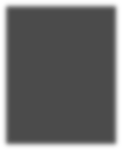
# **INDEX**

1. Certificate
2. Acknowledgement
3. Objective
4. Charles-Augustin de Coulomb
5. Coulomb’s Law
6. Theory
7. Materials required
8. Procedure
9. Observations
10. Calculations
11. Result
12. Precautions
13. Sources of error
14. Bibliography

**ESTIMATE THE CHARGE INDUCED ON EACH OF THE TWO IDENTICAL STYRO FOAM (OR PITH) BALLS SUSPENDED IN A VERTICAL PLANE BY MAKING USE OF COULOMB’S LAW**

***Charles-Augustin*** ***de*** ***Coulomb***



**Charles-Augustin de Coulomb** (14 June 1736 –

23 August 1806) was a French military engineer and physicist. He is best known for developing what is now known as Coulomb's law, the description of the electrostatic force of attraction and repulsion, but also did important work on friction.

The SI unit of electric charge, the coulomb, was named in his honour in 1908. In 1785, Coulomb presented his first three reports on Electricity and Magnetism.

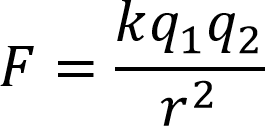
Coulomb describes "How to construct and use an electric balance (torsion balance) based on the property of the metal wires of having a reaction torsion force proportional to the torsion angle." Coulomb also experimentally determined the law that explains how "two bodies electrified of the same kind of Electricity exert on each other."

Coulomb explained the laws of attraction and repulsion between electric charges and magnetic poles, although he did not find any relationship between the two phenomena. He thought that the attraction and repulsion were due to different kinds of fluids.

## Coulomb’s Law

Coulomb's law, or Coulomb's inverse-square law, is a law of physics for quantifying Coulomb's force, or electrostatic force. Electrostatic force is the amount of force with which stationary, electrically charged particles either repel, or attract each other. This force and the law for quantifying it, represent one of the most basic forms of force used in the physical sciences, and were an essential basis to the study and development of the theory and field of classical electromagnetism. The law was first published in 1785 by French physicist Charles-Augustin de Coulomb.

In its scalar form, the law is:



where k is Coulomb's constant (k ≈ 9×109 N m2 C-2), q1 and q2 are the signed magnitudes of the charges, and the scalar r is the distance between the charges. The force of the interaction between the charges is attractive if the charges have opposite signs (i.e., F is negative) and repulsive if like-signed (i.e., F is positive).

Being an inverse-square law, the law is analogous to Isaac Newton's inverse-square law of universal gravitation. Coulomb's law can be used to derive Gauss's law, and vice versa. The law has been tested extensively, and all observations have upheld the laws of Newton.

OBJECTIVE:-

To estimate the charge induced on each of the two identical styrofoam (or pith) balls suspended in a vertical plane by making use of Coulomb’s law.

## MATERIALS REQUIRED:-

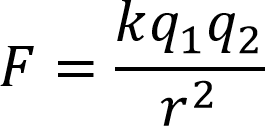
* Small size identical styrofoam balls
* Physical balance or electronic balance
* Meter Scale
* Teflon thread
* Stand
* Glass rod (or plastic rod)
* Silk cloth (or wool cloth)

## THEORY:-

The fundamental concept in electrostatics is electrical charge. We are all familiar with the fact that rubbing two materials together — for example, a rubber comb on cat fur — produces a “static” charge. This process is called charging by friction. Surprisingly, the exact physics of the process of charging by friction is poorly understood. However, it is known that the making and breaking of contact between the two materials transfers the charge.

The charged particles which make up the universe come in three kinds: positive, negative, and neutral. Neutral particles do not interact with electrical forces. Charged particles exert electrical and magnetic forces on one another, but if the charges

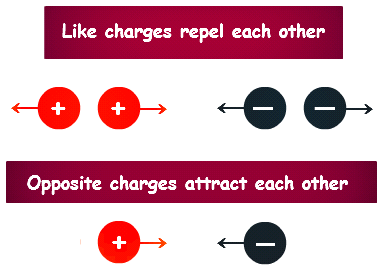
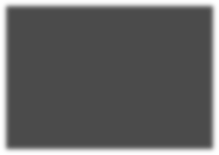
are stationary, the mutual force is very simple in form and is given by Coulomb's Law:



