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For Class 9 Mathematics	Click here
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For Class 10 Mathematics	Click here
For Class 11 Physics	Click here
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For Class 11 Biology	Click here
For Class 11 mathematics	Click here
For Class 12 Physics	Click here
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C. U. Q

CHARGE & CONSERVATION OF CHARGE

1. Two identical metallic spheres A and B of exactly equal masses are given equal positive and negative charges respectively. Then

1) mass of A > Mass of B
2) mass of A < Mass of B
3) mass of A = Mass of B
4) mass of A $\geq$ Mass of B

2. Two spheres of equal mass A and B are given +q and -q charge respectively then

1) mass of A increases 2) mass of B increases
3) mass of A remains constant
4) mass of B decreases

3 A soap bubble is given a negative charge, then its radius.

1) Decreases 2) Increases
3) Remanins unchanged
4) Nothing can be predicted as information is insufficient

COULOMB'S LAW

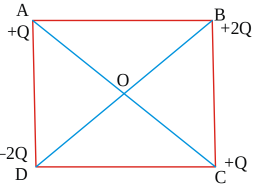
4. Two charges are placed at a distance apart. If a glass slab is placed between them, force between them will

1) be zero 2) increase
3) decrease 4) remains the same

5. A negatively charged particle is situated on a straight line joining two other stationary particles each having charge +q. The direction of motion of the negatively charged particle will depend on

1) the magnitude of charge
2) the position at which it is situated
3) both magnitude of charge and its position
4) the magnitude of +q

6. **Four charges are arranged at the corners of a square ABCD as shown in the figure. The force on the positive charge kept at the centre 'O' is**



1) zero
2) along the diagonal AC
3) along the diagonal BD
4) perpendicular to side AB

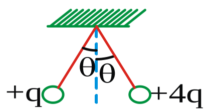
7. **Two identical +ve charges are at the ends of a straight line AB. Another identical +ve charge is placed at 'C' such that AB=BC. A, B and C being on the same line. Now the force on 'A'**

1) increases
2) decreases
3) remains same
4) we cannot say

8. **Two identical pendulums A and B are suspended from the same point. Both are given positive charge, with A having more charge than B. They diverge and reach equilibrium with the suspension of A and B making angles θ_1 and θ_2 with the vertical respectively.**

1) $\theta_1 > \theta_2$
2) $\theta_1 < \theta_2$
3) $\theta_1 = \theta_2$
4) The tension in A is greater than that in B

9. **Two metal spheres of same mass are suspended from a common point by a light insulating string. The length of each string is same. The spheres are given electric charges +q on one end and +4q on the other. Which of the following diagram best shows the resulting positions of spheres?**

1)


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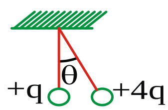

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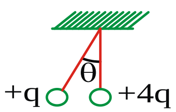

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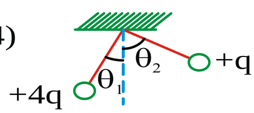
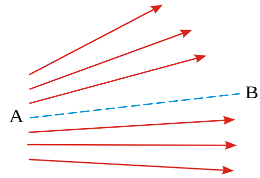


10. **Two point charges $-q$ and $+2q$ are placed at a certain distance apart. Where should a third point charge be placed so that it is in equilibrium?**

1) on the line joining the two charges on the right of $+2q$
2) on the line joining the two charges on the left of $-q$
3) between $-q$ and $+2q$
4) at any point on the right bisector of the line joining $-q$ and $+2q$.

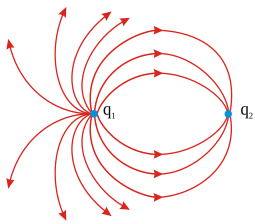
ELECTRIC FIELD

11. **Figure shows the electric lines of force emerging from a charged body. If the electric field at 'A' and 'B' are E_A and E_B respectively and if the displacement between 'A' and 'B' is 'r' then**



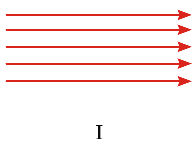
1) $E_A > E_B$
2) $E_A < E_B$
3) $E_A = \frac{E_B}{r}$
4) $E_A = \frac{E_B}{r^2}$

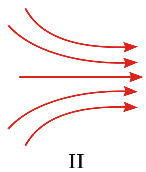
12. **Figure shows lines of force for a system of two point charges. The possible choice for the charges is**



1) $q_1 = 4\mu C, q_2 = -1.0\mu C$
2) $q_1 = 1\mu C, q_2 = -4\mu C$
3) $q_1 = -2\mu C, q_2 = +4\mu C$
4) $q_1 = 3\mu C, q_2 = 2\mu C$

13. **Drawings I and II show two samples of electric field lines**





1) The electric fields in both I and II are produced. by negative charge located somewhere on the left and positive charges located somewhere on the right
2) In both I and II the electric field is the same every where
3) In both cases the field becomes stronger on moving from left to right
4) The electric field in I is the same everywhere, but in II the electric field becomes stronger on moving from left to right

14. **An electron is projected with certain velocity into an electric field in a direction opposite to the field. Then it is**

1) accelerated
2) retarded
3) neither accelerated nor retarded
4) either accelerated or retarded

15. **The acceleration of a charged particle in a uniform electric field is**
1) proportional to its charge only
2) inversely proportional to its mass only
3) proportional to its specific charge
4) inversely proportional to specific charge

16. **An electron and proton are placed in an electric field. The forces acting on them are F_1 and F_2 and their accelerations are a_1 and a_2 respectively then**
1) $\bar{F}_1 = \bar{F}_2$ 2) $\bar{F}_1 + \bar{F}_2 = 0$
3) $|\bar{a}_1| = |\bar{a}_2|$ 4) $|\bar{a}_1| \geq |\bar{a}_2|$

17. **The bob of a pendulum is positively charged. Another identical charge is placed at the point of suspension of the pendulum. The time period of pendulum**
1) increases 2) decreases
3) becomes zero 4) remains same.

18. **Intensity of electric field inside a uniformly charged hollow sphere is**
1) zero 2) non zero constant
3) change with r
4) inversely proportional to r

19. **A positive charge q_0 placed at a point P near a charged body experiences a force of repulsion of magnitude F, the electric field E of the charged body at P is**
1) $\frac{F}{q_0}$ 2) $< \frac{F}{q_0}$ 3) $> \frac{F}{q_0}$ 4) F

20. **A cube of side b has charge q at each of its vertices. The electric field at the centre of the cube will be (KARNATAKA CET 2000)**
1) zero 2) $\frac{32q}{b^2}$ 3) $\frac{q}{2b^2}$ 4) $\frac{q}{b^2}$

21. **An electron and proton are sent into an electric field. The ratio of force experienced by them is**
1) 1 : 1 2) 1 : 1840
3) 1840 : 1 4) 1 : 9.11

22. **An electron enters an electric field with its velocity in the direction of the electric lines of force. Then**
1) the path of the electron will be a circle
2) the path of the electron will be a parabola
3) the velocity of the electron will decrease
4) the velocity of the electron will increase

23. **A charged bead is capable of sliding freely through a string held vertically in tension. An electric field is applied parallel to the string so that the bead stays at rest of the middle of the string. If the electric field is switched off momentarily and switched on**
1) the bead moves downwards and stops as soon as the field is switched on
2) the bead moved downwards when the field is switched off and moves upwards when the field is switched on
3) the bead moves downwards with constant acceleration till it reaches the bottom of the string
4) the bead moves downwards with constant velocity till it reaches the bottom of the string

24. **An electron is moving with constant velocity along x-axis. If a uniform electric field is applied along y-axis, then its path in the x-y plane will be**
1) a straight line 2) a circle
3) a parabola 4) an ellipse

25. **An electron of mass M_e, initially at rest, moves through a certain distance in a uniform electric field in time t_1. proton of mass M_p also initially at rest, takes time t_2 to move through an equal distance in this uniform electric field. Neglecting the effect of gravity the ratio t_2 / t_1 is nearly equal to**
1) 1 2) $\sqrt{M_p / M_e}$ 3) $\sqrt{M_e / M_p}$ 4) 1836

26. **Dimensions of ε_0 are**
1) $\left[M^{-1}L^{-3}T^4A^2\right]$ 2) $\left[M^0L^{-3}T^3A^3\right]$
3) $\left[M^{-1}L^{-3}T^3A\right]$ 4) $\left[M^{-1}L^{-3}TA^2\right]$

27. **Two point charges q and -2q are placed some distance d apart. If the electric field at the locatiion of q is E, that at the location of -2q is (1987)**
1) $-\frac{E}{2}$ 2) –2E 3) $\frac{E}{2}$ 4) – 4E

28. $E = -\frac{dV}{dr}$**, here negative sign signified that**
1) E is opposite to V 2) E is negative
3) E increases when V decreases
4) E is directed in the direction of decreasing V

29. An electron moves with a velocity $\vec{v}$ in an electric field $\vec{E}$. If the angle between $\vec{v}$ and $\vec{E}$ is neither 0 nor π, then path followed by the electron is

1) straight line 2) circle
3) ellipse 4) parabola

30. A charged particle is free to move in an electric field

1) It will always move perpendicular to the line of force
2) It will always move along the line of force in the direction of the field.
3) It will always move along the line of force opposite to the direction of the field.
4) It will always move along the line of force in the direction of the field or opposite to the direction of the field depending on the nature of the charge

31. Two parallel plates carry opposite charges such that the electric field in the space between them is in upward direction. An electron is shot in the space and parallel to the plates. Its deflection from the original direction will be

1) Upwards 2) Downwards
3) Circular 4) does not deflect

ELECTRIC POTENTIAL AND POTENTIAL ENERGY

32. Potential at the point of a pointed conductor is

1) maximum 2) minimum
3) zero 4) same as at any other point

33. An equipotential line and a line of force are

1)perpendicular to each other
2)parallel to each other
3) in any direction 4) at an angle of 45^0

34. When a positively charged conductor is placed near an earth connected conductor, its potential

1) always increases 2) always decreases
3) may increase or decrease 4) remains the same

35. If a unit charge is taken from one point to another over an equipotential surface, then

1) work is done on the charge
2) work is done by the charge
3) work on the charge is constant
4) no work is done

36. Electric potential at some point in space is zero. Then at that point

1) electric intensity is necessarily zero
2) electric intensity is necessarily non zero.
3) electric intensity may or may not be zero
4) electric intensity is necessarily infinite.

