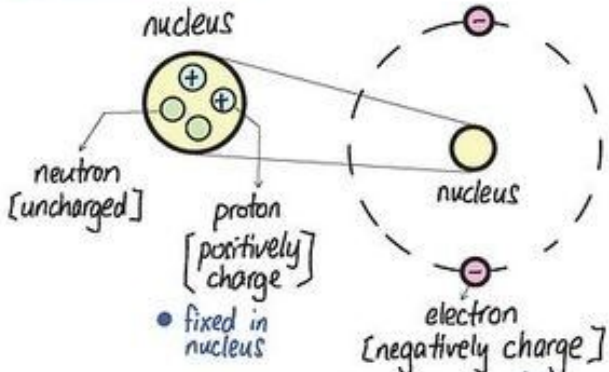
STATIC ELECTRICITY
SUMMARY

1 ELECTRIC CHARGE (Q)

SI unit : coulumbs (C)

- positive charge [protons]
  - cannot be moved
- negative charge [electrons]
  - can be moved or transferred



NOTE! 1C of charge ≠ 1 electrons !!!

- The amount of charge carried by an electron or a proton is 1.6×10^{-19} C.
- In 1C of charge, there are

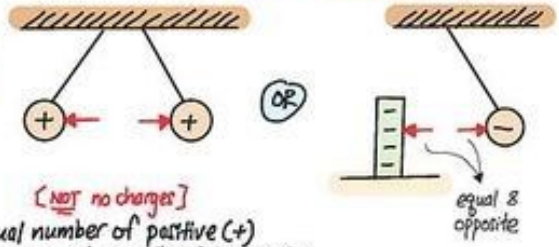
$$\frac{1C}{1.6 \times 10^{-19} C} = 6.25 \times 10^{18} \text{ electrons}$$

- An atom is electrically neutral
  → equal no. of electrons and protons
- An atom becomes charged (ions) when :
  - electrons are removed → positively charged → + ions
  - electrons are added → negatively charged → − ions

2 LAWS OF ELECTROSTATICS

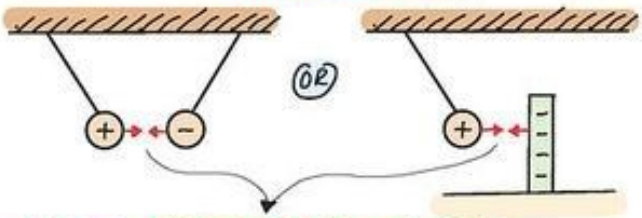
- LIKE CHARGES REPEL [+, +] or [−, −]
- UNLIKE CHARGES ATTRACT [+, −]

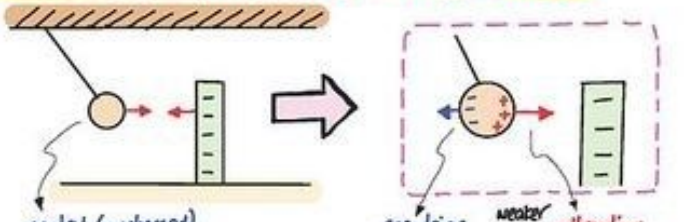
REPULSION : LIKE CHARGES ONLY



[NOT no charges]
equal number of positive (+) charges and negative (−) charges

ATTRACTION : UNLIKE CHARGES — OR — **CHARGED AND UNCHARGED [NEUTRAL] BODIES**



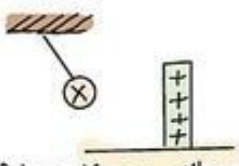


* REFER TO "CHARGED BODY NEAR A BODY" for details.

NOTE! ACTION - REACTION PAIR

- Attract or Repulsion forces always come in a pair
- they are equal & opposite

EXAMPLES :



Sphere X can either be negatively charged or neutral

Given X is charged, determine the charge on X, Y & Z.



X : positive [unlike charges attract]

Y : positive [like charges repel]

EVAN'S SPACE PHYSICS

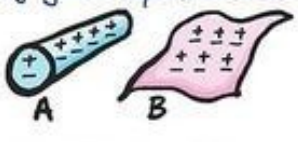
3 ELECTRICAL INSULATORS VS CONDUCTORS

[no mobile electrons]
- cannot conduct electricity, electrons are not able to move freely and are on the surface.

