



**Class: 10th**

**Subject: Physics**

**Unit 13: ELECTROSTATICS**

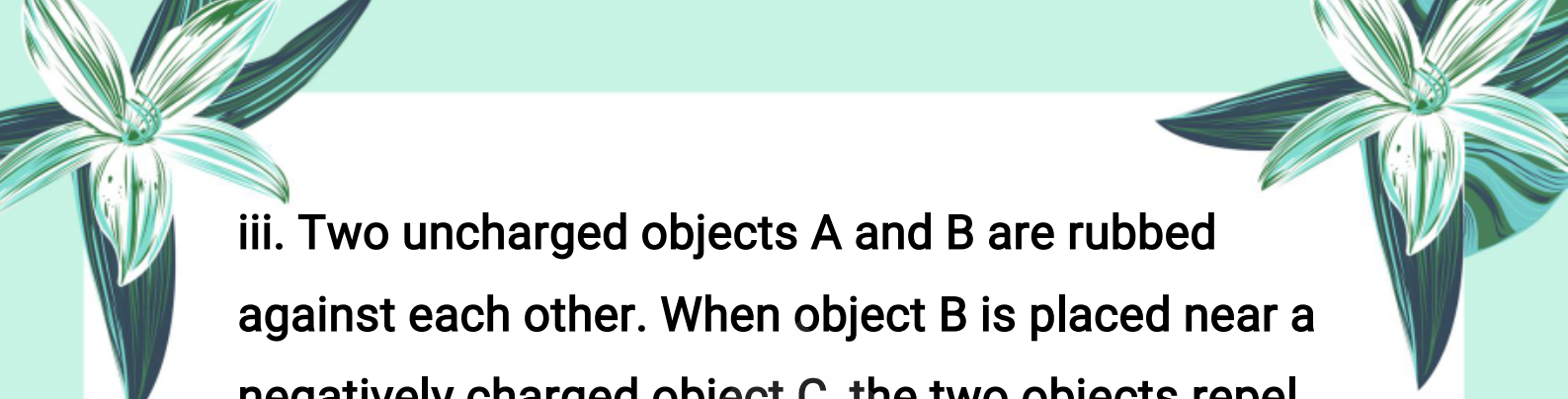
**Exercise MCQs:**

i. A positive electric charge:


- (a) attracts other positive charge
- (b) repels other positive charge
- (c) attracts a neutral charge
- (d) repels a neutral charge

ii. An object gains excess negative charge after being rubbed against another object, which is:

- (a) neutral
- (b) negatively charged
- (c) positively charged
- (d) either a, b or c



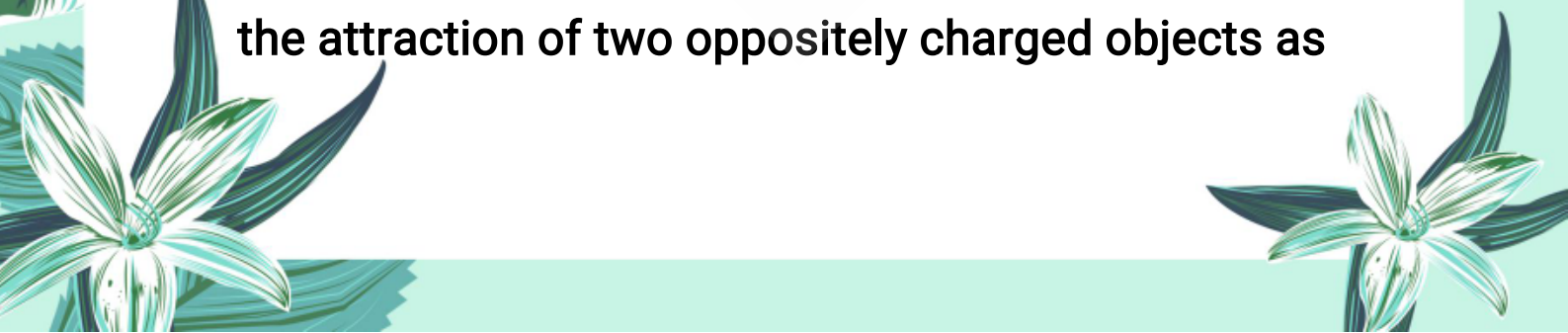
iii. Two uncharged objects A and B are rubbed against each other. When object B is placed near a negatively charged object C, the two objects repel each other. Which of the following statements is true about object A?

- 
- (a) remains uncharged
  - (b) becomes positively charged
  - (c) becomes negatively charged
  - (d) unpredictable

iv. When you rub a plastic rod against your hair several times and put it near some bits of paper, the pieces of paper are attracted towards it. What does this observation indicate?

- (a) the rod and the paper are oppositely charged
- (b) the rod acquires a positive charge
- (c) the rod and the paper have the same charges
- (d) the rod acquires a negative charge


v. According to Coulomb's law, what happens to the attraction of two oppositely charged objects as





their distance of separation increases?


- (a) increases
- (b) decreases
- (c) remains unchanged
- (d) cannot be determined



vi. The Coulomb's law is valid for the charges which are:

- (a) moving and point charges
- (b) moving and non-point charges
- (c) stationary and point charges
- (d) stationary and large size charges

vii. A positive and a negative charge are initially 4 cm apart. When they are moved closer together so that they are now only 1 cm apart, the force between them is:

- (a) 4 times smaller than before
  - (b) 4 times larger than before
  - (c) 8 times larger than before
- 

(d) 16 times larger than before

viii. Five joules of work is needed to shift 10 C of charge from one place to another. The potential difference between the places is:

(a) 0.5 V

(b) 2 V

(c) 5 V

(d) 10 V

ix. Two small charged spheres are separated by 2 mm. Which of the following would produce the greatest attractive force?

(a) +1q and +4q

(b) -1q and -4q

(c) +2q and +2q

(d) +2q and -2q

x. Electric field lines:

(a) always cross each other

(b) never cross each other

- (c) cross each other in the region of strong field
- (d) cross each other in the region of weak field

### Important MCQs:

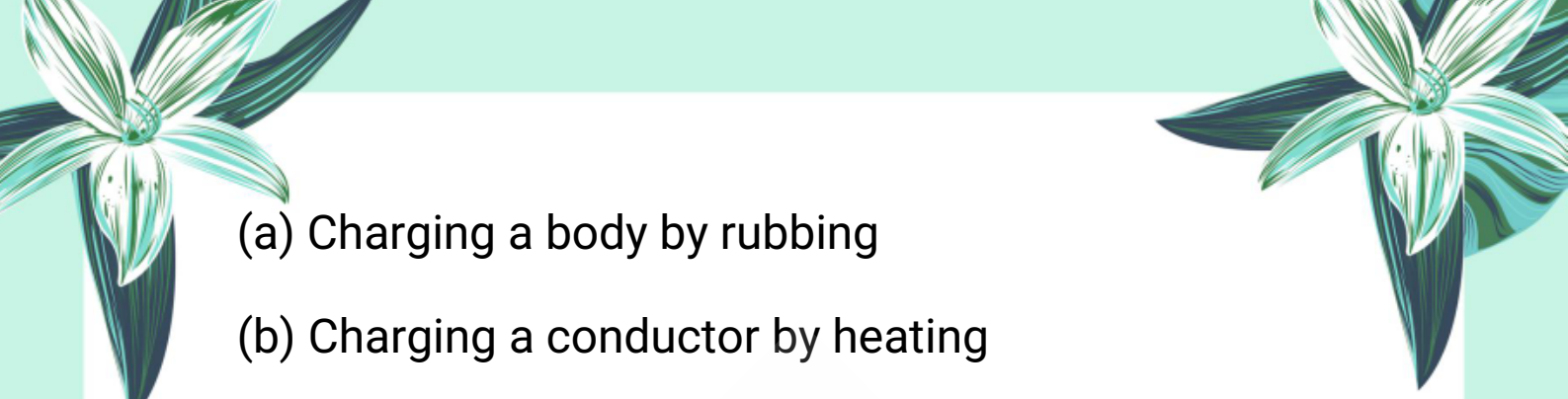
1. What are the two types of electric charges?

- (a) Positive and neutral
- (b) Negative and neutral
- (c) Positive and negative
- (d) Static and dynamic

2. What happens when two like charges are brought close to each other?

- (a) They attract
- (b) They merge
- (c) They repel
- (d) They discharge

3. What is electrostatic induction?

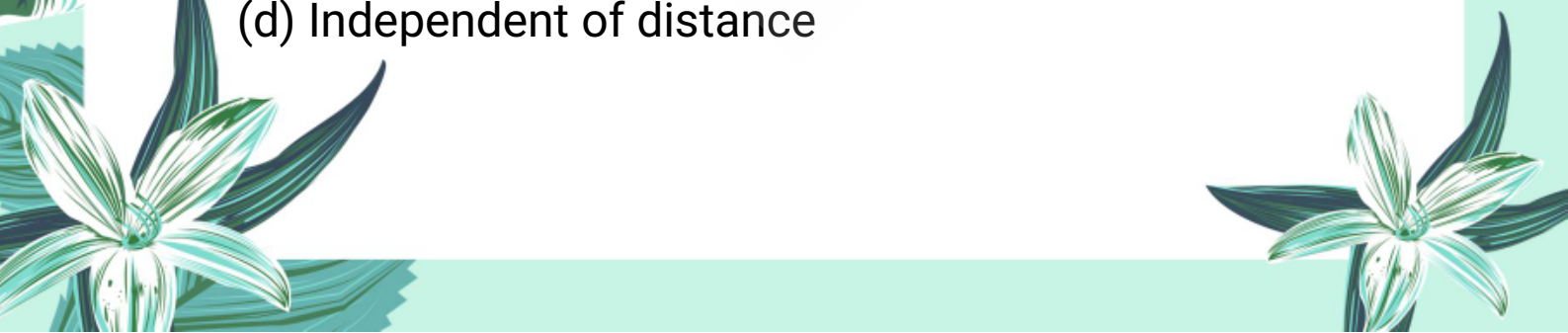
- 
- (a) Charging a body by rubbing
  - (b) Charging a conductor by heating
  - (c) Charging a conductor without contact
  - (d) Discharging a charged body



**4. Coulomb's law is used to calculate:**

- (a) Electric current
- (b) Electric potential
- (c) Magnetic force
- (d) Force between two charges

**5. According to Coulomb's law, the electrostatic force is:**

- (a) Inversely proportional to the product of the charges
  - (b) Directly proportional to the square of the distance
  - (c) Inversely proportional to the square of the distance
  - (d) Independent of distance
- 

**6. What is an electric field?**

- (a) A space without any force
- (b) A region where magnetic forces act
- (c) A region around a charge where electric force is experienced
- (d) A region of gravitational influence

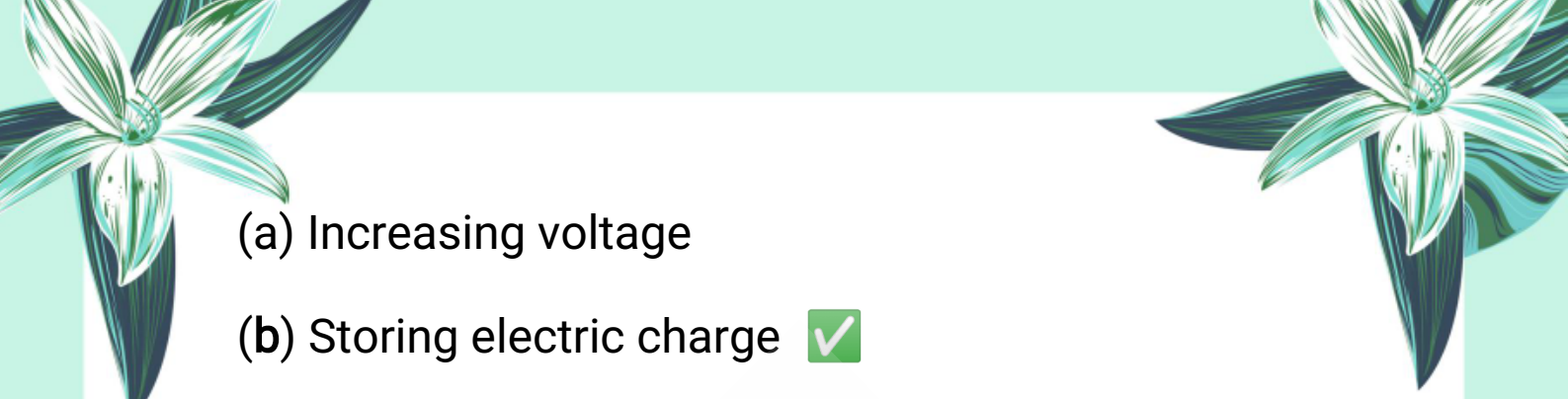
**7. Electric potential is defined as:**


- (a) Heat energy required to move a charge
- (b) Kinetic energy of a charged body
- (c) Work done in moving a unit positive charge from infinity
- (d) Power consumed by a charge

**8. The SI unit of electric potential is:**

- (a) Coulomb
- (b) Ampere
- (c) Volt
- (d) Ohm

**9. What is a capacitor used for?**

- 
- (a) Increasing voltage
  - (b) Storing electric charge
  - (c) Producing electricity
  - (d) Reducing resistance



10. In a parallel combination of capacitors, the total capacitance is:

- (a) Equal to the smallest capacitor
- (b) The sum of individual capacitances
- (c) Always one farad
- (d) The average of the capacitances

11. What happens when a plastic comb is rubbed through dry hair and brought near small pieces of paper?

- (a) It repels them
- (b) It attracts them
- (c) Nothing happens
- (d) It melts the paper


12. The property of attraction or repulsion between





**objects is due to:**

- (a) Friction
- (b) Heat
- (c) Electric charges
- (d) Magnetism



**13. Rubbing two neutral bodies together can produce:**

- (a) Only heat
- (b) Only one type of charge
- (c) Two types of electric charges
- (d) Magnetic field

**14. Which of the following materials was used by the Greeks to discover static electricity?**

- (a) Silk
- (b) Plastic
- (c) Amber
- (d) Copper

**15. What is the total charge on a neutral aluminum**



rod during electrostatic induction?