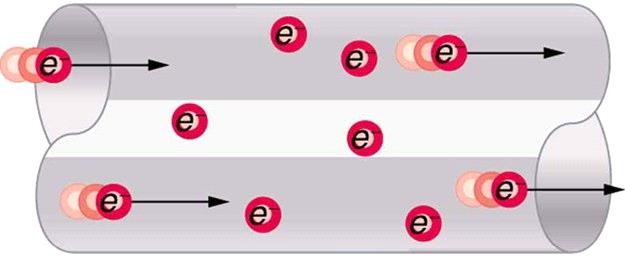
where F is the electrical force between any two stationary charged particles with charges q2 and q2(measured in coulombs), r is the separation between the charges (measured in meters), and k is a constant of nature (equal to 9×109 Nm2/C2 in SI units).

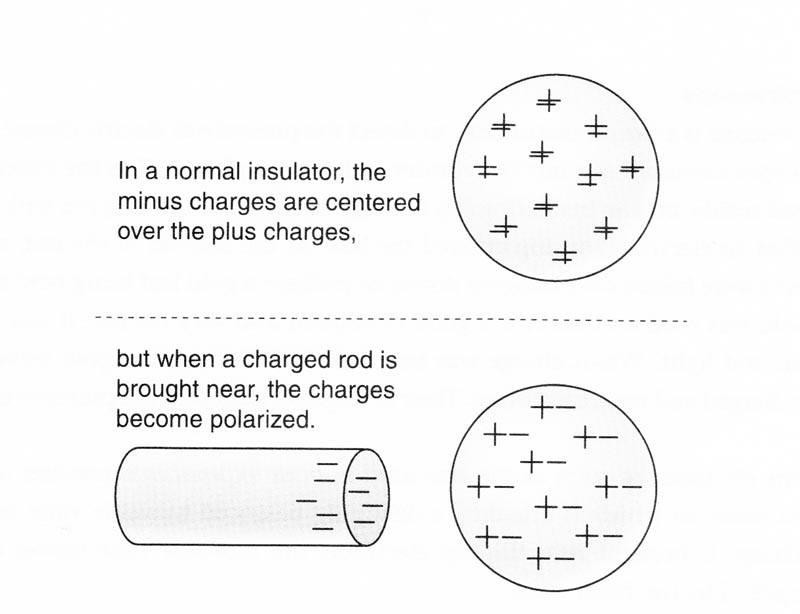
The study of the Coulomb forces among arrangements of stationary charged particles is called electrostatics. Coulomb's Law describes three properties of the electrical force:

* The force is inversely proportional to the square of the distance between the charges, and is directed along the straight line that connects their centers.
* The force is proportional to the product of the magnitude of the charges.
* Two particles of the same charge exert a repulsive force on each other, and two particles of opposite charge exert an attractive force on each other.



Most of the common objects we deal with in the macroscopic (human-sized) world are electrically neutral. They are composed of atoms that consist of negatively charged electrons moving in quantum motion around a positively charged nucleus. The total negative charge of the electrons is normally exactly equal to the total positive charge of the nuclei, so the atoms (and therefore the entire object) have no net electrical charge. When we charge a material by friction, we are transferring some of the electrons from one material to another.



Materials such as metals are conductors. Each metal atom contributes one or two electrons that can move relatively freely through the material. A conductor will carry an electrical current. Other materials such as glass are insulators. Their electrons are bound tightly and cannot move. Charge sticks on an insulator, but does not move freely through it.

A neutral particle is not affected by electrical forces.

Nevertheless, a charged object will attract a neutral macroscopic object by the process of electrical polarization. For example, if a negatively charged rod is

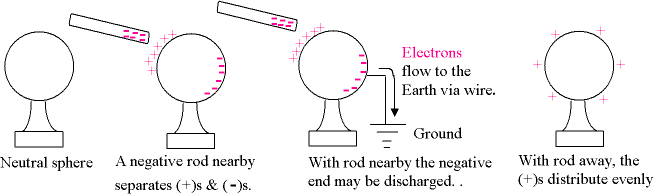
brought close to an isolated, neutral insulator, the electrons in the atoms of the insulator will be pushed slightly away from the

negative rod, and the positive nuclei will be attracted slightly toward the negative rod. We say that the rod

has induced polarization in the insulator, but its net charge is still zero.