37. When an electron approaches a proton, their electro static potential energy

1) decreases 2) increases
3) remains unchanged 4) all the above

38. An electron and a proton move through a potential difference of 200V. Then

1) electron gains more energy
2) proton gains more energy
3) both gain same energy
4) none of them gain energy

39. Two charges +q and –q are kept apart. Then at any point on the right bisector of line joining the two charges.

1) the electric field strength is zero
2) the electric potential is zero
3) both electric potential and electric field strength are zero
4) both electric potential and electric field strength are non - zero

40. When 'n' small drops are made to combine to form a big drop, then the big drop's

1) Potential increases to $n^{1/3}$ times original potential and the charge density decreases to $n^{1/3}$ times original charge
2) Potential increases to $n^{2/3}$ times original potential and charge density increases to $n^{1/3}$ times original charge density
3) Potential and charge density decrease to $n^{1/3}$ times original values
4) Potential and charge density increases to 'n' times original values

41. A hollow metal sphere of radius 5cm is charged such that the potential on its surface is 10V. The potential at the centre of the sphere is

1) 0 V 2) 10 V
3) same as at point 5cm away from the surface
4) same as at point 25cm from the surface

42. The work done (in Joule) in carrying a charge of 'x' coulomb between two points having a potential difference of 'y' volt is

1) $\frac{x}{y}$ 2) $\frac{x^2}{y}$ 3) $\frac{y}{x}$ 4) xy

43. Two charges q and -q are kept apart. Then at any point on the perpendicular bisector of line joining the two charges. (2008E)

1) the electric field strength is zero
2) the electric potential is zero
3) both electric potential and electric field strength are zero
4) both electric potential and electric field strength are non-zero

44. Electric potential at the centre of a charged hollow spherical conductor is

1) zero
2) twice as that on the surface
3) half of that on the surface
4) same as that on the surface

45. Which of the following pair is related as in work and force

1) electric potential and electric intensity
2) momentum and force
3) impulse and force
4) resistance and voltage

46. The equipotential surfaces corresponding to single positve charge are concentric spherical shells with the charge at its origin. The spacing between the surfaces for the same change in potential

1) is uniform throughout the field
2) is getting closer as $r \to \infty$
3) is getting closer as $r \to 0$
4) can be varied as one wishes to

47. Four identical charges each of charge q are placed at the corners of a square. Then at the centre of the square the resultant electric intensity E and the net electric potential V are

1) $E \neq 0, V = 0$ 2) $E = 0, V = 0$
3) $E = 0, V \neq 0$ 4) $E \neq 0, V \neq 0$

48. Two positive charges q and q are placed at the diagonally opposite corners of a square and two negative charges -q and -q are placed at the other two corners of the square. Then at the centre of the square the resultant electric intensity E and the net electric potential V are

1) $E \neq 0, V = 0$ 2) $E = 0, V = 0$
3) $E = 0, V \neq 0$ 4) $E \neq 0, V \neq 0$

49. Two copper spheres of the same radii, one hollow and the other solid, are charged to the same potential, then

1) hollow sphere holds more charge
2) solid sphere holds more charge
3) both hold equal charge
4) we can't say

50. Equipotential surfaces are shown in figure a and b. The field in

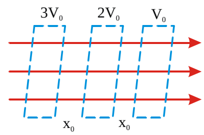


FIGURE (A)

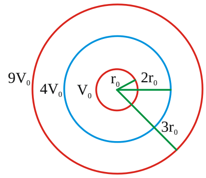


FIGURE (B)

1) a is uniform only 2) b is uniform only
3) a and b is uniform 4)both are nonuniform

51. Due to the motion of a charge, its magnitude

1) changes
2) does not changes
3) increases (or) decreases depends on its speed
4) can not be predicted

52. Induction preceeds attraction because

1) an uncharged body can attract an uncharged body due to induction of opposite charge on it
2) a charged body can attract an uncharged body due to induction of same charge on it.
3) a charged body can attract an uncharged body due to induction of opposite charge on it.
4) a charged body can attract another charged body due to induction of same charge on it.

53. The coulomb electrostatic force is defined for

1) two spherical charges at rest
2) two spherical charges in motion
3) two point charges in motion
4) two point charges at rest

54. The Electric field is given by $\vec{E} = \frac{\vec{F}}{q_0}$, here the test charge '$q_0$' should be

a) Infinitesimally small and positive
b) Infinitesimally small and negative

1) only a 2) only 'b'
3) a (or) b 4) neither 'a' or 'b'

55. The p.d $(V_B - V_C)$ between two points from C to B

1) does not depend on the path
2) depends on the path
3) depends on test charge
4) independent of electric field

56. Match List-I with List-II

List-I	List-II
a) proton and electron	e) gains same velocity in an elctric field for same time
b) proton and positron	f) gains same KE in an electric field for same time.
c) Deutron and α - particle	g) experience same force in electric field
d) electron and positron	h) gains same KE when accelerated by same potential difference.

1) $a-h, b-g, c-e, d-f$

2) $a-h, b-g, c-f, d-e$

3) $a-g, b-h, c-e, d-f$

4) $a-e, b-f, c-g, d-h$

57. Match List-I with List-II

List-I	List-II
a) Electric potential inside a charged conducting sphere	e) inversly proportional to square of the distance (r^2)
b) Electric potential charged sphere	f) directly proportional outside the conducting to distance (r) from the centre
c) Electric field	g) constant inside the non conducting charged sphere
d) Electric field charged sphere	h) inversly outside a conducting proportional to distance (r)

1) $a-f, b-e, c-g, d-h$

2) $a-e, b-f, c-h, d-g$

3) $a-h, b-g, c-e, d-f$

4) $a-g, b-h, c-f, d-e$

58. Match the following

List-I	List-II
a) Fluid flow	d) Temperature difference
b) Heat flow	e) Pressure difference
c) Charge flow	f)Potential difference

1) $a-e, b-d, c-f$

2) $a-d, b-e, c-f$

3) $a-f, b-e, c-d$

4) $a-e, b-f, c-d$

59. Match List-I with List-II

List-I	List-II
a) Two like charges are brought nearer	e) the force between them decreases.
b) Two unlike charge of some brought nearer	f) potential energy of the system increases
c) When a third charge of same nature is placed equidistance from two like charges	g) mutual forces are not affected
d) When a dielectric medium is introduced between two charges	h) potential energy of the system decreases

1) $a-h, b-f, c-g, d-e$

2) $a-f, b-h, c-g, d-e$

3) $a-h, b-f, c-e, d-g$

4) $a-g, b-e, c-f, d-h$

60. Match the following :

a) Electric field outside a conducting charged sphere	e) Constant
b) Electric potential out side the conducting charged sphere	f) directly propor national to distance from centre
c) Electric field inside a non-conducting charged sphere	g) inversely propor tional to the distance
d) Electric potential in side a charged conducting sphere	h) inversely proportional to the square of the distance

1) $a-h,\ b-g,\ c-e,\ d-f$

2) $a-e,\ b-f,\ c-h,\ d-g$

3) $a-h,\ b-g,\ c-f,\ d-e$

4) $a-g,\ b-h,\ c-f,\ d-e$

DIPOLE

61. The angle between electric dipolemoment p and the electric field E when the dipole is in stable equilibrium

1) 0 2) $\pi/4$ 3) $\pi/2$ 4) π

62. 'Debye' is the unit of

1) electric flux 2) electric dipolemoment
3) electric potential 4) electric field intensity

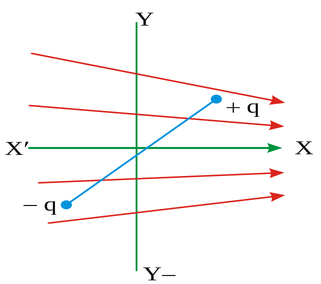
63. The electric field at a point at a distance r from an electric dipole is proportional to

1) $\frac{1}{r}$ 2) $\frac{1}{r^2}$ 3) $\frac{1}{r^3}$ 4) r^2

64. An electric dipole placed with its axis in the direction of a uniform electric field experiences

1) a force but not torque
2) a torque but no force
3) a force as well as a torque
4) neither a force nor a torque

65. An electric dipole is placed in a non uniform electric field increasing along the +ve direction of X - axis. In which direction does the dipole



1) move along + ve direction of X - axis, rotate clockwise
2) move along - ve direction of X - axis, rotate clockwise
3) move along + ve direction of X - axis, rotate anti clockwise
4) move along - ve direction of X - axis, rotate anti clockwise

66. An electric dipole placed in a nonuniform electric field experiences

1) a force but no torque
2) a torque but no force
3) a force as well as a torque
4) neither a force nor a torque

67. If E_a be the electric field intensity due to a short dipole at a point on the axis and E_r be that on the perpendicular bisector at the same distance from the dipole, then

1) $E_a = E_r$ 2) $E_a = 2E_r$

3) $E_r = 2E_a$ 4) $E_a = \sqrt{2E_r}$

68. The electric potential due to an extremely short dipole at a distance r from it is proportional to

1) $\frac{1}{r}$ 2) $\frac{1}{r^2}$ 3) $\frac{1}{r^3}$ 4) $\frac{1}{r^4}$

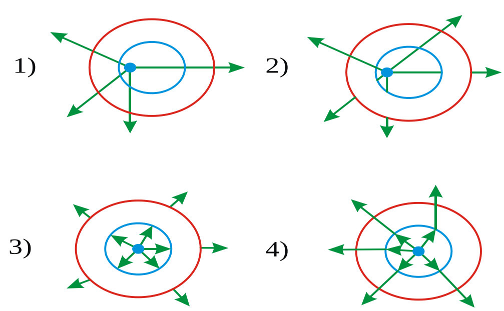
69. An electric dipole when placed in a uniform electric field will have minimum potential energy, if the angle between dipole moment and electric field is

1) zero 2) $\pi/2$ 3) π 4) $3\pi/2$

70. The angle between the electric dipole moment and the electric field strength due to it, on the equatorial line is

1) 0^0 2) 90^0 3) 180^0 4) 60^0

71. A metallic shell has a point charge q kept inside its cavity. Which one of the following diagrams correctly represents the electric lines of forces ?



