

## Electric charges and fields

**Question:** Which is bigger - a coulomb or a charge on an electron? How many electronic charges form one coulomb of charge?

**Question:** A comb drawn through person's hair on a dry day causes  $10^{22}$  electrons to leave the person's hair and stick to the comb. Calculate the charge carried by the comb.

**Question:** If a body gives out  $10^9$  electrons every second, how much time is required to get a total charge of 1 C from it?

**Question:** How much positive and negative charge is there in a cup of water?

**Question:** Calculate the charge carried by  $12.5 \times 10^8$  electrons.

**Question:** How many electrons would have to be removed from a copper penny to leave it with a positive charge of  $10^{-7} \text{ C}$  ?

**Question:** Calculate the charge on an alpha particle. Given charge on a proton =

$$1.6 \times 10^{-19} \text{ C}.$$

**Question:** Calculate charge on  ${}_{26}^{56}\text{Fe}$  nucleus. Given charge on a proton

$$= 1.6 \times 10^{-19} \text{ C}.$$

**Question:** Determine the total charge on 75.0 kg of electrons.

**Question:** How many mega coulombs of positive (or negative) charge are Present in 2.0 mole of neutral hydrogen ( $H_2$ ) gas ?

**Question:** Estimate the total number of electrons present in 100g of water. How much is the total negative charge carried by these electrons? Avogadro's number =  $6.02 \times 10^{23}$  and molecular mass of water = 18.

**Question:** The electrostatic force of repulsion between two positively charged ions carrying equal charges is  $3.7 \times 10^{-9}N$ , when they are separated by a distance of 5 A How many electrons are missing from each ion?

**Question:** A free pith-ball A of 8 g carries a positive charge of  $5 \times 10^{-8}$  C. What must be the nature and magnitude of charge that should be given to a second pith-ball B fixed 5 cm below the former ball so that the upper ball is stationary?

**Question:** A particle of mass  $m$  and carrying charge  $-q_1$  is moving around a charge  $+q_2$  along a circular path of radius  $r$ . Prove that the period of revolution of the charge  $-q_1$  about  $+q_2$  is given by

$$T = \sqrt{\frac{16\pi^3 \epsilon_0 m r^3}{q_1 q_2}}$$

**Question:** Two particles, each having a mass of 5g and charge  $1.0 \times 10^{-7}C$ , stay in limiting equilibrium on a horizontal table with a separation of 10 cm between them. The coefficient of friction between each particle and the table is the same. Find  $\mu$ .

**Question:** (a) Two insulated charged copper spheres A and B have their centers separated by a distance of 50 cm.

What is the mutual force 1, electrostatic repulsion if the charge on each is  $6.5 \times 10^{-7}$ ? The radii of A and B are negligible compared to the distance of separation. Also compare this force with their mutual gravitational attraction if each weighs 0.5 kg.

(b) What is the force of repulsion if

(i) each sphere is charged double the above amount, and the distance between them is halved;

(ii) the two spheres are placed in water?  
(Dielectric constant of water = 80).

**Question:** Suppose the spheres A and B in Example 9 have identical sizes. A third sphere of the same size but uncharged is brought in contact with the first, then brought in contact with the second, and finally removed from both. What is the new force of repulsion between A and B?

**Question:** Two similarly equally charged identical metal spheres A and B repel each other with a force of  $2.0 \times 10^{-5}$  N. A third identical uncharged sphere C is touched to A, then placed at the midpoint between A and B. Calculate the net electrostatic force on C.

**Question:** Two identical charges, Q each, are kept at a distance r from each other. A third charge q is placed on the line joining the above two charges such that all the three charges are in equilibrium. What is the magnitude, sign and position of the charge q?

**Question:** Two-point charges  $+4e$  and  $+e$  are 'fixed' a distance 'a' apart. Where should a third point charge  $q$  be placed on the line joining the two charges so that it may be in equilibrium? In which case the equilibrium will be stable and in which unstable?

**Question:** Two-point charges of charge values  $Q$  and  $q$  are placed at distances  $x$  and  $x/2$  respectively from a third charge of charge value  $4q$ , all charges being in the same straight line. Calculate the magnitude and nature of charge  $Q$ , such that the net force experienced by the charge  $q$  is zero.

**Question:** A charge  $Q$  is to be divided on two objects. What should be the values of the charges on the two objects so that the force between the objects can be maximum?

**Question:** Two identical spheres, having charges of opposite sign attract each other with a force of  $0.108\text{ N}$  when separated by  $0.5\text{ m}$ . The spheres are connected by a conducting wire, which then removed, and thereafter they repel each other with a force of  $0.036\text{ N}$ . What were the initial charges on the spheres?

