < V_B$ (b) $V_A > V_B$

(c) $V_A < V_C$ (d) $V_A > V_C$

31. Two equal point charges are fixed at $x = -a$ and $x = +a$ on the x-axis. Another point charges Q is placed at the origin. The change in the electrical potential energy of Q, when it is displaced by a small distance x along the x-axis, is approximately proportional to

(a) x (b) x^2

(c) x^3 (d) $1/x$

32. An infinite number of charges, each equal to q, are placed along the x-axis at x = 1, x = 2, x = 8,… and so on. The potential at the point x = 0 due to this set of charges is

(a) $\frac{q}{\pi\varepsilon_0}$ (b) $\frac{q}{2\pi\varepsilon_0}$

(c) $\frac{q}{3\pi\varepsilon_0}$ (d) $\frac{q}{4\pi\varepsilon_0}$

33. The flux of electric field $E = 200\ \hat{i}\ NC^{-1}$ through a cube of side 10 cm, oriented so that its faces are parallel to the co-ordinate axes is

(a) zero (b) 2 $NC^{-1}\ m^2$

(c) 6 $NC^{-1}\ m^2$ (d) 12 $NC^{-1}\ m^2$

34. The electric field in a region is given by

$$E = (2\hat{i} + 3\hat{j}) \times 10^3\ NC^{-1}$$

The electric flux through a rectangular surface 10 cm × 20 cm held parallel to the y-z plane is

(a) 40 $NC^{-1}\ m^2$ (b) 50 $NC^{-1}\ m^2$

(c) 60 $NC^{-1}\ m^2$ (d) zero

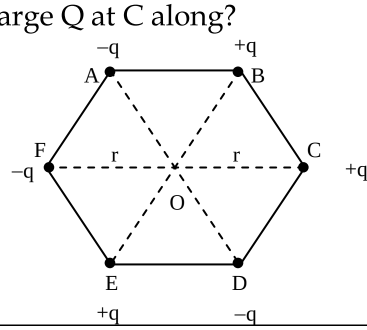
35. Three negative point charge –q each, the three positive point charges +q, +q and +Q are placed at the vertices of a regular hexagon as shown in figure. For what value of Q will be electric field at O to due to the five charges at A, B, D, E and F be twice the electric field at centre O due to charge Q at C along?

(a) q

(b) $\frac{q}{2}$

(c) 2q

(d) 5q



36. Three infinite long plane sheets carrying uniform charge densities

$$\sigma_1 = -\sigma,\ \sigma_2 = +2\sigma \text{ and } \sigma_3 = +3\sigma$$

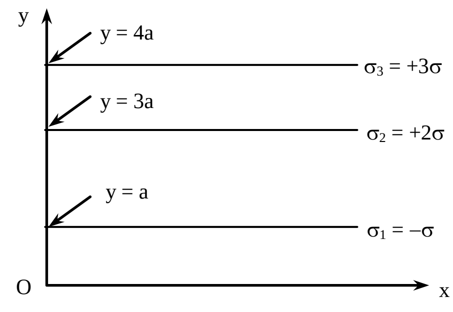
are placed parallel to the x-z plane at y = a, y = 3a and y = 4a as shown in figure. The electric field at point P is

(a) zero

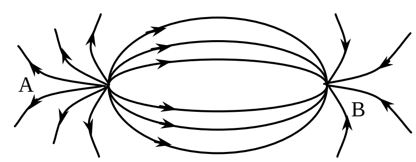
(b) $-\frac{2\sigma}{\varepsilon_0}\hat{j}$

(c) $-\frac{3\sigma}{\varepsilon_0}\hat{j}$

(d) $\frac{3\sigma}{\varepsilon_0}\hat{j}$



37. The spatial distribution of the electric field due to two charges (A, B) is shown in figure. Which one of the following statements is correct?



(a) A is +ve and B is – ve and |A| > |B|

(b) A is –ve and B is +ve, |A| = |B|

(c) Both are +ve but A > B

(d) Both are –ve but A > B

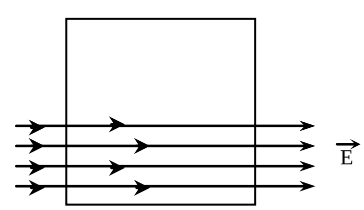
38. A square surface of side L metre is in the plane of the paper. A uniform electric field $\vec{E}$ (Volt/m), also in the plane of the paper, is limiting only to lower half of the square surface. The electric flux in SI units associated with the surface is:

(a) EL^2

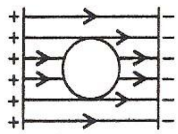
(b) $EL^2/2\varepsilon_0$

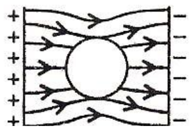
(c) $EL^2/2$

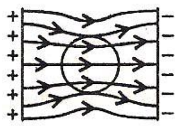
(d) zero

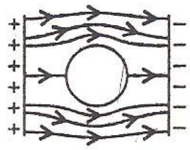


39. An uncharged metal sphere is placed between two equal and oppositely charged metal plates. The nature of lines of force will be:

(a) 

(b) 

(c) 

(d) 

40. Charge is distributed uniformly on the surface of a spherical balloon (an insulator) with a point q inside. The electric force on q is greater when:

(a) it is near the inside surface of the balloon
(b) it is at the centre of balloon
(c) it is anywhere inside (the force is same everywhere and is non-zero)
(d) it is anywhere inside (the force is zero everywhere)

41. The electric potential V at any point (x, y, z) (all in metre) in space is given by $V = 4x^2$ volt. The electric field at the point (1m 0, 2m) in volt/metre is:

