

SUBJECT: PHYSICS

TOPIC: ELECTRIC FIELD AND CHARGES

Pre-Content/content Post-Content	Learning outcomes/Objectives	
<u>PRE-CONTENT:</u>	General	Specific
properties of charges& concept of frictional electricity learnt by students in lower classes Q1Why does a balloon stick to wall on being rubbed with dry hair? Q2Why do bits of paper stick to a plastic comb on being rubbed with dry hair? <u>CONTENT</u> • Electric charge Frictional electricity,charge,electrostatics Kinds of charges , ,conductors and insulators, electrostatic induction, basic properties of charge, electric charge versus mass, Coulombs law in vector form,,dielectric constant,electrostatic force versus gravitational force, Principle of superposition • Electric field & Field lines - Electric field due to- a point charge-system of charges - Electric field lines ,electric field lines for different charged conductors Continuous charge distribution • Electric dipole Electric dipole and dipole field at axial and equatorial point	Students will be able to: • list various features of charges • differentiate Charging by friction, conduction,and induction • State and explain Various Laws of Electrostatics • conceptualize Electrostatic Field &field lines • comprehend Electric dipole and its various features	Students will be able to: • recall that bodies having same kind of charge repel each other while those having opposite kinds of charge attract each other. • differentiate between Charging by friction, conduction, induction • explain quantization of charge(the discrete nature), for an isolated system the net charge always remains conserved. Charge is additive, charge is scalar • compare and contrast charge with mass • State Coulomb's law in electrostatics and compare with the Newton's law of gravitation. • express Coulomb's law in vector form in SI system. • State the Principle of superposition and apply it for calculating force on a given charge due to other charges in its vicinity • explain electric field and its significance and its unit. • define, list and explain properties of electric lines of force • derive electric field intensity at a point due to a point charge, for a system of charges distributed discretely and continuous charge distribution. • explain an electric dipole and define its dipole moment . • compute electric field at axial and its equatorial line

Teacher's Activity	Student's Activity	Teacher's observation and Remedial
Teacher will - enable students to recall various properties of charges learnt by them in lower classes. They will be introduced to other properties-quantization of charge, for an isolated system the net charge always remains constant. Charge is additive and scalar. -enable students to compare and contrast charge with mass - conduct activities to enable students differentiate between Charging by friction, conduction, induction(<u>Annexure1A,1B</u>) (ATTACHED AT THE END) - explain Coulomb's law of electrostatics and Principle of superposition by giving various illustrations and using ICR. - explain concept of electrostatic Field, field lines and their significance and properties through PPT comprising of animations - enable students to define dipole and derive its field at axial and equatorial point of a dipole	Students will - recall various properties of charges learnt by them in lower classes and will get introduced to other properties-quantization of charge, and for an isolated system, the net charge always remains constant. Charge is additive and scalar by nature. - list differences and similarities between charge and mass - perform activities to figure out difference between Charging by friction, Induction and conduction - draw an analogy of Coulombs Law with Universal law of Gravitation and solve numerical on Coulomb's law and Principle of superposition - realise concept of electrostatic Field, field lines and their significance and properties and draw field lines for various charge configurations - derive an expression for field due to dipole at axial and equatorial point and solve related numerical problems	

Pre-Content/content Post-Content	Learning outcomes/Objectives	
	General	Specific
Torque on a dipole and its PE in uniform electric field, Dipole in non uniform field Area Vector , Electric flux, Gauss's theorem and Gaussian surface, Coulomb's law from Gauss's law Applications of Gauss's theorem -electric field due to infinitely long straight wire, uniformly charged infinite plane charged sheet , uniformly charged thin spherical shell (field inside and outside), non-conducting solid charged sphere (field inside and outside) <u>Post Content</u> Practical application of electrostatic shielding	Students will be able to: derive various expressions for a dipole state, explain and apply Gauss's Theorem	Students will be able to: derive the expression of torque on a dipole and its PE in uniform electric field in terms of the dipole moment vector p and the electric field vector E. represent area in vector form of area define and illustrate electric flux. State and prove Gauss's theorem for electrostatics for regular and irregular surfaces using the concept of solid angle. apply Gauss's theorem to calculate electric field due to infinitely long line charge, uniformly charged infinite plane sheet and uniformly charged thin spherical shell (field inside and outside), non-conducting solid charged sphere and interpret the dependence electric field on distance in each case i.e. for an infinite plane sheet of charge E varies as $1/r$, and for a charged sheet it is independent of the distance from the sheet, for a uniformly charged thin spherical shell it varies as $1/r^2$ outside the shell and is zero inside the shell, for a uniformly charged non conducting solid sphere it varies as $1/r^2$ outside the sphere and is non zero inside it 3/10