**Question:** Two small spheres each having mass  $m\text{ kg}$  and charge  $q$  coulomb are suspended from a point by insulating threads each  $l$  metre long but of negligible mass. If  $\theta$  is the angle, each thread makes with the vertical when equilibrium has been attained, show that

$$q^2 = (4mgl^2 \sin^2 \theta) 4\pi\epsilon_0$$

**Question:** Obtain the dimensional formula of  $\epsilon_0$ .

**Question:** Calculate coulomb force between two  $\alpha$ -particles separated by a

distance of  $3.2 \times 10^{-15}$  m in air.

**Question:** Calculate the distance between two protons such that the electrical

repulsive force between them is equal to the weight of either.

**Question:** How far apart should the two electrons be, if the force each exerts on

the other is equal to the weight of the electron? Given that  $e = 1.6 \times 10^{-19} C$  and  $m_e = 9.1 \times 10^{-31} kg$ .

**Question:** A pith-ball A of mass  $9 \times 10^{-5} kg$  carries a charge of  $5 \mu C$ . What

must be the magnitude and sign of the charge on a pith-ball B held 2 cm directly above the pith-ball A, such that the pith-ball A remains stationary?

**Question:** Two identical metal spheres having equal and similar charges repel

each other with a force of 103 N when they are placed 10cm apart in a medium of dielectric constant 5. Determine the charge on each sphere.

**Question:** The distance between the electron and proton in hydrogen atom is

$5.3 \times 10^{-11} m$ . Determine the magnitude of the ratio of electrostatic and gravitational force between them.

Given  $m_e = 9.1 \times 10^{-31} kg$ ,  $m_p = 1.67 \times 10^{-27} kg$ ,  
 $e = 1.6 \times 10^{-19} C$  and  $G = 6.67 \times 10^{-11} Nm^2 kg^{-2}$ .

**Question:** Two identical metallic spheres, having unequal, opposite charges are

placed at a distance 0.90 m apart in air. After bringing them in contact with each other, they are again placed at the same distance apart. Now the force of repulsion between them is 0.025 N. Calculate the final charge on each of them.

**Question:** A small brass sphere having a positive charge of  $1.7 \times 10^{-8} \text{C}$  is

made to touch another sphere of the same radius having a negative charge of  $3.0 \times 10^{-9} \text{C}$ . Find the force between them when they are separated by a distance of 20 cm. What will be the force between them when they are immersed in an oil of dielectric constant 3 ?

**Question:** The sum of two point charges is  $7 \mu\text{C}$ . They repel each other with a

force of 1N when kept 30cm apart in free space. Calculate the value of each charge.

**Question:** Two point charges  $q_1 = 5 \times 10^{-6} \text{C}$  and  $q_2 = 3 \times 10^{-6} \text{C}$  are located

at positions (1m, 3m, 2m) and (3m, 5m, 1m) respectively. Find the forces  $\vec{F}_{12}$  and  $\vec{F}_{21}$  using vector form of Coulomb's law.

**Question:** Three equally charged small objects are placed as shown in Fig.

1.18. The object A exerts an electric force on object B equal to  $3.0 \times 10^{-6} \text{N}$ .



**Fig. 1.18**

- (i) What electric force does C exert on B?
- (ii) What is the net electric force on B?

**Question:** Two identical metallic spheres A and B, each carrying a charge  $q$ , repel each other with a force  $F$ . A third metallic sphere C of the same size, but uncharged, is successively made to touch the spheres A and B, and then removed away. What is the force of repulsion between A and B?

**Question:** Two point charges  $+9e$  and  $+e$  are kept at a distance  $a$  from each other. Where should we place a third charge  $q$  on the line joining the two charges so that it may be in equilibrium?

**Question:** Two point electric charges of values  $q$  and  $2q$  are kept at a distance  $d$  apart from each other in air. A third charge  $Q$  is to be kept along the same line in such a way that the net force acting on an  $q$  and  $2q$  is zero. Calculate the position of charge  $Q$  in terms of  $q$  and  $d$ .

**Question:** A charge  $q$  is placed at the center of the line joining two equal charges  $Q$ . Show that the system of three charges will be in equilibrium if  $q = -\frac{Q}{4}$ .

**Question:** Two pith-balls each weighing  $10^{-3}kg$  are suspended from the same

point by means of silk threads 0.5m long. On charging the balls equally, they are found to repel each other to a distance of 0.2m. Calculate the charge on each ball.

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