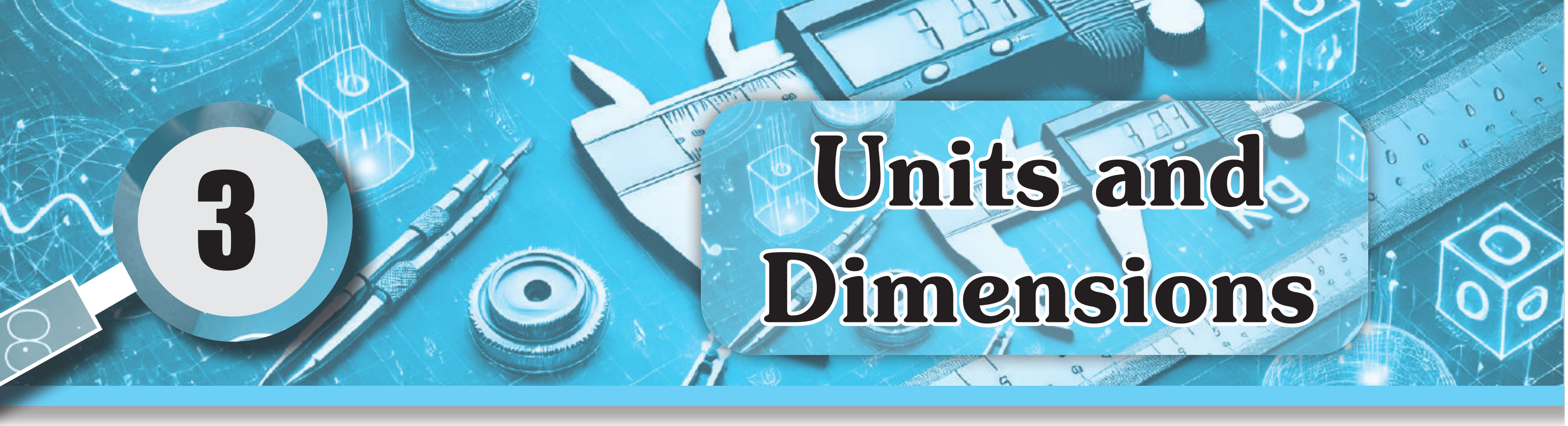
MR Physics

Question Solving Med Easy

Complete 11th & 12th Syllabus For NEET and JEE Aspirants

Contents



3 Units and Dimensions

Physical Quantity

1. Which of the following group of physical quantity can be considered as a group of fundamental physical quantity.
   (*a*) Force, mass time
   (*b*) Mass, force, acceleration
   (*c*) Velocity, time, displacement
   (*d*) Velocity, momentum, mass
   (*e*) None of the above
2. Which does not have same unit as other:-
   (*a*) watt - sec (*b*) kilowatt - hour
   (*c*) eV (*d*) Joule - sec
3. Unit of distance is :
   (*a*) Femtometer (*b*) Angstrom
   (*c*) Parsec (*d*) Light year
   (*e*) All of these
4. **Assertion (A):** Astronomical unit, light year and parsec measures distance
   Reason (R): Each has dimension of distance.
   (*a*) If both Assertion (A) & Reason (R) are True & the Reason (R) is a correct explanation of the Assertion (A).
   (*b*) If both Assertion (A) & Reason (R) are True but Reason (R) is not a correct explanation of the Assertion (A).
   (*c*) If Assertion (A) is True but the Reason (R) is False.
   (*d*) If both Assertion (A) & Reason (R) are false.
5. Which of the following is a characteristic of unit?
   (*a*) The unit must be universally accepted
   (*b*) It must be invariable and well defined
   (*c*) It must be of suitable size and easily available
   (*d*) All the above
6. Ratio of two similar physical quantity has units.
   (*a*) True (*b*) False

Unit Conversion

7. The magnitude of physical quantity and units are directly proportional to each other.
   (*a*) True (*b*) False
8. If Area of object is $5 m^2$ then find its value in C.G.S unit?
   (*a*) $5 \times 10^4\ cm^2$ (*b*) $3 \times 10^4\ m^2$
   (*c*) $2 \times 10^4\ cm^2$ (*d*) $1 \times 10^4\ m^2$
9. Convert 25 m/s in C.G.S unit
10. If unit of length becomes double then value of area $5 m^2$ in new unit will be :-
    (*a*) $\frac{1}{4}$ (*b*) $\frac{3}{2}$ (*c*) $\frac{5}{4}$ (*d*) $\frac{5}{2}$
11. Convert 1 newton into Dyne.
    (*a*) 10^4 (*b*) 10^5 (*c*) 10^3 (*d*) 10^7
12. Convert values of 10 joule in CGS unit?
    (*a*) 10×10^7 (*b*) 1×10^7 (*c*) 1×10^5 (*d*) 3×10^5
13. In a new system of units, unit of mass is x kg, unit of length is y metre and unit of time is z second. Now if 1 newton = F new units then F =
    (*a*) $\frac{z}{xy}$ (*b*) $\frac{z^2}{xy}$ (*c*) $\frac{z}{xy^2}$ (*d*) $\frac{z}{x^2y}$
14. In new system of unit, unit of length is 10 m, unit of time is 2s, unit of mass is 5 kg, then find unit of torque in new system of unit.
    (*a*) 125 Nm (*b*) 0.125 Nm
    (*c*) 8 Nm (*d*) 8×10^{-3} Nm
15. If unit of length 10 m and unit of mass is 5 kg and unit of time is 2 sec then, find value of 10 Joule energy in new system of unit.
    (*a*) $\frac{2}{25}$ (*b*) $\frac{3}{8}$ (*c*) $\frac{1}{16}$ (*d*) $\frac{2}{3}$
16. The density of a material in CGS system of units is $4\ g\ cm^{-3}$ In a system of units in which unit of length is 10 cm and unit of mass is 100 g, the value of density of material will be
    (*a*) 0.04 (*b*) 0.4 (*c*) 40 (*d*) 400
17. In a new system of units, unit of mass is α kg unit of length is β m and unit of time is γ s. In this symstem, 10J will be represented as.
    (*a*) $10\alpha^{-1}\beta^2\gamma^2$ (*b*) $10\alpha^{-2}\beta^{-1}\gamma^{-2}$
    (*c*) $10\alpha^{-1}\beta^{-2}\gamma^2$ (*d*) $10\alpha\beta^2\gamma^{-2}$

18. Given below are two statements:

Statement I: Two physical quantities having same dimensions, may have different units.

Statement II: Shake and light year, both measure time.

In the light of the above statements, choose the most appropriate answer from the options given below:

(*a*) Both statement I and statement II are correct.
(*b*) Statement I is correct and statement II is incorrect
(*c*) Statement I is incorrect and statement II is correct
(*d*) Both statements I and statements II are incorrect

19. Light year is used to measure:

(*a*) distance between stars
(*b*) distance between atoms
(*c*) revolution time of earth around sun
(*d*) none of these

20. The wrong unit conversion among the following is :

(*a*) 1 angstrom = 10^{-10} m
(*b*) 1 fermi = 10^{-15} m
(*c*) 1 light year = 9.46×10^{15} m
(*d*) 1 astronomical unit = 1.496×10^{-11} m

21. Which of the following is not the unit of time ?

(*a*) microsecond (*b*) leap year
(*c*) lunar months (*d*) parallactic second
(*e*) Solar day

22. The unit of Stefan's constant σ is :

(If rate of heat radiation is given by σAT^4 where *A* is Area and T is temperature)

(*a*) $Wm^{-2}K^{-1}$ (*b*) $Wm^2 K^{-4}$
(*c*) $Wm^{-2}K^{-4}$ (*d*) $Wm^{-2} K^4$

23. Match Column-I with Column-II and select correct option.

Column-I		Column-II	
(A)	Mega	(P)	10^{-9}
(B)	Nano	(Q)	10^{-15}
(C)	Micro	(R)	10^{6}
(D)	Femto	(S)	10^{-6}
(E)	Pico	(T)	10^{-12}

	A	B	C	D	E
(*a*)	R	P	S	T	Q
(*b*)	S	P	R	Q	T
(*c*)	R	P	S	Q	T
(*d*)	S	P	R	T	Q

24. Which of the following ratios express pressure ?

(i) Force/Area
(ii) Energy/Volume
(iii) Energy/Area
(iv) Force/Volume

(*a*) Only (i) is correct. (*b*) Only (ii) is correct.
(*c*) Only (iii) is correct. (*d*) Both (i) and (ii) are correct.

25. The unit of thermal conductivity is :

(*a*) $Wm^{-1}K^{-1}$ (*b*) $Hm\ K^{-1}$
(*c*) $Jm^{-1}\ K^{-1}$ (*d*) $Wm\ K^{-1}$

Dimension

26. The dimension of mutual inductance is:

(*a*) $[ML^2T^{-2} A^{-1}]$ (*b*) $[ML^2T^{-3} A^{-1}]$
(*c*) $[ML^2T^{-2} A^{-2}]$ (*d*) $[ML^2T^{-3} A^{-2}]$

27. The SI unit of a physical quantity is pascal-second. The dimensional formula of this quantity will be

(*a*) $[ML^{-1}T^{-1}]$ (*b*) $[ML^{-1}T^{-2}]$
(*c*) $[ML^2T^{-1}]$ (*d*) $[ML^{-1}L^3 T^0]$

28. Dimension of Stress

29. Dimension of electric resistance

30. Dimension of Self Induction

31. Dimension of Permeability

32. Dimension of Magnetic field and magnetic flux

33. Dimension of Coefficient of viscosity

34. Dimension of $\frac{1}{\mu_0 \in_0}$ should be equal to

(*a*) T^2/L^2 (*b*) T/L
(*c*) L^2/T^2 (*d*) L/T

35. If the dimensions of a physical quantity are given by $M^aL^bT^c$, then the physical quantity will be

(*a*) Velocity if $a = 1, b = 0, c = -1$
(*b*) Acceleration if $a = 1, b = 0, c = -2$
(*c*) Force if $a = 0, b = -1, c = -2$
(*d*) Pressure if $a = 1, b = -1, c = -2$

36. If E, L, M and G denote the quantities as energy, angular momentum, mass and constant of gravitation respectively, then the dimensions of *P* in the formula $P = EL^2M^{-5}G^{-2}$ are:

(*a*) $[M^0L^0T^0]$ (*b*) $[M^1L^1T^{-2}]$
(*c*) $[M^0L^1T^0]$ (*d*) $[M^{-1}L^{-1}T^2]$

37. A quantity *f* is given by $f = \sqrt{\frac{hc^5}{G}}$ where c is speed of light, G universal gravitational constant and *h* is the Planck's constant. Dimension of *f* is that of

(*a*) Energy (*b*) Momentum
(*c*) Area (*d*) Volume

38. Which two of the following five physical parameters have the same dimensions?

1. Energy density 2. Refractive index
3. Dielectric constant 4. Young's modulus
5. Magnetic field

(*a*) 1 and 4 (*b*) 1 and 5
(*c*) 2 and 4 (*d*) 3 and 5

39. Which of the following pairs have same dimensional formula?

(*a*) Bulk modulus and energy density

(*b*) Latent heat and velocity

(*c*) Specific heat and latent heat

(*d*) Both (*a*) and (*b*)

40. The unit of electric flux is

(*a*) $\frac{Vm^2}{C}$ (*b*) volt-second

(*c*) $\frac{Nm^2}{C}$ (*d*) $\frac{N}{C^2\ m}$

41. Match List-I with List-II:

List-I		List-II	
A.	Surface tension	I.	kg $m^{+1}s^{-1}$
B.	Pressure	II.	kg $m^{-1}s^{-2}$
C.	Viscosity	III.	kg $m^{-1}s^{-2}$
D.	Impulse	IV.	kg s^{-2}

Choose the correct answer from the options given below:

(*a*) A-IV, B-III, C-II, D-I (*b*) A-IV, B-III, C-I, D-II

(*c*) A-III, B-IV, C-I, D-II (*d*) A-II, B-I, C-III, D-IV

42. Match List-I with List-II:

List-I		List-II	
A.	Torque	I.	kg $m^{-1}s^{-2}$
B.	Energy density	II.	kg ms^{-1}
C.	Pressure gradient	III.	kg $m^{-2}s^{-2}$
D.	Impulse	IV.	kg $m^2\ s^{-2}$

Choose the correct answer from the options given below:

