12^{th} CBSE

PHYSICS PROJECT

SHREE SKANDA CENTRAL SCHOOL

SUBMITTED BY:

ANJAN.R

CERTIFICATE

This is to certify that the PHYSICS project titled "Electromagnetic Induction" has been successfully completed by Anjan.R of class XII,Shree Skanda Central School, in the partial fulfillment by Central Board Of Secondary Education (CBSE) leading to the award of the annual examination of the year 2014 -2015

INTERNAL EXAMINER EXTERNAL EXAMINER

ACKNOWLEDGEMENT

" There are times when silence speak so much more louder

than words of praise to only as good as belittle a person,

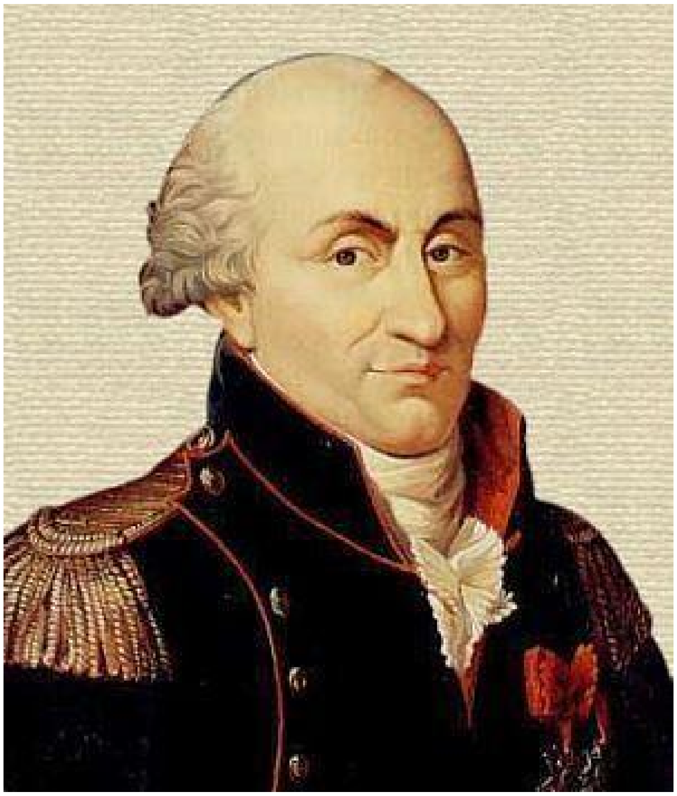
whosewords do not express, but only put a veneer

over true feelings, which are of gratitude at this point of time."

I would like to express my sincere gratitude to my physics mentor for his vital support, guidance and encouragement, without which this project would not have come forth. I would also like to express my gratitude to the OTHER staff of the Department of Physics for their support during the making of this project.

TO ESTIMATE THE CHARGE INDUCED ON EACH OF THE TWO IDENTICAL STRYO FOAM (OR PITH) BALLS SUSPENDED IN A VERTICAL PLANE BY

MAKING USE OF COULOMB'S LAW



Coulomb

Coulomb graduated in November 1761 from École royale du génie de Mézières. Over the next twenty years he was posted to a variety of locations where he was involved in engineering - structural, fortifications, soil mechanics, as well as other fields of engineering. His first posting was to Brest but in February 1764 he was sent to Martinique, in the West Indies, where he was put in charge of building the new Fort Bourbon and this task occupied him until June 1772.

On his return to France, Coulomb was sent to Bouchain. However, he now began to write important works on applied mechanics and he presented his first work to the Académie des Sciences in Paris in 1773. In 1779 Coulomb was sent to Rochefort to collaborate with the Marquis de Montalembert in constructing a fort made entirely from wood near Ile d'Aix. During his period at Rochefort, Coulomb carried on his research into mechanics, in particular using the shipyards in Rochefort as laboratories for his experiments.

Upon his return to France, with the rank of Captain, he was employed at La Rochelle, the Isle of Aix and Cherbourg. He discovered an inverse relationship of the force betweenelectric charges and the square of its distance, later named after him as Coulomb's law.

COULOMB'S LAW

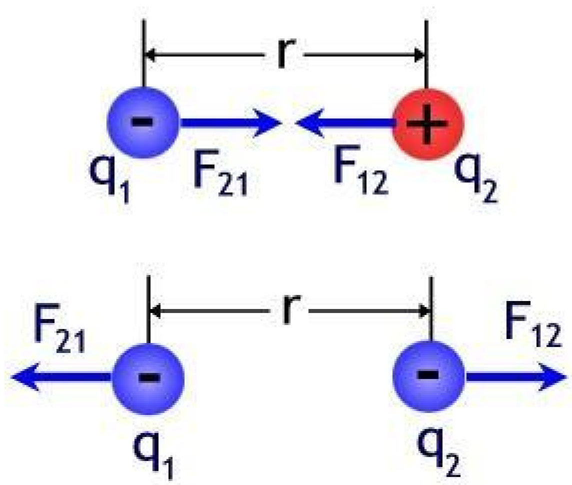
In 1785 Augustine de Coulomb investigated the attractive and repulsive forces between charged objects, experimentally formulating what is now referred to as Coulomb's Law: "The magnitude of the electric force that a particle exerts on another is directly proportional to the product of their charges and inversely proportional to the square of the distance between them." Mathematically, this electrostatic F acting on two charged particles (q1, q2) is expressed as