ASSERTION & REASON

In each of the following questions, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it. Mark the correct answer.

1) Both ‘A’ and ‘R’ are true and ‘R’ is the correct explanation of ‘A’
2) Both ‘A’ and ‘R’ are true and ‘R’ is not the correct explanation of ‘A’
3) ‘A’ is true and ‘R’ is false
4) ‘A’ is false and ‘R’ is true

72. Assertion(A) : Force between two point charges at rest is not changed by the presence of third point charge between them.
Reason(R): Force depends on the magnitude of the first two charges and seperation between them

73. Assertion (A): Electric potential at any point on the equatorial line of an electric dipole is zero
Reason (R): Electric potential is scalar

74. Assertion (A) : Electrons always move from a region of lower potential to a region of highe potential
Reason (R) : Electrons carry a negative charge

75. Assertion(A): A metallic shield in form of a hollow shell may be built to block an electric field.
Reason (R): In a hollow spherical shield, the electric field inside it is zero at every point.

76. Assertion (A): For practical purpose, the earth is used as a reference for zero potential in electrical circuits.
Reason (R): The electrical potential of a sphere of radius R with charge Q uniformly distributed on the surface is given by $\frac{Q}{4\pi\varepsilon_0 R}$

77. Assertion(A): Coulomb force between charges is central force
Reason (R): Coulomb force depends on medium between charges

78. Assertion(A): Electric and gravitational fields are acting along same line. When proton and α - particle are projected up veritically along that line, the time of flights is less for proton.
Reason (R): In the given electric field acceleration of a charged particle is directly proportional to specific charge

79. Assertion(A): When a proton with certain energy moves from low potential to high potential then its KE decreases.
Reason (R): The direction of electric field is opposite to the potential gradient and work done against it is negative.

80. Assertion(A): In bringing an electron towards a proton electrostatic potential energy of the system increases.
Reason (R): Potential due to proton is positive

81. Assertion(A): The surface of a conductor is an equipotential surface
Reason (R): Conductor allows the flow of charge

82. Assertion (A) : A charge ' q_1 ' exerts some force on a second charge ' q_2 ' . If a third charge ' q_3 ' is brought near , the force exerted by q_1 on q_2 does not change
Reason (R): The elecrtostatic force between two charges is independent of presence of third charge

83. Assertion (A) : A point charge 'q' is rotated along a circle around another point charge Q. The work done by electric field on the rotating charge in half revolution is zero.
Reason (R) : No work is done to move a charge on an equipotential line or surface.

84. Assertion: (A): Work done by electric force is path independent.
Reason: (R): Electric force is conservative

85. Assertion (A): In bringing an electron towards a proton electrostatic potential energy of the system increases.
Reason (R): Potential due to proton is positive.

86. Assertion(A): Two particles of same charge projected with different velocity normal to electric field experience same force
Reason (R): A charged particle experiences force, independent of velocity in electric field

87. Assertion(A): The coulomb force is the dominating force in the universe
Reason (R): The coulomb force is stronger than the gravitational force.

88. Assertion(A): A circle is drawn with a point positive charge $(+q)$ at its centre. The work done in taking a unit positive charge once around it is zero
Reason (R): Displacement of unit positive charge is zero

89. Assertion(A): Electric potential at any point on the equatorial line of electric dipole is zero.
Reason (R): Electric potential is scalar

90. **Assertion(A): The potential at any point due to a group of 'N' point charges is simply arrived at by the principle of superposition**
Reason (R): The potential energy of a system of two charges is a scalar quantity

91. **Assertion (A): The electrostatic potential energy is independent of the manner in which the cofiguration is achieved**
Reason (R): Electrostatic field is conservative field

STATEMENT QUESTIONS

92. **Statement-1:- For a charged particle moving from point P to point Q, the net work done by an electrostatic field on the particle is independent of the path connecting point P to point Q.**
Statement-2:- The net work done by a conservative force on an ojecte moving along a closed loop is zero
1) Statement-1 is true, statement-2 is true, Statement-2 is the correct explanation of statement-1.
2) Statement-1 is true, statement-2 is true, Statement-2 is not the correct explanation of statement-1.
3) Statement-1 is false, Statement-2 is true.
4) Statement-1 is true, Statement-2 is false

93. **A dielectric slab of thickness d is inserted in a parallel plate capacitor whose negative plate is at x = 3d. The slab is equidistant from the plates. The capacitor is given some charge. As 'x' goes from 0 to 3d:**
1) the magnitude of the electric field remains the same
2) the direction of the electric field remains the same
3) the electric potential increases continuously
4) the electric potential dicreases at first, then increases and again dicreases

94. **Choose the wrong statement**
1) Work done in moving a charge on equipotential surface is zero.
2) Electric lines of force are always normal to an equipotential surface
3) When two like charges are brought nearer, then electrostatic potential energy of the system gets decreased.
4) Electric lines of force diverge from positive charge and converge towards negative charge.

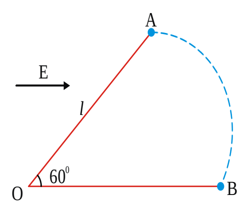
95. **Out of the following statements**
A. Three charge system can not have zero mutual potential energy
B. The mutual potential energy of a system of charges is only due to positive charges
1) A is wrong and B is correct
2) A is correct and B is wrong
3) Both A and B are correct
4) Both A and B are wrong

96. **Statement A: Electrical potential may exist at a point where the electrical field is zero**
Statement B : Electrical Field may exist at a point where the electrical potential is zero.
Statement C : The electric potential inside a charge conducting sphere is constant.
1) A, B are true 2) B,C are true
3) A,C are true 4) A,B,C are true

97. **Statement A: If an electron travels along the direction of electric field it gets accelerated**
Statement B: If a proton travels along the direction of electric field it gets retarded
1) Both A & B are true 2) A is true, B is false
3) A is false, B is true 4) Both A & B are false

98. **A : Charge cannot exist without mass but mass can exist without charge.**
B : Charge is invariant but mass is variant with velocity
C : Charge is conserved but mass alone may not be conserved.
1) A, B, C are true 2) A, B, C are not true
3) A, B are only true 4) A, B are false, C is true

99. **A particle of mass m and charge q is fastened to one end of a string fixed at point O. The whole system lies on a frictionless horizontal plane. Initially, the mass is at rest at A. A uniform electric field in the direction shown is then switched on. Then**



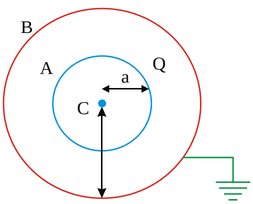
1) the speed of the particle when it reaches B is $\sqrt{\dfrac{2qE\ell}{m}}$

2) the speed of the particle when it reaches B is $\sqrt{\frac{qE\ell}{m}}$

3) the tension in the string when particles reaches at B is $\frac{Eq}{2}$.

4) the tension in the string when the particle reaches at B is qE.

100. A conducting sphere A of radius a, with charge Q, is placed concentrically inside a conducting shell B of radius b. B is earthed. C is the common centre of the A and B



p) The field at a distance r from C, where $a \le r \le b$, is $k\frac{Q}{r^2}$

q) The potential at a distance r from C, where $a \le r \le b$, is $k\frac{Q}{r}$

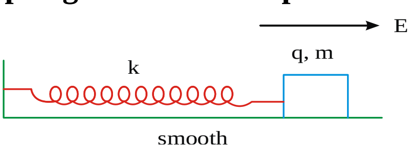
r) The potential difference between A and B is $kQ\left(\frac{1}{a}-\frac{1}{b}\right)$

s) The potential at a distance r from C, where $a \le r \le b$, is $kQ\left(\frac{1}{r}-\frac{1}{b}\right)$

Choose the correct answer

1. p and r are true 2. q is true
3. p,r,s are true 4. p,q,r,s are true

101. A block of mass m is attached to a spring of force constant k. Charge on the block is q. A horizontal electric field E is acting in the direction as shown. Block is released with the spring in unstretched position



a) block will execute SHM

b) Time period of oscillation is $2\pi\sqrt{\frac{m}{k}}$

c) amplitude of oscillation is $\frac{qE}{k}$

d) Block will oscillate but not simple harmonically

Choose the correct answer

1) a and b are true 2) d is true
3) a,b,c are true 4) a,b,c,d are true

102. A charge is moved against repulsion. Then there is

A) decreasing its kinetic energy
B) increasing its potential energy
C) increasing both the energies
D) decreasing both the energies.

1) A, B, C, D are true 2) A, B, C are true
3) A, B are true 4) A only true

103. Which of the following statements are correct?

a) The electrostatic force does not depend on medium in which the charges are placed
b) The electrostatic force between two charges does not exist in vacuum
c) The gravitational force between masses can be usually neglected in comparision with electrostatic force
d) Any excess charge given to a conductor, not always resides on the outer surfaceof the conductor.

1) both a & c 2) only 'c' 3) both c & d 4) all

104. The property of the electric line of force

a) The tangent to the line of force at any point is parallel to the directio of 'E' at the point
b) No two lines of force intersect each other

1) both a & b 2) only a 3) only b 4) a or b

105. Which of the following statements are correct.

a) Electric lines of force are just imaginary lines
b) Electric lines of force will be parallel to the surface of conductor
c) If the lines of force are crowded, them field is strong
d) Electric lines of force are closed loops

1) both a & c 2) both b & d
3) only a 4) all

106. Statement(A): Negative charges always move from a higher potential to lower potential point
Statement (B): Electric potential is vector.