(*a*) A-IV, B-III, C-I, D-II (*b*) A-I, B-IV, C-III, D-II

(*c*) A-IV, B-I, C-II, D-III (*d*) A-IV, B-I, C-III, D-II

43. Match List-I with List-II:

List-I		List-II	
A.	Planck's constat (h)	I.	$[M^1L^2T^{-2}]$
B.	Stopping potential (Vs)	II.	$[M^1L^1T^{-1}]$
C.	Work function (ϕ)	III.	$[M^1L^2T^{-1}]$
D.	Momentum (p)	IV.	$[M^1L^2T^{-3}A^{-1}]$

(*a*) A-III, B-I, C-II, D-IV (*b*) A-III, B-IV, C-I, D-II

(*c*) A-II, B-IV, C-III, D-I (*d*) A-I, B-III, C-IV, D-II

44. Match List-I with List-II:

List-I		List-II	
A.	Young's Modulus (Y)	I.	$[M L^{-1}T^{-1}]$
B.	Co-efficient of Viscosity (η)	II.	$[M L^2T^{-1}]$
C.	Planck's Constant (h)	III.	$[M L^{-1}T^{-2}]$
D.	Work Function (ϕ)	IV.	$[M L^2T^{-2}]$

Choose the correct answer from the options given below:

(*a*) A-II, B-III, C-IV, D-I (*b*) A-III, B-I, C-II, D-IV

(*c*) A-I, B-III, C-IV, D-II (*d*) A-I, B-II, C-III, D-IV

45. Match List-I with List-II:

List-I (Quantity)		List-II (Dimensional Formula)	
A.	Pressure gradient	I.	$[M^0L^2\ T^{-2}]$
B.	Energy density	II.	$[ML^{-1}T^{-2}]$
C.	Electric field	III.	$[M^1\ L^{-2}T^{-2}]$
D.	Latent heat	IV.	$[M^1\ L^1\ T^{-3}\ A^{-1}]$

Choose the correct answer from the options given below:

(*a*) A-III, B-II, C-I, D-IV (*b*) A.-II, B-III, C-IV, D-I

(*c*) A-III, B-II, C-IV, D-I (*d*) A-II, B-III, C-I, D-IV

46. Match List-I with List-II:

List-I		List-II	
A.	Angular momentum	I.	$[M\ L^2\ T^{-2}]$
B.	Torque	II.	$[ML^{-2}T^{-2}]$
C.	Stress	III.	$[ML^2T^{-1}]$
D.	Pressure gradient	IV.	$[ML^{-1}\ T^{-2}]$

Choose the correct answer from the options given below:

(*a*) A-I, B-IV, C-III, D-II (*b*) A-III, B-I, C-IV, D-II

(*c*) A-II, B-III, C-IV, D-I (*d*) A-IV, B-II, C-I, D-III

47. If L, C and R are the self inductance, capacitance and resistance respectively, which of the following does not have the dimension of time?

(*a*) RC (*b*) L/R (*c*) $\sqrt{LC}$ (*d*) L/C

48. **Assertion (A):** The dimensional formula for product of resistance and conductance is same as for dielectric constant.

Reason (R): Both have dimensions of time constant

(*a*) If both Assertion (A) & Reason (R) are True & the Reason (R) is a correct explanation of the Assertion (A).

(*b*) If both Assertion (A) & Reason (R) are True but Reason (R) is not a correct explanation of the Assertion (A).

(*c*) If Assertion (A) is True but the Reason (R) is False.

(*d*) If both Assertion (A) & Reason (R) are false.

49. The pair of quantities having same dimensions is

(*a*) Impulse and Surface Tension

(*b*) Angular momentum and Work

(*c*) Work and Torque

(*d*) Young's modulus and Energy

50. Which two of the following five physical parameters have the same dimensions ?

(A) energy density (B) refractive index

(C) dielectric constant (D) Young's modulus

(E) magnetic field

(*a*) A and D (*b*) A and E

(*c*) B and D (*d*) C and E

51. Choose the incorrect statement

(*a*) Solid angle has a unit but no dimensions

(*b*) Relative density has neither unit nor dimensions

(*c*) Universal gravitational constant (G) has a SI unit $Nm^2 kg^{-2}$

(*d*) Reynolds number is having a unit

52. If y = force and x = velocity then dimension of $\frac{dy}{dx}$

(*a*) $[MT^{-1}]$ (*b*) $[LT^{-2}]$

(*c*) $[ML^2T^2]$ (*d*) $[MLT^{-1}]$

53. **Assertion (A):** If x and y are the distances along x and y axes respectively then the dimensions of $\frac{d^3y}{dx^3}$ is $M^0 L^{-2} T^0$.

Reason (R): Dimensions of $\int_a^b y dx$ is $M^0 L^2 T^0$

(*a*) If both Assertion (A) & Reason (R) are True & the Reason (R) is a correct explanation of the Assertion (A).

(*b*) If both Assertion (A) & Reason (R) are True but Reason (R) is not a correct explanation of the Assertion (A).

(*c*) If Assertion (A) is True but the Reason (R) is False.

(*d*) If both Assertion (A) & Reason (R) are false.

54. Fill in the blanks with correct statement, according to given statement

Dimension	(1) ______	(2) ______	(*c*) A physical quantity have dimension	(*d*) A physical quantity does not have dimension
Unit	(*a*) A physical quantity have unit	(*b*) A physical quantity does not have unit	(3) ______	(4) ______

55. A unitless physical quantity may have dimension

(*a*) True (*b*) False

56. A dimensionless physical quantity may be unitless

(*a*) True (*b*) False

57. A physical quantity have unit must have dimension

(*a*) True (*b*) False

58. A physical quantity have dimension may have unit

(*a*) True (*b*) False

59. Select correct options

(*a*) Two physical quantities of different dimensions may have same unit

(*b*) Two physical quantities of different units may have same dimensions

(*c*) Unit less quantities must be dimensionless /

(*d*) Both (*b*) & (*c*)

60. **Assertion (A):** The unit vectors $\hat{i}, \hat{j}$ and $\hat{k}$ have units of distance and dimensions $[M^0L^1T^0]$

Reason (R): The product of a scalar and a vector is a new scalar.

(*a*) If both Assertion (A) & Reason (R) are True & the Reason (R) is a correct explanation of the Assertion (A).

(*b*) If both Assertion (A) & Reason (R) are True but Reason (R) is not a correct explanation of the Assertion (A).

(*c*) If Assertion (A) is True but the Reason (R) is False.

(*d*) If both Assertion (A) & Reason (R) are false.

61. Which of the following is a dimensional constant?

(*a*) Relative density (*b*) Gravitational constant

(*c*) Refractive inbox (*d*) Poisson's ratio

62. The relation between [E] and [B] is

(*a*) $[E] = [B][L][T]$ (*b*) $[E] = [B][L]^{-1}[T]$

(*c*) $[E] = [B][L][T]^{-1}$ (*d*) $[E] = [B][L]^{-1}[T]^{-1}$

63. In the expression $P = El^2m^{-5}G^{-2}$, where E, m, l and G denote energy, mass, angular momentum and gravitational constant, respectively.

The dimensions of P are

(*a*) $[MLT^0]$ (*b*) $[M^2LT^{-1}]$

(*c*) $[M^0L^0T^0]$ (*d*) $[M^0 LT^{-2}]$

64. The pairs of physical quantities that have the same dimensions is/are

I. Volumetric strain and coefficient of friction.

II. Disintegration constant of a radioactive substance and frequency of light wave.

III. Heat capacity and gravitational potential.

IV. Stefan's constant and Wien's constant.

(*a*) I, II and IV (*b*) I, III and IV

(*c*) I, II and III (*d*) I and II

65. Match the following columns.

	Column-I		Column-II
(A)	A physical quantity which has a unit but no dimensions	1.	Gravitational constant
(B)	A physical quantity which has neither unit nor dimensions	2.	Reynold number
(C)	A constant which has a unit	3.	Strain
(D)	A constant which has no unit	4.	Plane angle

(*a*) 4 3 1 2 (*b*) 3 4 2 1

(*c*) 1 2 3 4 (*d*) 1 4 2 3

66. Which of the following physical quantities have the same dimensions?

(*a*) Electric displacement ($\vec{D}$) and surface charge density

(*b*) Displacement current and electric field

(*c*) Current density and surface charge density

(*d*) Electric potential and energy

85. Y = log $e^{\alpha t}$ then find dimension of α?

86. F = 2V – 6t. Find dimension of '2' & '6' Where F is force, V = velocity, t = time

(*a*) Both are dimensionless (*b*) MT^{-1}, MLT^{-3}

(*c*) $ML^{-1}T^{-2}$, MLT^{-3} (*d*) MTT^{-3}, MT^{-1}

87. Force (F) and density (*d*) are related as $F = \frac{\alpha}{\beta + \sqrt{d}}$ Then, the dimensions of α and β are

(*a*) $[M^{3/2} L^{-1/2} T^{-2}]$, $[ML^{-3} T^0]$

(*b*) $[M^{3/2} L^{-1/2} T^{-2}]$, $[M^{1/2} L^{-3/2} T^0]$

(*c*) $[M^2 L^2 T^{-1}]$, $[ML^{-1} T^{-3/2}]$

(*d*) $[MLT^{-2}]$, $[ML^{-2} T^{-2/3}]$

88. The force is given in terms of time *t* and displacement *x* by the equation $F = A \cos Bx + C \sin Dt$

The dimensional formula of $\frac{AD}{B}$ is

(*a*) $[M^2L^2T^{-3}]$ (*b*) $[M^1L^1T^{-2}]$ (*c*) $[ML^2T^{-3}]$ (*d*) $[M^0LT^{-1}]$

Dimensional Analysis

89. If force (F), acceleration (*a*) and time *t* is used as a fundamental P.Q. then find dimension of length in terms of them :-

(*a*) $F^0a^1T^2$ (*b*) Fa^2T^2 (*c*) $F a^2 T^0$ (*d*) $F^0 a T$

90. If time (*t*), energy (*E*) and momentum (*P*) taken as base quantities then dimension of mass (*m*), is

(*a*) $m = k t^0 P^2 E^{-1}$ (*b*) $m = k t^0 P^{-1} E^2$

(*c*) $m = k t P^2 E$ (*d*) $m = k t^0 P^2 E$

91. If mass (M), velocity (V) and time (T) are taken as fundamental units, then the dimensions of force (F) are

(*a*) [M V T] (*b*) $[M V T^{-1}]$

(*c*) $[M^2 V T]$ (*d*) $[M^{-1}V^{-1}T]$

92. The frequency of vibrations *f* of a mass m suspended from a spring of spring constant K is given by a relation of type $f = cm^x K^y$, where *c* is a dimensionless constant. The values of *x* and *y* are

(*a*) $x = \frac{1}{2}, y = \frac{1}{2}$ (*b*) $x = \frac{-1}{2}, y = \frac{-1}{2}$

(*c*) $x = \frac{1}{2}, y = \frac{-1}{2}$ (*d*) $x = \frac{-1}{2}, y = \frac{1}{2}$

93. If force acceleration and time are basic fundamental P.Q. then find dimension of energy

(*a*) $F^2A^{-1}T$ (*b*) $F A T^2$

(*c*) $F A T^{-2}$ (*d*) $F A^{-1}T$

94. If surface tension (S), moment of inertia (I) and Planck's constant (*h*), were to be taken as the fundamental units, the dimensional formula for linear momentum would be

(*a*) $S^{3/2}[I^{1/2}h^0]$ (*b*) $S^{1/2}[I^{1/2}h^0]$

(*c*) $S^{1/2}[I^{1/2}h^{-1}]$ (*d*) $S^{1/2}[I^{3/2}h^{-1}]$

95. The frequency (*v*) of an oscillating liquid drop may depend upon radius (*r*) of the drop, density (ρ) of liquid and the surface tension (s) of the liquid as: $v = r^a \rho^b s^c$. The values of *a,b* and *c* respectively are

(*a*) $\left(-\frac{3}{2}, -\frac{1}{2}, \frac{1}{2}\right)$ (*b*) $\left(\frac{3}{2}, -\frac{1}{2}, \frac{1}{2}\right)$

(*c*) $\left(\frac{3}{2}, \frac{1}{2}, -\frac{1}{2}\right)$ (*d*) $\left(-\frac{3}{2}, \frac{1}{2}, \frac{1}{2}\right)$

96. The speed of a wave produced in H_2O is given by $v = \lambda^a g^b \rho^c$, where λ, g, ρ pare wavelength of wave, acceleration due to gravity & density of water respectively. The value of a, b & c respectively are :

(*a*) $\frac{1}{2}, 0, \frac{1}{2}$ (*b*) 1, 1, 0

(*c*) 1, –1, 0 (*d*) $\frac{1}{2}, \frac{1}{2}, 0$

97. If force F, area A and density D are taken as the fundamental units, the representation of Young's modulus 'Y' will be:

(*a*) $[F^{-1}A^{-1}D^{-1}]$ (*b*) $[FA^{-2}D^2]$

(*c*) $[FA^{-1}D]$ (*d*) $[FA^{-1}D^0]$

98. If maximum acceleration of oscillating particle is α and maximum velocity is β, then find time period

(*a*) $2\pi\frac{\alpha}{\beta}$ (*b*) 2παβ (*c*) $2\pi\frac{\beta}{\alpha}$ (*d*) $\frac{2\pi\alpha^2}{\beta^2}$

99. Plank's constant (*h*), speed of light in vacuum (*c*) and Newton's gravitational constant (*G*) are three fundamental constants, Which of the following combinations of these has the dimension of length?