- (a) Positive
- (b) Negative
- (c) Zero
- (d) Double

16. Attraction between a charged rod and a neutral rod is due to:

- (a) Conduction
- (b) Friction
- (c) Electrostatic induction
- (d) Magnetic force

17. Which of the following is NOT a sure test of charge?

- (a) Repulsion
- (b) Attraction
- (c) Induction
- (d) Conduction

18. The device used to detect the presence of

**electric charge is called:**


- (a) Galvanometer
- (b) Voltmeter
- (c) Electroscope
- (d) Ammeter

**19. In a gold leaf electroscope, the part that holds the gold leaves is:**

- (a) Brass rod
- (b) Glass jar
- (c) Insulator
- (d) Brass disk

**20. When a charged body is brought near the disk of an uncharged electroscope and leaves diverge, it shows:**

- (a) The body is neutral
- (b) The body has charge
- (c) The leaves are broken
- (d) The electroscope is faulty




**21. Which process allows an electroscope to be charged without touching?**

- (a) Conduction
- (b) Induction
- (c) Radiation
- (d) Friction



**22. During charging by induction, if we want to make the electroscope positively charged, we:**

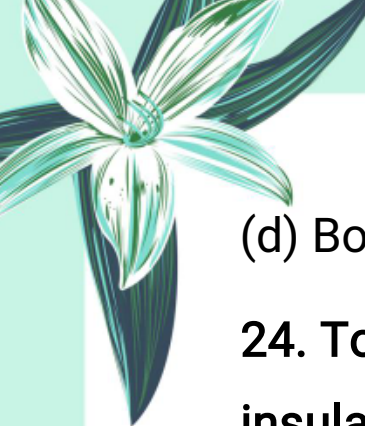
- (a) Bring positive rod and touch
- (b) Bring negative rod and ground the disk
- (c) Rub the disk
- (d) Heat the rod



**23. If divergence of leaves increases when a body is brought near a positively charged electroscope, the body has:**

- (a) No charge
- (b) Negative charge
- (c) Positive charge





(d) Both charges

**24. To check whether a material is conductor or insulator using electroscope, we:**

(a) Rub the material

(b) Heat the electroscope

(c) Touch the material to disk and observe leaves



(d) Weigh the material

**25. If the leaves of a charged electroscope collapse after touching a material, it means the material is:**

(a) A conductor 

(b) An insulator

(c) A magnet

(d) A semi-metal

**26. Who discovered the fundamental law of electric force between two charges?**

(a) Isaac Newton

(b) Michael Faraday



(c) Charles Coulomb

(d) Benjamin Franklin

**27. According to Coulomb's law, the electric force between two charges is:**

(a) Inversely proportional to their sum

(b) Directly proportional to the square of the distance

(c) Directly proportional to the product of charges

(d) Independent of the charges

**28. In Coulomb's law, force is inversely proportional to:**

(a) Distance

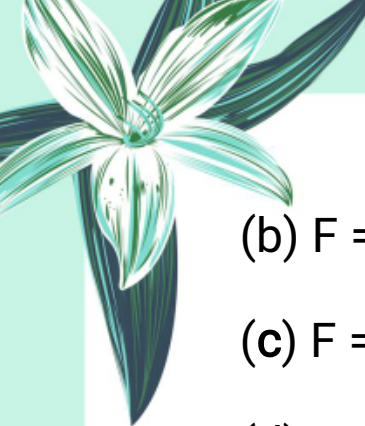
(b) Square of distance

(c) Charge

(d) Mass

**29. Which of the following is the correct formula for Coulomb's Law?**

(a)  $F = k \times (q_1 + q_2) / r$



(b)  $F = k \times q / r^2$

(c)  $F = k \times (q_1 \times q_2) / r^2$  ✓

(d)  $F = q \times E$

**30. The SI unit of electric field intensity is:**



(a) Volt

(b) Coulomb

(c) Newton per Coulomb (N/C) ✓

(d) Ampere

**31. What is the value of the electrostatic constant 'k' in air?**

(a)  $9 \times 10^6 \text{ N}\cdot\text{m}^2/\text{C}^2$

(b)  $9 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$  ✓

(c)  $1.6 \times 10^{-19} \text{ C}$


(d)  $3 \times 10^8 \text{ m/s}$

**32. Electric field intensity is defined as the:**

(a) Force per unit mass

(b) Force per unit charge ✓

(c) Voltage per unit distance



A decorative border surrounds the page, featuring stylized green and blue flowers in the corners and a butterfly on the left side. A large, faint watermark of a bird is visible in the center background.

(d) Work per unit charge

**33. Electric field lines are directed from:**

(a) Negative to positive

(b) Neutral to negative

(c) Positive to negative

(d) Lower to higher potential

**34. Which of the following is a vector quantity?**

(a) Charge

(b) Electric field intensity

(c) Electric potential

(d) Resistance

**35. Who introduced the concept of electric field lines?**

(a) Charles Coulomb

(b) James Maxwell

(c) Michael Faraday

(d) Albert Einstein

**36. Electric potential at a point in an electric field is**

**defined as:**

- (a) Force on a unit charge
- (b) Work done in moving a unit charge from the field
- (c) Work done in bringing a unit positive charge from infinity to that point
- (d) Energy stored in a battery

**37. The SI unit of electric potential is:**

- (a) Coulomb
- (b) Newton
- (c) Joule
- (d) Volt

**38. Electric potential is which type of quantity?**

- (a) Vector
- (b) Scalar
- (c) Tensor
- (d) Directional

**39. If one joule of work is done in bringing one coulomb charge from infinity to a point, the electric**



potential at that point is:

- (a) 0.5 volt
- (b) 1 volt
- (c) 10 volts
- (d) 100 volts

40. When a positive charge moves from lower potential to higher potential, it:

- (a) Gains energy
- (b) Loses energy
- (c) Remains neutral
- (d) Becomes negative

41. A capacitor is a device used to:

- (a) Generate current
- (b) Convert voltage
- (c) Store electric charge
- (d) Measure resistance

42. A capacitor consists of:

- (a) One metal plate only

(b) Two parallel metal plates separated by air or insulator

(c) Two wires and a coil

(d) One charged sphere

**43. The charge stored on a capacitor is directly proportional to:**

(a) The resistance of the wire

(b) The size of the plates

(c) The potential difference across its plates

(d) The temperature

**44. The formula to calculate charge stored in a capacitor is:**

(a)  $Q = IR$

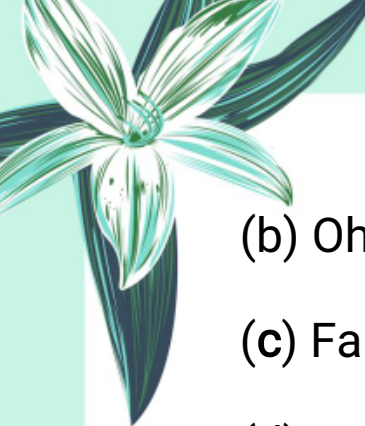
(b)  $Q = V/C$

(c)  $Q = CV$

(d)  $Q = V^2/C$

**45. The SI unit of capacitance is:**

(a) Volt



(b) Ohm

(c) Farad

(d) Coulomb

**46. 1 Farad is defined as:**



(a) 1 volt per coulomb

(b) 1 coulomb per volt

(c) 1 joule per volt

(d) 1 ampere per volt

**47. In parallel combination of capacitors, the total capacitance is:**

(a) Equal to the smallest capacitance

(b) Sum of individual capacitances


(c) Inverse of sum

(d) Always constant

**48. In parallel combination, the potential difference across each capacitor is:**

(a) Different

(b) Half of total





(c) Same

(d) Zero

**49. In series combination of capacitors, the charge on each capacitor is:**



(a) Different

(b) Same

(c) Zero

(d) Depends on voltage

**50. Which of the following is not a practical unit of capacitance?**

(a) Microfarad



(b) Nanofarad

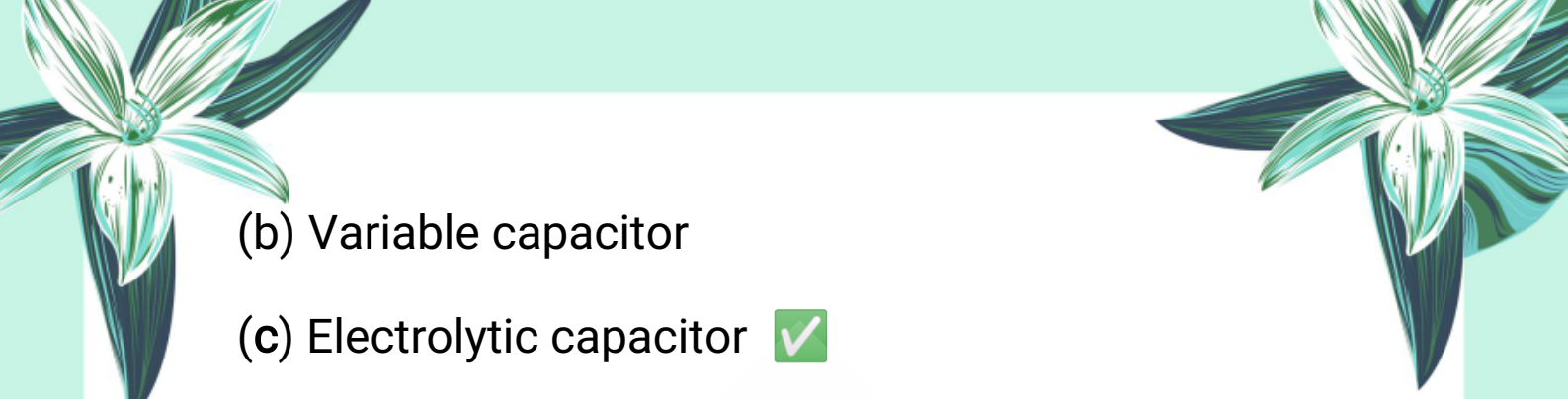
(c) Picofarad

(d) Kilofarad


**51. A capacitor used to store large amount of charge at low voltage using chemical reaction is called:**

(a) Paper capacitor




- 
- (b) Variable capacitor
  - (c) Electrolytic capacitor
  - (d) Ceramic capacitor

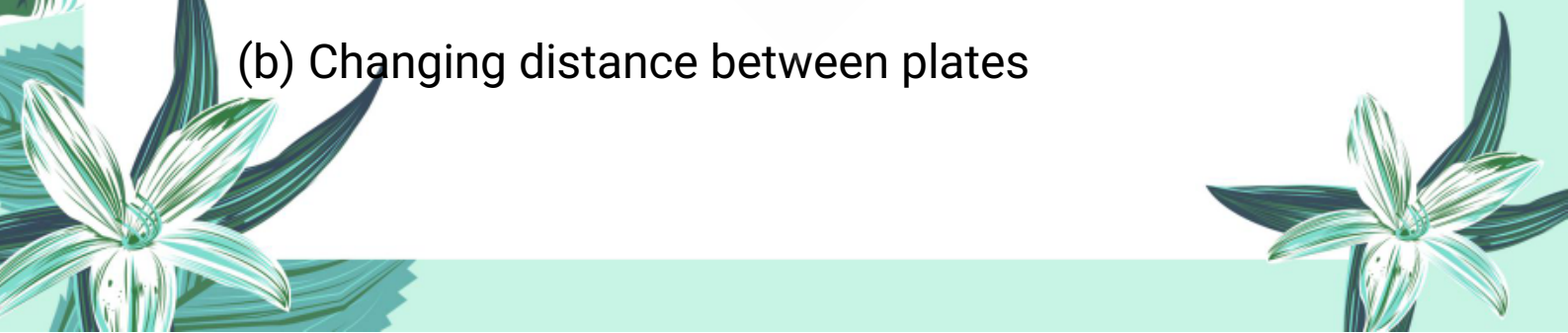
**52. In a mica capacitor, the dielectric material used is:**

- 
- (a) Plastic
  - (b) Mica
  - (c) Oil
  - (d) Air

**53. Variable capacitors are commonly used in:**

- 
- (a) Electric fans
  - (b) Radios for tuning
  - (c) Electric heaters
  - (d) Motors

**54. The capacitance in variable capacitors is changed by:**

- 
- (a) Increasing temperature
  - (b) Changing distance between plates



(c) Rotating movable plates

(d) Adding more wires

**55. In electrostatic air cleaner, dust particles are removed by:**



(a) Heating them

(b) Magnetic repulsion

(c) Electrostatic attraction

(d) Blowing them away

**56. In electrostatic powder painting, paint is sprayed by giving:**

(a) Same charge as car body

(b) Opposite charge to car body

(c) No charge

(d) Neutral particles

**57. Paper capacitors are usually shaped as:**

(a) Flat plates

(b) Cylinders

(c) Spheres





(d) Coils

**58. The phenomenon of lightning is caused by:**

(a) Flow of water

(b) Build-up of static charges in thunderclouds

(c) Magnetism

(d) Movement of stars

**59. A lightning conductor protects buildings by:**

(a) Absorbing lightning

(b) Reflecting light

(c) Providing a discharge path to Earth

(d) Breaking the charge

**60. A fire can occur while filling petrol due to:**

(a) High pressure

(b) Static electricity generated by friction

(c) Poor quality fuel

(d) Engine heat



The page is decorated with various illustrations: a white butterfly with black markings on its wings is on the left side. There are several green and white flowers with long, narrow leaves scattered around the page, including one in the top left, one in the top right, one in the bottom left, and one in the bottom right. A large, faint watermark of a butterfly is visible in the center of the page, and the text 'StudyNotes360.com' is written diagonally across it.

## Important Short Questions :

1. What are the two types of electric charges?

Answer:

The two types of electric charges are:

- Positive charge
- Negative charge

2. What happens when like and unlike charges are brought close to each other?

Answer:

- Like charges repel each other.
- Unlike charges attract each other.

3. Define electrostatic induction.

Answer:

Electrostatic induction is the process of charging a conductor without any contact with the charging body.


4. State Coulomb's Law in words.

Answer:



**Coulomb's Law states that:**

**The force between two charged bodies is:**

- Directly proportional to the product of the charges
  - Inversely proportional to the square of the distance between them
- 

**5. What is an electric field?**

**Answer:**

An electric field is the region around a charged body in which a unit positive charge experiences a force.

**6. Define electric potential and give its SI unit.**

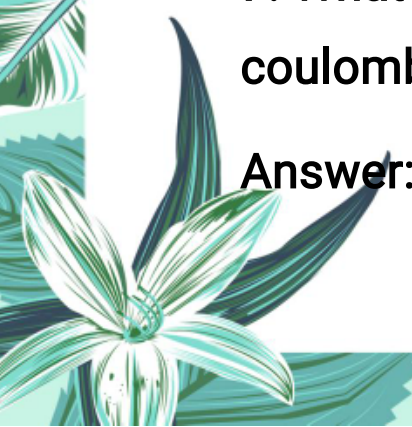
**Answer:**

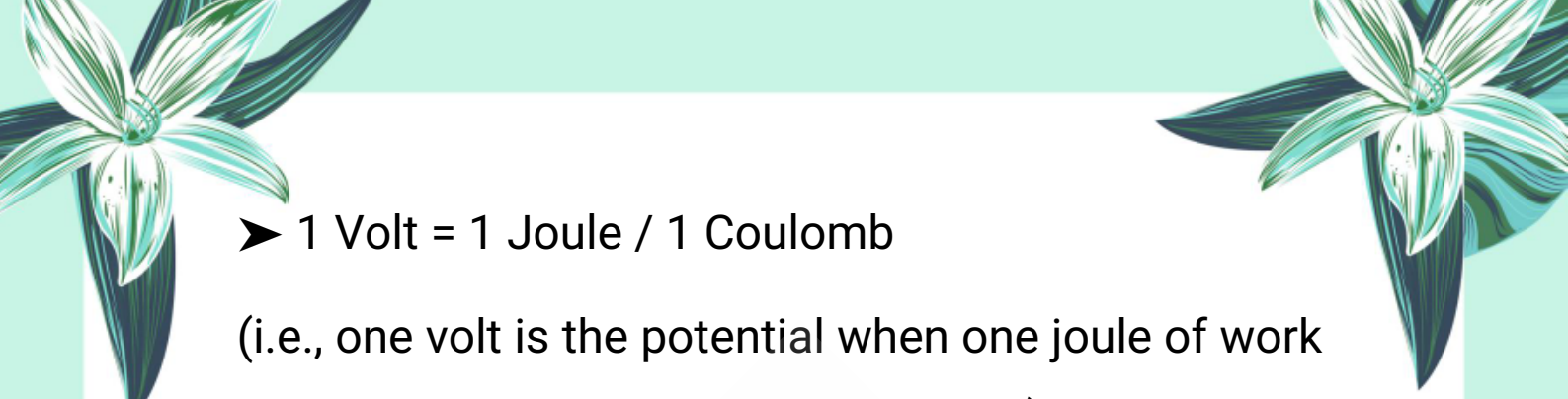
Electric potential at a point is the work done in moving a unit positive charge from infinity to that point.

**SI Unit: Volt (V)**

**7. What is the relation between volt, joule, and coulomb?**

**Answer:**





➤ 1 Volt = 1 Joule / 1 Coulomb

(i.e., one volt is the potential when one joule of work is done to move one coulomb charge.)

**8. What is a capacitor?**

**Answer:**



A capacitor is a device used to store electric charge.

**9. Define capacitance. What is its SI unit?**

**Answer:**

Capacitance is the ability of a capacitor to store electric charge.