1) A is true but B is false
2) B is true but A is false
3) Both A and B false
4) Both A and R are true

107. Statement (A): A solid conducting sphere holds more charge than a hollow conducting sphere of same radius

Statement (B) : Two spheres A and B are connected by a conducting wire. No charge will flow from A to B, when their radii are R and 2R and charges on them are 2q and q respectively

1) A is true, B is false
2) A is false B is true
3) Both A and B are true
4) Both A and B are false

108. A ring with a uniform charge Q and radius R, is placed in the yz plane with its centre at the origin

a) The field at the origin is zero

b) The potential at the origin is $k\frac{Q}{R}$

c) The filed at the point (x, 0, 0) is $k\frac{Q}{x^2}$

d) The field at the point (x, 0, 0) is $k\frac{Q}{R^2+x^2}$

Choose the correct answer

1) a and b are true   2) c is true
3) a,b,c are true   4) a,b,c,d are true

109. A positively charged thin metal ring of radius R is fixed in the xy plane, with its centre at the origin O. A negatively charged particle P is released from rest at the point (0, 0, z_0), where z_0>0. Then the motion of P is

a) Periodic, for all value of z_0 satisfying $0 < z_0 < \infty$

b) Simple harmonic, for all values of z_0 satisfying $0 < z_0 \le R$

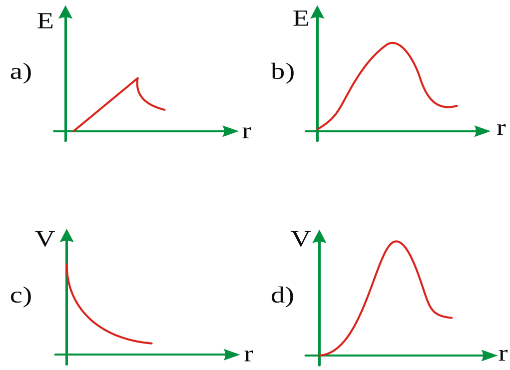
c) Approximately simple harmonic, provided z_0<<R

d) Such that P crosses O and continues to move along the negative z-axis towards $z = -\infty$

Choose the correct answer

1) a and b are true   2) c is true
3) a,c,d are true   4) a,b,c,d are true

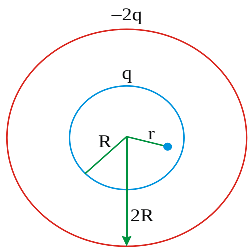
110. A circular ring carries a uniformly distributed positive charge. The electric field (E) and potential (V) varies with distance (r) from the centre of the ring along its axis as



Choose the correct answer

1) b and c are true   2) a is true
3) a,b,c are true   4) a,b,c,d are true

111. Two concentric shells of radii R and 2R have given charges q and – 2q as shown in figure. In a region r < R



a) E = 0   b) $E \neq 0$ c) V = 0   d) $V \neq 0$

Choose the correct answer

1) a and c are true   2) c is true
3) a,d,c are true   4) a,b,c,d are true

C.U.Q - KEY

1) 2	2) 2	3) 2	4) 3	5) 2	6) 3
7) 1	8) 3	9)1	10) 2	11) 1	12) 1
13) 4	14) 1	15) 3	16) 2	17) 4	18) 1
19) 2	20) 1	21) 1	22) 3	23) 4	24) 3
25) 2	26) 1	27) 3	28) 4	29) 4	30) 4
31) 2	32) 4	33) 1	34) 2	35) 4	36) 3
37) 1	38) 3	39) 2	40) 2	41) 2	42) 4
43) 2	44) 4	45) 1	46) 3	47) 3	48) 2
49) 3	50) 1	51) 2	52) 3	53) 2	54) 1
55) 1	56) 1	57) 1	58) 1	59) 2	60) 3
61) 1	62) 1	63) 3	64) 4	65) 1	66) 3
67) 2	68) 2	69) 1	70) 3	71) 3	72) 1
73) 1	74) 1	75) 1	76) 2	77) 2	78) 1
79) 2	80) 4	81) 2	82) 2	83) 1	84) 1
85) 4	86) 1	87) 4	88) 2	89) 2	90) 2
91) 1	92) 1	93) 2	94) 3	95) 4	96) 4
97) 4	98) 1	99) 2	100) 3	101) 3	102) 3
103) 2	104) 1	105) 1	106) 3	107) 4	108) 1
109) 1	110) 1	111) 1			

LEVEL - I (C.W)

ELECTRIC CHARGES AND CONSERVATION OF CHARGE

1. One million electrons are added to a glass rod. The total charge on the rod is
1) $10^{-13}C$ 2) $-1.6\times10^{-13}C$
3) $+1.6\times10^{-12}C$ 4) $10^{-12}C$

2. A body has a charge of 9.6×10^{-20} coulomb. It is
1) possible
2) not possible
3) may (or) may not possible
4) Data not sufficient

COULOMB'S LAW

3. A force of 4N is acting between two charges in air. If the space between them is completely filled with glass $(\varepsilon_r = 8)$, then the new force will be
1) 2N 2) 5N 3) 0.2N 4) 0.5N

4. There are two charges $+1\mu c$ and $+2\mu c$ kept at certain seperation . The ratio of electro static forces acting on them will be in the ratio of
1) 1 : 2 2) 2 : 1 3) 1 : 1 4) 1 : 4

5. Two identical metal spheres possess +60C and –20C of charges. They are brought in contact and then separated by 10 cm.The force between them is
1) $36\times10^{13}N$ 2) $36\times10^{14}N$
3) $36\times10^{12}N$ 4) $3.6\times10^{12}N$

6. A charge q is placed at the centre of the line joining two equal charges Q. The system of three charges will be in equilibrium if q is equal to
1) $-\frac{Q}{2}$ 2) $-\frac{Q}{4}$ 3) $+\frac{Q}{4}$ 4) $\frac{Q}{2}$

7. Three charges -q, +q and -q are placed at the corners of an equilateral triangle of side 'a'. The resultant electric force on a charge +q placed at the centroid O of the triangle is
1) $\frac{3q^2}{4\pi\varepsilon_0 a^2}$ 2) $\frac{q^2}{4\pi\varepsilon_0 a^2}$ 3) $\frac{q^2}{2\pi\varepsilon_0 a^2}$ 4) $\frac{3q^2}{2\pi\varepsilon_0 a^2}$

8. A charge of $+2\mu C$ is placed at x=0 and a charge of $-32\mu C$ at x=60 cm. A third charge –Q be placed on the x-axis such that it experiences no force. The distance of the point from $+2\mu C$ is(in cm)
1) -20 2) 20 3) 15 4) 10

ELECTRIC FIELD

9. Two charges of $50\,\mu C$ and $100\,\mu C$ are separated by a distance of 0.6m. The intensity of electric field at a point midway between them is
1) $50\times10^6\,V/m$ 2) $5\times10^6\,V/m$
3) $10\times10^6\,V/m$ 4) $10\times10^{-6}\,V/m$

10. Two point charges Q and -3Q are placed some distnace apart. If the electic field at the location of Q is $\vec{E}$, the field at the location of -3Q is
1) $\vec{E}$ 2) $-\vec{E}$ 3) $+\frac{\vec{E}}{3}$ 4) $-\frac{\vec{E}}{3}$

11. A mass m carrying a charge q is suspended from a string and placed in a uniform horizontal electric field of intensity E. The angle made by the string with the vertical in the equilibrium position is
1) $\theta = \tan^{-1}\frac{mg}{Eq}$ 2) $\theta = \tan^{-1}\frac{m}{Eq}$
3) $\theta = \tan^{-1}\frac{Eq}{m}$ 4) $\theta = \tan^{-1}\frac{Eq}{mg}$

12. A proton of mass 'm' charge 'e' is released from rest in a uniform electric field of strength 'E'. The time taken by it to travel a distance 'd' in the field is
1) $\sqrt{\frac{2de}{mE}}$ 2) $\sqrt{\frac{2dm}{Ee}}$ 3) $\sqrt{\frac{2dE}{me}}$ 4) $\sqrt{\frac{2Ee}{dm}}$

13. An infinite number of charges each of magnitude q are placed on x - axis at distances of 1,2, 4, 8, ... meter from the origin. The intensity of the electric field at origin is
1) $\frac{q}{3\pi\varepsilon_0}$ 2) $\frac{q}{6\pi\varepsilon_0}$ 3) $\frac{q}{2\pi\varepsilon_0}$ 4) $\frac{q}{4\pi\varepsilon_0}$

14. A uniformly charged thin spherical shell of radius R carries uniform surface charge density of σ per unit area. It is made of two hemispherical shells, held together by pressing them with force F.F is proportional to
1) $\frac{1}{\varepsilon_o}\sigma^2R^2$ 2) $\frac{1}{\varepsilon_o}\sigma^2R$ 3) $\frac{1}{\varepsilon_o}\frac{\sigma^2}{R}$ 4) $\frac{1}{\varepsilon_o}\frac{\sigma^2}{R^2}$

ELECTRIC POTENTIAL AND POTENTIAL ENERGY

15. The p.d. between two plates separated by a distance of 1 mm is 100 V. The force on an electron placed in between the plates is
1) $10^5\,N$ 2) $1.6\times10^{-24}\,N$
3) $1.6\times10^{-14}\,N$ 4) $1.6\times10^{-19}\,N$

16. **An infinite number of charges each equal to 'q' are placed along the X-axis at x = 1, x = 2, x = 4, x = 8 ..... The potential at the point x = 0 due to this set of charges is**

1) $\frac{Q}{4\pi \in_o}$ 2) $\frac{2Q}{4\pi \in_o}$ 3) $\frac{3Q}{4\pi \in_o}$ 4) $\frac{Q}{\pi \in_o}$

17. **A, B, C are three points on a circle of radius 1 cm. These points form the corners of an equilateral triangle. A charge 2C is placed at the centre of the circle. The work done in carrying a charge of** $0.1\,\mu C$ **from A to B is**