(*a*) $\frac{\sqrt{hG}}{c^{3/2}}$ (*b*) $\frac{\sqrt{hG}}{c^{5/2}}$ (*c*) $\sqrt{\frac{hc}{G}}$ (*d*) $\frac{\sqrt{Gc}}{h^{3/2}}$

100. If dimensions of critical velocity v_c of a liquid flowing through a tube are expressed as $\eta^x \rho^y r^z$ where η ρ r are the coefficient of viscosity of liquid, density of liquid and radius of the tube respectively, then the values of *x,y* and *z* are given by

(*a*) 1,1,1 (*b*) 1, –1,–1

(*c*) –1,–1,1 (*d*) –1,–1,–1

101. If momentum [P], area [A] and time [T] are taken as fundamental quantities, then the dimensional formula for coefficient of viscosity is:

(*a*) $[PA^{-1}T^0]$ (*b*) $[PAT^{-1}]$

(*c*) $[PA^{-1}T]$ (*d*) $[PA^{-1}T^{-1}]$

102. A spherical ball is moving through a viscous medium. If the viscous force acting on the ball is proportional to speed of the ball, then the dimensions of proportionality constant is

(*a*) $[M L^{-1} T^{-1}]$ (*b*) $[M L^{-2} T^{-1}]$

(*c*) $[M L T^{-2}]$ (*d*) $[M L^0 T^{-1}]$

103. Force acting on object is proportional to squre of velocity then find dimensions of proportional constant.

MR* CORNER

Direction: In the questions given below, the first statement is given as Assertion(A) and other as Reason(R). for each questions, choose correct option from the following

(*a*) If both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(*b*) If both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

(*c*) If Assertion (A) is true but Reason (R) is false.

(*d*) If both Assertion (A) and Reason (R) are false.

1. **Assertion (A):** Force can be added to pressure.
   Reason (R): Force and pressure have same dimensions.
2. **Assertion (A):** Both velocity and speed have same dimensions.
   Reason (R): Velocity cannot be added to speed.
3. **Assertion (A):** The given equation $x = x_0 + u_0 t + 1/2\ at^2$ is dimensionally correct, where x is the distance travelled by a particle in time t, initial position x_0 initial velocity u_0 and uniform acceleration a is along the direction of motion.
   Reason (R): Dimensional analysis can be used for checking the dimensional consistency or homogeneity of the equation.
4. **Assertion (A):** Mass, length and time are fundamental physical quantities.
   Reason (R): They are independent of each other.
5. **Assertion (A):** Density is a derived physical quantity.
   Reason (R): Density cannot be derived from the fundamental physical quantities.
6. **Assertion (A):** When we change the unit of measurement of a quantity, its numerical value changes.
   Reason (R): Smaller the unit of measurement, smaller is its numerical value.
7. **Assertion (A):** L/R and CR both have the same dimensions.
   Reason (R): L/R and CR both have the dimension of time.
8. **Assertion (A):** A screw gauge having a smaller value of pitch has greater accuracy.
   Reason (R): The least count of screw gauge is directly propor- tional to the number of divisions on circular scale.
9. **Assertion (A):** All unitless quantities are dimensionless.
   Reason (R): Dimensions are exponent raised to fundamental units in derived units.
10. **Assertion (A):** Power of an engine depends on mass, angular speed, torque and angular momentum, so the formula of power is not derived with the help of dimensional method.
    Reason (R): In mechanics, if a particular quantity depends on more than three quantities, then we cannot derive the formula of the quantity by the help of dimensional method.
11. **Assertion (A):** Temperature cannot be expressed as a derived quantity in terms of length and mass.
    Reason (R): Temperature is a fundamental quantity.
12. **Assertion (A):** Quality factor is dimensionless.
    Reason (R): Quality factor depends on resistance, inductance and capacitance of LCR series circuit.
13. **Assertion (A):** The unit of EMF is Joule/Coulomb.
    Reason (R): EMF is an electromagnetic force.
14. **Assertion (A):** A physical quantity is measured and its value is always found to be nu; where n is the numerical value and u is the unit.
    Reason (R): $n \propto \frac{1}{u}$.
15. **Assertion (A):** The random error in the arithmetic mean of 100 observations is x; then random error in the arithmetic mean of 400 observations would be $x/4$.
    Reason (R): Arithmetic mean of the magnitudes of absolute errors in n measurements of the quantity is represented by $\overline{\Delta a} = \frac{|\Delta a_1| + |\Delta a_2| + ... + |\Delta a_n|}{n}$
16. **Assertion (A):** Systematic error can be minimised.
    Reason (R): Systematic error can be calculated.
17. **Assertion (A):** The period of oscillation of a simple pendulum in the experiment is recorded as 2.63 s, 2.56 s, 2.42 s, 2.71 s and 2.80 s, respectively. The average absolute error is 0.11 s.
    Reason (R): Mean absolute error $= \frac{\text{Sum of absolute errors}}{\text{Numbers of observations}}$
18. **Assertion (A):** Measurement's precision is determined by least count of measuring instrument.
    Reason (R): Smaller the least count, more is the precision
19. **Assertion (A):** Specific gravity of liquid is dimensionless.
    Reason (R): It is the ratio of density of liquid to density of water.
20. **Assertion (A):** Methods of dimensions cannot be used for deriving formula containing trigonometric ratios.
    Reason (R): Trigonometric ratios have no dimensions.
21. **Assertion (A):** Both plane and solid angles are fundamental units.
    Reason (R): Both have the same units.
22. **Assertion (A):** Astronomical unit is a unit for measuring large distances.
    Reason (R): It is the distance covered by light in one year.

Answer Key

1. (a) **2.** (d) **3.** (e) **4.** (a) **5.** (d) **6.** (b) **7.** (b) **8.** (a) **9.** 2500 m/s
10. (c) **11.** (b) **12.** (a) **13.** (b) **14.** (a) **15.** (a) **16.** (c) **17.** (c) **18.** (b) **19.** (a)
20. (d) **21.** (d) **22.** (c) **23.** (c) **24.** (d) **25.** (a) **26.** (c) **27.** (a) **28.** $ML^{-1}T^{-2}$ **29.** $ML^2T^{-3}A^{-2}$
30. $ML^2T^{-2}A^{-2}$ **31.** $MLT^{-2}A^{-2}$ **32.** $MT^{-2}A^{-1}$, $ML^2T^{-2}A^{-1}$ **33.** $ML^{-1}T^{-1}$ **34.** (c) **35.** (d)
36. (a) **37.** (a) **38.** (a) **39.** (a) **40.** (c) **41.** (a) **42.** (d) **43.** (b) **44.** (b) **45.** (c)
46. (b) **47.** (d) **48.** (c) **49.** (c) **50.** (a) **51.** (d) **52.** (a) **53.** (b) **54.** (1) May have dimension/may be dimensionless, (2) Must be dimensionless/does not have dimension, (3) Must have unit, (4) May or may not have unit
55. (b) **56.** (a) **57.** (b) **58.** (b) **59.** (d) **60.** (d) **61.** (b) **62.** (c) **63.** (c) **64.** (d)
65. (a) **66.** (a) **67.** (d) **68.** (b) **69.** $a = MLT^{-3}$, $b = MLT^{-4}$ **70.** $A = LT^{-1}$, $B = T^{-1}$ **71.** (b)
72. (c) **73.** (b) **74.** (b) **75.** (b) **76.** (a) **77.** $\beta = L^{-1}$, $\alpha = T^{-1}$ **78.** (a) **79.** (d)
80. $\alpha = [MLT^{-2}]$, $\beta = [M^0L^0T^0]$, $\gamma = [L^{-1}]$ **81.** (b) **82.** $A = L^1$, $k = L^{-1}$, $\omega = T^{-1}$ **83.** (b) **84.** (a)
85. $\alpha = T^{-1}$ **86.** (b) **87.** (b) **88.** (c) **89.** (a) **90.** (a) **91.** (b) **92.** (d) **93.** (b) **94.** (b)
95. (a) **96.** (d) **97.** (d) **98.** (c) **99.** (a) **100.** (b) **101.** (a) **102.** (d) **103.** (d) **104.** (a)
105. (a) **106.** (b) **107.** (a,b,d) **108.** (a) **109.** (a) **110.** (d) **111.** (c) **112.** (b, d) **113.** (a) **114.** (a)
115. (d) **116.** (d) **117.** (a) **118.** (d) **119.** (d) **120.** (d) **121.** (a) **122.** (1) Must be physically wrong, (2) May or amy not physically correct, (3) May or may be dimensionally correct (4)Must be dimensionally correct $S_n = u + \frac{a}{2}(2n-1)$
(S_nth → dimensionally correct becouse it is displacement in one sec.) **123.** (d) **124.** (c)

125. (i) 3, (ii) 4, (iii) 4, (iv) infinite. **126.** (b) **127.** (d) **128.** I-B, II-A, III-D, IV-C **129.** (b) **130.** (b)
131. (b) **132.** (b) **133.** (a) **134.** (i) 119.9 (ii) 201.87 **135.** (b) **136.** (d) **137.** (d) **138.** (a) **139.** (a)
140. (a) **141.** (a) **142.** (a) **143.** (a) **144.** (i) 2.62, (ii) 0.01, 0.06, 0.2, 0.09, 0.18, (iii) 0.11, (iv) 0.042, (iv) 4.2%
145. (a) **146.** 1% **147.** (a)
148. (d) **149.** (c) **150.** 5% **151.** (b) **152.** (i) $\frac{\Delta x}{x} = \frac{0.6}{30}$, (ii) $\frac{\Delta y}{y} = \frac{0.6}{10}$, (iii) $\frac{\Delta z}{z} = \left(\frac{0.5}{20} + \frac{0.1}{10}\right)$, (iv) $\frac{\Delta m}{m} = \frac{7}{200}$
153. (a) **154.** (c) **155.** (a) **156.** sum = (50 ± 0.7)°C, Difference = (30 ± 0.7)°C **157.** (c) **158.** (d) **159.** (d)
160. (d) **161.** (d) **162.** (b) **163.** (b) **164.** (b) **165.** (d) **166.** 10.1% **167.** (b) **168.** (c) **169.** (a)
170. $\frac{\pi}{\sqrt{3}}$% **171.** 45° **172.** 10% **173.** 125% **174.** (I) (150 ± 6) Ω, (II) (33.1 ± 3.1) Ω **175.** (b)
176. (1) Vernier Calliper, (2) screw gauge, (3) metre scale, (4) Vernier Calliper, (5) Vernier Calliper, (6) screw gauge, (7) screw gauge 14
177. (d) **178.** (c) **179.** (a) **180.** (a) **181.** (c) **182.** (c) **183.** 12/20 **184.** (c) **185.** 15.6 mm
186. (b) **187.** (b) **188.** (c) **189.** (c) **190.** (a) **191.** (d) **192.** (d) **193.** (d) **194.** (b)
195. (a) **196.** (b) **197.** 12% **198.** 3% **199.** (d)

MR* CORNER

1. (d) **2.** (b) **3.** (a) **4.** (a) **5.** (c) **6.** (c) **7.** (a) **8.** (c) **9.** (b) **10.** (a)
11. (a) **12.** (b) **13.** (b) **14.** (a) **15.** (b) **16.** (d) **17.** (a) **18.** (a) **19.** (a) **20.** (a)
21. (d) **22.** (d)

