# Coulomb's law, force between two point charges
## CLASS-XII

**SUBJECT : PHYSICS**
**CHAPTER NUMBER: 01**
**CHAPTER NAME : ELECTRIC CHARGES AND FIELDS**

# LEARNING OUTCOME

- To use Coulomb's Law equation to make predictions of the effect of alteration in the quantity of charge or the separation distance upon the amount of electrostatic force.

- To use Coulomb's Law equation to algebraically solve for an unknown quantity (F, d, $Q_1$ or $Q_2$) in a physics word problem.

- To combine Coulomb's Law equation with Newton's second law, also verify third law of motion, free-body diagrams and trigonometric functions to analyse physical situations that include interacting charges.

- Students use Coulomb's Law and compare the electric force to the gravitational force between two protons.

- To have a big Idea that : the electric force is many trillions of times stronger than the gravitational force.

# REVIEW

- What are the various kinds of charges you experience in day to day life?

- In which case two charges attract or repel each other?

- When glass rod is rubbed with silk then which one is positive and negative?

- What is the value of one electronic charge?
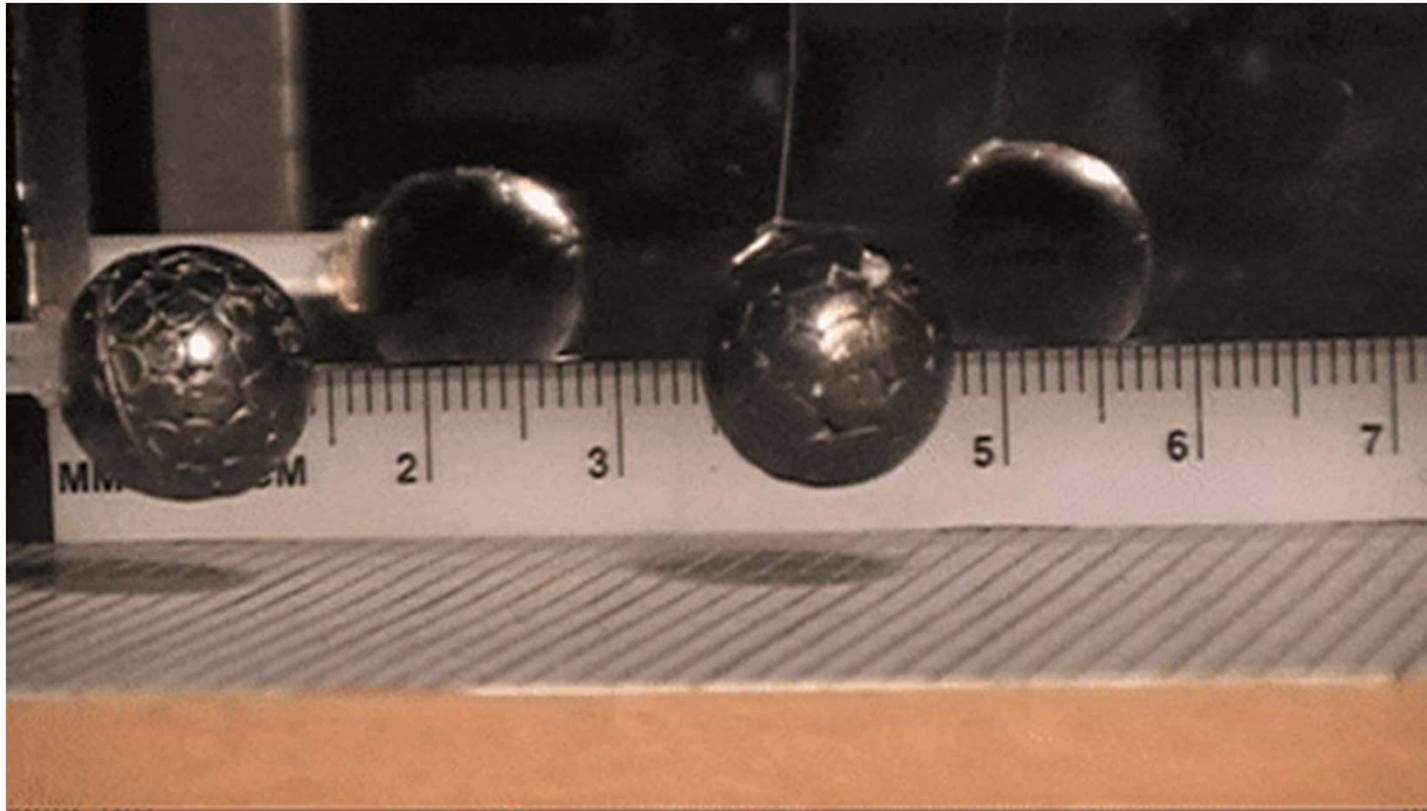
- What are charges in compound like HCl?