1) Zero 2) $18\times10^{11}\,J$ 3) $1.8\times10^{11}\,J$ 4) $54\times10^{11}\,J$

18. **Charges +q, -4q and +2q are arranged at the corners of an equilateral triangle of side 0.15m. If q=1** μ **C, their mutual potential energy is**

1) 0.4J 2) 0.5J 3) 0.6J 4) 0. 8J

19. **An electron of mass 'M' kg and charge 'e' coulomb travels from rest through a potential difference of 'V' volt. The final velocity of the electron is (in m/s)**

1) $\frac{2eV}{M}$ 2) $\frac{2MV}{e}$ 3) $\sqrt{\frac{2eV}{M}}$ 4) $\sqrt{\frac{2MV}{e}}$

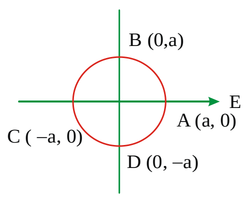
20. **A charge 'Q' is placed at each corner of a cube of side 'a'. The potential at the centre of the cube is (2008 M)**

1) $\frac{8Q}{\pi\varepsilon_0 a}$ 2) $\frac{4Q}{4\pi\varepsilon_0 a}$ 3) $\frac{4Q}{\sqrt{3}\pi\varepsilon_0 a}$ 4) $\frac{2Q}{\pi\varepsilon_0 a}$

21. **A uniform electric field pointing in positive x-direction exists in a region let A be the orgin B be the point on the x-axis at x = +1 cm and C be the point on the Y axis at y = +1cm. Then the potentials at the points A, B and C satisfy**

1) $V_A < V_B$ 2) $V_A > V_B$ 3) $V_A < V_C$ 4) $V_A > V_C$.

22. **The electric field at the origin is along the +ve x-axis. A small circle is drawn with the centre at the origin cutting the axes at the points A, B, C and D having coordinates (a, 0), (0, a), (-a, 0), (0, -a) respectively. Out of points on the periphery of the circle, the potential is minimum at**



1) A 2)B

3)C 4)D

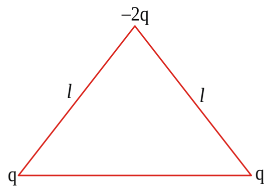
DIPOLE

23. **An electric dipole is along a uniform electric field. If it is deflected by 60⁰, work done by an agent is** 2×10^{-19} **J. Then the work done by an agent if it is deflected by 30⁰ further is**

1) $2.5\times10^{-19}\,J$ 2) $2\times10^{-19}\,J$

3) $4\times10^{-19}\,J$ 4) $2\times10^{-16}\,J$

24. **The dipole moment of the given system is**



1) $\sqrt{3}ql$ along perpendicular bisector of q - q line

2) 2 ql along perpendicular bisector of q - q line

3) ql $\sqrt{2}$ along perpendicular bisector of q - q line

4) 0

LEVEL - I (C.W) KEY

1)2	2) 2	3) 4	4) 3	5) 1	6) 2
7) 3	8) 1	9)2	10) 3	11) 4	12) 2
13) 1	14) 1	15) 3	16) 2	17) 1	18) 3
19) 3	20) 3	21) 2	22)1	23) 2	24) 1

LEVEL - I (C.W) HINTS

1. $Q = \pm ne$ n is integer

2. $Q = \pm ne$ n is integer

3. $F^{|} = \frac{F}{K}$

4. $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$

5. $F = \frac{1}{4\pi\varepsilon_0}\frac{(q_1+q_2)^2}{4d^2}$

6. $\frac{1}{4\pi\varepsilon_0}\frac{QQ}{l^2} + \frac{1}{4\pi\varepsilon_0}\frac{qQ}{\left(\frac{l}{2}\right)^2} = 0$

7. $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$

8. $x = \frac{d}{\sqrt{\frac{q_2}{q_1}} - 1}$

9. $E = \frac{1}{4\pi\varepsilon_0}\frac{q_1}{x_1^2} - \frac{1}{4\pi\varepsilon_0}\frac{q_2}{x_2^2}$

10. $\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^3}\vec{r}$

11. $qE = mg\tan\theta$

12. $s = \frac{1}{2}\frac{qE}{m}t^2$

13. $E = \frac{q}{4\pi\varepsilon_0}\left[\frac{1}{1^2} + \frac{1}{2^2} + \frac{1}{4^2} + - - - - - - -\right]$

14. Pressure $= \frac{\sigma^2}{2\varepsilon_o}$ and Force $= \frac{\sigma^2}{2\varepsilon_o} \times \pi R^2$

15. $F = Eq = \frac{Vq}{d}$

16. $V = \frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{1} + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + - - -\right]$

17. Equipotential surface

18. $U = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1q_2}{r_1} + \frac{q_2q_3}{r_2} + \frac{q_1q_3}{r_3}\right]$

19. $\frac{1}{2}mv^2 = eV$ 20. $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{d}$

21. Along the field direction potential decreases.

22. $V = -\vec{E} \cdot d\vec{r}$ 23. $W_1 = pE(1-\cos\theta)$ and $W_2 = pE(\cos\theta_1 - \cos\theta_2)$

24. $p_1 = lq = p_2$ and $P_R = \sqrt{3}ql$

LEVEL - I (H. W)

COULOMB'S LAW

1. A charge Q is divided into two parts q_1 and q_2 such that they experience maximum force of repulsion when separated by certain distance. The ratio of Q, q_1 and q_2 is
1) 1 : 1 : 2 2) 1 : 2 : 2 3) 2 : 2 : 1 4) 2 : 1 : 1

2. Two charges each 1μc are at $P(2\hat{i}+3\hat{j}+\hat{k})m$ and $Q(\hat{i}+\hat{j}-\hat{k})m$. Then the force between them is _____
1) 100N 2) 10N 3) 10^4 dyne 4) 100 dyne

3. Two charges of $+200\mu C$ and $-200\mu C$ are placed at the corners B and C of an equilateral triangle ABC of side 0.1 m. The force on a charge of $5\mu C$ placed A is
1) 1800 N 2) $1200\sqrt{3}N$ 3) $600\sqrt{3}N$ 4) $900N$

4. Two equally charged pith balls 3 cm apart repel each other with a force of 4×10^{-5} newton. The charge on each ball is
1) $2\times10^{9}C$ 2) $2\times10^{-9}C$ 3) $\frac{2}{3}\times10^{9}C$ 4) $\frac{2}{3}\times10^{-9}C$

ELECTRIC FIELD

5. An electron $(mass = 9.1\times10^{-31}kg)$ is sent into an electric field of intensity 9.1×10^{6} newton/coulomb. The acceleration produced is
1) $1.6\times10^{18}\ m/s^2$ 2) $1.6\times10^{6}\ m/s^2$
3) $1.6\times10^{-18}\ m/s^2$ 4) $1.6\times10^{-6}\ m/s^2$

6. The electric field at (30, 30) cm due to a charge of -8 nC at the origin in NC^{-1} is
1) $-400(\bar{i}+\bar{j})$ 2) $400(\bar{i}+\bar{j})$
3) $-200\sqrt{2}(\bar{i}+\bar{j})$ 4) $200\sqrt{2}(\bar{i}+\bar{j})$

7. Two charges of 10 μC and -90 μC are separated by a distance of 24 cm. Electrostatic field strength from the smaller charge is zero at a distance of
1) 12 cm 2) 24 cm 3) 36 cm 4) 48 cm

8. Two electric charges of $+10^{-9}C$ and $-10^{-9}C$ are placed at the corners A and B of an equilateral triangle ABC side 5cm. The electric intensity at C is
1) 1800N/C 2) 3600 N/C 3) 900N/C 4) 2700 N/C

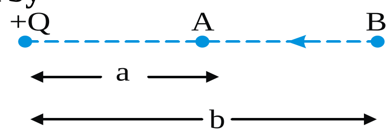
ELECTRIC POTENTIAL AND POTENTIAL ENERGY

9. If $4\times10^{20}eV$ is required to move a charge of 0.25 coulomb between two points, the potential difference between these two points is
1) 256 volt 2) $\frac{1}{256}$ volt
3) $256\times10^{+19}$ volt 4) 250 volt

10. Two electric charges of $9\mu C$ and $-3\mu C$ are placed 0.16m apart in air. There are two points A and B on the line joining the two charges at distances of (i) 0.04m from $-3\mu C$ and in between the charges and (ii) 0.08m from $-3\mu C$ and out side the two charges. The potentials at A and B are
1) 0V, 5V 2) 0V, 0V 3) 5V, 0V 4) 5V, 10V

11. Four charges $+3\mu C$, $-1\mu C$, $+5\mu C$ and $-7\mu C$ are arranged on the circumference of a circle of radius 0.5 m. The potential at the centre is
1) Zero 2) $18\times10^{4}V$
3) $-18\times10^{4}V$ 4) $288\times10^{3}V$

12. A positive point charge 'q' is carried from a point 'B' to a point 'A' in the electric field of a point charge +Q. If the permittivity of free space is $\in_0$, the work done in the process is given by



1) $\frac{qQ}{4\pi\in_0}\left[\frac{1}{a}-\frac{1}{b}\right]$ 2) $\frac{qQ}{4\pi\in_0}\left[\frac{1}{a}+\frac{1}{b}\right]$
3) $\frac{qQ}{4\pi\in_0}\left[\frac{1}{a^2}-\frac{1}{b^2}\right]$ 4) $\frac{qQ}{4\pi\in_0}\left[\frac{1}{a^2}+\frac{1}{b^2}\right]$

13. An electric cell does 5 joules of work in carrying 10 Coulomb's of charge around a closed circuit. The emf of the cell is
1) 2V 2) 0.5V 3) 4V 4) 1V

14. Two positive charges $12\mu C$ and $10\mu C$ are initially separated by 10cm. The work done in bringing the two charges 4cm closer is
1) 7.2J 2) 3.6J 3) 8.4J 4) 12.4J

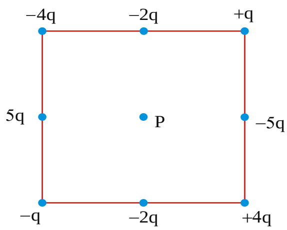
15. An insulated charged conducting sphere of radius 5 cms has a potential of 10V at the surface. What is the potential at centre?
1) 10V 2) zero
3) same as that at 5 cms from the surface
4) same as that at 25 cms from the surface

16. **A positive charge 'Q' is fixed at a point. A negatively charged particle of mass 'm' and charge 'q' is revolving in a circular path of radius 'r_1' with 'Q' as the centre. The work to be done to change the radius of the circular path from r_1 to r_2 in Joules is**

1) 0 2) $\frac{Qq}{4\pi\varepsilon_o}\left[\frac{1}{r_1}-\frac{1}{r_2}\right]$

3) $\frac{1}{4\pi\varepsilon_o}\frac{Qq}{4\pi\varepsilon_o}\left[\frac{1}{r_1}-\frac{1}{r_2}\right]$ 4) $\frac{Qq}{4\pi\varepsilon_o}\left[\frac{1}{r_2}-\frac{1}{r_1}\right]$

17. **Figure bellow shows a square array of charged particles, with distance d between adjacenet particle. What is the electric potential at point P at the centre of the square if the electric potential is zero at infinity ?**



1) Zero 2) $\frac{-2q}{4\pi\epsilon_0 d}$

3) $\frac{-4q}{4\pi\epsilon_0 d}$ 4) $\frac{q}{4\pi\epsilon_0 d}$.