PHYSICS WALLAH

LAKSHYA
NEET

CLASS-XII

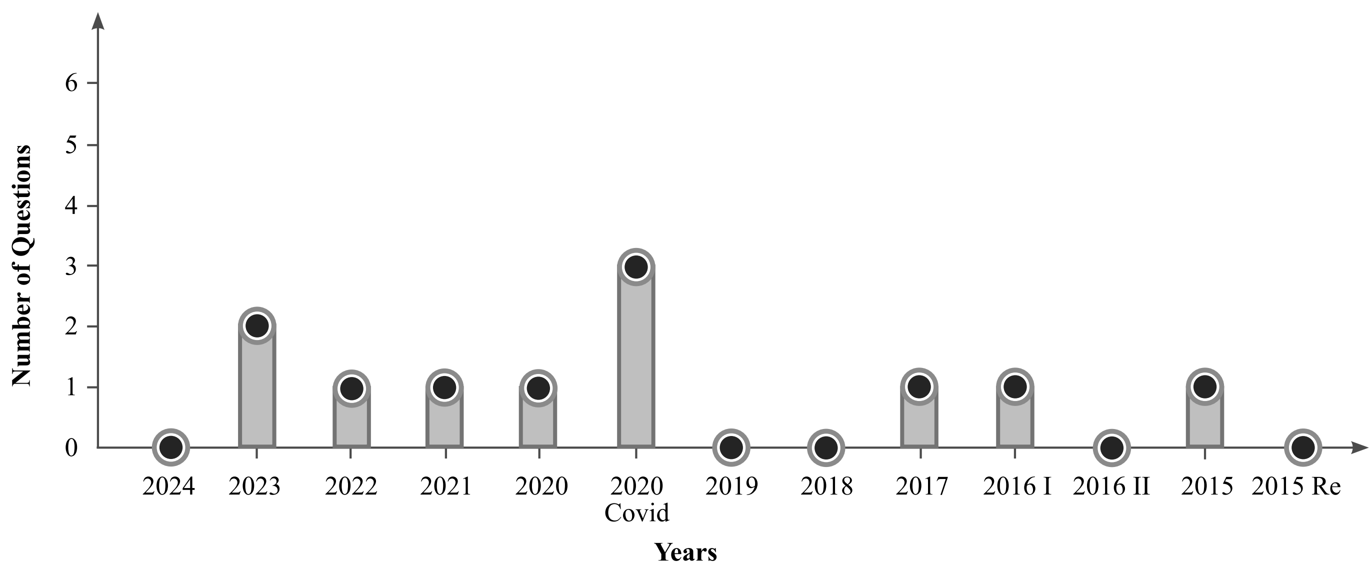
- Electric Charges and Fields
- Electrostatic Potential and Capacitance
- Current Electricity

PHYSICS
Module 1

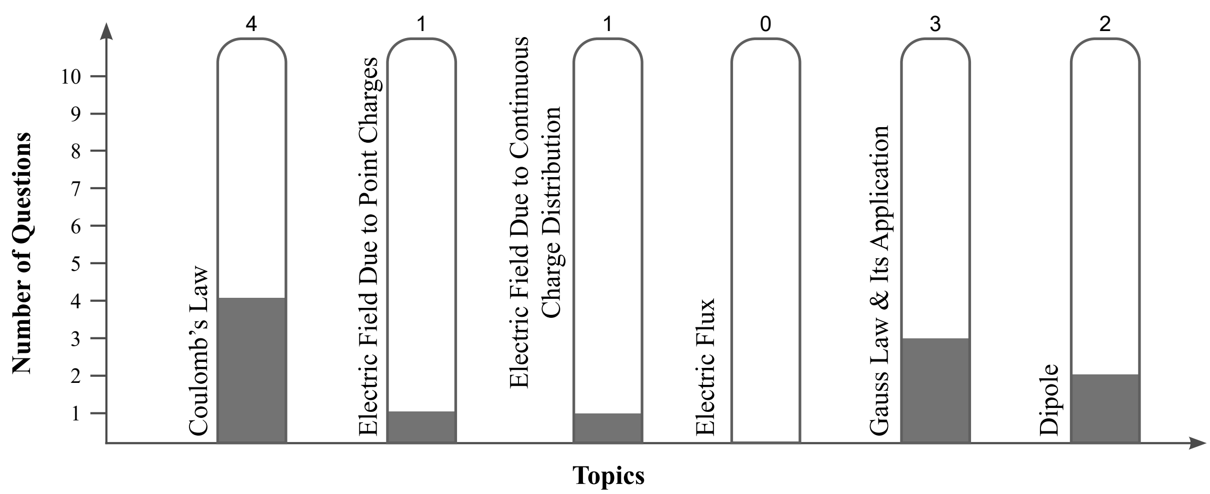
CHAPTER 1

Electric Charges and Fields

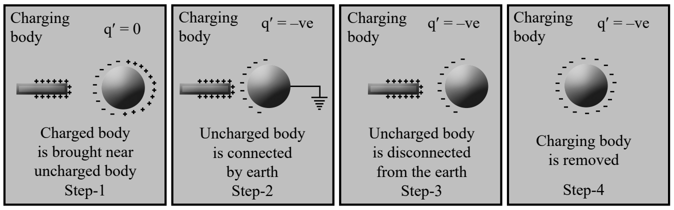
Year Wise Number of Questions Analysis (2024-2015)



Topicwise Number of Questions Analysis (2024-2015)



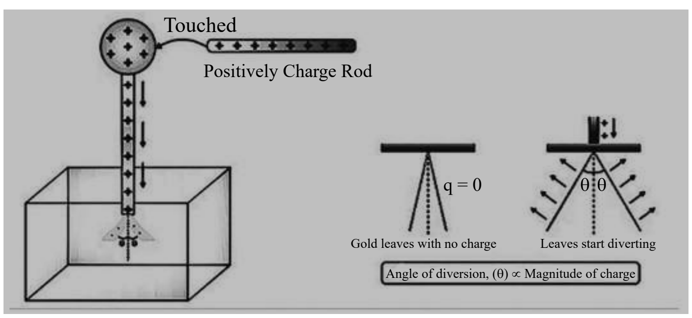
Charging a body by induction (in four successive steps)



Gold leaf electroscope

1. Gold leaf electroscope is a simple apparatus to detect charge on a body.
2. It consists of a vertical metal rod, housed in a box with thin gold leaves attached to its bottom end. The body whose charge is to be determined is touched to the sphere attached at the top of the electroscope. As the charge flows to the vertical rod in the apparatus, the gold leaves divert, thereby indicating the charge.

   A gold leaf electroscope is a simple device used to detect the charge on a body. When the body is touched to the sphere at the top of the electroscope, the charge flows down the metal rod, causing the thin gold leaves at the bottom to diverge. The angle of diversion between the leaves is related to the magnitude of the charge on the body. A larger angle typically indicates a greater charge.



Train Your Brain

Example 1: What is the total charge of a system containing five charges +1, +2, –3, +4 and –5 in some arbitrary unit?

Sol. Total charge is + 1 + 2 – 3 + 4 – 5 = –1 in the same unit.

Example 2: How many electrons are there in one coulomb of charge?

Sol. $n = \frac{Q}{e} = \frac{1\text{ coulomb}}{1.6\times10^{-19}\text{ coulomb}} = 6.25 \times 10^{18}$ electrons.

Example 3: Which of the following charge is not possible?

(1) 1.6×10^{-18} C (2) 1.6×10^{-19} C

(3) 1.6×10^{-20} C (4) 1.6×10^{-5} C

Sol. 1.6×10^{-20} C, because this is 1/10 of electronic charge and hence not an integral multiple of charge of electron. So option 3 is correct.

Example 4: An electron at rest has a charge of 1.6×10^{-19} C. It starts moving with a velocity $v = \frac{c}{2}$, where c is the speed of light, then the new charge on it is:

(1) 1.6×10^{-19} coulomb

(2) $1.6 \times 10^{-19}\sqrt{1-\left(\frac{1}{2}\right)^2}$ coulomb

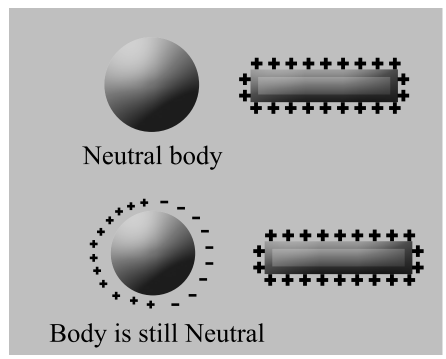
(3) $1.6 \times 10^{-19}\sqrt{\left(\frac{2}{1}\right)^2-1}$ coulomb

(4) $\frac{1.6\times10^{-19}}{\sqrt{1-\left(\frac{1}{2}\right)^2}}$ coulomb

Sol. Charge does not depend on velocity. So, Option 1 is correct.

Example 5: If a charged body is put near a neutral conductor, will it attract the conductor or repel it?

Sol.



They attract each other due to induction effect.

Example 6: How many electrons must be removed from a body to make it electrified by 3.2 C of charge?

Sol. From $Q = ne$

$\Rightarrow n = \frac{Q}{e} = \frac{3.2}{1.6\times10^{-19}}$

$\Rightarrow n = 2 \times 10^{19}$

Example 7: In 1 g of a solid, there are 5×10^{21} atoms. If one electron is removed from 0.01% atoms of the solid, the charge gained by the solid is;

(1) + 0.08C (2) + 0.8C

(3) – 0.08C (4) – 0.8C

Sol. 0.01% of $5 \times 10^{21} = \frac{5\times10^{21}\times0.01}{100} = 5 \times 10^{17}$

$\therefore$ Charge gained = $5 \times 10^{17}\, e$

$= 5 \times 10^{17} \times 1.6 \times 10^{-19} = +\,0.08$ C

So option 1 is correct.

Concept Application

1. The electric charge in uniform motion produces;
   (1) An electric field only
   (2) A magnetic field only
   (3) Both electric and magnetic field
   (4) Neither electric nor magnetic field
2. The weight of a body which is charged negatively by rubbing;
   (1) Remain constant
   (2) Decreases
   (3) Increases
   (4) May increase or may decrease
3. Which of the following option is correct?
   (1) The total number of charged particles in the universe remains conserved.
   (2) The magnitude of total positive charge of the universe is constant.
   (3) The magnitude of total negative charge of the universe is constant.
   (4) The total charge of the universe is constant.
4. If a glass rod is rubbed with silk, it acquires a positive charge because;
   (1) protons are added to it
   (2) protons are removed from it
   (3) electrons are added to it
   (4) electrons are removed from it
5. Which one of the following statement regarding electrostatics is wrong?
   (1) Charge is quantized
   (2) Charge is conserved
   (3) There is an electric field near an isolated charge at rest
   (4) A stationary charge produces both electric and magnetic fields
6. In nature, the electric charge of any system is always equal to;
   (1) half integral multiple of the least amount of charge
   (2) zero
   (3) one third of the least amount of charge
   (4) integral multiple of the least amount of charge

COULOMB'S LAW

Coulomb's law states that the magnitude of the electrostatic force of attraction or repulsion between two stationary point charges is directly proportional to the product of the magnitudes of charges and inversely proportional to the square of the distance between them.

$$F = \frac{1}{4\pi \in_0} \frac{q_1 q_2}{d^2} \quad \text{(in air or vaccum)}$$

$$F = \frac{kq_1q_2}{d^2}, \text{ where } K = \frac{1}{4\pi\varepsilon o}$$

- $\in_0 = 8.857 \times 10^{-12} \frac{C^2}{Nm^2}$ or $\frac{farad}{metre}$,

  and $\frac{1}{4\pi \in_0} = 9 \times 10^9 \, Nm^2 / C^2 = k$ (say)

  Relative permitivity ($\in_r$): The relative permitivity is the ratio of absolute permitivity of the medium to the absolute permitivity of the free space $\in_r = \frac{\in}{\in_0} = K$ (dielectric constant)

  $\in_r$ has no units and dimensional formula is
  [M° L°T° A°]

  and also $\in_r = \frac{\text{Force between two charges in air}}{\text{(Force between the same two charges in the medium at same distance)}}$

  $= \frac{F_{air}}{F_{medium}}$

- For air $K = 1$
  $K > 1$ for any dielectric medium;
  $K = \infty$ for conducting medium like metals

  Force between two charges in a medium

- $F = \frac{1}{4\pi \in_0 \in_r} \frac{q_1 q_2}{d^2} = \frac{1}{4\pi \in_0 K} \frac{q_1 q_2}{d^2}$

  (Net force on either charges in a medium)

  $\in_0$-permitivity of free space or vacuum or air.

  $\in_r(K)$ = Relative permitivity or dielectric constant of the medium in which the charges are situated.