Teacher's Activity	Student's Activity	Teacher's observation and Remedial
Teacher will • guide students to derive expression for torque on a dipole and its PE in uniform electric field • enable students to comprehend the need for calling Area a vector quantity and explain the concept of electric flux by taking example of stream of water flowing through a ring held in different orientations • explain Gauss's Theorem and its applications using ICR technique and discussion method • prepare and guide students to solve assignment consisting of a variety of direct, conceptual, numerical and previous years' board problems. (Annexure1C,1D)	Students will • derive expressions of torque on a dipole and its PE in uniform electric field and identify the conditions of stable and unstable equilibrium by solving related numerical problems • conceptualise Area vector and electric flux. • will derive other applications of Gauss's Theorem on their own after few being explained by teacher • solve the NCERT in text questions and back exercise, will also solve the assignment consisting of a variety of direct, conceptual, numerical and previous years' board problems.	

- **TEACHING AIDS:** Textbooks, smart board, ICR, tools in Physics lab
- **METHODOLOGY/ INNOVATIVE METHODS:** Activity based teaching, discussion method, Experimentation
- **INTERDISCIPLINARY LINKS** Concept of free and bound electrons as learnt in chemistry to explain frictional electricity, Mathematics-solving numericals, conversion of units

Subject	PHYSICS
Class	XII
Chapter/Unit	Electrostatics
Topic	Electrostatic Induction--(charging from a distance)
Time	10 min
Nature of Activity	Individual

What will I learn (Learning Outcome)?

The phenomenon of charging by induction

Skills:

Experimenting, observing and analyzing

What I have to do?

To perform an activity to practically realize the phenomenon of induction

What do I require?

A piece of thermocol to serve the purpose of base for holding two circular pieces of aluminum foil vertically fixed on it, two circular pieces of aluminum foil ,PVC rod, silk cloth piece, A small empty cardboard box

What do I need to know?

The concept of electrostatic induction

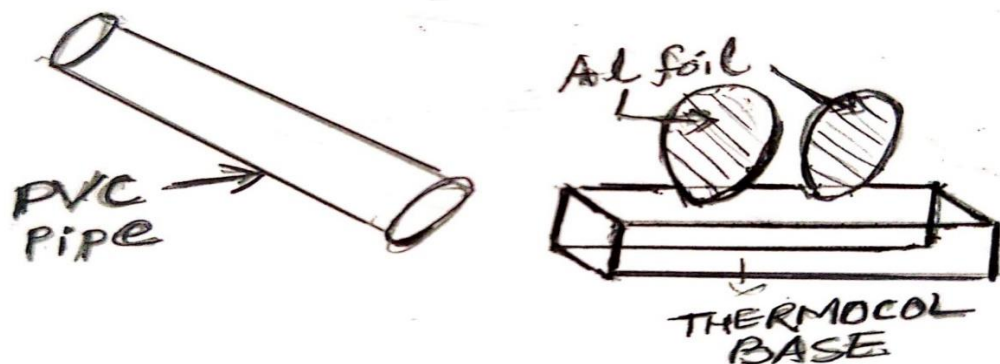
➤ Teacher's Activity Teacher will

- enable students to recall the process of charging by induction
- Teacher will facilitate students to perform a simple activity to make them understand the process of induction