The polarization of charge in the insulator is small, but now it’s positive charge is a bit closer to the negative rod, and its negative charge is a bit farther away. Thus, the positive charge is attracted to the rod more strongly than the negative charge is repelled, and there is an overall net attraction.

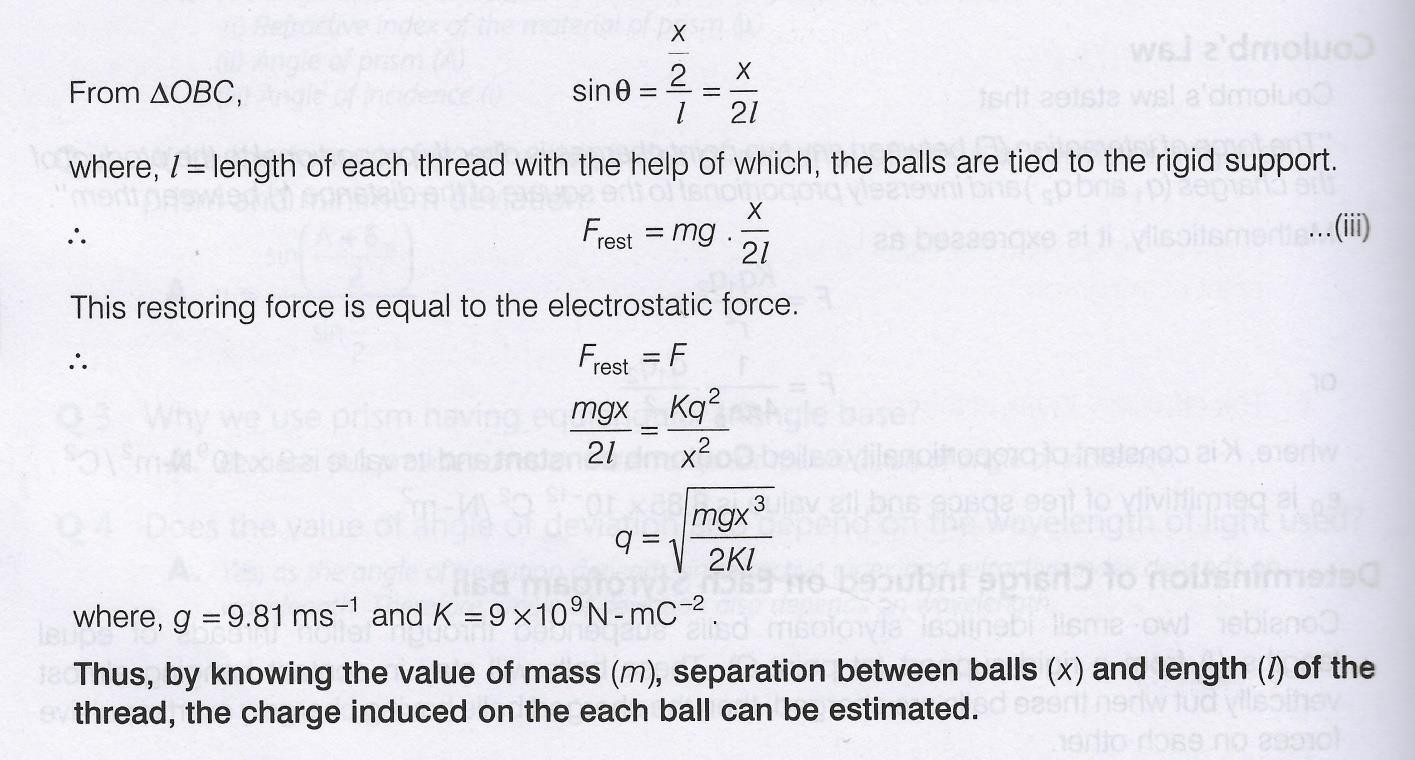
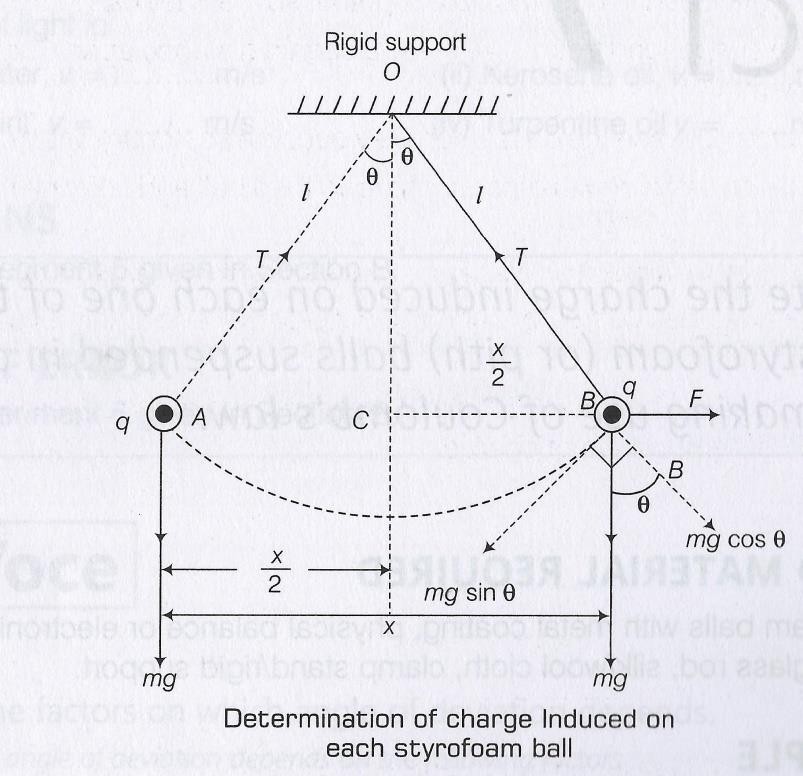
If the negative rod is brought near an isolated, neutral conductor, the conductor will also be polarized. In the conductor, electrons are free to move through the material, and some of them are repelled over to the opposite surface of the conductor, leaving the surface near the negative rod with a net positive charge. The conductor has been polarized, and will now be attracted to the charged rod.