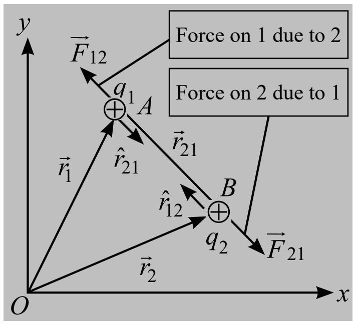
Comparison of Electrostatic and Gravitational Force

1. **Identical Properties:**
   - Both the forces are central forces, i.e., they act along the line joining the centers of two charged bodies.
   - Both the forces obey inverse square law,
   - Both are conservative forces, i.e. the work done by them is independent of the path followed.
   - Both the forces are effective even in free space.
2. **Non identical properties:**
   - Gravitational forces are always attractive in nature while electrostatic forces may be attractive or repulsive.
   - Gravitational constant of proportionality does not depend upon medium, the electrical constant of proportionality depends upon medium.
   - Electrostatic forces are extremely large as compared to gravitational forces

Coulomb's Law in Vector Form

Let q, and q_2 be two like charges placed at points A and B, respectively, in vacuum. $\vec{r_1}$ is the position vector of point A, and

$\vec{r_2}$ is the position vector of point B. Let $\vec{r}_{21}$ be vector from A to B, then



$\vec{r}_{21} = \vec{r}_2 - \vec{r}_1$

and $|\vec{r}_{21}| = r = |\vec{r}_2 - \vec{r}_1|$

$$\hat{r}_{21} = \frac{\vec{r}_{21}}{r} = \frac{\vec{r}_2 - \vec{r}_1}{|\vec{r}_2 - \vec{r}_1|}$$

From figure it is clear that $\vec{F}_{21}$ and $\hat{r}_{21}$ are in the same direction, so

$$\vec{F}_{21} = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}\hat{r} = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}\frac{\hat{r}}{r} = \frac{q_1q_2}{4\pi\varepsilon_0}\frac{\vec{r}}{r^3}$$

$$= \frac{q_1q_2}{4\pi\varepsilon_0}\frac{\vec{r}_2 - \vec{r}_1}{|\vec{r}_2 - \vec{r}_1|}$$

The above equations give the Coulomb's law in vector form. As we know that charges apply equal and opposite forces on each other, we have $\vec{F}_{12} = -\vec{F}_{21}$

or $\vec{F}_{12} = \frac{q_1q_2}{4\pi\varepsilon_0}\frac{\vec{r}_1 - \vec{r}_2}{|\vec{r}_1 - \vec{r}_2|^3}$

We can also write in terms of unit vector notation:

$$\vec{F}_{12} = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}\hat{r}_{12}$$

where $\hat{r}_{12}$ is a unit vector directed toward q_1, from q_2. This force of Coulomb's law is illustrated in figure. For three different point charge distributions, we have $\hat{r}_{12} = -\hat{r}_{21}$. So

$$\vec{F}_{12} = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}\hat{r}_{12} = \frac{1}{4\pi\varepsilon_0}\frac{q_2q_1}{r^2}(-\hat{r}_{21})$$

$$= -\frac{1}{4\pi\varepsilon_0}\frac{q_2q_1}{r^2}\hat{r}_{21} = -\vec{F}_{21}$$

Principle of Superposition

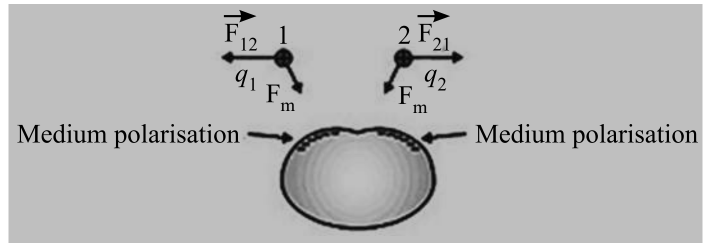
The principle of superposition states that for a system of charges $q_1, q_2, ..., q_n$, the force on q_1 due to q_2 is the same as given by Coulomb's law, *i.e.*, it is unaffected by the presence of the other charges $q_3, q_4, ..., q_n$. The total force $\vec{F}_1$ on the charge q_1, due to all other charges is given by the vector sum of the forces $\vec{F}_{12}, \vec{F}_{13}, ..., \vec{F}_{1n}$:

i.e., $\vec{F}_1 = \vec{F}_{12} + \vec{F}_{13} + ... + \vec{F}_{1n} = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1q_2}{r_{12}^2}\hat{r}_{12} + \frac{q_1q_3}{r_{13}^2}\hat{r}_{13} + ... + \frac{q_1q_n}{r_{1n}^2}\hat{r}_{1n}\right]$

$$\vec{F}_1 = \frac{q_1}{4\pi\varepsilon_0}\sum_{i=2}^{n}\frac{q_i}{r_{1i}^2}\hat{r}_{1i}$$

Force Affected by a Medium

When a medium is in close vicinity of two point charges, then the medium gets polarised.



Due to polarization, medium also starts applying force on the charges.

$$\vec{F}_{Net} = \vec{F}_0 - \vec{F}_m$$

$\vec{F}_{Net}$ ↑	$\vec{F}_0$ ↑	$\vec{F}_m$ ↑
Net force	Force in Vaccum	Force appliecd by medium

$$\frac{F_0}{\in_r} = F_0 - F_m$$

$$\boxed{F_m = F_0\left(1 - \frac{1}{\in_r}\right)}$$

where, $\in_r$ = Relative permittivity of medium or dielectric constant of medium.

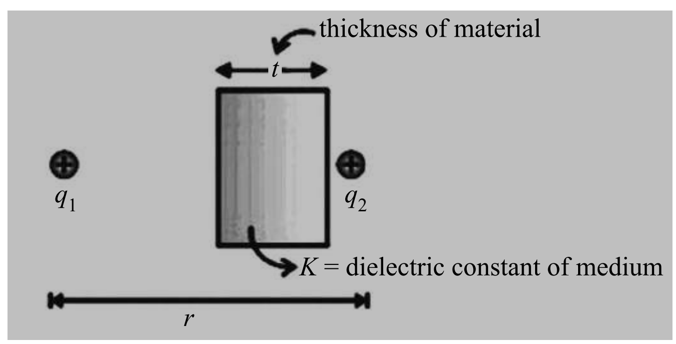
Conclusion

From the above result, it can be seen that the net force (F_{Net}) between the charges decreases. It happens because of the polarization of medium.

Also, note that Coulomb's force between the charges is not affected by any medium. The decrease in the net force is because of an additional force due to medium polarisation.

Force of Interaction between Charges if Space between them is Partially Filled

Consider the following figure in which a dielectric slab of thickness t is kept in between the two charges q_1 and q_2.



In such a case, the separation (r) between the charges is to be replaced by an effective distance given by, $r' = (r - t) + t\sqrt{k}$

The net force between the charges then becomes,

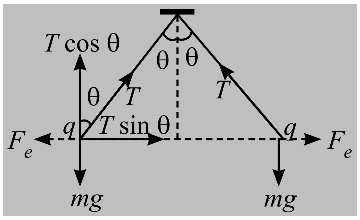
$$\boxed{F_{net} = \frac{1}{4\pi\in_0} \times \frac{q_1q_2}{r'^2}}$$

where, r' = effective distance between the charges.

Force between Multiple Charges

Equilibrium of suspended point charge system (Pith Ball problems)

When two identically charged pith balls are suspended from a common point of suspension by equal-length insulated cords, if each ball has mass m then the problem related to it can be treated as.



$T \sin\theta = F_e$ ...(*i*)

$T \cos\theta = mg$ ...(*ii*)

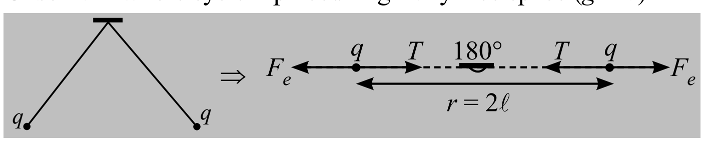
$\tan\theta = \dfrac{F_e}{mg}$ ...(*iii*)

$r = 2\ell \sin\theta$ (distance between charges, where ℓ is length of of string)

$$F_e = \frac{kq^2}{r^2} = \frac{kq^2}{4\ell^2 \sin^2\theta}$$

$$T = \sqrt{(F_e)^2 + (mg)^2}$$

Case-1: If whole system placed in gravity free space ($g = 0$)

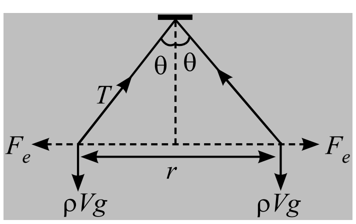


$$F_e = \frac{kq^2}{r^2} = \frac{kq^2}{4\ell^2}$$

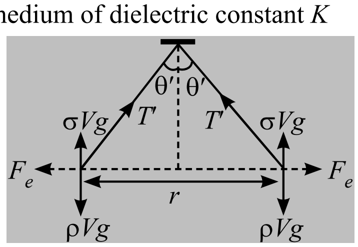
Tension in thread $T = \dfrac{kq^2}{4\ell}$

Case-2: If density of material is ρ and volume is V then

In air, $\tan\theta = \dfrac{F_e}{mg} = \dfrac{F_e}{V\rho g}$



Case-3: If experiment is done inside liquid having density σ and dielectric constant K then (Consider density of material is ρ and volume V). In medium of dielectric constant K



$$T'\sin\theta' = \frac{F_e}{K}$$

$$T'\cos\theta' + F_B = mg$$

$$T'\cos\theta' = \rho Vg - \sigma Vg$$

$$\tan\theta' = \frac{\frac{F_e}{K}}{(\rho Vg - \sigma Vg)}$$

In Air, $\tan\theta = \dfrac{F_e}{V\rho g}$

In Medium $\tan\theta' = \dfrac{\frac{F_e}{K}}{(\rho Vg - \sigma Vg)}$

$$\tan\theta' = \frac{F_e}{\rho VgK\left(\frac{\rho - \sigma}{\rho}\right)}$$

$$\tan\theta' = \frac{\tan\theta}{K\left(1 - \frac{\sigma}{\rho}\right)}$$

If $K\left(1 - \frac{\sigma}{\rho}\right) > 1$, $\theta' < \theta$

If $K\left(1 - \frac{\sigma}{\rho}\right) < 1$, $\theta' > \theta$

If $K\left(1 - \frac{\sigma}{\rho}\right) = 1$, $\theta' = \theta$

Electrostatic Equilibrium

The point where the resultant force on a charged particle becomes zero is called equilibrium position.

1. **Stable Equilibrium:** A charge is initially in equilibrium position and is displaced by a small distance. If the charge tries to return back to the same equilibrium position then this equilibrium is called position of stable equilibrium.
2. **Unstable Equilibrium:** If charge is displaced by a small distance from its equilibrium position and the charge has no tendency to return to the same equilibrium position. Instead it goes away from the equilibrium position.
3. **Neutral Equilibrium:** If charge is displaced by a small distance and it is still in equilibrium condition then it is called neutral equilibrium.

Limitations of Coulomb's Law

- Coulomb's law cannot be applied if the point charges are not at rest. The reason for this is that when the two charged particles are brought together, the distribution of charges on them changes.
- Coulomb's law cannot be applied if the shape of the charges is arbitrary because, in irregular shapes, it becomes difficult to determine the distance between the particles.

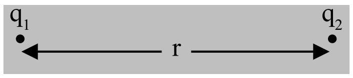
Short Notes

Coulomb's Law

Force between two charges $\vec{F} = \frac{1}{4\pi \in_0 \in_r} \frac{q_1 q_2}{r^2} \hat{r}$,

$\in_0$-permitivity of free space or vacuum or air.

$\in_r(K)$ = Relative permitivity or dielectirc constant of the medium in which the charges are situated.



Principle of Superposition

Force on a point charge due to many charges is given by

$$\vec{F} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + ...$$

Notes: The force due to one charge is not affected by the presence of other charges.

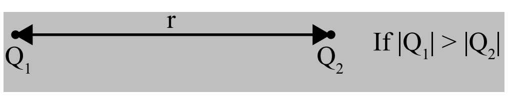
Electric Field or Electric Field Intensity (Vector Quantity)

$$\vec{E} = \frac{\vec{F}}{q}, \text{ unit is N/C or V/m.}$$

Electric Field Due to Point Charge Q

$$\vec{E} = \lim_{q_0 \to 0} \frac{\vec{F}}{q_0} = \frac{1}{4\pi \in_0} \frac{Q}{r^2} \hat{r}$$

Null Point for Two Charges



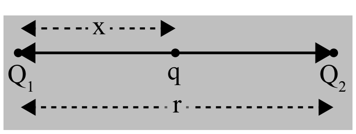
$\Rightarrow$ Null point near Q_2

$$x = \frac{\sqrt{Q_1}\, r}{\sqrt{Q_1} \pm \sqrt{Q_2}}; \; x \to \text{distance of null point from } Q_1 \text{ charge}$$

(+) for like charges

(–) for unlike charges

Equilibrium of Three Point Charges



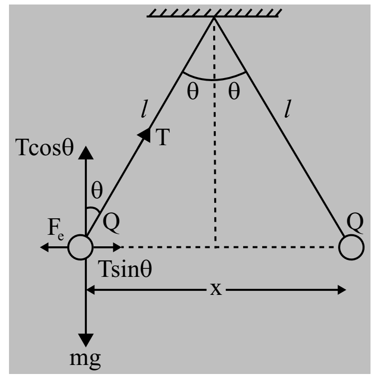
(i) Two charges must be of like nature.