**SI Unit:** Farad (F)

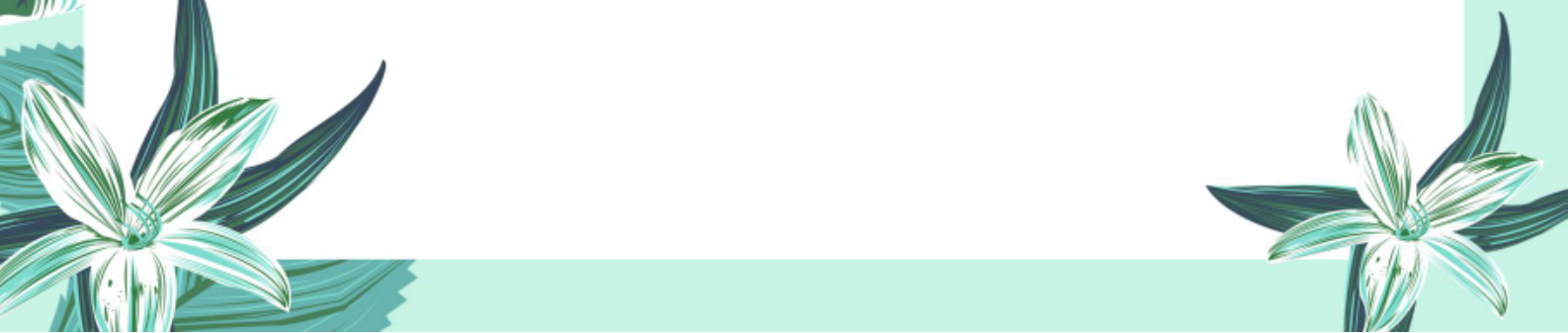
**10. Write the formula for equivalent capacitance of:**

(a) Capacitors in parallel

(b) Capacitors in series

**Answer:**

**(a) Parallel Combination:**

$$C = C_1 + C_2 + C_3 + \dots + C_n$$





**(b) Series Combination:**

$$1/C = 1/C_1 + 1/C_2 + 1/C_3 + \dots + 1/C_n$$

**11. How can a neutral body be charged?**

**Answer:**



A neutral body can be charged by rubbing it with another neutral body, which transfers electrons and produces electric charges.

**12. What is the difference between attraction and repulsion in terms of charge?**


**Answer:**


- Attraction can occur between unlike charges or due to induction.
- Repulsion occurs only between like charges and is a sure test of charge.

**13. What is electrostatic induction?**

**Answer:**

Electrostatic induction is the process in which a charged body causes a redistribution of charges in a nearby neutral conductor without direct contact.





**14. What does the attraction between a charged and uncharged object indicate?**

**Answer:**

It indicates electrostatic induction, not necessarily the presence of opposite charges.



**15. What is an electroscope?**

**Answer:**

An electroscope is a device used to detect the presence, magnitude, and type of electric charge on a body.

**16. How does an electroscope detect the presence of charge?**

**Answer:**

When a charged body is brought near the electroscope's disk, its leaves diverge due to electrostatic induction, indicating the presence of charge.

**17. How can an electroscope be positively charged using induction?**





**Answer:**

- Bring a negatively charged rod near the disk 'n
- Connect the disk to the ground 'n
- Remove the earth connection 'n
- Then remove the rod.



The electroscope is left with a positive charge.

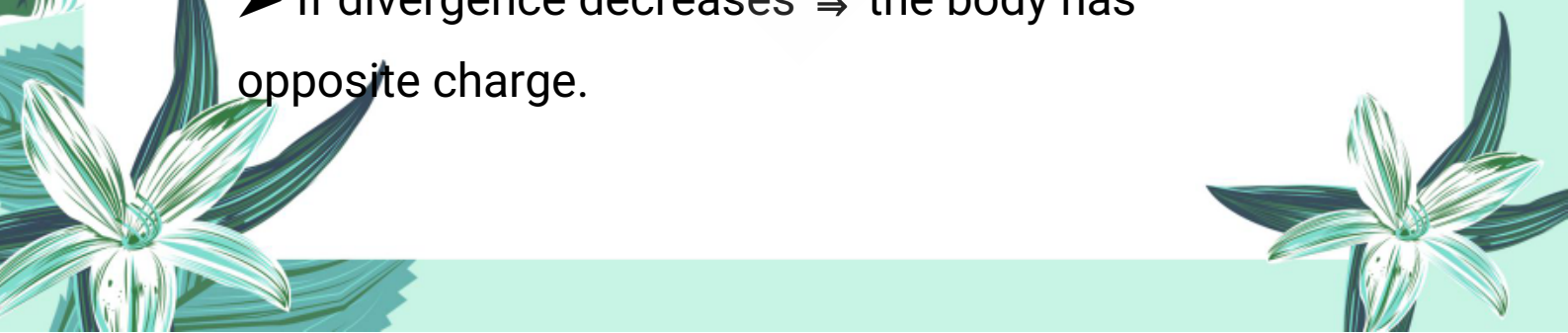
**18. What is the principle behind the divergence of leaves in an electroscope?**

**Answer:**

The like charges on both leaves repel each other, causing them to diverge. Greater charge leads to greater divergence.

**19. How can we detect the type of charge using a charged electroscope?**

**Answer:**

- If divergence increases  $\Rightarrow$  the body has same charge as electroscope.
  - If divergence decreases  $\Rightarrow$  the body has opposite charge.
- 

20. How can electroscope be used to distinguish between conductors and insulators?


**Answer:**

- If the leaves collapse after touching the test material, it is a conductor.
- If there is no change in divergence, it is an insulator.

21. What is Coulomb's Law?

**Answer:**

Coulomb's Law states that the force between two point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them.

 **Formula:**

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

22. What is the SI unit of electric charge?

**Answer:**

The SI unit of charge is Coulomb (C).



**23. What happens to the electrostatic force if the distance is doubled?**

**Answer:**

The force reduces to one-fourth of its original value.



**24. What does the electrostatic force depend on?**

**Answer:**

👉 It depends on:

The magnitude of charges

The distance between them

**25. What is an electric field?**

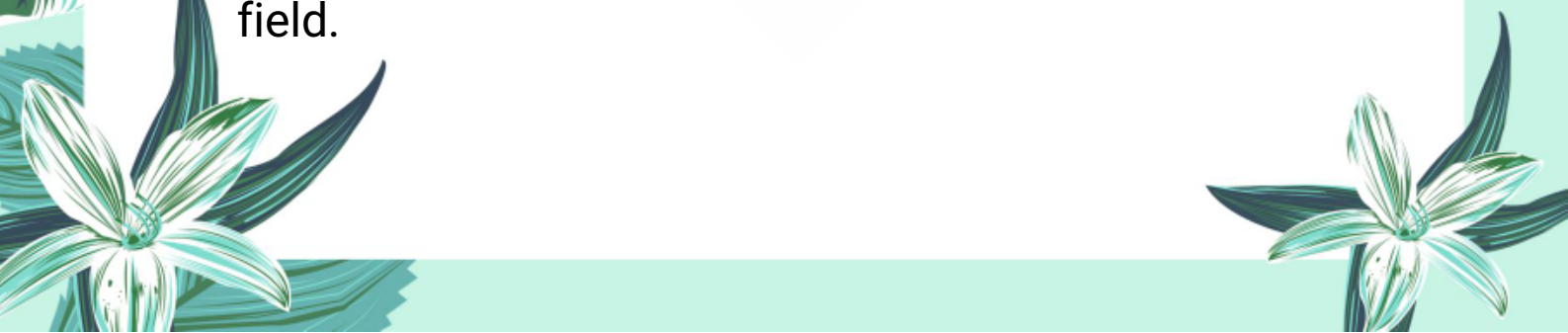
**Answer:**

The region around a charged object where it exerts a force on another charge is called an electric field.

**26. Define electric field intensity.**

**Answer:**

Electric field intensity is the force experienced by a unit positive charge placed at a point in the electric field.





**Formula:**

$$E = F/q$$

**27. What is the SI unit of electric field intensity?**

**Answer:**

The unit is Newton per Coulomb (N/C).



**28. What is the direction of electric field lines?**

**Answer:**

Electric field lines move from positive charge to negative charge.

**29. Who introduced the concept of electric field lines?**



**Answer:**

Michael Faraday introduced electric field lines.

**30. What is electric potential?**

**Answer:**

Electric potential is the work done in bringing a unit positive charge from infinity to a point in the electric field.



**31. What is the SI unit of electric potential?**

**Answer:**

👉 The unit is Volt (V).

**32. Write the formula of electric potential.**

**Answer:**

$$V = W/q$$

**Where:**

V = Electric potential

W = Work done

q = Charge

**33. What is a capacitor?**

**Answer:**

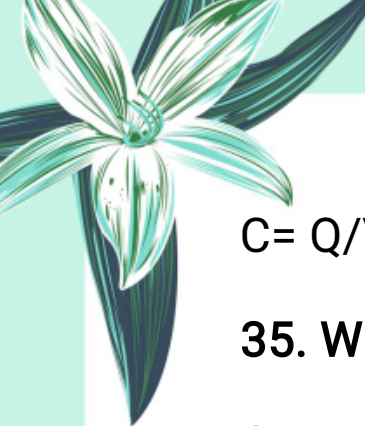
A capacitor is a device used to store electric charge.

**34. Define capacitance.**

**Answer:**

Capacitance is the ability of a body to store charge per unit potential difference.


**Formula:**


$$C = Q/V$$

**35. What is the SI unit of capacitance?**

**Answer:**

👉 The unit is Farad (F).



**36. Why are parallel plate capacitors not commonly used in modern electronic devices?**

**Answer:**

Because they must be large in size to store enough charge, which is not suitable for compact electronic devices.

**37. What is the function of a dielectric in a capacitor?**


**Answer:**

A dielectric increases the capacitance of a capacitor by reducing the electric field between the plates and preventing current flow.

**38. Write two main differences between fixed and variable capacitors.**


**Answer:**





**1. Fixed Capacitor:** Has a constant capacitance value.

**2. Variable Capacitor:** Its capacitance can be adjusted by changing the overlapping area of plates.



**39. What is an electrolytic capacitor? Explain its structure briefly.**

**Answer:**

It is a type of capacitor that stores large charges at low voltages. It consists of a metal foil and an electrolyte, with a thin oxide layer acting as the dielectric.

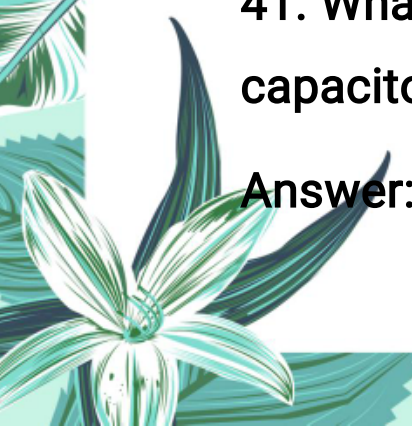
**40. How does a variable capacitor change its capacitance?**


**Answer:**

By rotating one set of plates so that the overlapping area with the fixed plates increases or decreases, thus changing the capacitance.

**41. What material is used as a dielectric in mica capacitors and why?**

**Answer:**






Mica is used because it is a good insulator and has a high dielectric strength, even though it is fragile.

**42.. Give two practical uses of capacitors in electrical appliances.**

**Answer:**

- 
1. Tuning in radios and televisions.
  2. Running motors in fans, air conditioners, and washing machines.

**43. Describe the working principle of an electrostatic air cleaner.**

**Answer:**

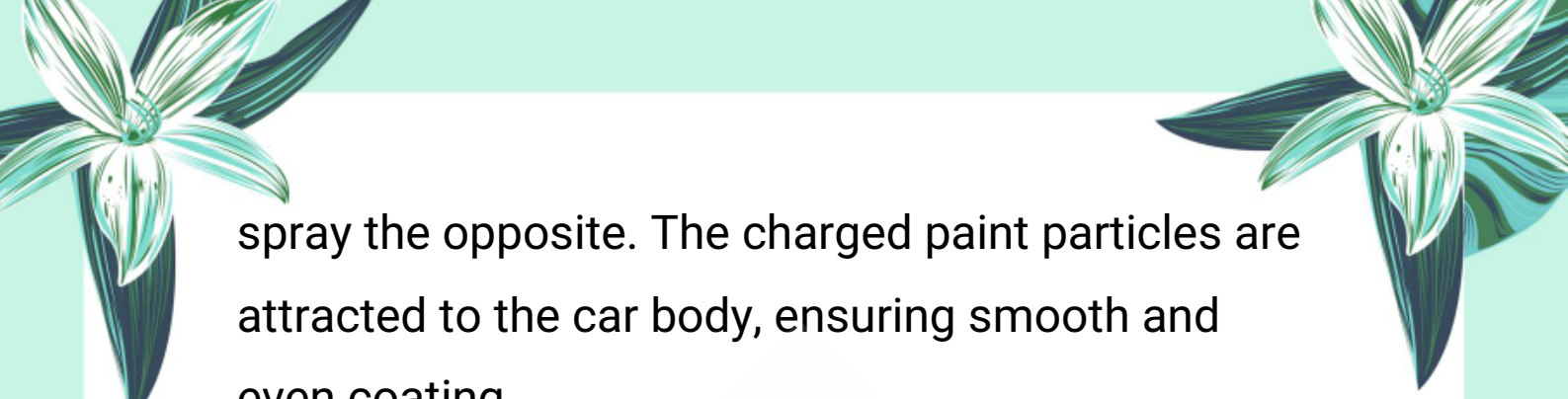
Dusty air passes through a positively charged mesh, making particles positively charged. These are then attracted to a negatively charged mesh where they get trapped.

**44. How is static electricity used in the painting of automobiles?**

**Answer:**

The car body is given one charge and the paint





spray the opposite. The charged paint particles are attracted to the car body, ensuring smooth and even coating.

**45. What are the two common hazards caused by static electricity? Give one example for each.**



**Answer:**

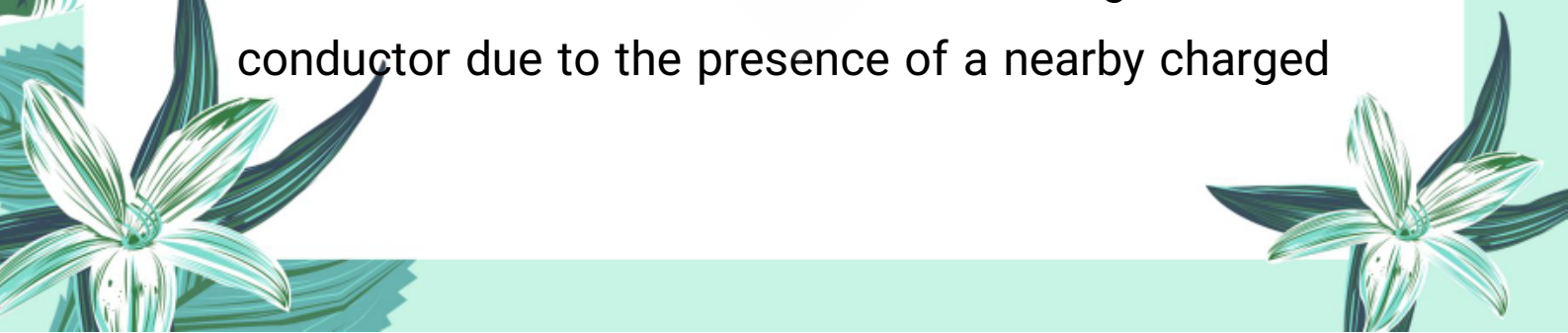
- 1. Lightning:** Caused by discharge from charged clouds to the ground.
- 2. Fire or Explosion:** Caused by charge buildup during petrol transfer or friction.

### **Important Long Questions:**

☀ Q1: How can an electroscope be charged by electrostatic induction? Explain with diagram.

❖ **Definition of Electrostatic Induction:**

Electrostatic induction is the process of charging a conductor without touching it with a charged body. This involves the redistribution of charges in the conductor due to the presence of a nearby charged



object.

## ◆ Step-by-step Process to Charge Electroscope by Induction:

### ◆ Step 1: Bring a Charged Body Near the Electroscope

- Bring a negatively charged rod close to the brass disk of a neutral electroscope (without touching).
- Due to electrostatic induction, positive charges appear on the brass disk and negative charges move to the gold leaves.
- The gold leaves diverge because they now carry like charges (negative).

### ◆ Step 2: Earth the Electroscope

- While keeping the charged rod near the disk, connect the disk to Earth using a conducting wire.
- The negative charges on the leaves flow to the Earth, neutralizing the leaves.
- The positive charges remain on the disk due to

attraction by the negative rod.