(a) 8 along negative x-axis
(b) 8 along positive x-axis
(c) 16 along positive x-axis
(d) 16 along positive x-axis

42. Two identical metal balls A and B of radius r rare placed at a distance a (a >> r) from each other and are charged. Potential at A is V_1 and at B is V_2. The charge q_1 and q_2 on these balls in CGS esu are:

(a) $q_1 = \frac{rV_2 + aV_1}{r^2 + a^2}$, $q_2 = \frac{rV_1 + aV_2}{r^2 + a^2}$

(b) $q_1 = \left(\frac{rV_2 - aV_1}{r^2 - a^2}\right)$ra, $q_2 = \left(\frac{rV_1 - aV_2}{r^2 - a^2}\right)$ ra

(c) $q_1 = \frac{aV_2}{(r^2 - a^2)}$, $q_2 = \frac{rV_1}{(r^2 - a^2)}$

(d) $q_1 = \frac{rV_1}{(r^2 - a^2)}$, $q_2 = \frac{rV_2}{(r^2 - a^2)}$

43. The electric potential in a certain region of space is given by $V = -3x^2 + 4x$, where x is in metre and V is in volt. I nthe region, the equipotential surface are:

(a) plane parallel to y-plane
(b) planes parallel to yz-plane
(c) concentric cylinders with axis as x-axis
(d) concentric spheres with axis as x-axis

44. A charge soap bubble of radius r is in equilibrium with pressure inside and outside equal. If T is the surface tension of soap solution, then potential of the soap bubble is:

(a) $\sqrt{8T\varepsilon_0 / r}$ (b) $\sqrt{8Tr/\varepsilon_0}$

(c) $\sqrt{8Tr\varepsilon_0}$ (d) None of these

45. Ten electrons are equally spaced and fixed around a circle of radius R. Relative to V = 0 at infinity, the electrostatic potential V and the electric field $\vec{E}$ at the centre C are:

(a) $V \neq 0$ and $\vec{E} \neq 0$ (b) $V \neq 0$ and $\vec{E} = 0$

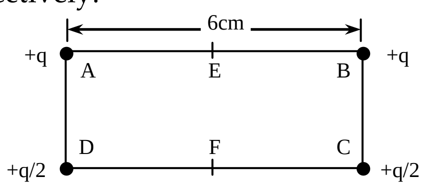
(c) $V = 0$ and $\vec{E} \neq 0$ (d) $V = 0$ and $\vec{E} = 0$

46. A system consists of two thin concentric metallic shells of radii R_1 and R_2 ($R_1 > R_2$) with corresponding charges q_1 and q_2. The total electric energy of the system is:

(a) $\frac{(q_1+q_2)^2}{4\pi\varepsilon_0 R_1}$ (b) $\frac{q_2^2}{4\pi\varepsilon_0 R_2}$

(c) $\frac{(q_1+q_2)^2}{4\pi\varepsilon_0 R_2}$ (d) $\frac{1}{4\pi\varepsilon_0}\left[\frac{q_1^2}{2R_1}+\frac{q_2^2}{2R_2}+\frac{q_1 q_2}{R_2}\right]$

47. Find the potential difference between the points E and F as shown in the figure. Assume E and F are the mid-points of AB and DC respectively:



(a) (1.2×10^9 q) volt

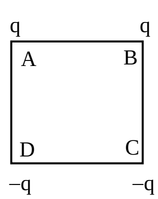
(b) (1.8×10^9 q) volt

(c) (10^9 q) volt

(d) (1.5×10^9 q) volt

(e) (3×10^9 q) volt

48. Charges are placed on the vertices of a square as shown. Let $\vec{E}$ be the electric field and V the potential at the centre. If the charges on A and B are interchanged with those on D and C respectively, then:



(a) $\vec{E}$ changes, V remains unchanged

(b) $\vec{E}$ remains unchanged, V changes

(c) both $\vec{E}$ and V charge

(d) $\vec{E}$ and V remain unchanged

49. Positive and negative point charges of equal magnitude are kept at $\left(0,0,\frac{a}{2}\right)$ and $\left(0,0,\frac{-a}{2}\right)$ respectively. The work done by the electric field when another positive point charge is moved from (–a, 0, 0) to (0, a, 0) is:

(a) positive

(b) negative

(c) zero

(d) dependent on the path connecting the initial and final positions

50. Eight charges, each of magnitude q are placed at the vertices of a cube placed in vacuum. Electric potential at the centre of the cube due to this system of charges is: (ε_0 is permittivity of vacuum and a is length of each side of the cube)

(a) $\frac{2q}{\pi\varepsilon_0 a}$ (b) $\frac{4q}{\sqrt{3}\pi\varepsilon_0 a}$

(c) zero (d) $\frac{\sqrt{3}q}{\pi\varepsilon_0 a}$

ANSWERS KEY

1	D	**11**	B	**21**	B	**31**	B	41	A
2	B	**12**	D	**22**	B	**32**	B	42	B
3	B	**13**	D	**23**	D	**33**	A	43	B
4	C	**14**	C	**24**	D	**34**	A	44	B
5	B	**15**	C	**25**	C	**35**	B	45	B
6	B	**16**	C	**26**	C	**36**	C	46	D
7	D	**17**	C	**27**	C	**37**	B	47	A
8	D	**18**	D	**28**	A	**38**	D	48	A
9	A	**19**	B	**29**	B	**39**	B	49	C
10	C	**20**	A	**30**	B	**40**	D	50	B