(ii) Third charge should be of unlike nature.

$$x = \frac{\sqrt{Q_1}}{\sqrt{Q_1} + \sqrt{Q_2}} r \text{ and } q = \frac{-Q_1 Q_2}{\left(\sqrt{Q_1} + \sqrt{Q_2}\right)^2}$$

Equilibrium of Suspended Point Charge System

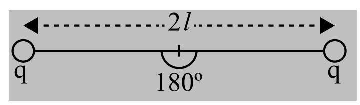
For equilibrium position



$$\Rightarrow \tan\theta = \frac{F_e}{mg} = \frac{kQ^2}{x^2 mg}$$

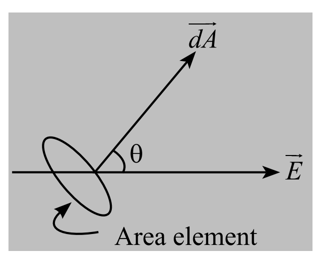
$$T = \sqrt{(F_e)^2 + (mg)^2}$$

If whole set up is taken into an artificial satellite ($g_{eff} \simeq 0$)



$$\Rightarrow T = F_e = \frac{kq^2}{4\ell^2}$$

Electric flux:



$$\phi = \int d\phi = \int \vec{E}.d\vec{A}$$

❖ If field is uniform $\Rightarrow \vec{E}$ = constant

$\phi = \vec{E}.\int d\vec{A}$ $\qquad \int d\vec{A}$ = total area vector of a plane surface

$$\Rightarrow \boxed{\phi = \vec{E}.\vec{A}}$$

$$\Rightarrow \boxed{\phi = EA\cos\theta}$$

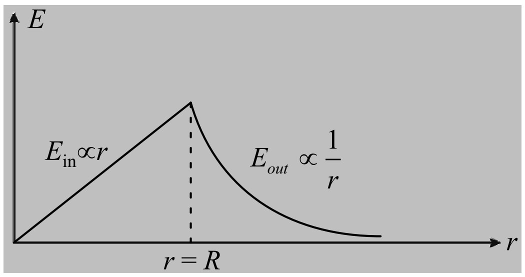
Electric Field due to Uniformly Charged Infinitely Long Solid Cylinder

(*i*) ***E* at outside point:**

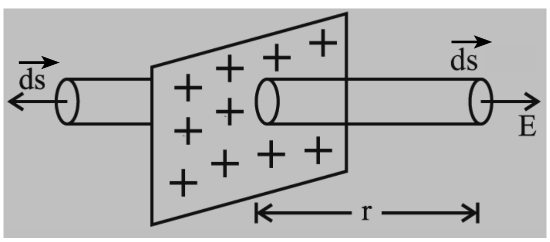
$$E_{out} = \frac{\rho R^2}{2r\ \varepsilon_0} \quad (\rho\text{-Volume charge density})$$

(*ii*) ***E* at inside point:**

$$E_{in} = \frac{\rho r}{2\varepsilon_0}$$

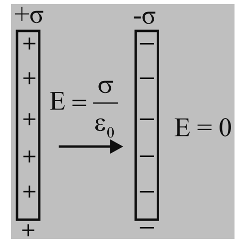


Electric Field Intensity due to a Uniformly Charged Infinite Plane Sheet



$$E = \frac{\sigma}{2\varepsilon_0}$$

Electric Field Intensity due to two Equally and Oppositely Charged Parallel Plane Sheets.

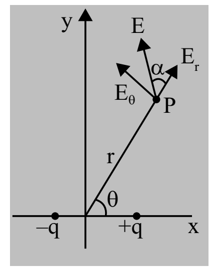


$$E = \frac{\sigma}{\varepsilon_0} \quad \text{(between two plates)}$$

$E = 0$ (outside the plates)

Electric Dipole

- Electric dipole moment $\vec{p} = q(2\vec{a})$
- Torque on dipole placed in uniform electric field $\vec{\tau} = \vec{p} \times \vec{E}$
- At a point which is at a distance r from dipole midpoint and making angle θ with dipole axis.



Electric field $E = \frac{1}{4\pi \epsilon_0} \frac{p\sqrt{1+3\cos^2\theta}}{r^3}$

Direction $\tan\alpha = \frac{E_\theta}{E_r} = \frac{1}{2}\tan\theta$

- Electric field at axial point (or End-on) $\vec{E} = \frac{1}{4\pi \epsilon_0} \frac{2\vec{p}}{r^3}$ of dipole
- Electric field at equatorial position (Broad-on) of dipole $\vec{E} = \frac{1}{4\pi \epsilon_0} \frac{(-\vec{p})}{r^3}$
- Time period of SHM of dipole in uniform electric field $T = 2\pi\sqrt{\frac{I}{pE}}$

1. Consider a neutral conducting sphere. A positive point charge is placed outside the sphere. The net charge on the sphere is

(1) Zero

(2) Negative and distributed uniformly over the surface of the sphere

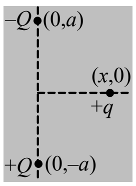
(3) Negative and distributed non-uniformly over the surface of the sphere

(4) Negative and appears only at the point on the sphere closest to the point charge

Sol. When a positive point charge is placed outside a conducting surface, redistribution of charges takes place on the surface. But the total charge is zero as no charge enters or loses the surface.

Therefore, option (1) is the correct answer.

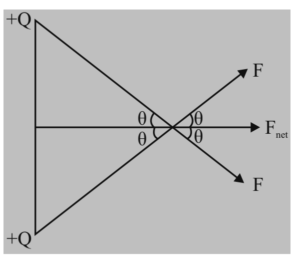
2. 3 point charges are placed as shown in the figure. The net force on charge q is



(1) $\dfrac{2KQqx^2}{(a^2+x^2)a^2}$ (2) $\dfrac{2KQqx}{(a^2+x^2)^{3/2}}$

(3) $\dfrac{KQqx}{(a^2+x^2)^{3/2}}$ (4) $\dfrac{3}{2}\dfrac{KQqx}{(a^2+x^2)^{3/2}}$

Sol.



$F_{net} = 2F\cos\theta = 2 \times \dfrac{KQq}{(a^2+x^2)}\dfrac{x}{\sqrt{a^2+x^2}} = \dfrac{2KQqx}{(a^2+x^2)^{3/2}}$

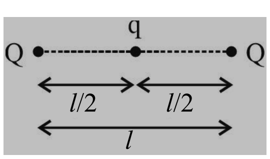
Therefore, option (2) is the correct answer.

3. Two equal charges 'Q' are placed at a distance l apart. A third charge 'q' is placed at mid-point between them such that entire system is in equilibrium. The value of charge q is

(1) $-\dfrac{Q}{4}$ (2) $\dfrac{Q}{4}$

(3) $\dfrac{Q}{2}$ (4) $-\dfrac{Q}{2}$

Sol.



$F_{net} = O$

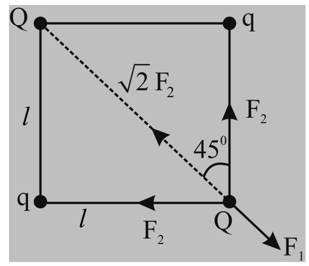
$\Rightarrow \dfrac{KQ^2}{l^2} + \dfrac{KQq}{\left(\dfrac{l}{2}\right)^2} = 0 \Rightarrow q = -\dfrac{Q}{4}$

Therefore, option (1) is the correct answer.

4. Charge Q is placed at each of the two diagonally opposite corner of a square. Also charge q is placed at each of the other two corners. If net force on charge Q is zero, then $\dfrac{Q}{q}$ is:

(1) $-2\sqrt{2}$ (2) -2 (3) $-\sqrt{2}$ (4) $\dfrac{1}{\sqrt{2}}$

Sol.



Let F_1 be the force between Q and Q. For the net force on Q to be zero, the force between Q and q should be attractive Let F_2 be the force between Q and q.

$\therefore$ Net force on Q is zero.

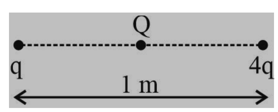
$2F_2 \cos 45^0 = -F_1$

$\therefore \sqrt{2}F_2 = -F_1 \Rightarrow \sqrt{2}\dfrac{KQq}{l^2} = -\dfrac{KQ^2}{(\sqrt{2}l)^2}$

$\Rightarrow \dfrac{Q}{q} = -2\sqrt{2}$

Therefore, option (1) is the correct answer.

5. Considers the following system of two charges q and 4q, separated by a distance of 1m. Charge 'Q' is placed near them such that entire system comes in equilibrium. The value of charge Q is:



(1) $\dfrac{9}{4}q$ (2) $-\dfrac{4}{9}q$ (3) $\dfrac{2}{9}q$ (4) $\dfrac{5}{9}q$

Sol. Let the charge 'Q' is placed at a distance of 'r' from charge 'q'. For the system to be in equilibrium

$\dfrac{KQq}{r^2} = \dfrac{KQ4q}{(1-r)^2} \Rightarrow r = \dfrac{1}{3}$

Force on 'q' due to '$4q$'

$F_1 = \dfrac{Kq \times 4q}{1^2}$

Force on 'q' due to Q

Board Level Problems

MULTIPLE CHOICE QUESTIONS

1. If a body has positive charge on it, then it means it has
(1) Gained some protons
(2) Lost some protons
(3) Gained some electrons
(4) Lost some electrons

2. Sure, check for presence of electric charge on two bodies is
(1) Process of induction
(2) Repulsion between bodies
(3) Attraction between bodies
(4) Frictional force between bodies

3. If a solid and a hollow conducting sphere have same radius then
(1) Hollow sphere will hold more maximum charge
(2) Solid sphere will hold more maximum charge
(3) Both the spheres will hold same maximum charge
(4) Both the sphere can't hold charge

4. When a conducting soap bubble is negatively charged then
(1) Its size starts varying arbitrarily
(2) It expands
(3) It contracts
(4) No change in its size takes place

5. Consider three-point objects *P*, *Q* and *R*, *R* and *Q* repel each other, while *P* and *R* attract. What is the nature of force between *P* and *Q*?
(1) Repulsive force (2) Attractive force
(3) No force (4) Data not sufficient

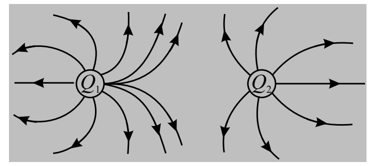
6. Which of the following processes involves the principle of electrostatic induction?
(1) Pollination (2) Chocolate making
(3) Xerox copying (4) All of these

7. The electric field intensity at a point in vacuum is equal to
(1) Zero
(2) Force a proton would experience there
(3) Force an electron would experience there
(4) Force a unit positive charge would experience there

8. A sphere of radius has electric charge uniformly distributed in its entire volume. At a distance *d* from the centre inside the sphere the electric field intensity is directly proportional to
(1) $\frac{1}{d}$ (2) $\frac{1}{d^2}$ (3) d (4) d^2

9. The electric field at distance 2R from the centre of a uniformly charged non-conducting sphere of radius is *R* is *E*. The electric field at a distance *R*/2 from the centre will be
(1) Zero (2) 2*E* (3) 4*E* (4) 16*E*

10. Figure shows electric lines of forces due to charges and Hence



(1) Q_1 and Q_2 both are negative
(2) Q_1 and Q_2 both are positive
(3) $Q_1 > Q_2$
(4) Both (2) and (3)

ASSERTION AND REASON QUESTIONS

Directions: These questions consist of two statements each, printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following four responses.
(1) Both Assertion and Reason are True and the Reason is a correct explanation of the Assertion.
(2) Both Assertion and Reason are True but Reason is not a correct explanation of the Assertion.
(3) Assertion is True but the Reason is False.
(4) Assertion is False but Reason is True.

1. Assertion (A): When an electric dipole is placed in uniform electric field, net force on it will be zero.
Reason (R): Force on the constituent charges of the dipole will be equal and opposite when it is in uniform electric field.

2. Assertion (A): Gauss' theorem is applicable on any closed surface.
Reason (R): In order to find the value of electric field due to a charge distribution, Gauss' theorem should be applied on a symmetrical closed surface.