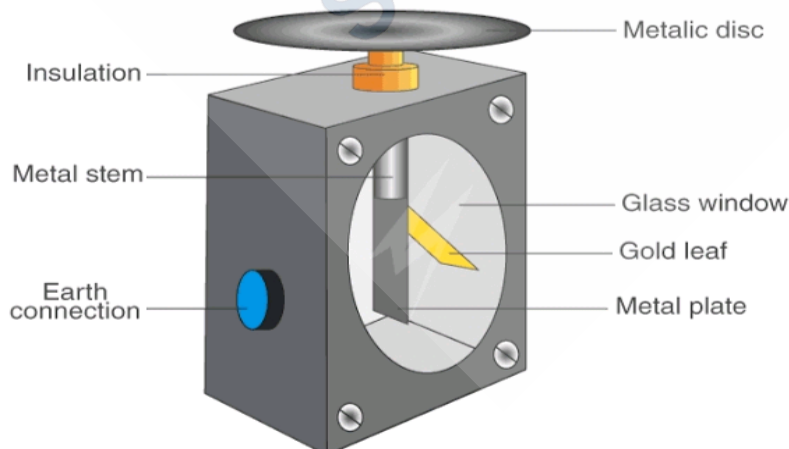
◆ **Step 3:** Remove the Earth Connection First, Then the Rod

- First, disconnect the earthing wire, so the positive charge stays on the electroscope.
- Now, remove the charged rod.
- The electroscope is now left with a positive charge, and the leaves diverge due to repulsion.

📖 **Result:**

The electroscope is successfully charged positively without any direct contact. The same process can be used to give a negative charge using a positively charged rod.

📊 **Diagram:**



 **Summary:**

Electrostatic induction is a useful and safe way to charge an electroscope without any physical contact. This principle is widely used in studying electrostatics and testing charges.

 **Q2: Explain how electroscope can be used to distinguish between conductors and insulators.** **Answer:** **Purpose:**

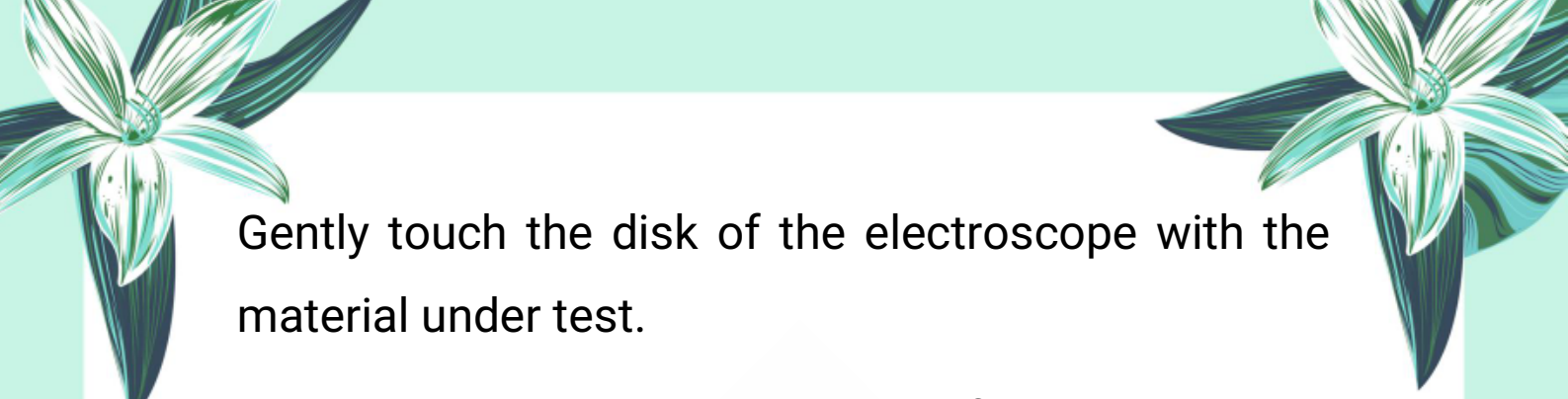
An electroscope can help determine whether an unknown material is a conductor or an insulator based on its ability to allow electric charge to move.

 **Method:** **Step 1: Charge the Electroscope**

First, charge the electroscope, either positively or negatively, using conduction or induction.

The gold leaves diverge, showing the presence of charge.


 **Step 2: Bring the Unknown Material in Contact**



Gently touch the disk of the electroscope with the material under test.

◆ **Step 3: Observe the Behavior of the Leaves**

● **If the Leaves Collapse:**

- 
- The material is a conductor.
  - Charges are conducted away through the material, reducing the charge on the electroscope.
  - As a result, leaf divergence decreases or collapses completely.

● **If the Leaves Stay the Same:**

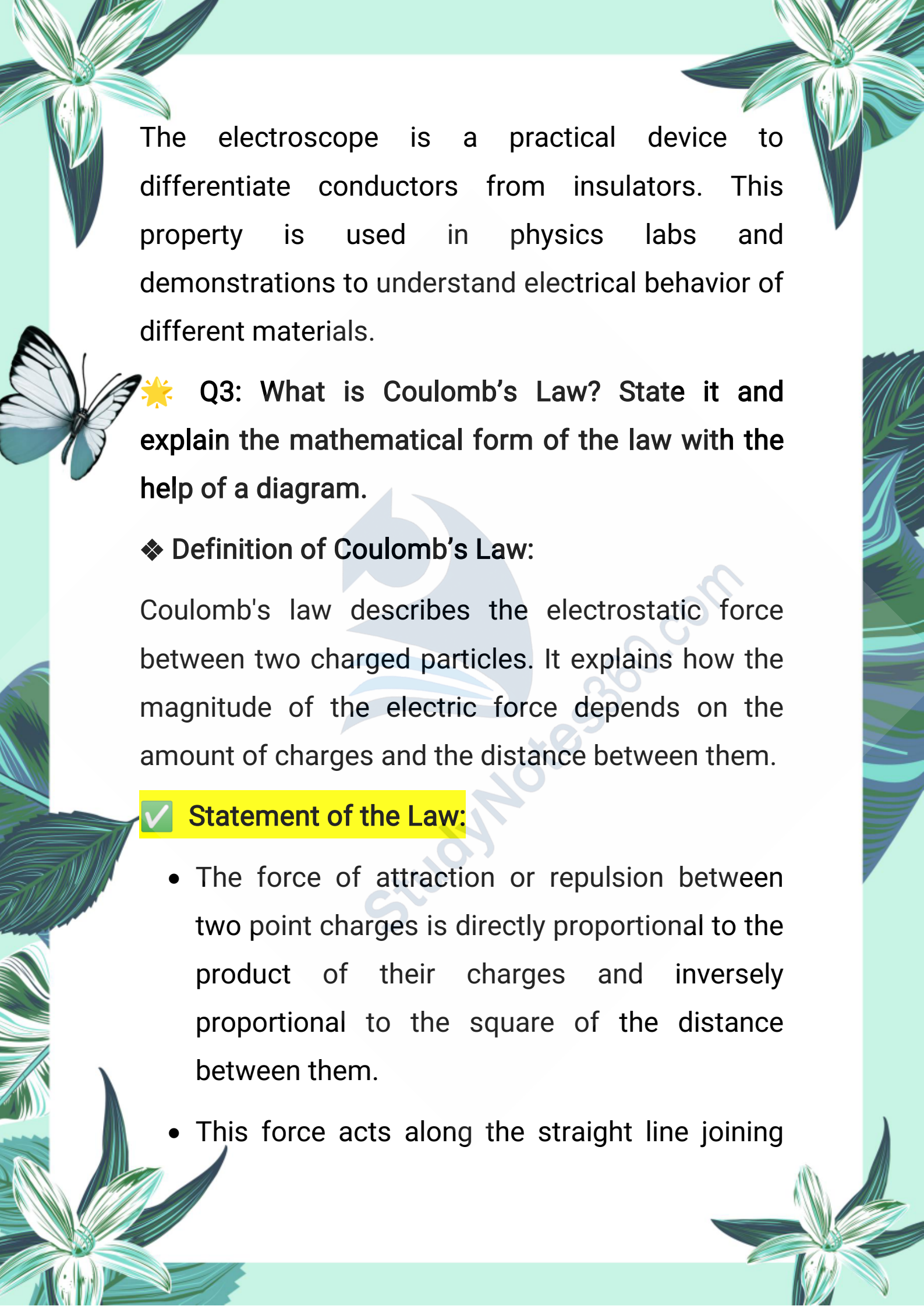
- The material is an insulator.
- Charges do not move, so there is no change in the divergence of the leaves.

📄 **Result Table:**

- Material Behavior Inference
- Leaves collapse/decrease It's a conductor
- No change in leaves It's an insulator

🔍 **Summary:**



The page is decorated with various illustrations: a large white flower with green leaves in the top left and bottom left corners, a white butterfly with black markings on its wings on the left side, and a large green leaf on the right side. The background is a light green color.

The electroscope is a practical device to differentiate conductors from insulators. This property is used in physics labs and demonstrations to understand electrical behavior of different materials.

☀️ Q3: What is Coulomb's Law? State it and explain the mathematical form of the law with the help of a diagram.

❖ **Definition of Coulomb's Law:**

Coulomb's law describes the electrostatic force between two charged particles. It explains how the magnitude of the electric force depends on the amount of charges and the distance between them.

✓ **Statement of the Law:**

- The force of attraction or repulsion between two point charges is directly proportional to the product of their charges and inversely proportional to the square of the distance between them.
- This force acts along the straight line joining

the two charges.

✓ **Mathematical Form:**

$$F = k \times (q_1 \times q_2) / r^2$$

**Where:**

Symbol	Quantity	Unit
F	Electrostatic force	Newton (N)
$q_1q_2$	Magnitudes of the two charges	Coulomb (C)
r	Distance between the charges	Meter (m)
k	Coulomb's constant	$F = k \times (q_1 \times q_2) / r^2$

✓ **Conditions:**

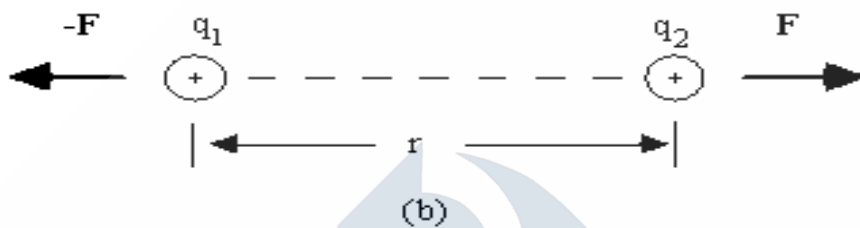
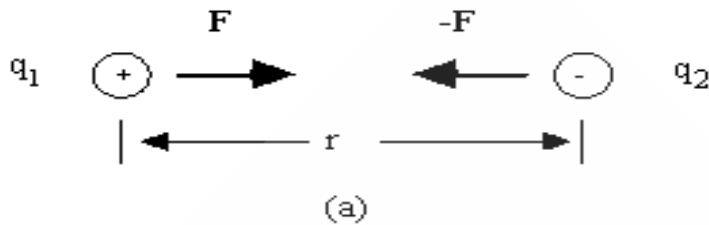
Coulomb's law is applicable only for point charges.

The charges must be stationary (not moving).

The medium between charges affects the value of

"k" (air or vacuum is standard).

✓ **Diagram:**



- The two charges  $q_1$  and  $q_2$  are separated by a distance  $r$ .
- Force  $F$  acts along the line joining the charges.
- If charges are **like**, force is **repulsive**.
- If charges are **unlike**, force is **attractive**.


🔍 **Summary:**

Coulomb's law is fundamental in electrostatics and helps us understand how charges interact in a medium such as air.



## Exercise Questions :

## Review Questions :



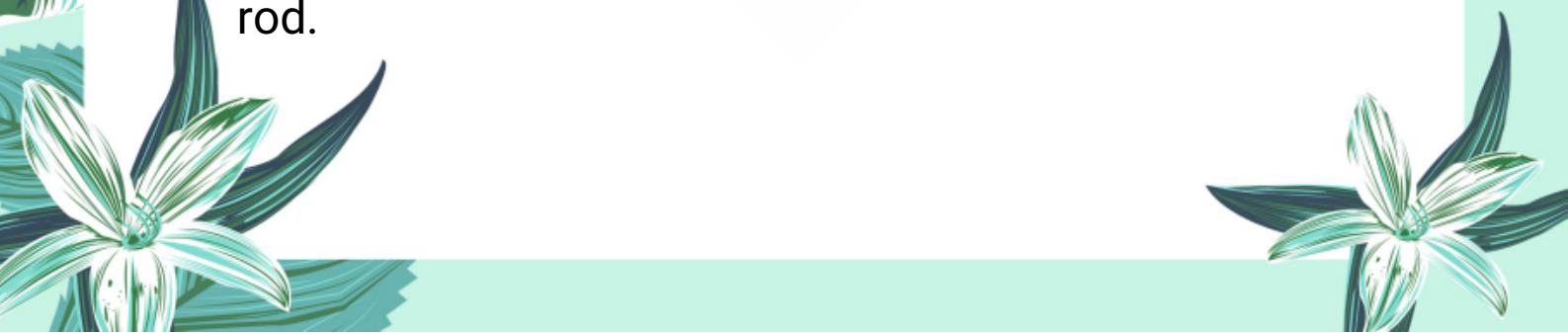
☀ Q13.1. How can you show by simple experiments that there are two types of electric charges?

❖ Answer:

We can prove that there are two types of electric charges – positive and negative – by using simple electrostatic experiments with charged rods and an electroscope.

◆ Experiment 1: Charging Two Plastic Rods by Rubbing

◆ Procedure:

1. Take two plastic rods and rub both with a piece of wool.
  2. Hang one of the rods freely using a thread.
  3. Bring the other rubbed rod close to the hanging rod.
- 



## Observation:

- The rods repel each other.



## Summary:

Both rods have same type of charge, and like charges repel.



- ◆ **Experiment 2: Charging Glass and Plastic Rod**

- ◆ **Procedure:**

1. Rub a glass rod with silk  $\Rightarrow$  becomes positively charged.
2. Rub a plastic rod with wool  $\Rightarrow$  becomes negatively charged.
3. Suspend the glass rod, and bring the plastic rod near it.

- ◆ **Observation:**

The rods attract each other.



## Summary:

The rods have opposite charges, and unlike charges attract.




- ◆ **Final Summary:**



**These experiments show:**

Like charges repel

Unlike charges attract So, there must be two types of electric charges:

- 
- ✓ Positive (+)
  - ✓ Negative (-)

☀ Q13.2. Describe the method of charging bodies by electrostatic induction.

❖ **Answer:**

Electrostatic induction is a method of charging a neutral body without direct contact with a charged body.

◆ **Step-by-Step Explanation:**

- ◆ **Step 1: Bring a Charged Object Near**
  - Take a negatively charged rod and bring it close to a neutral electroscope (do not touch).
  - The electrons in the disk of the electroscope are repelled downwards to the leaves.
- ◆ **Step 2: Earthing the Disk**

- While the rod is still near, touch the disk with your finger (grounding).
- Excess electrons flow from the disk to the Earth, leaving the disk positively charged.

◆ **Step 3: Remove the Finger**

Remove the finger first while the charged rod is still near.

◆ **Step 4: Remove the Charged Rod**

Finally, remove the charged rod.

◆ **Result:**

- The electroscope now becomes positively charged.
- The body was charged without touching it.

🔍 **Summary:**

Electrostatic induction allows us to charge a neutral object by influence, not contact. It is a safe and common method in electrostatics experiments.

☀ **Q13.3. How does electrostatic induction differ from charging by friction?**

❖ **Answer:****◆ 1. Definition of Charging by Friction:**

- When two different objects are rubbed together, electrons are transferred from one to the other.
- One becomes positively charged, and the other becomes negatively charged.

**◆ 2. Example of Charging by Friction:**

- Rubbing a plastic rod with wool transfers electrons from wool to rod.
- The plastic rod becomes negatively charged; wool becomes positively charged.

**◆ 3. Definition of Electrostatic Induction:**

- A charged object is brought close to a neutral conductor without touching it.
- This causes redistribution of charges inside the conductor due to the electric field.