18. **The radii of two charged metal spheres are 5cm and 10cm both having the same charge 60mC. If they are connected by a wire**

1) A charge of 20mC flows through the wire from larger to smaller sphere
2) A charge of 20mC flows through the wire from smaller to larger sphere
3) A charge of 40mC flows through the wire from smaller to larger sphere
4) No charge flows through the wire because both spheres have same charge.

19. **The electric potential at a point (x, 0, 0) is given by V = $\left[\frac{1000}{x}+\frac{1500}{x^2}+\frac{500}{x^3}\right]$ then the electric field at x = 1 m is (in volt/m)**

1) $-5500\hat{i}$ 2) $5500\hat{i}$ 3) $\sqrt{5500}\hat{i}$ 4) zero

DIPOLE

20. **An electric dipole of moment p is placed in the position of stable equilibrium in uniform electric field of intensity E. It is rotated through an angle θ from the intial position. The potential energy of electric dipole in the position is**

1) $pE\cos\theta$ 2) $pE\sin\theta$

3) $pE(1-\cos)\theta$ 4) $-pE\cos\theta$

21. **An electric dipole of moment $\vec{p}$ is placed normal to the lines of force of electric intensity $\vec{E}$, then the work done in deflecting it through an angle of 180^0 is**

1) pE 2) $+2pE$ 3) $-2pE$ 4) zero

LEVEL-I (H. W) KEY

1) 4	2) 4	3) 4	4) 2	5) 1	6) 3	7) 1
8) 2	9) 1	10) 2	11) 1	12) 1	13) 2	14) 4
15) 1	16) 2	17) 3	18) 2	19)2	20) 4	21) 4

LEVEL-I (H. W) HINTS

1. $F\alpha q_1q_2$ 2. $F=\frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$

3. $F_1=F_2=\frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$; $F_r=F_1=F_2$ because angle between then is 120^0

4. $F=\frac{1}{4\pi\varepsilon_0}\frac{q^2}{d^2}$ 5. $a=\frac{eE}{m}$

6. $\vec{E}=\frac{1}{4\pi\varepsilon_0}\frac{Q}{r^3}\vec{r}$ 7. $x=\frac{d}{\sqrt{\frac{q_2}{q_1}}-1}$ 8. $E=\frac{1}{4\pi\varepsilon_0}\frac{Q}{a^2}$

9. $W=q\Delta V$ 10. $V=\frac{1}{4\pi\varepsilon_0}\left[\frac{q_1}{r_1}+\frac{-q_2}{r_2}\right]$

11. $V=\frac{1}{4\pi\varepsilon_0}\sum\frac{Q}{r}$ 12. $W=\frac{q_1q_2}{4\pi\varepsilon_0}\left[\frac{1}{r_1}-\frac{1}{r_2}\right]$

13. $emf=\frac{W}{q}$ 14. $W=\frac{q_1q_2}{4\pi\varepsilon_0}\left[\frac{1}{r_1}-\frac{1}{r_2}\right]$

15. $V=\frac{1}{4\pi\varepsilon_0}\frac{Q}{R}$ 16. $W=\frac{q_1q_2}{4\pi\varepsilon_0}\left[\frac{1}{r_1}-\frac{1}{r_2}\right]$

17. $V=\frac{1}{4\pi\varepsilon_0}\sum\frac{Q}{r}$ 18. V=constant and $Q\alpha R$

19. $E=\frac{-dV}{dx}$ 20. $U=-\bar{p}.\bar{E}$ 21. $W_1=pE(1-\cos\theta)$

LEVEL-II (C.W)

COULOMB'S LAW

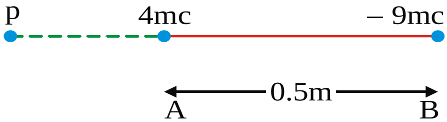
1. **Two charges when kept at a distance of 1m apart in vacuum hava some force of repulsion. If the force of repulsion between these two charges be same, when placed in an oil of dielectric constant 4, the distance of separation is**

1) 0.25m 2) 0.4m 3) 0.5m 4) 0.6m

2. **The excess (equal in number) number of electrons that must be placed on each of two small spheres spaced 3 cm apart with force of repulsion between the spheres to be $10^{-19}N$ is**
1) 25 2) 225 3) 625 4) 1250

3. **Two small conducting spheres each of mass $9\times10^{-4}kg$ are suspended from the same point by non conducting strings of length 100 cm. They are given equal and similar charges until the strings are equally inclined at 45^0 each to the vertical. The charge on each sphere is ..... coulomb**
1) 1.4×10^{-6} 2) 1.6×10^{-6} 3) 2×10^{-6} 4) 1.96×10^{-6}

4. **Two point charges of magnitude 4 μ C and -9 μ C are 0.5m apart. The electric intensity is zero at a distance 'x' m from ' A' and 'y' m from 'B'. 'x' and 'y' are respectively**



1) 0.5m, 1.0m 2) 1.0m, 1.5m
3) 2.0m, 1.5m 4) 1.5m, 2.0m

5. **A charge +q is fixed to each of three corners of a square. On the empty corner a charge Q is placed such that there is no net electrostatic force acting on the diagonally opposite charge. Then**
1) $Q=-2q$ 2) $Q=-2\sqrt{2}q$
3) $Q=-\sqrt{2q}$ 4) $Q=-4q$

6. **Electrical force between two point charges is 200N. If we increase 10% charge on one of the charges and decrease 10% charge on the other, then electrical force between them for the same distance becomes**
1) 198 N 2) 100 N 3) 200 N 4) 99 N

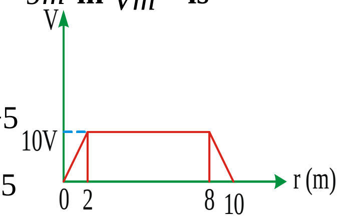
7. **N fundamental charges each of charge 'q' are to be distributed as two point charges seperated by a fixed distance, then the maximum to minimum force bears a ratio (N is even and greater than 2)**
1) $\frac{(N-1)^2}{4N^2}$ 2) $\frac{4N^2}{(N-1)}$ 3) $\frac{N^2}{4(N-1)}$ 4) $\frac{2N^2}{(N-1)}$

8. **A particle A having a charge of $2\times10^{-6}C$ and a mass of 100g is placed at the bottom of a smooth inclined plane of inclination 30⁰. The distance of another particle of same mass and charge, be placed on the incline so that it may remain in equilibrium is**
1) 27 cm 2) 16 cm 3) 30 cm 4) 45 cm

9. **Two identical particles of charge q each are connected by a massless spring of force constant k. They are placed over a smooth horizontal surface.They are released when unstretched. If maximum extension of the spring is r, the value of k is : (neglect gravitational effect)**
1) $k=\frac{q}{r}\sqrt{\frac{1}{\pi\varepsilon_0 r}}$ 2) $k=\frac{1}{4\pi\varepsilon_0}\frac{q^2}{l^2}\times\frac{1}{r}$
3) $k=\frac{2q}{r}\sqrt{\frac{1}{\pi\varepsilon_0 r}}$ 4) $k=\frac{q}{r}\sqrt{\frac{2}{\pi\varepsilon_0 r}}$

ELECTRIC FIELD

10. **In the figure shown, the electric field intensity at $r=1m,\ r=6m,\ r=9m$ in Vm^{-1} is**



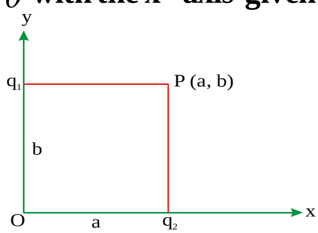
1)-5, -1.67, +5 2) -5, 0, +5
3) 0,1.67,0 4) +5, 1.67, -5

11. **Point charges of $3\times10^{-9}C$ are situated at each of three corners of a square whose side is 15 cm. The magnitude and direction of electric field at the vacant corner of the square is**
1) 2296 V/m along the diagonal
2) 9622 V/m along the diagonal
3) 22.0 V/m along the diagonal 4) zero

12. **A large flat metal surface has uniform charge density $+\sigma$. An electron of mass m and charge e leaves the surface at an angle at point A with speed v, and return to it at point B. The maximum value of AB is ____**
1) $\frac{vm\in_0}{\sigma e}$ 2) $\frac{v^2m\in_0}{e\sigma}$ 3) $\frac{v^2e}{\in_0\sigma m}$ 4) $\frac{v^2\sigma e}{\in_0 m}$