3. Assertion (A): The number of field lines drawn from a charge is proportional to the magnitude of the charge.
Reason (R): The electric field at any point is proportional to the magnitude of the source charge.

VERY SHORT ANSWER QUESTIONS

1. In an electric field an electron is kept freely. If the electron is replaced by a proton, what will be the relationship between the forces experienced by them?
2. Which orientation of an electric dipole in a uniform electric field would correspond to stable equilibrium?
3. When two electrically charged particles having charges of different magnitude are placed at a distance from each other, they experience a force of attraction . These two particles are put in contact and again placed at the same distance from each other. What is the nature of new force between them?
4. Can a charged body attract an uncharged body?
5. The force between two charges placed in vacuum is *F*. What happens to the force if the two charges are dipped in kerosene oil of dielectric constant, $k = 2$?
6. What is the line of symmetry of a dipole field?
7. Find the value of electric field that would exactly balance the weight of electron.

Prarambh Exercise-1 (Topicwise)

COULOMB'S LAW

1. One million electrons are added to a glass rod. The total charge on the rod is

(1) 10^{-13} C (2) -1.6×10^{-13} C
(3) $+1.6 \times 10^{-12}$ 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

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. 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) 36×10^{13}N (2) 36×10^{14}N
(3) 36×10^{12}N (4) 36×10^{11}N

5. Which of the following law gives existence of force between two stationary charged particles?

(1) Coulomb's law (2) Biot-savart's law
(3) Ohm's law (4) All of these

6. Electric charge of any system is

(1) Zero or neutral
(2) Half integral multiple of the least amount of charge
(3) Integral multiple of least amount of charge
(4) One third the least amount of charge

7. Two charged particles having charge 2×10^{-8}C each are joined by an insulating string of length 1m and the system is kept on a smooth horizontal table, what is the tension in the string?

(1) 3.6×10^{-6}N (2) 3.4×10^{-6}N
(3) 4×10^{-7}N (4) 3×10^{-4}N

8. How many electrons must be removed from a piece of metal to give it a positive charge of 1×10^{-7}C?

(1) 6.25×10^{-11} (2) 6.25×10^{-12}
(3) 6.25×10^{11} (4) 6.25×10^{13}

9. Two charged spheres separated at a distance R exert a force F on each other. If they are immersed in a liquid of dielectric constant 5 then what is the new force between them

(1) $\frac{F}{5}$ (2) F (3) 5F (4) $\frac{F}{2}$

10. Charges on two spheres are +10μC and –5μC respectively. They experience a force F. If each of them is given an additional charge +2μC then new force between them keeping the same distance is

(1) 18F (2) $\frac{F}{25}$ (3) $\frac{18F}{25}$ (4) $\frac{25}{18}$F

11. Three charges q_1, q_2, q_3 each equal to q placed at the vertices of an equilateral triangle of side l. What will be the force on a charge Q placed at the centroid of triangle?

(1) $\frac{1}{4\pi\epsilon_0}\frac{q^2}{l^2}$ (2) $\frac{1}{4\pi\epsilon_0}\frac{3q^2}{l^2}$

(3) $\frac{1}{4\pi\epsilon_0}\frac{2q^2}{l^2}$ (4) Zero

12. Total charge Q is broken in two parts Q_1 & Q_2 and they are placed at a distance R from each other. The maximum force of repulsion between them will occur when

(1) $Q_2 = \frac{Q}{4}, Q_1 = Q - \frac{Q}{4}$ (2) $Q_2 = \frac{Q}{3}, Q_1 = Q - \frac{Q}{3}$

(3) $Q_2 = \frac{Q}{4}, Q_1 = Q - \frac{3Q}{4}$ (4) $Q_2 = \frac{Q}{2}, Q_1 = Q - \frac{Q}{2}$

13. Two charges of +200μC and –200μC are placed at the corners B and C of an equilateral triangle ABC of side 0.1 m. The force on a charge of 5μC placed at A is

(1) 1800 N (2) $1200\sqrt{3}$N
(3) $600\sqrt{3}$N (4) 900 N

14. Two charges each of 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) 100 N (2) 10 N
(3) 10^4 dyne (4) 100 dyne

15. 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

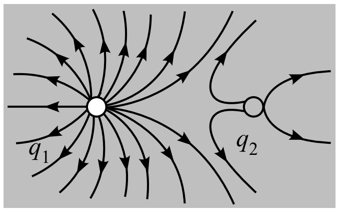
(1) 1 : 1 : 2 (2) 1 : 2 : 2
(3) 2 : 2 : 1 (4) 2 : 1 : 1

16. 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) $\frac{q^2}{4\pi\varepsilon_0 a^2}$

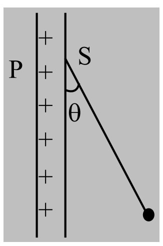
(3) $\frac{q^2}{2\pi\varepsilon_0 a^2}$ (4) $\frac{3q^2}{2\pi\varepsilon_0 a^2}$

1. Figure shows electric field lines due to a charge configuration from this we conclude that



(1) q_1 and q_2 are positive and $q_2 > q_1$
(2) q_1 and q_2 are positive and $q_1 > q_2$
(3) q_1 and q_2 are negative and $|q_1| > |q_2|$
(4) q_1 and q_2 are negative and $|q_2| > |q_1|$

2. A charged ball B hangs from a silk thread S, which makes an angle θ with a large charged conducting sheet P, as shown in the figure. The surface charge density σ of the sheet is proportional to:

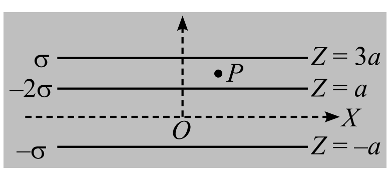


(1) sin θ (2) tan θ (3) cos θ (4) cot θ

3. A particle having charge q and mass m is projected with velocity $\vec{v} = 2\hat{i} - 3\hat{j}$ in a uniform electric field $\vec{E} = E_0\hat{j}$. Change in momentum Δp during any time interval t is given by?

(1) $\sqrt{13}\,m$ (2) qE_0t (3) $\frac{qE_0t}{m}$ (4) Zero

4. Three infinitely long charged sheets are placed as shown in figure. The electric field at point P is:



(1) $-\frac{2\sigma}{\varepsilon_0}\hat{k}$ (2) $\frac{2\sigma}{\varepsilon_0}\hat{k}$

(3) $-\frac{4\sigma}{\varepsilon_0}\hat{k}$ (4) $\frac{4\sigma}{\varepsilon_0}\hat{k}$

5. The electric field intensity outside a charged sphere of radius R at a distance r ($r > R$) is

(1) $\frac{\sigma R^2}{\varepsilon_0 r^2}$ (2) $\frac{\sigma r^2}{\varepsilon_0 R^2}$

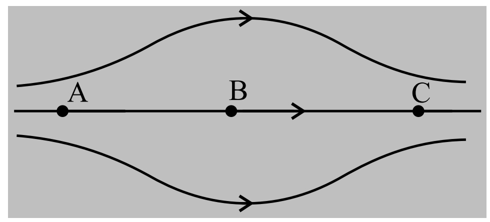
(3) $\frac{\sigma r}{\varepsilon_0 R}$ (4) $\frac{\sigma R}{\varepsilon_0 r}$

6. An electron of mass m and charge q is accelerated from rest in a uniform electric field of strength E. The velocity acquired by it as it travels a distance l is

(1) $\sqrt{\frac{2Eql}{m}}$ (2) $\sqrt{\frac{2Eq}{ml}}$

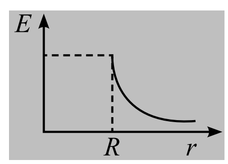
(3) $\sqrt{\frac{2Em}{ql}}$ (4) $\sqrt{\frac{Eq}{ml}}$

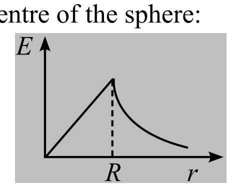
7. The figure shows some of the electric field lines corresponding to an electric field. The figure suggests

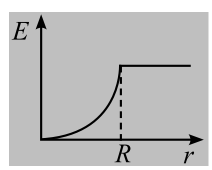


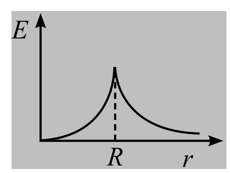
(1) $E_A > E_B > E_C$ (2) $E_A = E_B = E_C$
(3) $E_A = E_C > E_B$ (4) $E_A > E_C > E_B$

8. Which of the following graphs shows the variation of electric field E due to a hollow spherical conductor of radius R as a function of distance from the centre of the sphere:

(1) 

(2) 

(3) 

(4) 

9. In a region the intensity of an electric field is given by $\vec{E} = 2\hat{i} + 3\hat{j} + \hat{k}$ in NC^{-1}. The electric flux through a surface $\vec{S} = 10\hat{i}\ m^2$ in the region is:

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

10. A charged particle of charge q and mass m is released from rest in an uniform electric field E. Neglecting the effect of gravity, the kinetic energy of the charged particle after time 't' seconds is

(1) $\frac{Eqm}{t}$ (2) $\frac{E^2q^2t^2}{2m}$

(3) $\frac{2E^2t^2}{mq}$ (4) $\frac{Eq^2m}{2t^2}$

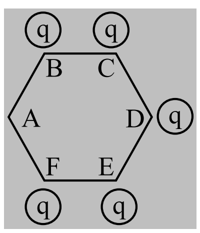
MATCH THE COLUMN MCQs

1. Match the entries of List-I with that of List-II:

	List-I		List-II
A.	Coulomb's law	P.	Total electric flux through a closed surface.
B.	Gauss's law	Q.	Vector sum of forces.
C.	Principle of superposition	R.	Force is inversely proportional to square of distance
D.	Quantization of charge	S.	Discrete nature of charge

(1) A-(Q); B-(R); C-(P); D-(S)
(2) A-(R); B-(P); C-(Q); D-(S)
(3) A-(P); B-(S); C-(R); D-(Q)
(4) A-(P); B-(Q); C-(R); D-(S)

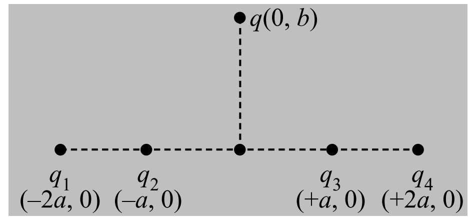
2. Five identical charges are kept at five vertices of a regular hexagon. Match the following two columns at centre of the hexagon. If in the given situation electric field at centre is E. Then,



	Column-I		Column-II
A.	If charge at B is removed, then electric field will become	P.	$2E$
B.	If charge at C is removed, then electric field will become	Q.	E
C.	If charge at D is removed then electric field will become	R.	zero
D.	If charges at B and C both are removed, then electric field will become	S.	$\sqrt{3}E$

(1) A-(S); B-(P); C-(R); D-(Q)
(2) A-(P); B-(S); C-(R); D-(Q)
(3) A-(Q); B-(R); C-(Q); D-(S)
(4) A-(S); B-(Q); C-(R); D-(P)

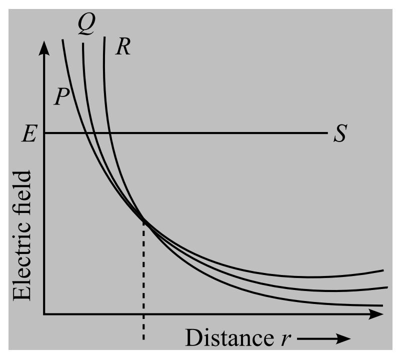
3. Four charges q_1, q_2, q_3 and q_4 of same magnitude are fixed along the x axis at $x = -2a, -a, +a$ and $+2a$, respectively. A positive charge q is placed on the positive y axis at a distance $b > 0$. Four options of the signs of these charges are given in Column-I. The direction of the forces on the charge q is given in Column-II. Match Column-I with Column-II and select the correct answer using the code given below the lists.



	Column-I		Column-II
A.	q_1, q_2, q_3, q_4 all positive	P.	$+x$
B.	q_1, q_2 positive and q_3, q_4 negative	Q.	$-x$
C.	q_1, q_4 positive and q_2, q_3 negative	R.	$+y$
D.	q_1, q_2, q_3, q_4 all are negative	S.	$-y$

(1) A-(R); B-(P); C-(S); D-(S)
(2) A-(P); B-(S); C-(R); D-(Q)
(3) A-(R); B-(Q); C-(P); D-(S)
(4) A-(S); B-(R); C-(Q); D-(P)

4. The curves in the graph show the variation of electric field E with distance r for various kinds of charge distributions given in List-I. Match them with their correct curves in List-II.