**◆ 4. Earthing in Induction:**

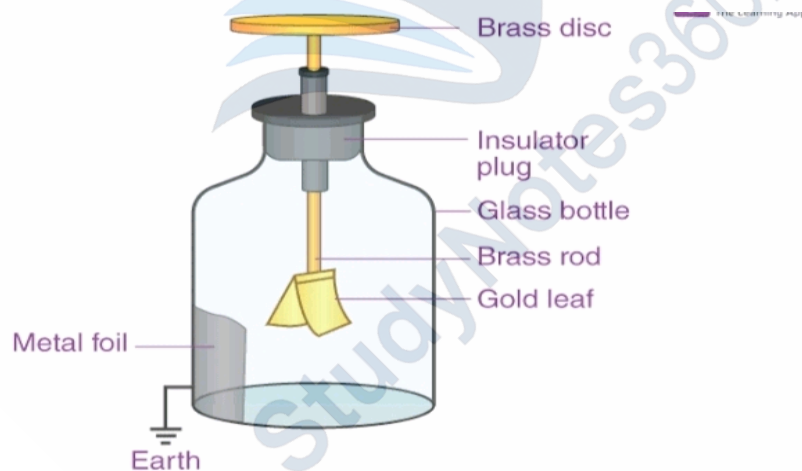
- If the conductor is connected to Earth, excess charges leave or enter.

- After removing the Earth and the charged object, the conductor becomes charged.

### ◆ 5. Key Differences:

- Friction involves rubbing and direct contact, whereas
- Induction involves no contact, only influence of electric field.

☀ Q13.4. What is a gold leaf electroscope? Discuss its working principle with a labeled diagram.



◆ Answer:

### ◆ 1. Definition:

A gold leaf electroscope is a device used to detect electric charge and check whether a material is a

The page features decorative illustrations of white flowers with green leaves in the corners and a butterfly on the left side. A large, faint watermark of a bird is visible in the background.

conductor or insulator.

## ◆ 2. Construction:

It consists of:

- A metallic rod inserted into a glass jar through an insulator (usually a cork).
- A metallic disk (or knob) at the top.
- Two thin gold leaves attached at the bottom inside the jar.
- The jar prevents air disturbance.

## ◆ 3. Working Principle:

- When a charged object is brought near the disk:
- Electrons in the rod redistribute due to electrostatic induction.
- Like charges move to the gold leaves.
- Both leaves get same charge and repel each other.

## ◆ 4. Amount of Divergence:

- The greater the charge, the more the leaves diverge.

- If the charged object is removed, the leaves slowly collapse.

### ◆ 5. Uses of Gold Leaf Electroscope:

- To detect presence of charge.
- To check polarity (positive or negative) of the charge.
- To identify conductors and insulators.

eaves, cork, glass jar.

☀ Q13.5. Suppose you have a glass rod which becomes positively charged when you rub it with wool. Describe how would you charge the electroscope: (i) negatively (ii) positively.

◆ Answer:

We can use a positively charged glass rod to charge the electroscope by electrostatic induction. Let's see both methods:

### ◆ (i) To Charge the Electroscope Negatively:

1. Bring the positively charged glass rod near the metal disk of the neutral electroscope without

The page is decorated with various illustrations: a white butterfly with black markings on its wings is on the left side. There are several green and white flowers with long, narrow leaves, some in the top corners and some at the bottom. The background is a light green color with a subtle pattern of leaves and flowers.

touching it.

2. The positive rod attracts electrons from the leaves and rod upwards toward the disk.

3. This leaves extra negative charge at the bottom (in the leaves).

4. Now touch the metal disk with your finger (earthing).

5. Electrons flow from Earth to the disk to neutralize the positive effect.

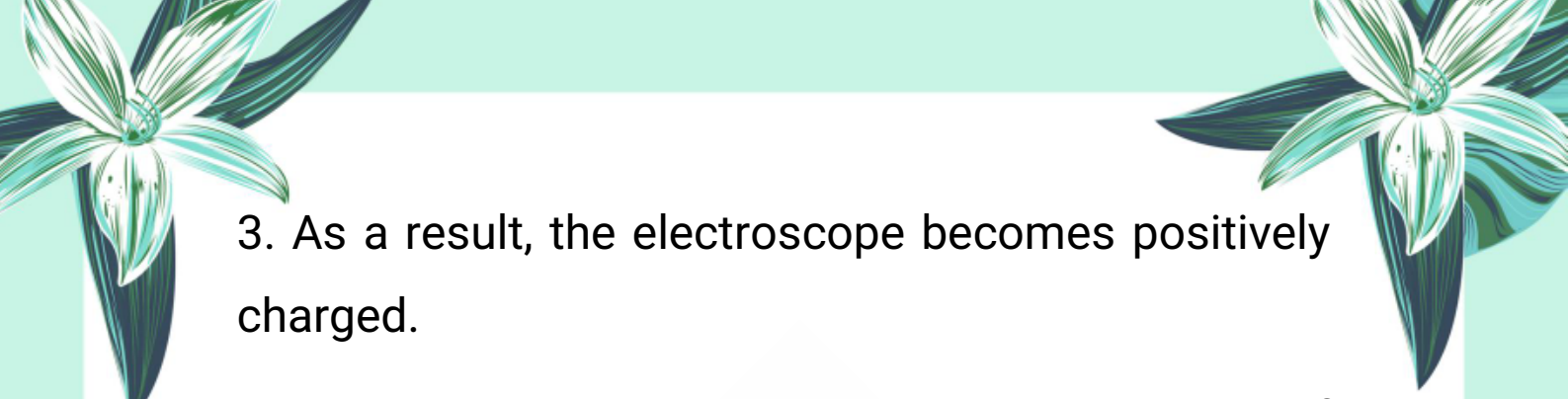
6. Remove your finger first, then remove the glass rod.

7. The electroscope is now negatively charged, and the gold leaves diverge due to repulsion of like charges.

◆ **(ii) To Charge the Electroscope Positively:**


1. Bring the positively charged glass rod in direct contact with the metal disk of the electroscope.

2. Electrons from the electroscope flow into the rod, leaving behind a deficiency of electrons.



3. As a result, the electroscope becomes positively charged.

4. The gold leaves diverge, indicating presence of like positive charges.



☀️ Q13.6. With the help of an electroscope, how can you find the presence of charge on a body?

❖ Answer:

An electroscope can detect whether a body is charged or not by observing the behavior of the gold leaves.

◆ **Steps to Detect Charge:**

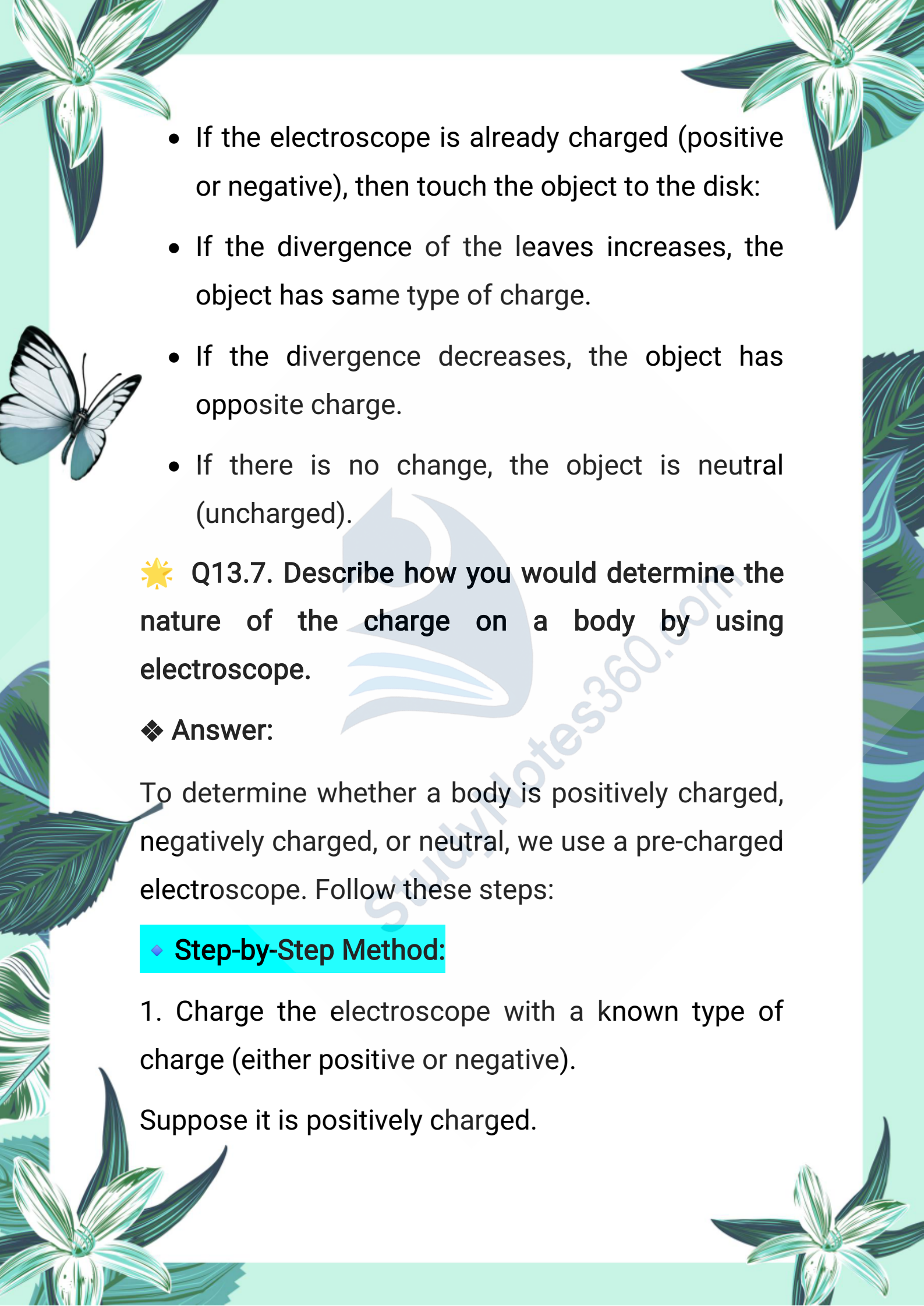
1. Bring the unknown body near the metallic disk of a neutral electroscope.

2. If the body is charged, it will induce opposite charges on the disk and similar charges on the gold leaves.

3. The gold leaves will repel each other and diverge, indicating that the object is charged.

◆ **Alternative Method:**



- 
- If the electroscope is already charged (positive or negative), then touch the object to the disk:
  - If the divergence of the leaves increases, the object has same type of charge.
  - If the divergence decreases, the object has opposite charge.
  - If there is no change, the object is neutral (uncharged).

☀ Q13.7. Describe how you would determine the nature of the charge on a body by using electroscope.

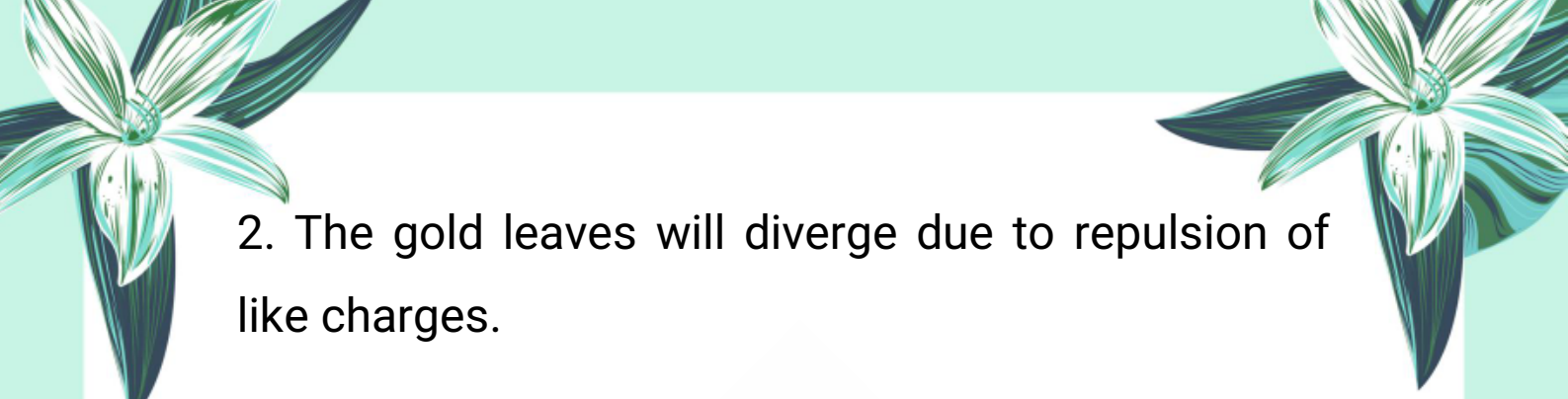
❖ Answer:

To determine whether a body is positively charged, negatively charged, or neutral, we use a pre-charged electroscope. Follow these steps:

◆ **Step-by-Step Method:**

1. Charge the electroscope with a known type of charge (either positive or negative).

Suppose it is positively charged.



2. The gold leaves will diverge due to repulsion of like charges.

3. Now, touch or bring the unknown object near the metallic disk of the electroscope.



◆ **Observe the Behavior of the Leaves:**

**If the leaves diverge more:**

- ⇒ The object has the same type of charge as the electroscope (positive in this case).
- If the leaves collapse or divergence decreases:
- ⇒ The object has opposite type of charge (negative).

**If there is no change:**

⇒ The object is neutral (uncharged).



**Summary:**

By observing the increase or decrease in leaf divergence, we can determine whether the unknown body is positively, negatively, or not charged.

☀ **Q13.8. Explain Coulomb's law of electrostatics and write its mathematical form.**





❖ **Answer:**

Coulomb's law tells us the amount of electrostatic force between two stationary electric charges.

**Statement:**



The force of attraction or repulsion between two point charges is:

- Directly proportional to the product of the magnitudes of both charges.
- Inversely proportional to the square of the distance between them.

**Mathematical Form:**

$$F = k \times (q_1 \times q_2) / r^2$$

**Where:**

F = Electrostatic force (in Newtons, N)

q<sub>1</sub> and q<sub>2</sub> = Magnitudes of the two charges (in Coulombs, C)

r = Distance between the charges (in meters, m)

k = Coulomb's constant

⇒ In air or vacuum:  $k = 9 \times 10^9 \text{ Nm}^2/\text{C}^2$



## Conditions for this Law:

- It only applies to point charges.
- Charges must be stationary.
- The medium must be air or vacuum unless stated otherwise.

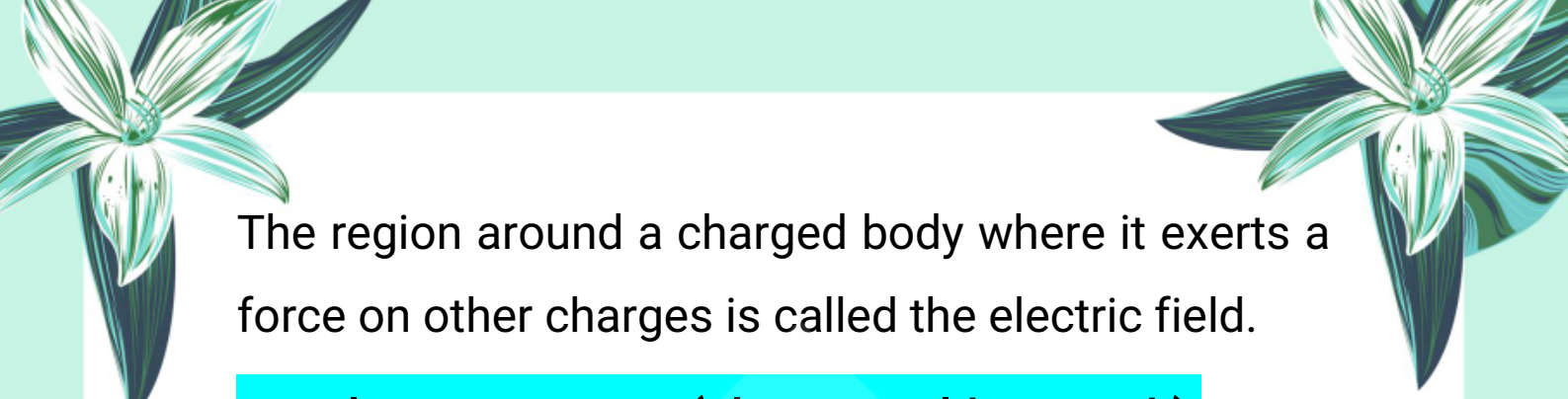
☀ 13.9. What is meant by electric field and electric intensity?