Now if we connect a conducting wire or any other conducting material from the polarized conductor to the ground, we provide a “path” through which the electrons can move. Electrons will actually move along this path to the ground. If the wire or path is subsequently disconnected, the conductor as a whole is left with a net positive charge. The conductor has been charged without

actually being touched with the charged rod, and its charge is opposite that of the rod. This procedure is called charging by induction.

Let the force between two stationary charges be F.



## **PROCEDURE:-**

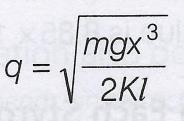
* Weight the mass of each identical pith balls by balance and note down it.
* Tie the balls with two silk or cotton threads and suspend at a point on a stand or a rigid support. Measure the length of threads by meter scale. The length of threads should be equal. Note down the length.
* Rub the glass rod with silk cloth and touch with both balls together so that the balls acquired equal charge.
* Suspend the balls freely and the balls stay away a certain distance between the balls when they become stationary. Note down the distance.
* Touch any one suspended ball with other uncharged third ball and takes the third ball away and repeat the step 4.
* Touch other suspended ball with other uncharged fourth ball and takes the fourth ball away and repeat the step 4.

## OBSERVATION:-

|  |  |  |
| --- | --- | --- |
| * Mass of each ball, (m) | = | g. |
| * Radius of each ball, (r) | = | mm. |
| * Length of each thread, (l) | = | cm. |

Calculations:-

By using the relation



Calculate the charge in each case.

|  |  |  |  |
| --- | --- | --- | --- |
| **S.NO** | **CHARGE ON BALL A ()** | **CHARGE ON BALL B**  **()** | **DISTANCE BETWEEN THE BALLS**  **(x cm)** |
| **1.** |  |  |  |
| **2.** |  |  |  |
| **3.** |  |  |  |
| **4.** |  |  |  |

## RESULTS:-

The charge on each ball = C

## PRECAUTIONS:-

* The suspended balls should not be touched by any conducting body.
* Rub the glass rod properly with the silk cloth to produce more charge.
* Weight the mass of the balls accurately.

## SOURCES OF ERROR:-

* The balls may not be of equal size and mass.
* The distance between the balls may be measured accurately.

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* Cortana