	List-I		List-II
A.	Electric field of a point sized dipole.	P.	P
B.	Electric field due to an infinitely long straight uniformly charged wire.	Q.	Q
C.	Electric field due to a uniformly charged plane sheet.	R.	R
D.	Electric field due to a point charge.	S.	S

(1) A-(Q); B-(S); C-(R); D-(P)
(2) A-(S); B-(R); C-(Q); D-(P)
(3) A-(P); B-(Q); C-(R); D-(S)
(4) A-(R); B-(P); C-(S); D-(Q)

PYQ's Exercise-4 (Important NEET PYQ's)

1. An electric dipole is placed at an angle of 30° with an electric field of intensity 2×10^5 NC^{-1}. It experiences a torque equal to 4 Nm. Calculate the magnitude of charge on the dipole, if the dipole length is 2 cm. **(2023)**

(1) 2 mC (2) 6 mC

(3) 8 mC (4) 4 mC

2. If $\oint_s \vec{E}\cdot d\vec{S} = 0$ over a surface, then: **(2023)**

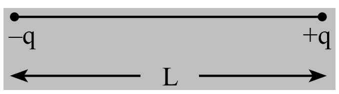
(1) The electric field inside the surface is necessarily uniform.

(2) The number of flux lines entering the surface must be equal to the number of flux lines leaving it.

(3) The magnitude of electric field on surface is constant.

(4) All the charges must necessarily be inside the surface.

3. Two point charges $-q$ and $+q$ are placed at a distance of L, as shown in the figure

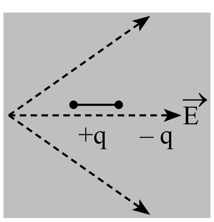


The magnitude of electric field intensity at a distance R ($R >> L$) varies as **(2022)**

(1) $\frac{1}{R^6}$ (2) $\frac{1}{R^2}$

(3) $\frac{1}{R^3}$ (4) $\frac{1}{R^4}$

4. A dipole is placed in an electric field as shown. In which direction will it move? **(2021)**



(1) Towards the right as its potential energy will decrease.

(2) Towards the left as its potential energy will decrease.

(3) Towards the right as its potential energy will increase.

(4) Towards the left as its potential energy will increase.

5. The electric field at a point on the equatorial plane at a distance r from the centre of a dipole having dipole moment $\vec{P}$ is given by,
(r >> separation of two charges forming the dipole, ϵ_0 – permitivity of free space) **(2020 Covid)**

(1) $\vec{E} = \frac{2\vec{P}}{4\pi\epsilon_0 r^3}$ (2) $\vec{E} = -\frac{2\vec{P}}{4\pi\epsilon_0 r^3}$

(3) $\vec{E} = -\frac{\vec{P}}{4\pi\epsilon_0 r^3}$ (4) $\vec{E} = \frac{\vec{P}}{4\pi\epsilon_0 r^3}$

6. A spherical conductor of radius 10 cm has a charge of 3.2×10^{-7} C distributed uniformly. What is the magnitude of electric field at a point 15 cm from the centre of the sphere?
$\left(\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ N m}^2/\text{C}^2\right)$ **(2020)**

(1) 1.28×10^5 N/C (2) 1.28×10^6 N/C

(3) 1.28×10^7 N/C (4) 1.28×10^4 N/C

7. A hollow metal sphere of radius R is uniformly charged. The electric field due to the sphere at a distance r from the centre **(2019)**

(1) Increases as r increases for $r < R$ and for $r > R$

(2) Zero as r increases for $r < R$, decreases as r increases for $r > R$

(3) Zero as r increases for $r < R$, increases as r increases for $r > R$

(4) Decreases as r increases for $r < R$ and for $r > R$

8. Two parallel infinite line charges with linear charge densities $+\lambda$ C/m and $-\lambda$ C/m are placed at a distance of 2R in free space. What is the electric field mid-way between the two line charges? **(2019)**

(1) Zero (2) $\frac{2\lambda}{\pi\varepsilon_0 R}$ N / C

(3) $\frac{\lambda}{\pi\varepsilon_0 R}$ N / C (4) $\frac{\lambda}{2\pi\varepsilon_0 R}$ N / C

9. Two point charges A and B, having charges $+Q$ and $-Q$ respectively, are placed at certain distance apart and force acting between them is F. If 25% charge of A is transferred to B, then force between the charges becomes **(2019)**

(1) F (2) $\frac{9F}{16}$

(3) $\frac{16F}{9}$ (4) $\frac{4F}{3}$

10. Suppose the charge of a proton and an electron differ slightly. One of them is $-e$, the other is $(e + \Delta e)$. If the net of electrostatic force and gravitational force between two hydrogen atoms placed at a distance d (much greater than atomic size) apart is zero, then Δe is of the order of [Given mass of hydrogen $m_h = 1.67 \times 10^{-27}$ kg] **(2017-Delhi)**

(1) 10^{-23}C (2) 10^{-37}C

(3) 10^{-47}C (4) 10^{-20}C

11. Two identical charged spheres suspended from a common point by two massless strings of lengths l, are initially at a distance d ($d << l$) apart because of their mutual repulsion. The charges begin to leak from both the spheres at a constant rate. As a result, the spheres approach each other with a velocity V. Then V varies as a function of the distance x between the spheres, as **(2016-I)**

(1) $V \propto x^{\frac{1}{2}}$ (2) $V \propto x$ (3) $V \propto x^{-\frac{1}{2}}$ (4) $V \propto x^{-1}$

12. The electric field in a certain region is acting radially outward and is given by E = Ar. A charge contained in a sphere of radius 'a' centered at the origin of the field, will be given by **(2015)**

(1) $A\varepsilon_0 a^2$ (2) $4\pi\varepsilon_0 Aa^3$
(3) $\varepsilon_0 Aa^3$ (4) $4\pi\varepsilon_0 Aa^2$

ANSWER KEY

CONCEPT APPLICATION

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

BOARD LEVEL PROBLEMS

Multiple Choice Questions

1. (4)	**2.** (2)	**3.** (3)	**4.** (2)	**5.** (2)	**6.** (4)	**7.** (4)	**8.** (3)	**9.** (2)	**10.** (4)

Assertion and Reason Questions

1. (1) **2.** (2) **3.** (1)

Case Based Study Type

1. (*i*)-(2), (*ii*)-(2) **2.** (*i*)-(1), (*ii*)-(1)

PRARAMBH EXERCISE-1 (TOPICWISE)

1. (2)	**2.** (2)	**3.** (4)	**4.** (1)	**5.** (1)	**6.** (3)	**7.** (1)	**8.** (3)	**9.** (1)	**10.** (3)
11. (4)	**12.** (4)	**13.** (4)	**14.** (4)	**15.** (4)	**16.** (4)	**17.** (1)	**18.** (4)	**19.** (1)	**20.** (2)
21. (2)	**22.** (2)	**23.** (3)	**24.** (4)	**25.** (1)	**26.** (2)	**27.** (1)	**28.** (3)	**29.** (4)	**30.** (4)
31. (3)	**32.** (3)	**33.** (4)	**34.** (1)	**35.** (1)	**36.** (2)	**37.** (1)	**38.** (1)	**39.** (3)	**40.** (1)
41. (2)	**42.** (2)	**43.** (2)	**44.** (4)	**45.** (4)	**46.** (1)	**47.** (3)	**48.** (1)	**49.** (4)	**50.** (3)
51. (2)	**52.** (1)	**53.** (3)	**54.** (4)	**55.** (1)	**56.** (4)	**57.** (2)	**58.** (3)	**59.** (4)	**60.** (3)
61. (1)	**62.** (1)	**63.** (4)	**64.** (1)						

PRABAL EXERCISE-2 (LEARNING PLUS)

1. (2)	**2.** (2)	**3.** (2)	**4.** (1)	**5.** (1)	**6.** (1)	**7.** (3)	**8.** (1)	**9.** (4)	**10.** (2)
11. (1)	**12.** (3)	**13.** (4)	**14.** (3)	**15.** (1)	**16.** (1)	**17.** (2)	**18.** (1)	**19.** (1)	**20.** (4)
21. (1)	**22.** (2)	**23.** (3)	**24.** (3)	**25.** (4)	**26.** (4)	**27.** (3)	**28.** (2)	**29.** (1)	**30.** (3)
31. (3)									

PARIKSHIT EXERCISE-3 (MULTICONCEPT)

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

PYQ'S EXERCISE-4 (IMPORTANT NEET PYQ's)

1. (1)	**2.** (2)	**3.** (3)	**4.** (1)	**5.** (3)	**6.** (1)	**7.** (2)	**8.** (3)	**9.** (2)	**10.** (2)
11. (3)	**12.** (2)								

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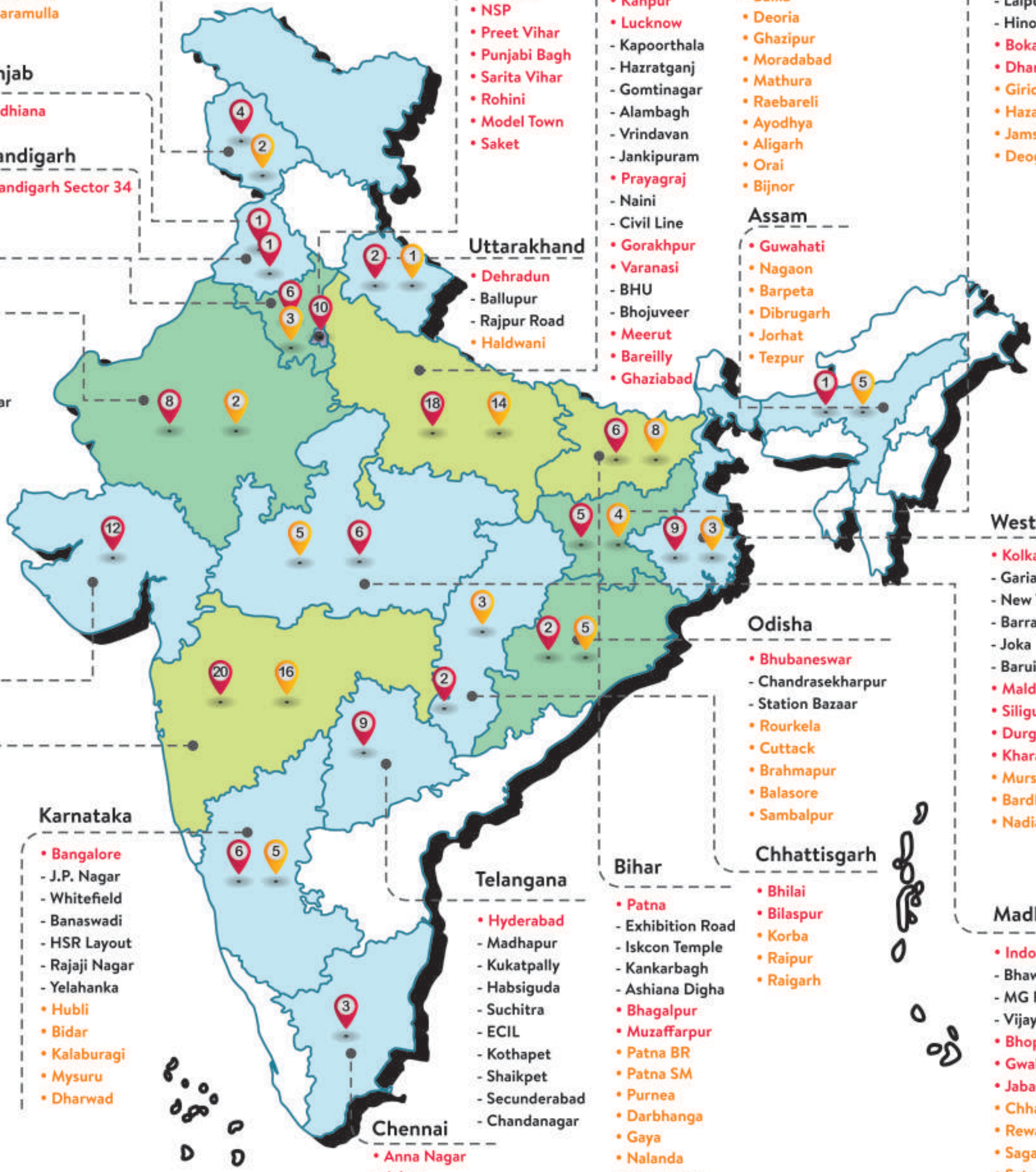

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- Baramulla

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- Rohtak
- Gurugram
  - South City
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- Narnaul
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