❖ Answer:

### ◆ Electric Field:


- The electric field is the space around a charged object in which it can exert an electric force on other charges.
- It is invisible.
- If you place another charge in this field, it will experience a force.
- It is represented by electric field lines that start from positive charges and end at negative charges.

👉 Definition:



The region around a charged body where it exerts a force on other charges is called the electric field.

◆ **Electric Intensity (Electric Field Strength):**



The electric intensity (also called electric field strength) is the force experienced by a unit positive charge placed in an electric field.

👉 **Definition:**

Electric intensity is the force acting per unit positive charge at a point in the electric field.

👉 **Formula:**

$$E = F / q$$

Where:

E = Electric intensity (N/C)

F = Force acting on the charge (in Newtons)



q = Magnitude of the test charge (in Coulombs)

☀ **13.10. Is electric intensity a vector quantity?**


**What will be its direction?**

◆ **Answer:**

- Yes, electric intensity is a vector quantity.
- 

- 
- 
- This means it has both magnitude and direction.

#### ◆ Direction of Electric Intensity:

- 
- It is always directed away from a positive charge.
  - It is always directed towards a negative charge.

#### ◆ Example:



- If you place a small positive test charge in the electric field, it will move in the direction of the electric field.
- If the source charge is positive, the test charge is pushed away.
- If the source charge is negative, the test charge is pulled toward it.

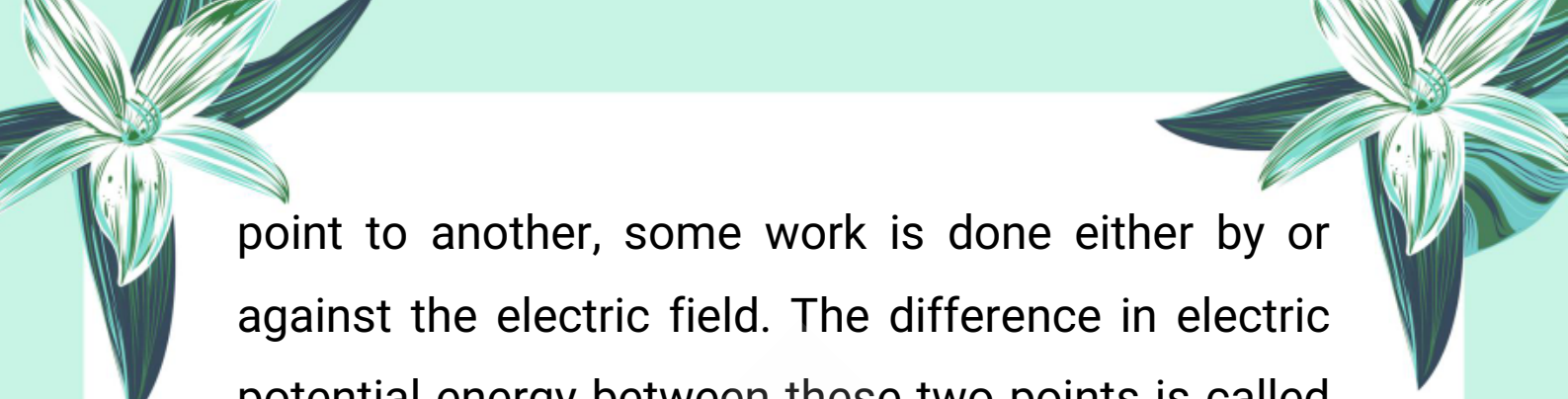
✨ 13.11: Define potential difference between two points. Also define its unit.

#### ◆ Answer:

### What is Potential Difference?


In an electric field, when a charge moves from one





point to another, some work is done either by or against the electric field. The difference in electric potential energy between these two points is called the potential difference.

◆ **Definition:**



Potential difference between two points is the work done in moving a unit positive charge from one point to the other in an electric field.

 **Mathematical Expression:**

$$V = W / q$$

Where:

V = Potential difference (Volt)

W = Work done or energy transferred (Joule)

q = Electric charge (Coulomb)

 **Unit of Potential Difference:**

The SI unit of potential difference is Volt (V).

> 1 Volt = 1 Joule / 1 Coulomb

**Meaning:**

If 1 joule of energy is used to move 1 coulomb of



charge, the potential difference is 1 volt.


### **Example to Understand:**

If a battery does 10 joules of work to move 2 coulombs of charge, then the potential difference is:

$$V = W / q = 10 \text{ J} / 2 \text{ C} = 5 \text{ volts}$$

### **Summary:**

Potential difference gives us an idea of how much energy per charge is transferred between two points in an electric circuit. It is what pushes the current in the circuit.

 **13.12:** Show that potential difference can be described as energy transfer per unit charge between two points.

 **Answer:**

 **Understanding the Concept:**

When a charged particle moves in an electric field, it either gains or loses energy. The energy gained or lost per unit charge is the potential difference.

 **Mathematical Proof:**



**We use the formula:**

$$V = W / q$$

**Where:**

V = Potential difference (in volts)

W = Energy transferred (in joules)

q = Charge moved (in coulombs)

◆ **Rearranging Formula:**

$$W = V \times q$$

**Meaning:**

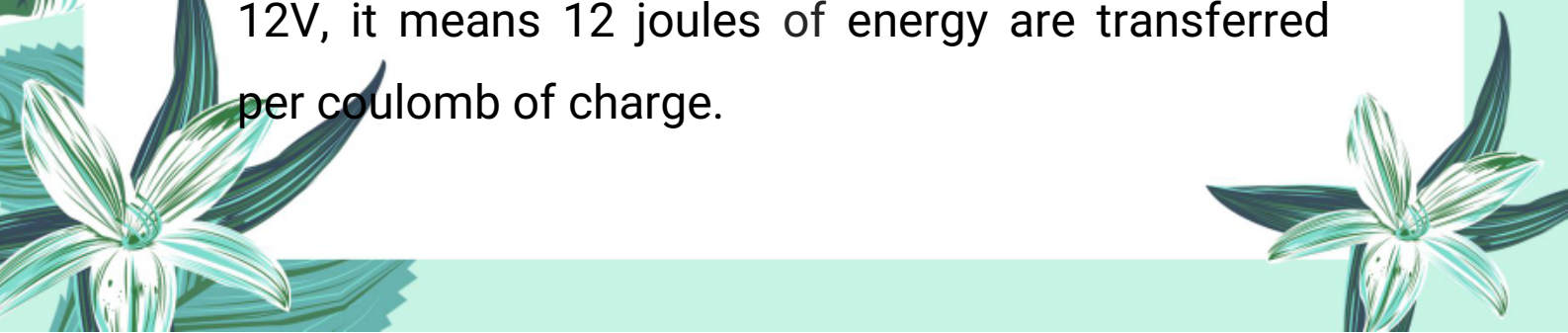
The total energy transferred (W) depends on how much charge (q) moves and the potential difference (V) between the points.

 **Interpretation:**

This equation shows that potential difference (V) is nothing but:

> Energy transferred per unit charge

**So,** when we say there is a potential difference of 12V, it means 12 joules of energy are transferred per coulomb of charge.





 **Example:**


If a 9V battery is connected and it moves 3 coulombs of charge, energy transferred is:

$$> W = V \times q = 9V \times 3C = 27 \text{ Joules}$$



 **Summary:**

We can clearly say that potential difference describes how much electrical energy is transferred per unit charge, and it plays a key role in driving current in an electric circuit.



 **13.13: What do you mean by the capacitance of a capacitor? Define units of capacitance.**

 **Answer:**

**What is a Capacitor?**

A capacitor is a device that is used to store electric charge. It consists of two metallic plates separated by an insulating material called dielectric.

 **Definition of Capacitance:**

- Capacitance is the ability of a capacitor to store electric charge per unit potential
- 
- 

difference.

- It measures how much charge (Q) a capacitor can store for a given voltage (V).

### **Formula for Capacitance:**

Capacitance (C) is defined by the formula:

$$C = Q \div V$$

Where:

C = Capacitance

Q = Charge stored

V = Potential difference across plates

### **Unit of Capacitance:**

The SI unit of capacitance is Farad (F).

> 1 Farad = 1 Coulomb per Volt

**But this is a very large unit. In practical use, we often use:**


microfarad ( $\mu\text{F}$ ) =  $10^{-6}$  F

nanofarad (nF) =  $10^{-9}$  F

picofarad (pF) =  $10^{-12}$  F

 **Summary:**

Capacitance tells us how efficiently a capacitor can store charge. Larger the capacitance, more charge it can store at the same voltage.

 **13.14:** Derive the formula for the equivalent capacitance for a series combination of a number of capacitors. **Answer:** **Capacitors in Series Combination:**

When capacitors are connected end-to-end (one after another), they are said to be in series combination.

Let's consider three capacitors:

$C_1$ ,  $C_2$ , and  $C_3$  connected in series.

 **Key Properties in Series Combination:**

1. The charge ( $Q$ ) on each capacitor is the same.
2. The total voltage ( $V$ ) across the combination is the sum of voltages across each capacitor.

So,

$$V = V_1 + V_2 + V_3$$

And using the formula  $C = Q \div V$ , we rewrite voltage as:

$$V_1 = Q \div C_1, V_2 = Q \div C_2, V_3 = Q \div C_3$$

### Total Voltage Across Series Capacitors:

$$V = Q \div C_1 + Q \div C_2 + Q \div C_3$$

Now,

$$V = Q \times (1/C_1 + 1/C_2 + 1/C_3)$$

We also know:

$$V = Q \div C_{eq}$$

Equating both:

$$Q \div C_{eq} = Q \times (1/C_1 + 1/C_2 + 1/C_3)$$

Divide both sides by Q:

$$1 \div C_{eq} = 1 \div C_1 + 1 \div C_2 + 1 \div C_3$$

### Final Formula:

The reciprocal of equivalent capacitance is equal to the sum of reciprocals of individual capacitances in series.

**That is:**

$$1/C_{eq} = 1/C_1 + 1/C_2 + 1/C_3$$

 **Summary:**

In a series combination, the equivalent capacitance is always less than the smallest individual capacitance.

 **Q13.15: Discuss different types of capacitors.**

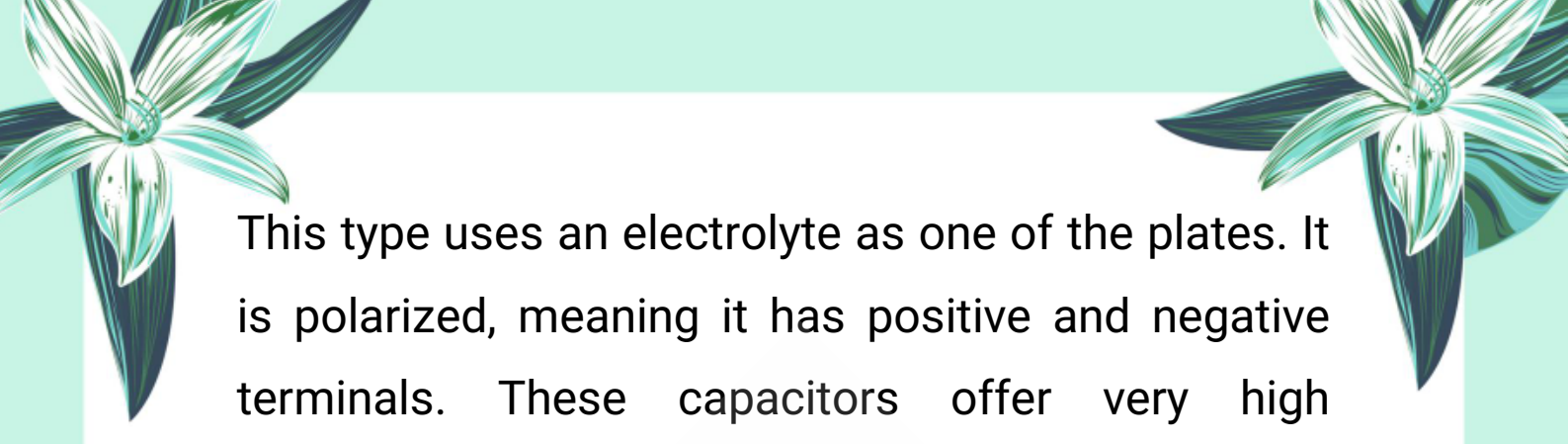
 **Answer:**

Capacitors are available in different types depending on their construction, materials used, size, and application. Each type has its own specific purpose and characteristics. Below are the commonly used types of capacitors:

 **1. Paper Capacitor:**

These capacitors use paper as the dielectric material placed between the metal plates. They are cheap and reliable and were commonly used in older electrical devices. However, they are now replaced by more efficient types.

 **2. Electrolytic Capacitor:**



This type uses an electrolyte as one of the plates. It is polarized, meaning it has positive and negative terminals. These capacitors offer very high capacitance and are widely used in power supply circuits and audio equipment.



### ◆ 3. Ceramic Capacitor:

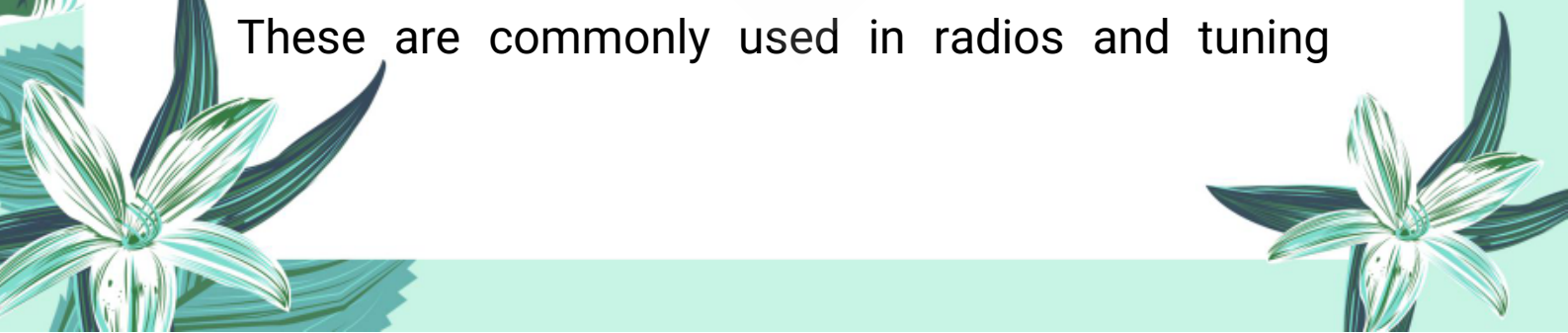
These are non-polarized capacitors that use ceramic material as the dielectric. They are small in size, cheap, and widely used in electronic circuits, especially in high-frequency applications.

### ◆ 4. Mica Capacitor:

These use mica as the dielectric material. They are known for their stability, accuracy, and long life. Mica capacitors are used in devices where precision is important, such as radio transmitters and measuring instruments.

### ◆ 5. Variable Capacitor:


Unlike fixed capacitors, variable capacitors can change their capacitance by rotating or sliding a dial. These are commonly used in radios and tuning



circuits.

### **Summary:**

Different types of capacitors are designed to suit specific purposes like size, frequency, voltage rating, and accuracy. The selection depends on the application and performance requirement.

 **Q13.16: What is the difference between variable and fixed type capacitor?**

### **Answer:**

Capacitors can be broadly categorized into two types based on whether or not their capacitance can be changed. These are fixed capacitors and variable capacitors.

#### **Fixed Capacitor:**

A fixed capacitor has a constant value of capacitance that cannot be changed. Once manufactured, its capacitance remains unchanged during use.