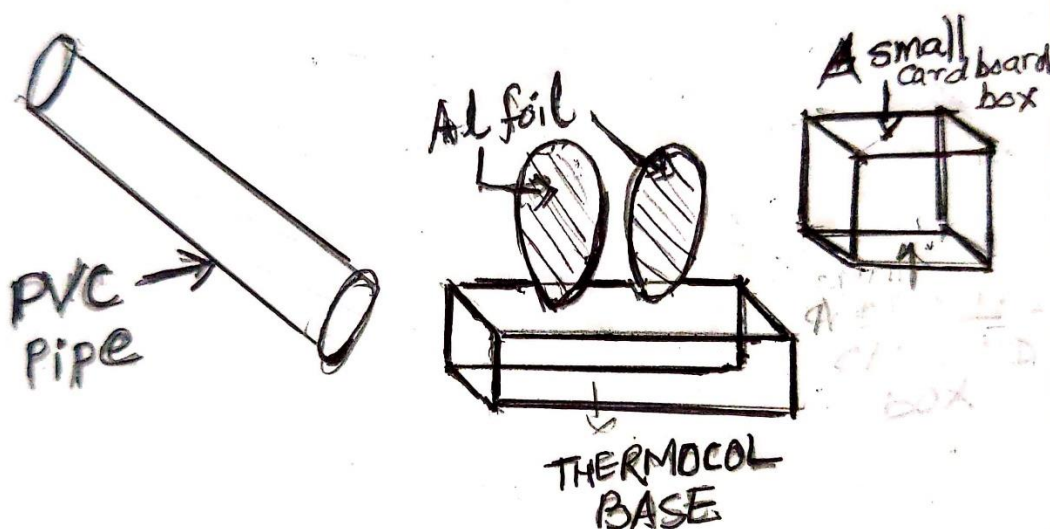
How will I proceed?**➤ Student's Activity**

Student will

- Fix two circular cutouts of aluminum foil namely A and B vertically parallel to each other on the thermocol base such that they are free to move to and fro about their vertical axis(Note – the aluminum foil cutout which is lying closer to PVC pipe is A, and the one which is farther from the PVC pipe is B)
- Bring a PVC rod rubbed with hair/silk cloth near A and observe A and B carefully



- Keep the small cardboard box behind B and again bring a PVC rod rubbed with hair/silk cloth piece near A and observe A and B



What have I observed?

	When PVC rod rubbed with hair is brought near A	When PVC rod rubbed with hair is brought near A and a small cardboard box is placed behind B
A and B remain stationary/move apart/ move closer		
side of A facing PVC pipe	----- (remains neutral/attains charge opposite to PVC pipe/ attains charge similar to PVC pipe)	----- (remains neutral/attains charge opposite to PVC pipe/ attains charge similar to PVC pipe)
side of A facing	----- (remains neutral/attains	----- (remains neutral/attains

away from PVC pipe	charge opposite to PVC pipe/ attains charge similar to PVC pipe	charge opposite to PVC pipe/ attains charge similar to PVC pipe
side of B facing A	----- (remains neutral/ attains charge opposite to charge on the side of A facing B/ attains charge similar to charge on the side of A facing B)	----- (remains neutral/ attains charge opposite to charge on the side of A facing B/ attains charge similar to charge on the side of A facing B)
side of B facing away from A	----- (remains neutral/ attains charge opposite to charge on the side of A facing B/ attains charge similar to charge on the side of A facing B)	----- (remains neutral/ attains charge opposite to charge on the side of A facing B/ attains charge similar to charge on the side of A facing B)
side of box facing B	N/A	----- (remains neutral/ attains charge opposite to the face of B facing the box/ attains charge similar to the face of B facing the box)
side of box facing away from B	N/A	----- (remains neutral/ attains charge opposite to the face of B facing the box/ attains charge similar to the face of B facing the box)

PVC pipe gets charged on rubbing with silk piece because of----- (induction/friction)

What have I learnt?

----- (Induction/conduction) is the process of temporarily electrifying a conductor in which ----- (Similar/opposite) charges appear at its closer end and ----- (Similar/opposite) charges at its farther end in the presence of a nearby charged body.

What am I curious to learn?

