DPP - 1

PROPERTIES OF CHARGE AND COULOMB'S LAW

Q.1 Two point charges $q_1 = 2 \times 10^{-3}$C and $q_2 = -3 \times 10^{-6}$C are separated by a distance x $= 10$ cm. Find the magnitude and nature of the force between the two charges.

Q.2 Two point charges $q_1 = 20\mu$C and $q_2 = 25\mu$C are placed at $(-1,1,1)$m and $(3,1,-2)$m, with respect to a coordinate system. Find the magnitude and unit vector along electrostatic force on q_2 ?

Q.3 20 positively charged particles are kept fixed on the X-axis at points $x = 1$ m, 2 m, 3 m, ... ,20 m. The first particle has a charge 1.0×10^{-6}C, the second 8×10^{-6}C, the third 27×10^{-6}C and so on. Find the magnitude of the electric force acting on a 1C charge placed at the origin.

Q.4 (i) Two charged particles having charge 4.0×10^{-6}C and mass 24×10^{-3}Kg each are joined by an insulating string of length 1 m and the system is kept on a smooth horizontal table. Find the tension in the string.

(ii) If suddenly string is cut then what is the acceleration of each particle?

(iii) Are they having equal acceleration?

Q.5 Two identical conducting spheres (of negligible radius), having charges of opposite sign, attract each other with a force of 0.108 N when separated by 0.5 meter. The spheres are connected by a conducting wire, which is then removed (when charge stops flowing), and thereafter repel each other with a force of 0.036 N keeping the distance same. What were the initial charges on the spheres?

Q.6 Two small spheres, each of mass 0.1gm and carrying same charge 10^{-9}C are suspended by threads of equal length from the same point. If the distance between the centres of the sphere is 3 cm, then find out the angle made by the thread with the vertical. $(g = 10\ m/s^2)$ & $\tan^{-1}\left(\frac{1}{100}\right) = 0.6°$

Q.7 The distance between two fixed positive charges 4e and e is ℓ. How should a third charge ' q ' be arranged for it to be in equilibrium? Under what condition will equilibrium of the charge ' q ' be stable (for displacement on the line joining 4e and e) or will it be unstable?

Q.8 Three charges, each of value q, are placed at the comers of an equilateral triangle. A fourth charge Q is placed at the centre O of the triangle.

(a) If $Q = -q$, will the charges at corners start to move towards centre or away from it.

(b) For what value of Q at O will the charges remain stationary?

Q.9 Two charged particles A and B, each having a charge Q are placed a distance d apart. Where should a third particle of charge q be placed on the perpendicular bisector of AB so that it experiences maximum force? Also find the magnitude of the maximum force.

Q.10 A charged particle q_1 is at position $(2,-1,3)$. The electrostatic force on another charged particle q_2 at (0,0,0) is:

(A) $\frac{q_1q_2}{56\pi\epsilon_0}(2\hat{i}-\hat{j}+3\hat{k})$

(B) $\frac{q_1q_2}{56\sqrt{14}\pi\epsilon_0}(2\hat{i}-\hat{j}+3\hat{k})$

(C) $\frac{q_1q_2}{56\pi\epsilon_0}(\hat{j}-2\hat{i}-3\hat{k})$

(D) $\frac{q_1q_2}{56\sqrt{14}\pi\epsilon_0}(\hat{j}-2\hat{i}-3\hat{k})$

Q.11 Three charges +4q, Q and q are placed in a straight line of length ℓ at points at distance $0, \ell/2$ and ℓ respectively from one end of line. What should be the value of Q in order to make the net force on q to be zero?

(A) $-q$ (B) $-2q$

(C) $-q/2$ (D) $4q$

Q.12 Two similar very small conducting spheres having charges $40\mu C$ and $-20\mu C$ are some distance apart. Now they are touched and kept at the same distance. The ratio of the initial to the final force between them is:

(A) 8: 1 (B) 4: 1

(C) 1: 8 (D) 1: 1

Q.13 Two point charges placed at a distance r in air exert a force F on each other. The value of distance R at which they experience force 4 F when placed in a medium of dielectric constant $K = 16$ is :

(A) r (B) r/4

(C) r/8 (D) 2r

Q.14 Three charges +Q, q, +Q are placed respectively, at distance, 0 d/2 and d from the origin, on the x-axis. If the net force experienced by +Q, Placed at x = 0, is zero, then value of q is

(9th jan 1st shift 2019)

(A) +Q/4 (B) –Q/2 (C) +Q/2 (D) –Q/4

Q.15 Two charges, each equal to q, are kept at x = – a and x = a on the x–axis. A particle of mass m and charge $q_0 = \frac{q}{2}$ is placed at the origin. If charge q0 is given a small displacement (y < < a) along the y–axis, the net force acting on the particle is proportional to **(JEE MAINS - 2013)**

(A) $-\frac{1}{y}$ (B) y (C) –y (D) $\frac{1}{y}$

Q.16 Two identical charged spheres suspended from a common point by two massless strings of length l are initially a distance d(d < < l) apart because of their mutual repulsion. The charge begins to leak from both the spheres at a constant rate. As a result the charges approach each other with a velocity v. Then as a function of distance x between them **(JEE MAINS - 2011)**

(A) $v \propto x^{-1/2}$ (B) $v \propto x^{-1}$ (C) $v \propto x^{1/2}$ (D) $v \propto x$