**Examples include:** ceramic, electrolytic, and mica capacitors. These are used where a fixed amount of

energy storage or filtering is needed in the circuit.

### ◆ Variable Capacitor:

- A variable capacitor is designed so that its capacitance can be adjusted manually or mechanically. This is usually done by rotating a knob or a dial that changes the overlapping area of plates or the distance between them.
- These are used in devices where tuning is required, such as in radio receivers, transmitters, and oscillators.

### 🔍 Key Difference:

A fixed capacitor stores a constant charge, while a variable capacitor allows the user to adjust the capacitance as needed during operation.

### 🔍 Summary:

Fixed capacitors are used in most general circuits, while variable capacitors are preferred in systems requiring manual control over the charge storing capacity, such as in tuning and filtering.

🌟 Q13.17: Enlist some uses of capacitors.

❖ **Answer:**

Capacitors are widely used in electrical and electronic devices due to their ability to store and release electric charge. Below are some of the most common uses of capacitors:

❖ **1. Energy Storage:**

Capacitors are used to store electrical energy and release it when needed. They can supply power temporarily when batteries are disconnected or when circuits need extra energy.

❖ **2. Filtering in Power Supplies:**


In power supply circuits, capacitors are used to smooth out fluctuations in voltage. They filter out unwanted AC signals from the DC output.

❖ **3. Timing Circuits:**

Capacitors are combined with resistors to form RC (resistor-capacitor) circuits, which are used in timers, oscillators, and delay circuits.

❖ **4. Tuning Radios:**

Variable capacitors are used to tune radio

The page is decorated with various illustrations: a large white flower with green leaves in the top left and bottom left corners; a white butterfly with black markings on its wings in the middle left; and a large green leaf in the middle right. The background is a light green color.

frequencies by adjusting the resonant frequency of circuits.

#### ◆ 5. Signal Coupling and Decoupling:

Capacitors are used to couple signals from one stage of an amplifier to another and to block DC components while allowing AC signals to pass.

#### ◆ 6. Motor Starters:

In single-phase electric motors, capacitors provide a starting torque and improve the efficiency of the motor.

#### ◆ 7. Flash Circuits in Cameras:

Capacitors charge up and then release energy suddenly to produce a bright flash of light in cameras.

☀ Q13.18: Discuss one application of static electricity.

◆ Answer:

One important application of static electricity is in the electrostatic paint spraying process.



## ◆ **Electrostatic Paint Spraying:**


This technique is widely used in automobile and furniture industries to apply paint efficiently and evenly.



## ◆ **Working Principle:**

- In this method, the paint particles are electrically charged, usually with a negative charge, as they come out of the nozzle of a spray gun. The object to be painted is given an opposite charge, usually positive, or is grounded.
- Due to the electrostatic attraction between opposite charges, the paint particles are attracted and stick to the surface of the object uniformly.

## ◆ **Advantages:**

- Less wastage of paint
  - Even and smooth coating
  - Can reach hidden corners and curves
  - Efficient and cost-effective
- 

 **Summary:**

**Electrostatic** paint spraying is a practical example of static electricity where the force between charged particles is used to apply paint efficiently, saving both material and time.

 **Q13.19: What are hazards of static electricity?** **Answer:**

While static electricity has many useful applications, it can also pose serious hazards, especially in certain environments. The dangers arise due to sudden discharges of static charge, which can cause sparks, fires, or even explosions.

 **Major Hazards of Static Electricity:** **1. Fire and Explosion in Fuel Industries:**

- In places like petrol stations, aircraft refueling, or chemical factories, the movement of flammable liquids can generate static charges.
- A spark discharge from static electricity can ignite vapors, leading to fires or explosions.

A decorative background with light green and blue tones. It features stylized flowers in the corners and a butterfly on the left side. A faint watermark of a cat is visible in the center.

## ◆ 2. Damage to Electronic Components:

Sensitive electronic devices like microchips or integrated circuits (ICs) can be damaged by electrostatic discharge (ESD). Even a tiny spark invisible to the eye can destroy internal circuits.

## ◆ 3. Danger in Hospitals (Oxygen-rich environments):

Static discharge near oxygen cylinders or equipment can cause fire, as oxygen supports rapid combustion.

## ◆ 4. Shock to Human Body:

When a person builds up static charge (e.g., by walking on a carpet), touching a metal object can give a mild electric shock. Though usually harmless, it can be dangerous while handling delicate equipment or in explosive environments.

## ◆ 5. Risk in Industrial Processes:

In industries involving powdered substances or fine particles, static electricity can cause dust explosions or attract particles to unwanted

surfaces.

### ✓ Precautions to Avoid Hazards:

- Use earthing wires to discharge excess charge.
- Install humidifiers, as dry air increases static buildup.
- Workers should wear anti-static clothing and shoes.
- Use conductive flooring and grounded equipment.

## CONCEPTUAL QUESTIONS:

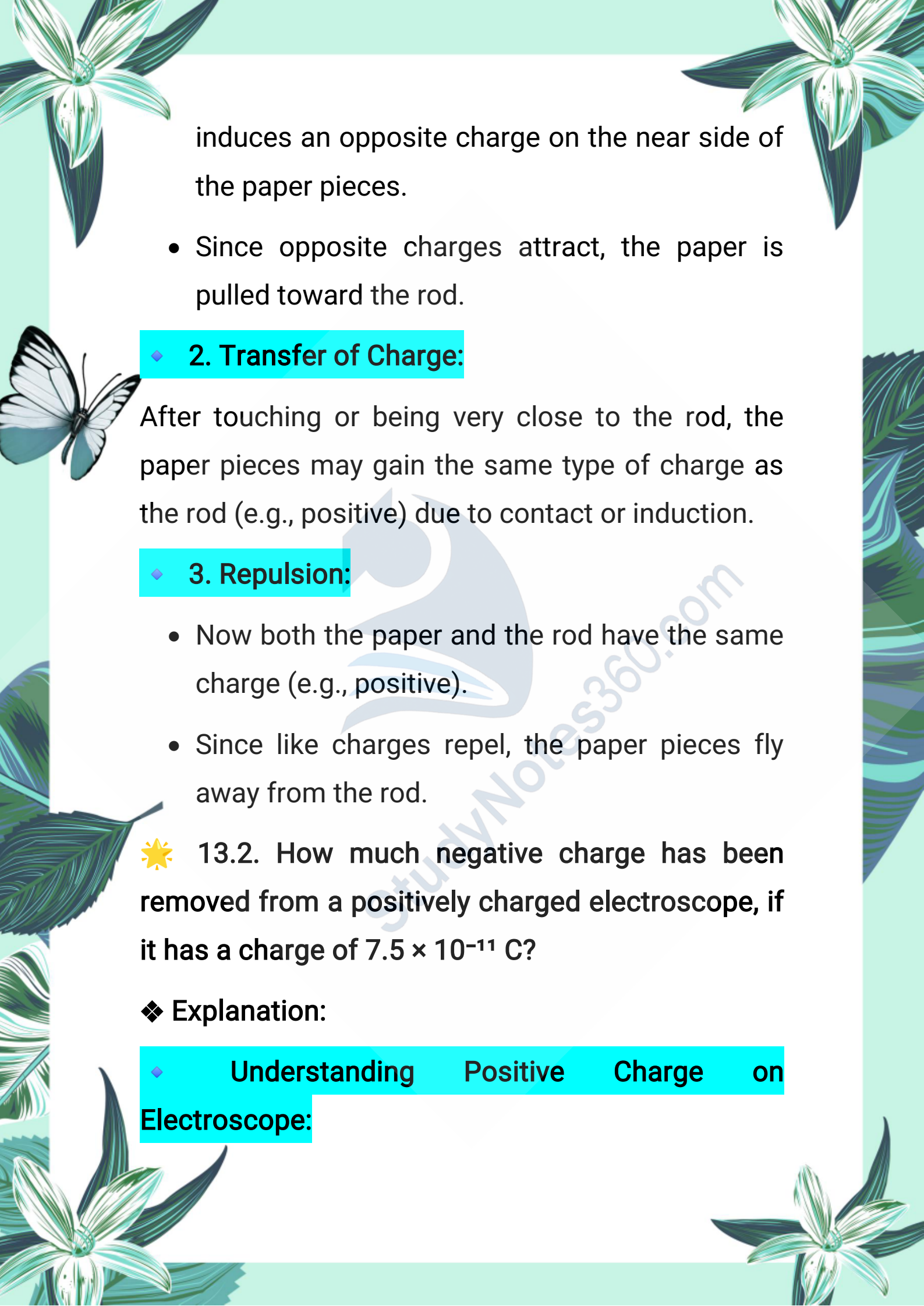
☀ 13.1. An electrified rod attracts pieces of paper. After a while these pieces fly away! Why?

### ❖ Explanation:

When a charged (electrified) rod is brought near small pieces of paper, the following process occurs:

#### ◆ 1. Attraction due to Electrostatic Induction:

- The charged rod (e.g., positively charged)



induces an opposite charge on the near side of the paper pieces.

- Since opposite charges attract, the paper is pulled toward the rod.

## ◆ 2. Transfer of Charge:

After touching or being very close to the rod, the paper pieces may gain the same type of charge as the rod (e.g., positive) due to contact or induction.

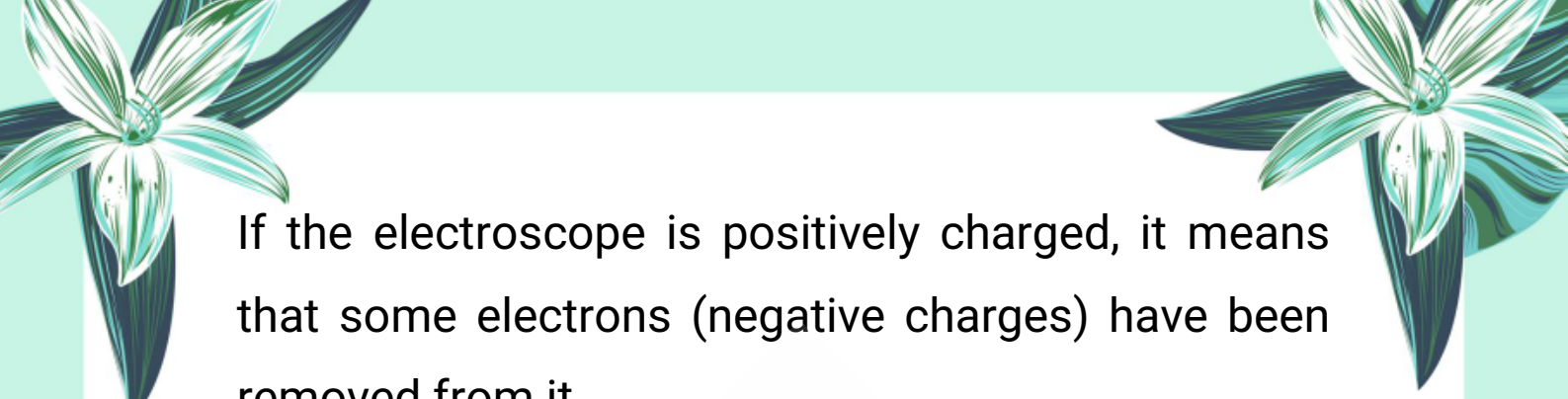
## ◆ 3. Repulsion:

- Now both the paper and the rod have the same charge (e.g., positive).
- Since like charges repel, the paper pieces fly away from the rod.

✨ 13.2. How much negative charge has been removed from a positively charged electroscope, if it has a charge of  $7.5 \times 10^{-11}$  C?

◆ Explanation:

◆ Understanding Positive Charge on Electroscope:



If the electroscope is positively charged, it means that some electrons (negative charges) have been removed from it.


So, the amount of negative charge removed = positive charge left on the electroscope.



 **Given:**

Total charge on electroscope =  $+7.5 \times 10^{-11} \text{ C}$

 **Answer:**

 The amount of negative charge removed =  $7.5 \times 10^{-11} \text{ C}$

This is because removing negative charge (electrons) results in an equivalent positive charge being left behind.

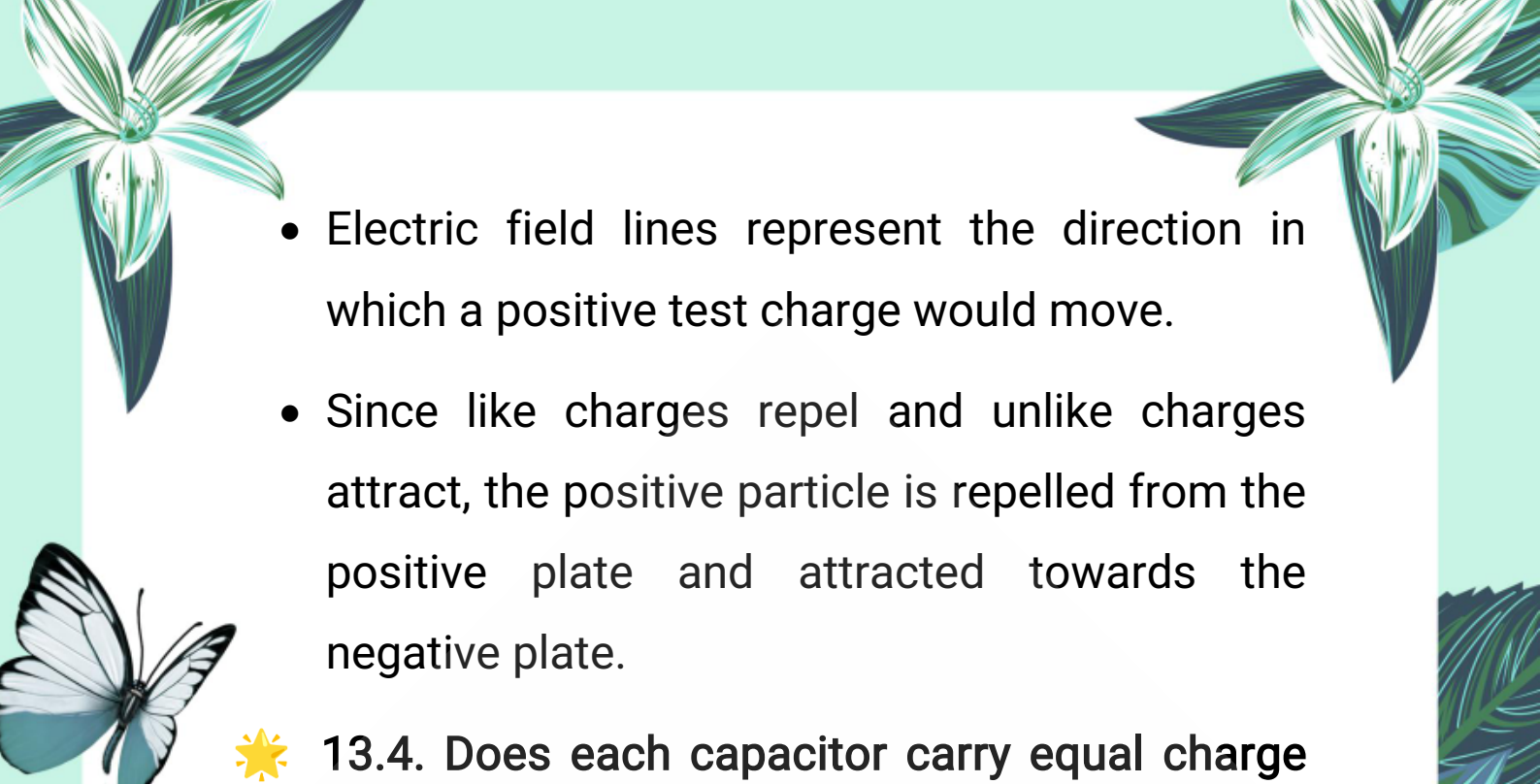
 **13.3. In what direction will a positively charged particle move in an electric field?**


 **Explanation:**

A positively charged particle always moves in the direction of the electric field lines.

 **Reason:**



- 
- Electric field lines represent the direction in which a positive test charge would move.
  - Since like charges repel and unlike charges attract, the positive particle is repelled from the positive plate and attracted towards the negative plate.



☀ 13.4. Does each capacitor carry equal charge in series combination? Explain.