An inflated balloon is charged by rubbing with fur, will it stick readily to a conducting wall or an insulating wall? Give reason

Let me evaluate myself

Q1 Define electrostatic induction Briefly explain how an insulated metal sphere can be positively charged by induction

Q2 A charged rod attracts bits of dry cork which after touching the rod, often jump away from it violently. Why?

Q3 A positive charge (+Q) is kept in the vicinity of an uncharged conducting plate. Sketch electric field lines originating from the point charge on to the surface of the plate

Q4 Two metal plates tightly held against each other and placed between two equal and unlike point charges perpendicular to the line joining them.

(i) What will happen to the plates when they are released?

(ii) Draw the pattern of electric field lines for the system.

Q5 A glass rod held in hand can be charged by rubbing with silk but a copper rod cannot be charged like this. Why?

(Annexure1B) ACTIVITY (Electrostatic Induction Versus Conduction)

Subject	PHYSICS
Class	XII
Chapter/Unit	Electrostatics
Topic	Electrostatic Induction Versus Conduction
Time	10 min
Nature of Activity	Individual

What will I learn (Learning Outcome)?

The phenomenon of charging by induction and conduction

Skills:

Experimenting, observing and analyzing

What I have to do?

To perform an activity to differentiate between charging by induction and conduction

What do I require?

A wooden meter scale, a convex lens, drinking pipe, silk cloth piece

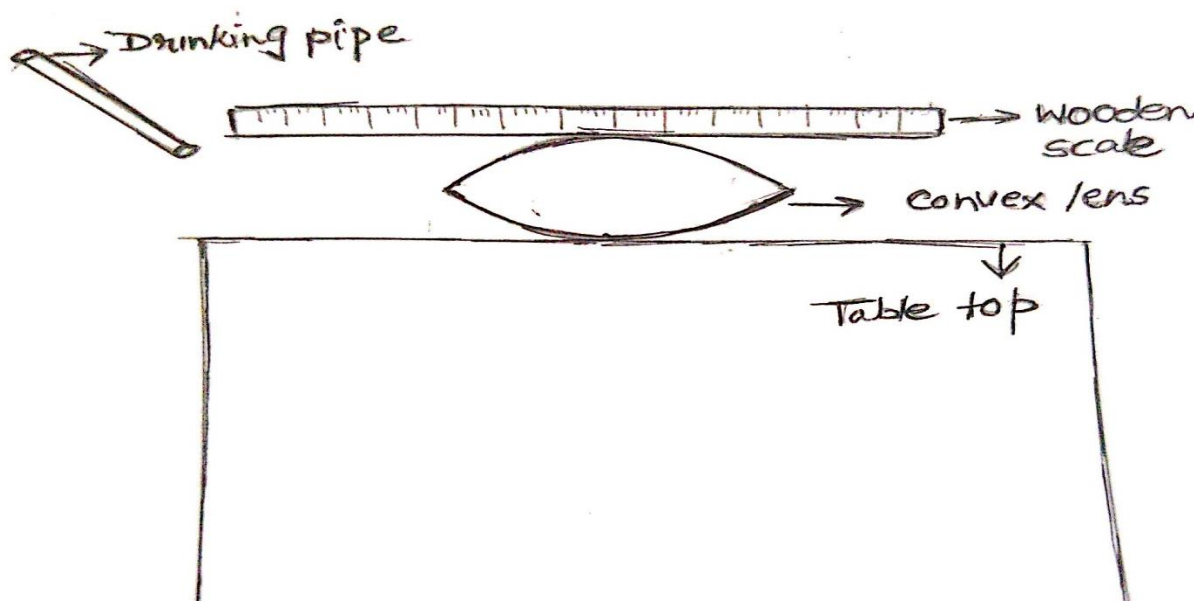
What do I need to know?

The process of electrostatic induction and conduction

➤ **Teacher's Activity**

Teacher will

- enable students recall the process of charging by induction and conduction
- facilitate students to perform a simple activity to enable them to differentiate between the process of induction and conduction



How will I proceed?