13. **'n' charges Q, 4Q, 9Q, 16Q ..... are placed at distances of 1, 2, 3 ..... metre from a point '0' on the same straight line. The electric intensity at '0' is**
1) $\frac{Q}{4\pi\in_0 n^2}$ 2) $\frac{Q}{4\pi\in_0 n}$ 3) Infinity 4) $\frac{nQ}{4\pi\in_0}$

14. **Two point charges $q_1=2\mu C$ and $q_2=1\mu C$ 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 point (a, b) will subtend an angle θ with the x - axis given by**



1) tan $\theta=1$ 2) tan $\theta=2$
3) tan $\theta=3$ 4) tan $\theta=4$

15. **A non-conducting ring of radius 0.5 m carries of 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 integral** $\int_{l=\infty}^{l=0} -\vec{E}.d\vec{l}$ **(l=0 being centre of the ring) in volts is**
1) +2 2) -1 3) -2 4) zero

ELECTRIC POTENTIAL AND POTENTIAL ENERGY

16. **Three charges +q, -q and -q are kept at the vertices of an equilaterial triangle of 10cm side. The potential at the mid point in between -q, -q, if q = 5 μC is**
1) $-6.4 \times 10^5 V$ 2) $-12.8 \times 10^4 V$
3) $-6.4 \times 10^4 V$ 4) $-12.8 \times 10^5 V$

17. **Two charges each 'Q' are released when the distance between is 'd'. Then the velocity of each charge of mass 'm' each when the distance between them is '2d' is**
1) $\frac{Q}{\sqrt{8\pi\varepsilon_0 dm}}$ 2) $\frac{Q}{\sqrt{4\pi\varepsilon_0 dm}}$ 3) $\frac{Q}{4\sqrt{\pi\varepsilon_0 dm}}$ 4) $\frac{Q}{\sqrt{2\pi\varepsilon_0 dm}}$

18. **An oil drop carrying charge 'Q' is held in equilibrium by a potential difference of 600V between the horizontal plates. In order to hold another drop of twice the radius in equilibrium a potential drop of 1600V had to be maintained. The charge on the second drop is**
1) $\frac{Q}{2}$ 2) 2Q 3) $\frac{3Q}{2}$ 4) 3Q

19. **A body of mass one gram and carrying a charge** $10^{-8} C$ **passes through two points P and Q. The electrostatic potential at Q is OV. The velocity of the body at Q is** $0.2 ms^{-1}$ **and at P is** $\sqrt{0.028} ms^{-1}$. **The potential at P is**
1) 150V 2) 300V 3) 600V 4) 900V

20. **Three charges each** $20\mu C$ **are placed at the corners of an equilateral triangle of side** $0.4m$. **The potential energy of the system is**
1) $18 \times 10^{-6} J$ 2) $9J$ 3) $9 \times 10^{-6} J$ 4) $27J$

21. **An electric field is expressed as** $\vec{E} = 2\hat{i} + 3\hat{j}$. **The potential difference** $(V_A - V_B)$ **between two points A and B whose positions vectors are given by** $r_A = \hat{i} + 2\hat{j}$ **and** $r_B = 2\hat{i} + \hat{j} + 3\hat{k}$ **is**
1) -1 V 2) 1 V 3) 2 V 4) 3 V

22. **Figure shows three circular arcs, each of radius R and total charge as indicated. The net electric potential at the centre of the curvature is**
1) $\frac{Q}{2\pi\varepsilon_o R}$ 2) $\frac{Q}{4\pi\varepsilon_o R}$ 3) $\frac{2Q}{\pi\varepsilon_o R}$ 4) $\frac{Q}{\pi\varepsilon_o R}$

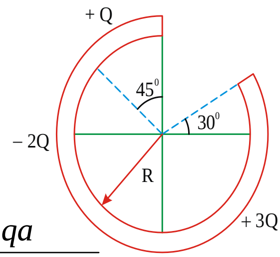
23. **Two identical conducting very large plates** P_1 and P_2 **having charges** $+4Q$ and $+6Q$ **are placed very closed to each other at separation d. The plate area of either face of the plate is A. The potential difference between plates** P_1 and P_2 **is**
1) $V_{P_1} - V_{P_2} = \frac{Qd}{A\varepsilon_o}$ 2) $V_{P_1} - V_{P_2} = \frac{-Qd}{A\varepsilon_o}$
3) $V_{P_1} - V_{P_2} = \frac{5Qd}{A\varepsilon_o}$ 4) $V_{P_1} - V_{P_2} = \frac{-5Qd}{A\varepsilon_o}$

DIPOLE

24. **An electric dipole consists of two opposite charges of magnitude** $1\mu C$ **separated by a distance of 2cm. The dipole is placed in an electric filed** $10^{-5} Vm^{-1}$. **The maximum torque that the field exert on the dipole is**
1) $10^{-3} Nm$ 2) $2 \times 10^{-13} Nm$
3) $3 \times 10^{-3} Nm$ 4) $4 \times 10^{-3} Nm$

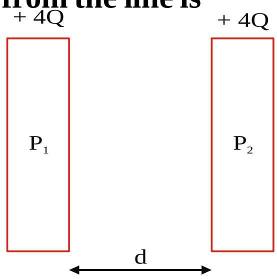
25. **An electric dipole is formed two particles fixed at the ends of a light rigid rad of length l. The mass of each particle is m and charges are -q and +q The system is suspended by a torsionless thread in an electric field of intensity E such that the dipole axis is parallel to the field if it is slightly displaced, the period of angular motion is**
1) $\frac{1}{2\pi}\sqrt{\frac{2qE}{ml}}$ 2) $2\pi\sqrt{\frac{ml}{qE}}$ 3) $2\pi\sqrt{\frac{ml}{2qE}}$ 4) $\frac{1}{2\pi}\sqrt{\frac{ml}{4qE}}$

26. **Two point charges - q and +q are located at points (0,0,-a) and (0,0,a) respectively. The electric potential at point (0,0,z) is** $(z > a)$



1) $\frac{qa}{4\pi\varepsilon_0 z^2}$ 2) $\frac{q}{4\pi\varepsilon_0 a}$
3) $\frac{2qa}{4\pi\varepsilon_0 (z^2 - a^2)}$ 4) $\frac{2qa}{4\pi\varepsilon_0 (z^2 + a^2)}$

27. Two equal charges 'q' of opposite sign are separated by a small distance '2a'. The electric intensity 'E' at a point on the perpendicular bisector of the line joining the two charges at a very large distance 'r' from the line is



1) $\frac{1}{4\pi\varepsilon_0}\frac{qa}{r^2}$ 2) $\frac{1}{4\pi\varepsilon_0}\frac{2qa}{r^3}$

3) $\frac{1}{4\pi\varepsilon_0}\frac{2qa}{r^2}$ 4) $\frac{1}{4\pi\varepsilon_0}\frac{qa}{r^3}$

LEVEL - II (C.W) KEY

1) 3	2) 3	3) 1	4) 2	5) 2	6) 1	7) 3
8) 1	9) 2	10) 2	11) 1	12) 2	13) 4	14)1
15) 1	16) 4	17) 1	18) 4	19) 3	20) 4	21)1
22) 1	23) 2	24) 2	25) 3	26) 3	27) 2	

LEVEL - II (C. W) HINTS

1. $t^1 = \frac{t}{\sqrt{k}}$

2. $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$ and q = ne

3. F = w tan θ where $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$

4. Distance of null point $x = \frac{d}{\sqrt{\frac{Q_2}{Q_1}} \pm 1}$

   +ve for like charges -ve for unlike charges

5. $\frac{1}{4\pi\in_0}\sqrt{2}\frac{q^2}{a^2} + \frac{1}{4\pi\in_0}\frac{Qq}{\left(\sqrt{2}a\right)^2} = 0$

6. $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$; $q_1^1 = \frac{110}{100}q_1$ and $q_2^1 = \frac{90}{100}q_2$

7. $\frac{F_{max}}{F\min} = \frac{\left(N/2\right)^2}{(N-1)1}$ 8. $mg\sin\theta = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{r^2}$

9. $F_C = kx$ 10. $E = -\frac{dV}{dr}$

11. $E = E\left(\sqrt{2}+1/2\right)E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$

   r = length of the side

12. Field near metal surface $E = \frac{\sigma}{\in_0}$

   Force on electron $= eE = \frac{e\sigma}{\in_0}$

   Acceleration of electron $a = \frac{e\sigma}{m\in_0}$

   It will act as projectile with max range $= \frac{u^2}{a} = \frac{u^2}{e\sigma}\times m\in_0$

13. $E = \frac{1}{4\pi\in_o}.\left[\frac{Q_1}{x_1^2} + \frac{Q_2}{x_2^2} + ... + \frac{Q_n}{x_n^2}\right]$

14. $Tan\theta = \frac{E_2}{E_1}$

15. $V_o = K\frac{q}{R}, V_\infty = 0$; $\int_{t=\infty}^{t=0} -\vec{E}.\vec{dl} = V_o - V_\infty$

16. $V = V_1 + V_2 + V_3$; $V_1 = V_2 = \frac{1}{4\pi\varepsilon_0}\frac{(-q)}{(a/2)}$

   $V_3 = \frac{1}{4\pi\varepsilon_0}\frac{(q)}{\left(\frac{\sqrt{3}a}{2}\right)}$

17. gain in K.E = loss in P.E 18. $\frac{V_1}{V_2} = \left(\frac{R_1}{R_2}\right)^3 . \frac{Q_2}{Q_1}$

19. $\frac{1}{2}m\left[v_Q^2 - v_p^2\right] = q\left[V_P - V_Q\right]$

20. $U = \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1 q_2}{r_{12}} + \frac{q_2 q_3}{r_{23}} + \frac{q_3 q_1}{r_{13}}\right)$