$$F = k\frac{q_1 q_2}{r^2}$$

where r is the separation distance between the objects and k is a constant of proportionality, called the Coulomb constant, **k = 9.0 × 109 N · m2/C2.** This formula gives us the magnitude of the force as well as direction by noting a positive force as attractive and a negative force as repulsive. Noting that like charges repel each other and opposite charges attracting each other, Coulomb measured the force between the objects, small metal coated balls, by using a torsion balance similar to the balance used to measure gravitational forces.

OBJECTIVE:-

To 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.



MATERIALS REQUIRED:-

- Small size identical balls (pitch or soft plastic)
- Physical balance or electronic balance
- Halfmeter Scale

- Cotton thread
- Stand
- Glass rod (or plastic rod)
- Silk cloth (or wollen 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:

$$F = k \frac{q_1 q_2}{r^2}$$

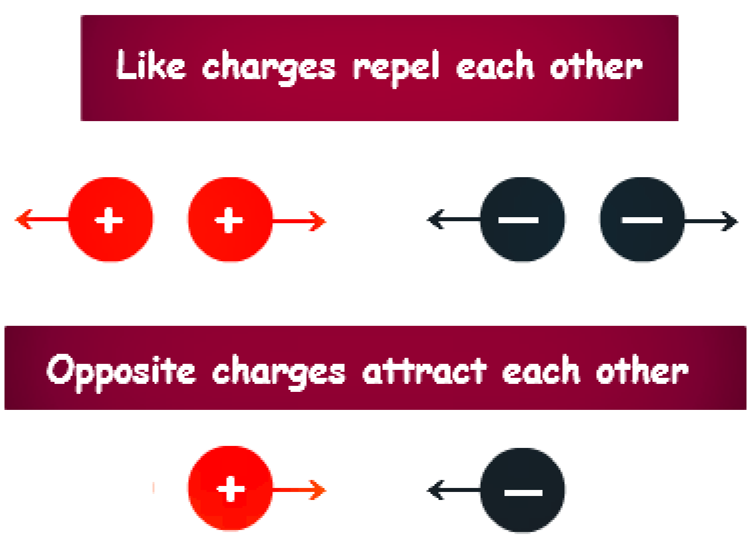
where F is the electrical force between any two stationary charged particles with charges q1 and q2(measured in coulombs), r is the separation between the charges (measured in meters), and k is a constant of nature (equal to 9×10^9 Nm^2/C^2 in SI units).

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:

1. 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.

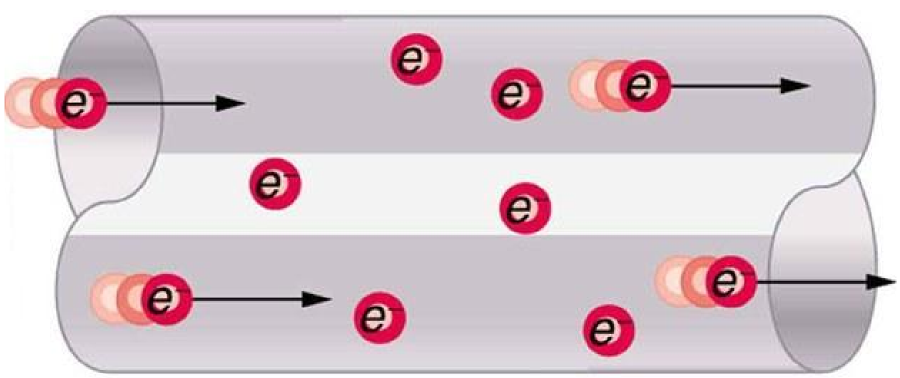
2. The force is proportional to the product of the magnitude of the charges.

3. 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.

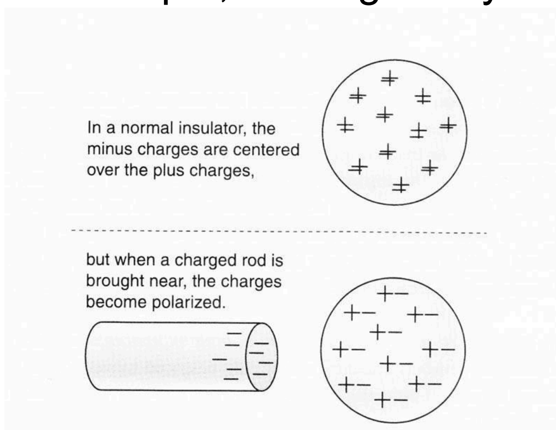


Most of the common objects we deal with in the macroscopic (human-sized) world are electrically neutral. They are composed of atoms that consist of negatively charged electrons moving in quantum motion around a positively charged nucleus. The total negative charge of the electrons is normally exactly 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.