# INTRODUCTION

1. Why is the water being attracted towards balloon?

# INTRODUCTION

- Why did the second pith ball move away on bringing the first ball nearer to it?
- What is the relationship between the force and masses of the ball?
- What is the relationship between the force and the separation distance between the balls?
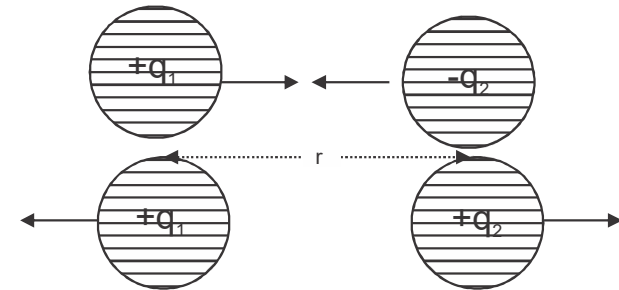
# COULOMB'S LAW

➤ The magnitude of the force of interaction between two point charges is directly proportional to the product of their charges and inversely proportional to the square of the distance of separation between them

$F \propto |q_1 q_2|$    and       $F \propto \frac{1}{r^2}$

$\therefore F \propto |\frac{q_1 q_2}{r^2}|$

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

k is called Coulomb's constant/ electrostatic constant.

# COULOMB'S LAW

Value of k depends upon:-

(a) System of unit(b) Medium in between the charged particles

In S.I system (medium air/ vacuum) $k = \dfrac{1}{4\pi \in_0} = \dfrac{1}{4\pi\left(8.85\times10^{-12}\right)} = 9\times10^9\,\text{Nm}^2\,/\,\text{C}^2$

Here, $\in_0$ is called the permittivity of free space. (It represents the response of free space for interaction of charges)

➤ Relative Permittivity/ Dielectric Constant:- $\varepsilon_r$ or $K = \dfrac{\varepsilon\left(\text{permitivity of medium}\right)}{\varepsilon_0\left(\text{permitivity of free space}\right)}$

**Note:-** It is a unitless and dimensional less quantity

# POINTS TO REMEMBER

**1** Force between two charged body when placed in the vacuum $F_0 = \dfrac{1}{4\pi\varepsilon_0} \dfrac{|q_1 q_2|}{r^2}$

**2** Force between two charged body when placed in a medium $F_m = \dfrac{1}{4\pi\varepsilon} \dfrac{|q_1 q_2|}{r^2}$

**3** If a dielectric is inserted in the space between the charges, the force between them, $\dfrac{F_0}{F_m} = \dfrac{\varepsilon}{\varepsilon_0} = \varepsilon_r$ or $K$

**4** If the dielectric is inserted in some part of the space: $F = \dfrac{F_0}{\varepsilon_r}$ Since, $\varepsilon_r > 1$ ( except vacuum),
so $F < F_0$ (i.e force between them decrease)

**5** If the dielectric is inserted in some part of the space: $F = \dfrac{1}{4\pi\varepsilon_0} \dfrac{|q_1 q_2|}{\left[\sqrt{k}t + (r-t)\right]^2}$

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# DI-ELECTRIC CONSTANT

| MEDIUM | DIELECTRIC CONSTANT |
|---|---|
| • Free space | |
| • Air | • 1 |
| • Water | • 1.00546 |
| • Metal | • 8.0 |
| | • ∞ |

# QUESTIONS

1.  Define 1 coulomb of charge from coulomb's law.

2.  Prove that Coulomb's law agrees with newton third law of motion

# HOME ASSIGNMENT

1. What happens to the force between two charges if one of the charges gets bigger?

2. What happens to the force between two charges when they are brought closer together?

3. Define I C of charge from Coulomb's Law.

4. Find out the force of interaction between two particles in air or vacuum at a distance of 1m.

5. How far apart the electrons are if the force exerted by one upon another is equal to the weight of the electron?

6. What is the force between two small charged spheres having charges of $2 \times 10^{-7} C$ and

   $3 \times 10^{-7} C$ and placed 30 cm apart in the air

# THANKING YOU
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