❖ **Explanation:**

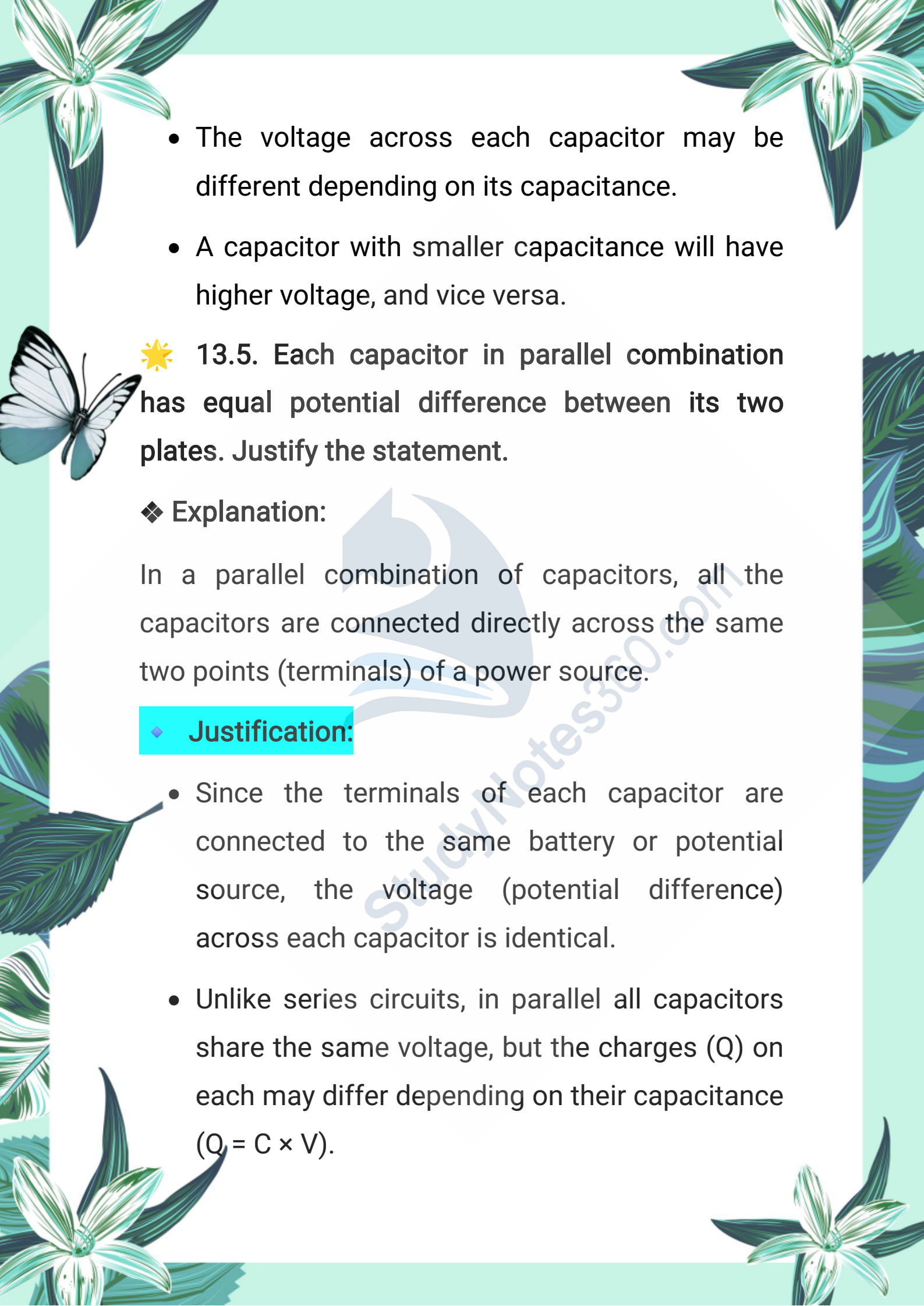
Yes, in a series combination, each capacitor carries the same amount of charge.

◆ **Why?**

- In a series circuit, the same current flows through all components.
- When capacitors are connected in series, they are like a single path for charge flow.
- Therefore, the charge ( $Q$ ) on all capacitors is equal, regardless of their capacitance.

🧪 **However:**



- 
- The page is decorated with various illustrations: a large white flower with green leaves in the top left and bottom left corners; a white butterfly with black markings on its wings on the left side; and a large green leaf on the right side. The background is a light green color.
- The voltage across each capacitor may be different depending on its capacitance.
  - A capacitor with smaller capacitance will have higher voltage, and vice versa.

☀ 13.5. Each capacitor in parallel combination has equal potential difference between its two plates. Justify the statement.

❖ **Explanation:**

In a parallel combination of capacitors, all the capacitors are connected directly across the same two points (terminals) of a power source.

◆ **Justification:**


- Since the terminals of each capacitor are connected to the same battery or potential source, the voltage (potential difference) across each capacitor is identical.
- Unlike series circuits, in parallel all capacitors share the same voltage, but the charges ( $Q$ ) on each may differ depending on their capacitance ( $Q = C \times V$ ).




 **Example:**

If a 12V battery is connected across three capacitors in parallel, each capacitor will have 12V across its plates, no matter what their capacitances are.

 **Summary:**

 All capacitors in a parallel combination have the same potential difference across them because they are connected across the same two points of the circuit.

 **13.6.** Perhaps you have seen a gasoline truck trailing a metal chain beneath it. What purpose does the chain serve?

 **Explanation:**

The metal chain trailing under a gasoline truck serves an important safety purpose – it discharges static electricity to the Earth.

 **Why is this needed?**

- While moving, friction between the truck's tires and the road causes a build-up of static charge


on the truck body.


- Gasoline is highly flammable, and a spark caused by static electricity can ignite gasoline vapors and cause an explosion or fire.

### **Function of the Chain:**

- The metal chain touches the ground and allows excess static charge to flow safely into the Earth (a process called earthing or grounding).
- This prevents charge buildup and reduces the risk of sparks or fire.

### **Summary:**

 The chain provides a path for static charges to discharge safely into the ground, preventing dangerous sparks that could ignite flammable substances like gasoline.

 **13.7.** If a high-voltage power line fell across your car while you were in the car, why should you not come out of the car?

### **Explanation:**

If a high-voltage power line falls on your car, the



car's metal body becomes electrically charged.

**⚠ Why it's dangerous to come out:**

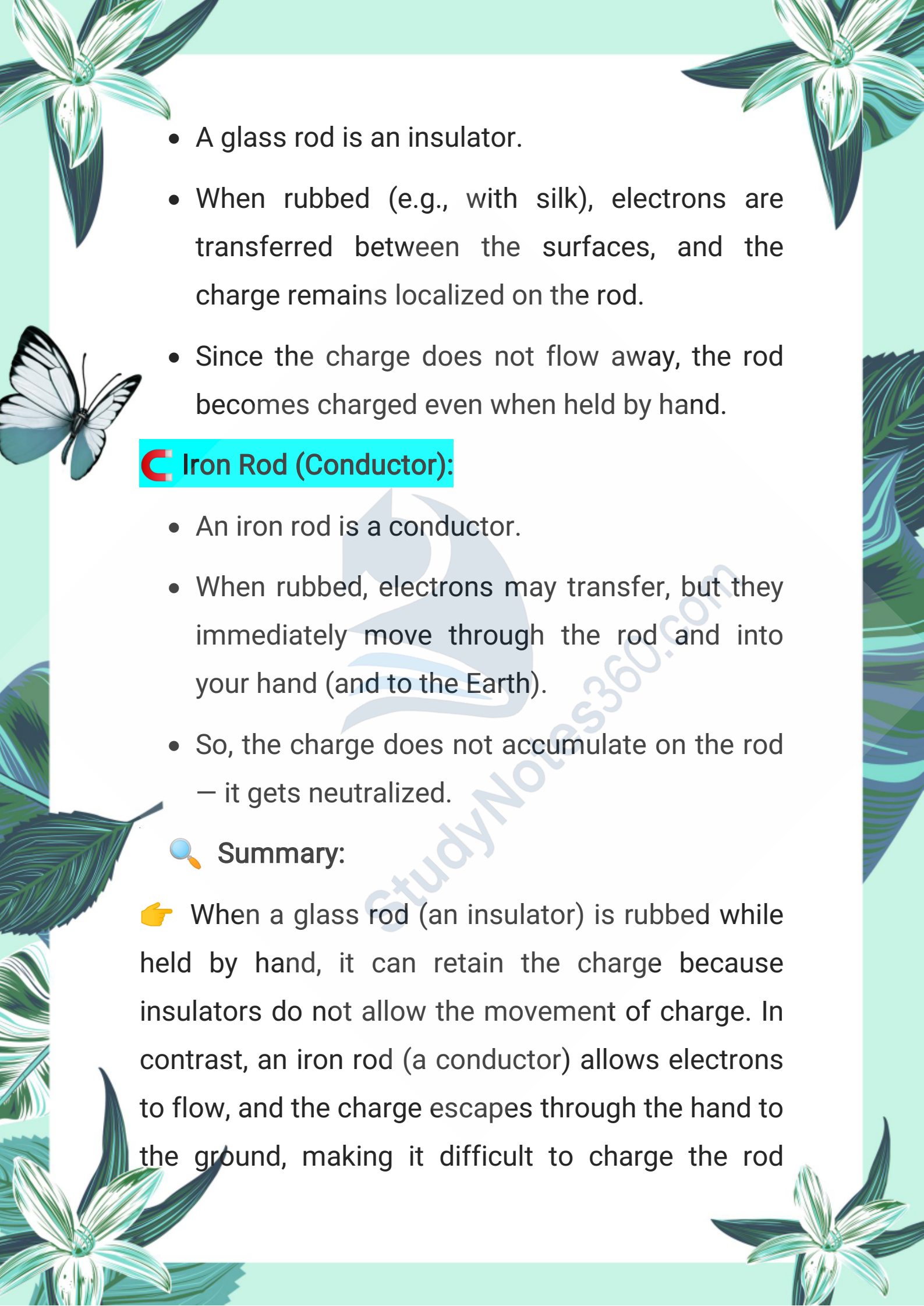
- The metal body of the car conducts electricity.
- When you're inside the car, you're safe because you and the inside of the car are at the same electric potential (like a Faraday cage).
- But if you step out, your body might touch the ground while still in contact with the car.
- This creates a potential difference between your body (touching the car) and the Earth (your feet), allowing electric current to pass through you, which could be fatal.

**☀ 13.8. Explain why a glass rod can be charged by rubbing when held by hand, but an iron rod cannot be charged by rubbing, if held by hand?**

**❖ Explanation:**

Charging by rubbing is known as charging by friction, and its success depends on whether the material is a conductor or insulator.


**🔧 Glass Rod (Insulator):**

- 
- A decorative border surrounds the page, featuring stylized green and white flowers in the corners and a white butterfly with black markings on the left side.
- A glass rod is an insulator.
  - When rubbed (e.g., with silk), electrons are transferred between the surfaces, and the charge remains localized on the rod.
  - Since the charge does not flow away, the rod becomes charged even when held by hand.

### **C** Iron Rod (Conductor):

- An iron rod is a conductor.
- When rubbed, electrons may transfer, but they immediately move through the rod and into your hand (and to the Earth).
- So, the charge does not accumulate on the rod – it gets neutralized.

#### Summary:


 When a glass rod (an insulator) is rubbed while held by hand, it can retain the charge because insulators do not allow the movement of charge. In contrast, an iron rod (a conductor) allows electrons to flow, and the charge escapes through the hand to the ground, making it difficult to charge the rod



while holding it.



**Note:**



This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further exploration of the subject. The content has been carefully selected to support effective learning and inspire students to engage with the topic more deeply.

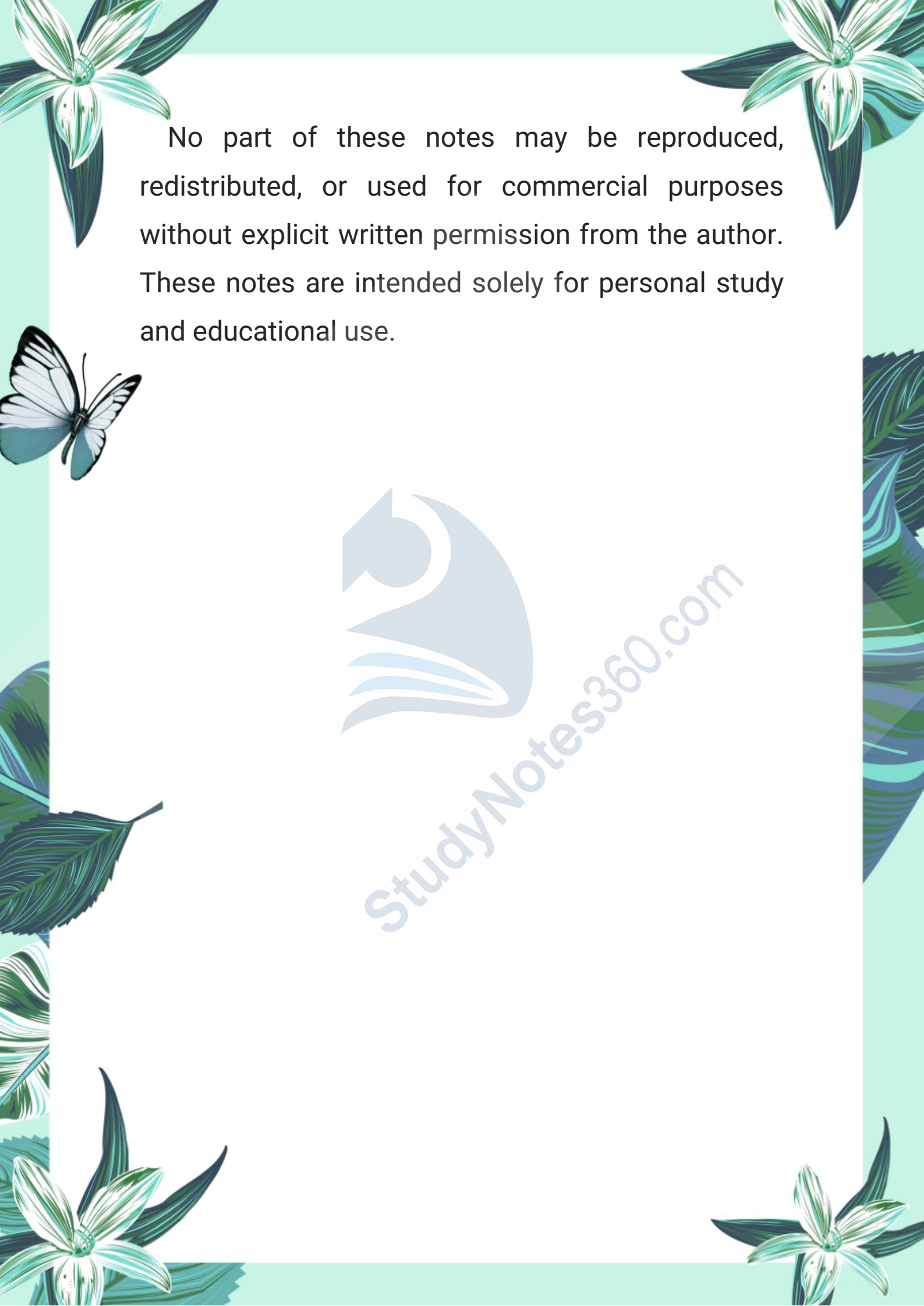
**Author: Muhammad Asghar**

**Purpose:** To contribute to education by offering insightful, valuable content that enhances learning and understanding.

**Copyright & Usage Policy**

© 2025 Muhammad Asghar. All rights reserved.



The page features a light green background with decorative illustrations of flowers and a butterfly. In the top-left and top-right corners, there are stylized flowers with white petals and green leaves. In the bottom-left and bottom-right corners, there are more flowers and green foliage. A butterfly with white wings and black markings is positioned on the left side. The text is centered in the upper half of the page.

No part of these notes may be reproduced, redistributed, or used for commercial purposes without explicit written permission from the author. These notes are intended solely for personal study and educational use.



StudyNotes360.com