Q.17 Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle of 30° with each other. When suspended in a liquid of density 0.8 g cm^{-3} , the angle remains the same. If density of the material of the sphere is 1.6 g c^{-3} , the dielectric constant of the liquid is **(JEE MAINS - 2010)**

(A) 1 (B) 4 (C) 3 (D) 2

Q.18 If g_E an g_M are are the accelerations due to gravity on the surfaces of the earth and the moon respectively and if Millikan's oil Drop experiment could be performed on the two surfaces, one will find the ratio $\frac{\text{electronic charge on the moon}}{\text{electronic chargeon themoon}}$ to be **(JEE MAINS - 2007)**

(A) g_M/g_E (B) 1 (C) 0 (D) g_E/g_M

Q.19. Two spherical conductors A and B and having equal radii and carrying equal charges in them repel each other with a force F when kept apart at some distance. A third spherical conductor having same radius as that of B but uncharged is brought in contact with B, then brought in contact with A and finally removed away from both. Then new force of repulsion between B and A is **(JEE MAINS - 2004)**

(A) F/4 (B) 3F/4 (C) F/8 (D) 3F/8

Q.20 Two equal negative charge $-q$ are fixed at points $(0, -a)$ and $(0, a)$ on y-axis. A positive charge Q is released from rest at the point $(2a, 0)$ on the x-axis. The charge Q will **(IIT 1984)**

(A) execute simple harmonic motion about the origin

(B) move to the origin remain at rest

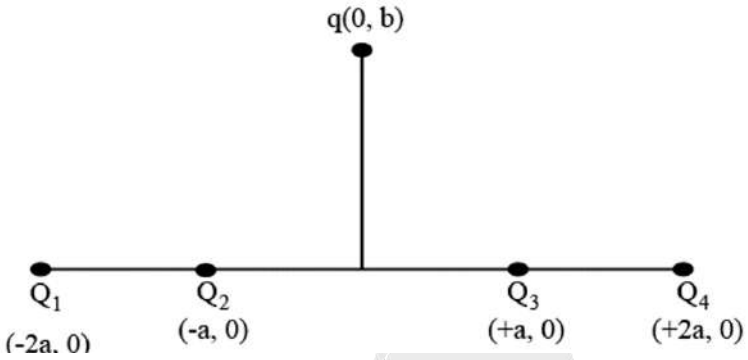
(C) move to infinity

(D) execute oscillatory but not simple harmonic motion.

Q.21 A charge q is placed at the centre of the line joining two equal charges Q. The system of the three charges will be in equilibrium if q is equal to **(IIT 1987)**

(a) $-\frac{Q}{2}$ (b) $-\frac{Q}{4}$ (c) $+\frac{Q}{4}$ (d) $+\frac{Q}{2}$.

Q.22 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 List I. The direction of the forces on the charge q is given in List II. Match List I with List II and select the correct answer using the code given below the lists. **(JEE ADV. 2012)**



List I		**List II**	
P.	Q_1, Q_2, Q_3, Q_4 all positive	**1.**	$+x$
Q.	Q_1, Q_2 positive; Q_3, Q_4 negative	**2.**	$-x$
R.	Q_1, Q_4 positive; Q_2, Q_3 negative	**3.**	$+y$
S.	Q_1, Q_3 positive; Q_2, Q_4 negative	**4.**	$-y$

Code :

(A) $P-3, Q-1, R-4, S-2$

(B) $P-4, Q-2, R-3, S-1$

(C) $P-3, Q-1, R-2, S-4$

(D) $P-4, Q-2, R-1, S-3$

23. Two small equally charged spheres, each of mass m, are suspended from the same point by silk threads of length 1 . The distance between the spheres x <<. Find the rate dq/dt with which the charge leaks off

each sphere if their approach velocity varies as $v = a/\sqrt{x}$, where a is a constant.

ANSWER KEY

Q.1 5400 N, attractive.

Q.2 $|F| = 0.18\ N, \hat{F} = \frac{(4\hat{i}-3\hat{k})}{5}$.

Q.3 $q_0\ K\left[\frac{q_1}{r_1^2} + \frac{q_2}{r_2^2} \ldots\ldots \frac{q_{20}}{r_{20}^2}\right] = 1.89 \times 10^6\ N$

Q.4 (i) $\frac{Kq_1q_2}{r^2} = 0.144\ N$

(ii) $\frac{Kq_1q_2}{mr^2} = 6\ m/s^2$

(iii) No (Magnitude is same but direction is different)

Q.5 $\pm 1.0 \times 10^{-6} C, \mp 3 \times 10^{-6} C$

Q.6 $\tan^{-1}(1/100) = 0.6°$

Q.7 $\frac{2\ell}{3}$ from charge 4e (If q is positive stable, If q is negative unstable)

Q.8 (a) moves towards the centre

(b) $-\frac{q}{\sqrt{3}}$

Q.9 $\frac{d}{2\sqrt{2}}, \frac{4Qq}{3\sqrt{3}\pi\varepsilon_0 d^2}$

Q.10 **(D)**

Q.11 **(A)**

Q.12 **(A)**

Q.13 **(C)**

Q.14 **(D)**

Q.15 **(B)**

Q.16 **(A)**

Q.17 **(D)**

Q.18 **(B)**

Q19. **(D)**

Q20. **(D)**

Q 21. **(B)**

Q 22. **(A)**

Q23. $\frac{dq}{dt} = \frac{3a}{2}\sqrt{2\pi\varepsilon_0 mg/l}$