21. $V_B - V_A = -\left[\int_1^2 2\,dx + \int_2^1 3\,dy\right]$

22. $V = V_1 + V_2 + V_3$

23. $V_{P_1} - V_{P_2} = \frac{-Q}{\varepsilon_o A/d}$

24. $\tau_{max} = pE = 2aqE$

25. $\tau = PE\sin\theta$; $\tau = I\alpha$; $I\alpha = PE\sin\theta$

   I = moment of inertia $= \frac{ml^2}{2}$

   $\therefore$ Time period $= 2\pi\sqrt{\frac{I}{pE}}$

26. The distance of point P from charge +q is $r_1 = z - a$ and from charge -q is $r_2 = z + a$

Potential at P is $\frac{1}{4\pi\epsilon_0}\left(\frac{q}{r_1}-\frac{q}{r_2}\right)=\frac{1}{4\pi\epsilon_0}\frac{2qa}{\left(z^2-a^2\right)}$

27. Similar to B on equitorial line of a short bar magnet

LEVEL - II (H. W)

COULOMB'S LAW

1. Two equally charged identical metal spheres A and B repel each other with a force F. Another identical uncharged sphere C is touched to A and then placed midway between A and B. The net force on C is in the direction

1) F towards A 2) F towards B
3) 2F towards A 4) 2F towards B

2. Two unlike charges seperated by a distance of 1m attract each other with a force of $0.108N$. If the charges are in the ratio $1:3$, the weak charge is

1) $2\mu C$ 2) $4\mu C$ 3) $6\mu C$ 4) $5\mu C$

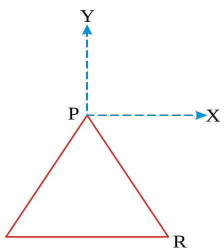
3. Three charges each equal to $10^{-9}C$ are placed at the corners of an equilateral triangle of side 1m. The force on one of the charges is

1) $9\times10^{-9}N$ 2) $9\sqrt{3}\times10^{-9}N$
3) $27\times10^{-9}N$ 4) $18\times10^{-9}N$

4. Two particles each of mass 'm' and carrying charge 'Q' are seperated by some distance. If they are in equilibrium under mutual gravitational and electro static forces, then Q/m (in c/Kg) is of the order of

1) 10^{-5} 2) 10^{-10} 3) 10^{-15} 4) 10^{-20}

5. There point charges + q, – q and + q are placed at the vertices P, Q and R of an equilateral triangle as shown. 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 charges at Q and R is

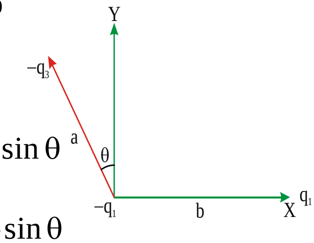


1) F along positive x–direction
2) F along negative x–direction
3) $\sqrt{2}$ F along positive x–direction
4) $\sqrt{2}$ F along negative x–direction

6. Three point charges +q, +q and –q are placed at the corners of an equilateral triangle of side 'a'. Another charge +Q is kept at the centroid. Force exerted on Q is:

1) $\frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a^2}$ 2) $\frac{1}{4\pi\varepsilon_0}\frac{6qQ}{a^2}$
3) $\frac{1}{4\pi\varepsilon_0}\frac{8qQ}{a^2}$ 4) $\frac{1}{4\pi\varepsilon_0}\frac{14qQ}{a^2}$

7. Three charges $-q_1, +q_2$ and $-q_3$ are placed as shown in fig. The X-component of the force on $-q_1$ is proportional to



1) $\frac{q_2}{b^2}-\frac{q_3}{a^2}\cos\theta$ 2) $\frac{q_2}{b^2}+\frac{q_3}{a^2}\sin\theta$
3) $\frac{q_2}{b^2}+\frac{q_2}{a^2}\cos\theta$ 4) $\frac{q_2}{b^2}-\frac{q_2}{a^2}\sin\theta$

ELECTRIC FIELD

8. The breakdown electric intensity for air is 3×10^6 V/m. The maximum charge that can be held by a sphere of radius 1 mm is

1) 0.33 C 2) 0.33 nC 3) 3.3 C 4) 3.3 μC

9. There is a uniform electric field of strength $10^3 V/m$ along y-axis. A body of mass 1 g and charge $10^{-6}C$ is projected into the field from origin along the positive x-axis with a velocity 10 m/s. Its speed in m/s after 10s is (neglect gravitation)

1) 10 2) $5\sqrt{2}$ 3) $10\sqrt{2}$ 4) 20

10. The point charges $+1C, +1C$ and $-1C$ are placed at the vertices A, B and C of an equilateral triangle of side 1m. Then
(A) The force acting on the charge at A is $9\times10^9 N$
(B) The electric field strength at A is $9\times10^9 NC^{-1}$

1) A is correct but B is wrong
2) B is correct but A is wrong
3) Both A and B are wrong
4) Both A and B are correct

11. A pendulum bob of mass m carrying a charge q is at rest in a uniform horizontal electric field of intensity E. The tension in the thread is

1) $T=\sqrt{(Eq)^2+(mg)^2}$ 2) $T=\sqrt{\left(\frac{E}{q}\right)^2+(mg)^2}$
3) $T=\sqrt{\left(\frac{E}{q}\right)^2+\left(\frac{m}{g}\right)^2}$ 4) $T=mg+Eq$

ELECTRIC POTENTIAL AND POTENTIAL ENERGY

12. **Four charges $10^{-8};-2\times10^{-8};+3\times10^{-8}$ and 2×10^{-8} coulomb are placed at the four corners of a square of side 1m the potential at the centre of the square is**
1) zero 2)360 volt 3) 180 volt 4) $360\sqrt{2}$ volt

13. **Two metal spheres of radii R_1 and R_2 are charged to the same potential. The ratio of the charge on the two spheres is**
1) 1 2) $\frac{1}{2}$ 3) R_1-R_2 4) $\frac{R_1}{R_2}$

14. **Two concentric, thin metallic spherical shells of radii R_1 and $R_2\,(R_1>R_2)$ bear charges Q_1 and Q_2 respectively. Then the potential at radius 'r' between R_1 and R_2 will be $\frac{1}{4\pi\in_0}$ times**
1) $\frac{Q_1+Q_2}{r}$ 2) $\frac{Q_1}{R_1}+\frac{Q_2}{r}$ 3) $\frac{Q_1}{R_1}+\frac{Q_2}{R_2}$ 4) $\frac{Q_1}{R_2}+\frac{Q_2}{R_2}$

15. **An electric charge $10^{-3}\mu C$ is placed at the origin (0, 0) of X-Y coordinate system. Two points A and B are situated at $\left(\sqrt{2},\sqrt{2}\right)$ and (2, 0) respecitvely. The potential difference between the points A and B will be:**
1) 9 V 2) zero 3) 2 V 4) 4.5 V

16. **A charge $-2\mu C$ at the origin, $-1\mu C$ at $+7cm$ and $1\mu C$ at $-7cm$ are placed on $X-$ axis. The mutual potential energy of the system is**
1) $-0.051J$ 2) $-0.045J$ 3) $0.045J$ 4) $-0.064J$

17. **Four equal charges Q are placed at the four corners of a square of side $'a'$ each. Work done in removing a charge $-Q$ from its centre to infinity is**
1) zero 2) $\sqrt{2}Q^2/4\pi\in_0 a$
3) $\sqrt{2}Q^2/\pi\in_0 a$ 4) $Q^2/2\pi\in_0 a$

18. **The electrostatic potential V at any point (x,y,z) in space is given by $V=4x^2$**
1) The y - and z - components of the electrostatic field at any point are not zero
2) The x - component of electric field intensity at any point is given by $\left(-8x\hat{i}\right)$
3) The x - component of electric field intensity at a point (2, 0,2) is $\left(-8\hat{i}\right)$
4) The y - and z - components of the field are constant in magnitude.

DIPOLE

19. **The self potential energy of hydrogen chloride whose dipole moment is $3.44\times10^{-30}C$ - m and separation between hydrogen and chlorine atoms is $1.01\times10^{-10}m$ is**
1) $1.036\times10^{-19}J$ 2) $3.2\times10^{5}J$
3) $4.5\times10^{7}J$ 4) $1.65\times10^{6}J$

LEVEL - II (H. W) KEY

1)1 2) 1 3) 2 4) 2 5) 2 6) 2 7) 2 8) 2
9)3 10) 4 11) 1 12) 4 13) 4 14) 2 15) 2 16) 4
17) 3 18) 2 19) 1

LEVEL - II (H .W) HINTS

1. $F=\frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$
2. $F=\frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$
3. $F_1=F_2=\frac{1}{4\pi\varepsilon_0}\frac{q^2}{r^2}$; $F_R=\sqrt{3}.\frac{1}{4\pi\varepsilon_0}\frac{q^2}{r^2}$
4. $F_e=\frac{1}{4\pi\varepsilon_0}\frac{q^2}{r^2}$ and $F_g=\frac{Gm^2}{r^2}$
5. $F_1=F_2$ and angle between them is 120^0
6. $F=\left(\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\right)2$ where $r=\frac{a}{\sqrt{3}}$
8. $E=\frac{1}{4\pi\in_o}.\frac{Q}{d^2}$
9. $v=u+at$ where $a=\frac{Eq}{m}$
10. $F=\frac{1}{4\pi\varepsilon_o}.\frac{q_1q_2}{r^2}$; $E=\frac{1}{4\pi\varepsilon_o}.\frac{q}{r^2}$
$F=\overline{F_1}+\overline{F_2}$; $E=\overline{E_1}+\overline{E_2}$
12. $V=\frac{1}{4\pi\varepsilon_0}\sum\frac{Q}{r}$
13. $V=\frac{1}{4\pi\varepsilon_0}\frac{Q}{R}$
14. Potential is constant within the sphere and is additive.
15. $V=\frac{q}{4\pi\varepsilon_o}\left(\frac{1}{r_1}-\frac{1}{r_2}\right)$
16. $PE=\frac{1}{4\pi\varepsilon_0}.\frac{q_1q_2}{r}$
17. Workdone = Electrostatic potential energy at the centre of the square
18. $E=\frac{-dV}{dx}$
19. $p=2qa\Rightarrow q=\frac{p}{2a}=3.41\times10^{-20}$
$\therefore PE=\frac{1}{4\pi\in_0}\frac{q^2}{2a}=1.036\times10^{-19}J$