Topic 1: Charges & Coulomb's Law

1) Point charges +4q, –q and +4q are kept on the X - axis at points x = 0, x = a and x = 2a respectively. Then:

(a) only –q is in stable equilibrium

(b) none of the charges is in equilibrium

(c) all the charges are in unstable equilibrium

(d) all the charges are in stable equilibrium

2) When air is replaced by a dielectric medium of force constant K ,the maximum force of attraction between two charges, separated by a distance

(a) decrease K – times

(b) increases K – times

(c) remains unchanged

(d) becomes $\frac{1}{K^2}$ times

3) An electron is moving round the nucleus of a hydrogen atom in a circular orbit of radius r. The Coulomb force $\vec{F}$ between the two is

(a) $K\frac{e^2}{r^3}\vec{r}$

(b) $K\frac{e^2}{r^2}\hat{r}$

(c) $-K\frac{e^2}{r^3}\hat{r}$

(d) $-K\frac{e^2}{r^3}\vec{r}$

$\left(\text{where } K = \frac{1}{4\pi\varepsilon_0}\right)$

4) Two positive ions, each carrying a charge q, are separated by a distance d. If F is the force of repulsion between the ions, the number of electrons missing from each ion will be (e being the charge of an electron)

(a) $\frac{4\pi\varepsilon_0 Fd^2}{e^2}$

(b) $\sqrt{\frac{4\pi\varepsilon_0 Fe^2}{d^2}}$

(c) $\sqrt{\frac{4\pi\varepsilon_0 Fd^2}{e^2}}$

(d) $\frac{4\pi\varepsilon_0 Fd^2}{q^2}$

5) Two metallic spheres of radii 1 cm and 3 cm are given charges of -1×10^{-2} C and 5×10^{-2} C respectively. If these are connected by a conducting wire, the final charge on the bigger sphere is:

(a) 2×10^{-2} C

(b) 3×10^{-2} C

(c) 4×10^{-2} C

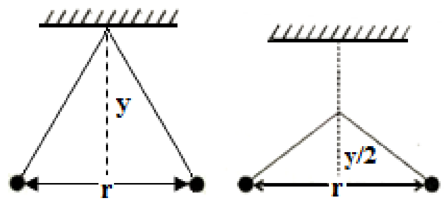
(d) 1×10^{-2} C

6) 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

(a) Q/2 (b) –Q/4

(c) Q/4 (d) –Q/2

7) Two pith balls carrying equal charges are suspended from a common point by strings of equal length. The equilibrium separation between them is r. Now the strings are rigidly clamped at half the height. The equilibrium separation between the balls now become



(a) $\left(\frac{r}{\sqrt[3]{2}}\right)$ (b) $\left(\frac{2r}{\sqrt{3}}\right)$

(c) $\left(\frac{2r}{3}\right)$ (d) $\left(\frac{r}{\sqrt{2}}\right)^2$

8) Two identical charged spheres suspended from a common point by two massless strings of lengths l, are initially at a distance d ($d \ll l$) 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:

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

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

9) Suppose the charge of a proton and an electron differ slightly. One of them is –e, the other is (e + Δe). 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]

(a) 10^{-23} C (b) 10^{-37} C

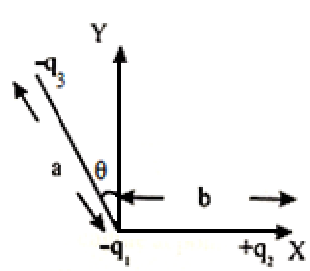
(c) 10^{-47} C (d) 10^{-20} C

10) If a charge q is placed at the centre of the line joining two equal charges Q such that the system is in equilibrium then the value of q is

(a) Q/2 (b) –Q/2

(c) Q/4 (d) –Q/4

11) Three charges $-q_1$, $+q_2$ and $-q_3$ are place as shown the figure. The x - component of the force on $-q_1$ is proportional to



(a) $\frac{q_2}{b^2} - \frac{q_3}{a^2}\cos\theta$

(b) $\frac{q_2}{b^2} + \frac{q_3}{a^2}\sin\theta$

(c) $\frac{q_2}{b^2} + \frac{q_3}{a^2}\cos\theta$

(d) $\frac{q_2}{b^2} - \frac{q_3}{a^2}\sin\theta$

12) Two spherical conductors B and C having equal radii and carrying equal charges on them repel each other with a force F when kept apart at some distance. A third spherical conductor having same radius as that B but uncharged is brought in contact with B, then brought in contact with C and finally removed away from both. The new force of repulsion between B and C is

(a) F/8

(b) 3F/4

(c) F/4

(d) 3F/8

13) If g_E and g_M 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 $\frac{\text{electronic charge on the moon}}{\text{electronic charge on the earth}}$ to be

(a) g_M / g_E

(b) 1

(c) 0

(d) g_E / g_M

14) A charge Q is placed at each of the opposite corners of a square. A charge q is placed at each of the other two corners. If the net electrical force on Q is zero, then Q/q equals:

(a) –1

(b) 1

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

(d) $-2\sqrt{2}$

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

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

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

(c) $v \propto x$

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

16) Two balls of same mass carrying equal charge are hung from a fixed support of length l. At electrostatic equilibrium, assuming that angles made by each thread is small, the separation, x between the balls is proportional to:

(a) l

(b) l^2

(c) $l^{2/3}$

(d) $l^{1/3}$

17) 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 q_0 is given a small displacement ($y \ll a$) along the y-axis, the net force acting on the particle is proportional to

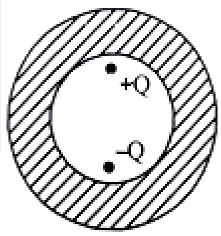
(a) y

(b) –y

(c) $\frac{1}{y}$

(d) $-\frac{1}{y}$

18) Shown in the figure are two point charges +Q and –Q inside the cavity of a spherical shell. The charges are kept near the surface of the cavity on opposite sides of the centre of the shell. If σ_1 is the surface charge on the inner surface and Q_1 net charge on it and σ_2 the surface charge on the outer surface and Q_2 net charge on it then:



(a) $\sigma_1 \neq 0, Q_1 = 0$
$\sigma_2 = 0, Q_2 = 0$

(b) $\sigma_1 \neq 0, Q_1 = 0$
$\sigma_2 \neq 0, Q_2 = 0$

(c) $\sigma_1 = 0, Q_1 = 0$
$\sigma_2 = 0, Q_2 = 0$

(d) $\sigma_1 \neq 0, Q_1 \neq 0$
$\sigma_2 \neq 0, Q_2 \neq 0$

ANSWER KEY									
1	2	3	4	5	6	7	8	9	10
c	a	d	c	b	b	a	c	b	d
11	12	13	14	15	16	17	18		
b	d	b	d	d	d	a	c		