➤ Student's Activity

Student will

- Place a convex lens on a table
- Place the wooden scale on convex lens such that its center lies on the lens and its ends do not touch the table and can freely rotate about its vertical axis passing through the lens
- Rub drinking pipe with silk cloth and bring it near one of the ends of the scale, observe the motion of scale ensuring that while the scale moves small gap is maintained between drinking pipe and the end of the scale by moving it.
- Now repeat the above step by touching the drinking pipe for a moment with one of the ends of the scale

What have I observed?

S. No.	Drinking pipe rubbed with a piece of silk and brought near one of the ends of the scale placed on a convex lens with its center lying on the scale	Drinking pipe rubbed with a piece of silk and touched for a moment with one of the ends of the scale, placed on a convex lens with its center lying on the scale
Motion of scale	Scale is----- (attracted towards/repelled by) the drinking pipe while rotating about its vertical axis passing through the lens	Scale is----- (attracted towards/repelled by) the drinking pipe while rotating about its vertical axis passing through the lens
Charge on the end of the scale and end of drinking pipe facing each other	----- (Similar/opposite)	----- (Similar/opposite)
Process involved	----- (Induction/ conduction)	----- (Induction/ conduction)

In this activity PVC pipe is being charged by rubbing it with silk piece by the process of charging by----- (induction/friction)

What have I learnt?

----- (Induction/conduction) is the process of temporarily electrifying a conductor in which ----- (Similar/opposite) charges appear at its closer end and ----- (Similar/opposite) charges appear at farther end in the presence of a nearby charged body. whereas conduction is transfer of charge **9/10** from one object at----- (higher/lower) potential to another at ----- (higher/lower) potential, when in physical contact with each other

What am I curious to learn?

To analyze the motion of scale in the above activity if the drinking pipe is brought near the scale at some point closer to its center instead of its edge as done in the above activity (Does the scale move with the same ease as it was moving in the above mentioned activity?)

Hint- Concept of torque learnt in class 11

Let me evaluate myself

Q1 Can two like charges attract each other? If yes, how?

Q2 How does a positively charged glass rod attract a neutral piece of paper?

Q3 A charged rod attracts bits of dry cork which after touching the rod, often jump away from it violently, why?

Q4 What is the difference between charging by induction, charging by conduction and charging by friction?

Q5 Suppose we want a conducting sphere lying on an insulated stand to get negatively charged, then which rod should be brought near sphere i.e. positive or negative? and why?

Q6 What is the reason for using convex lens in the above activity?

(Annexure 1C)

ELECTOSTATICS

Direct Questions based on IMPORTANT DERIVATIONS of ELECTOSTATICS

01. State Properties of electric charge and compare and contrast it with mass
02. Explain Working of electroscope with the help of neat and labelled diagram
03. Explain the process of charging a conducting sphere positively/Negatively by Induction
04. a) State Coulomb's Law and derive its expression in vector form,
b) Compare and contrast electrostatic force between two charged particles with gravitational force between them
05. Define one coulomb of charge and comment upon its largeness.
06. Derive dimensions of coulomb and electrical permittivity.
07. Define electric field intensity and write its unit and dimension.
08. Define electric dipole and electric dipole moment.
09. Derive an expression for electric field due to a dipole at a point on
(i) perpendicular bisector or equatorial line.
(ii) axial line.
10. Derive an expression for the torque acting on a dipole placed in uniform electric field.
11. Derive an expression for the Potential Energy possessed by dipole placed in uniform electric field.
12. State and prove Gauss's Theorem.
13. Derive an expression for electric field intensity due to
a) an infinitely long straight uniform charged wire
b) an infinitely long thin plane conducting charged sheet
c) an infinitely long thick plane conducting charged sheet of charge
d) two infinitely long plane parallel sheets equal and oppositely charged
(i) to the left of the sheets (ii) to the right of the sheets (iii) between two sheets.
e) uniformly charged thin spherical shell (conducting solid/hollow sphere) at a point
(i) outside the shell (ii) inside the shell (iii) on the surface of the shell
f) a uniformly charged non conducting solid sphere at a point
(i) on the solid sphere (ii) outside the sphere (iii) inside the solid sphere

(Annexure 1D) - Previous Years' Board question