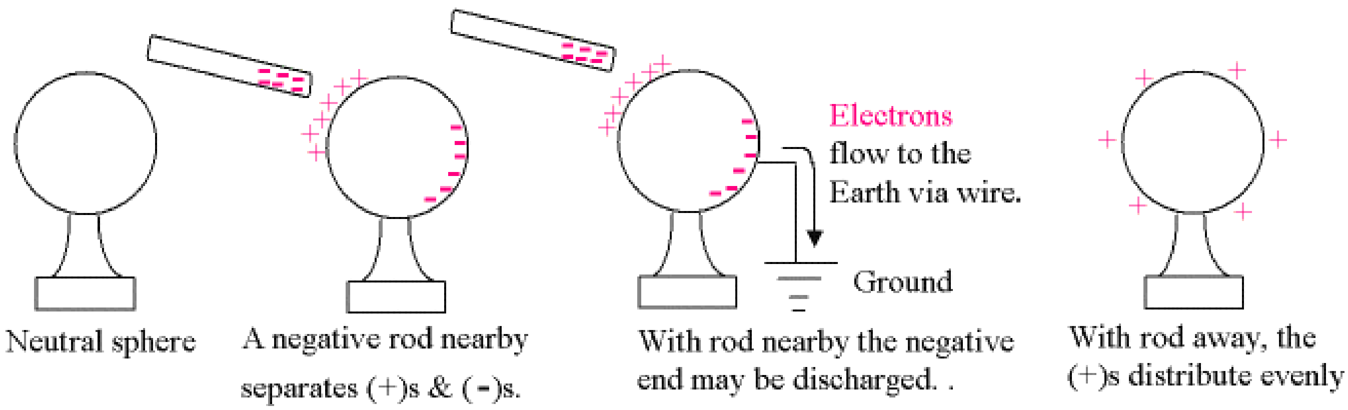
A neutral particle is not affected by electrical forces. Nevertheless, a charged object will attract a neutral macroscopic object by the process of electrical polarization. For example, if a negatively charged rod is brought close to an isolated, neutral insulator, the electrons in the atoms of the insulator 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.

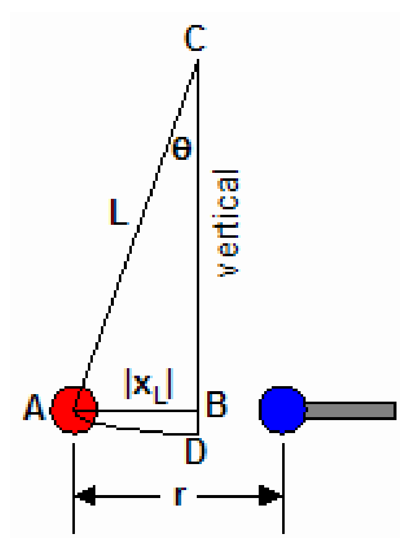
Now if we connect a conducting wire or any other conducting material from the polarized conductor to the ground, we provide a "path" through which the electrons can move. Electrons will actually move along this path to the ground. If the wire or path is subsequently disconnected, the conductor as a whole 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

$$F = k\frac{q_1 q_2}{r^2}$$



The Weight of the ball

W=mg

The restoring force on each ball

=mgsin $sin\,\theta$

From the diagram in the right

In triangle ACB

$\sin sin\ \theta = \frac{x}{2l}$

Let the charge on each ball is

q1=q2=q

Then at equlilibrium

mg$\sin sin\ \theta = \frac{kq \times q}{x^2}$

$= mg\frac{x}{2l} = \frac{kq^2}{x^2}$

- ⇨ g= $\frac{mgx^3}{2lk}$

PROCEDURE:-

1) Weight the mass of each identical pitch balls by balance and note down it.
2) 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 half meter scale. The length of threads should be equal. Note down the length.
3) Rub the glass rod with silk cloth and touch with both balls together so that the balls acquired equal charge.
4) Suspend the balls freely and the balls stay away a certain distance between the balls when they become stationary. Note down the distance.

5) Touch any one suspended ball with other uncharged third ball and takes the third ball away and repeat the step 4.
6) Touch other suspended ball with other uncharged fourth ball and takes the fourth ball away and repeat the step 4.

OBSERVATION:-

1. Mass of each ball,(m) = _____g.
2. Radius of each ball,(r) = _____mm.
3. Length of each thread,(l) = _____cm.

S.NO	CHARGE ON BALL A (q_1)	CHARGE ON BALL B (q_2)	DISTANCE BETWEEN THE BALLS (x cm)
1.			
2.			
3.			
4.			

Calculations:-

By using the relation

$$g= \left[\frac{mgx^3}{2lk}\right]^{1/2}$$

Calculate the charge in each case:

RESULTS:-

The charge on each ball = _______C

PRECAUTIONS:-

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

SOURCE OF ERROR:-

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