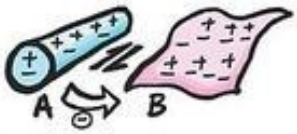
A. INSULATORS : CHARGING BY FRICTION

[assume given B becomes negatively charged after rubbing]

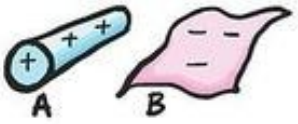
[e.g. glass, Perspex, silk, wool etc]



- **BEFORE RUBBING**
  - A and B are electrically neutral
  - i.e. both contain equal number of protons and electrons.



- **DURING RUBBING**
  - due to friction cause by rubbing
  - there is a transfer of electrons from A to B



- **AFTER RUBBING**
  - A loses electrons and becomes positively charged.
  - B gains electrons and becomes negatively charged.

- Different insulators have different affinities for electrons i.e. some gains electrons easily whereas some loses electrons easily.
- When rubbed, the atoms at their surface are disturbed. Only electrons from these atoms are transferred.

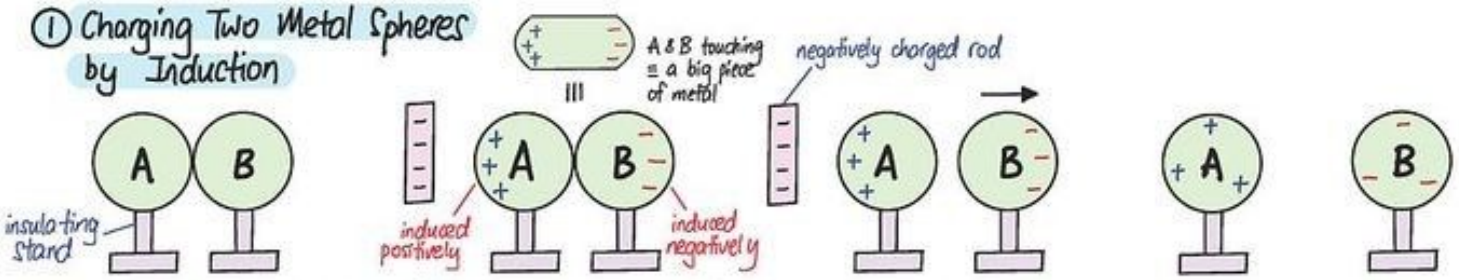
[no need to memorise which materials will become what charge when rubbed together]

[mobile electrons]
- can conduct electricity, electrons are able to move freely.

B. CONDUCTORS : CHARGING BY INDUCTION

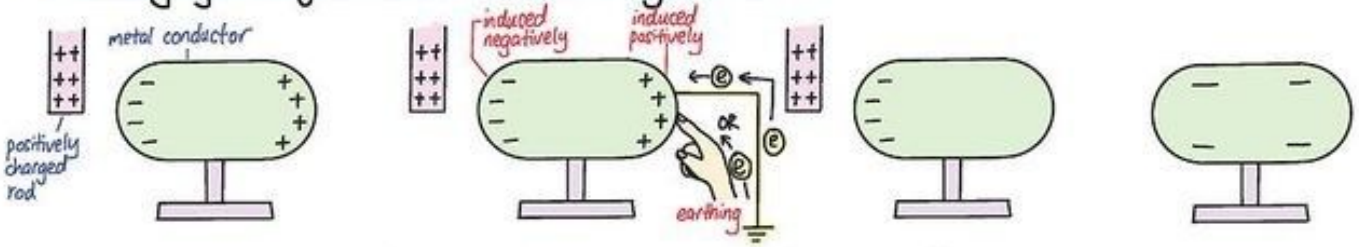
- Induction is the process of charging a conductor without contact between the conductor and the charging body.
- Conductors can be charged by induction, but not by friction, as mobile electrons can be easily transferred to and away from conductors.

① Charging Two Metal Spheres by Induction



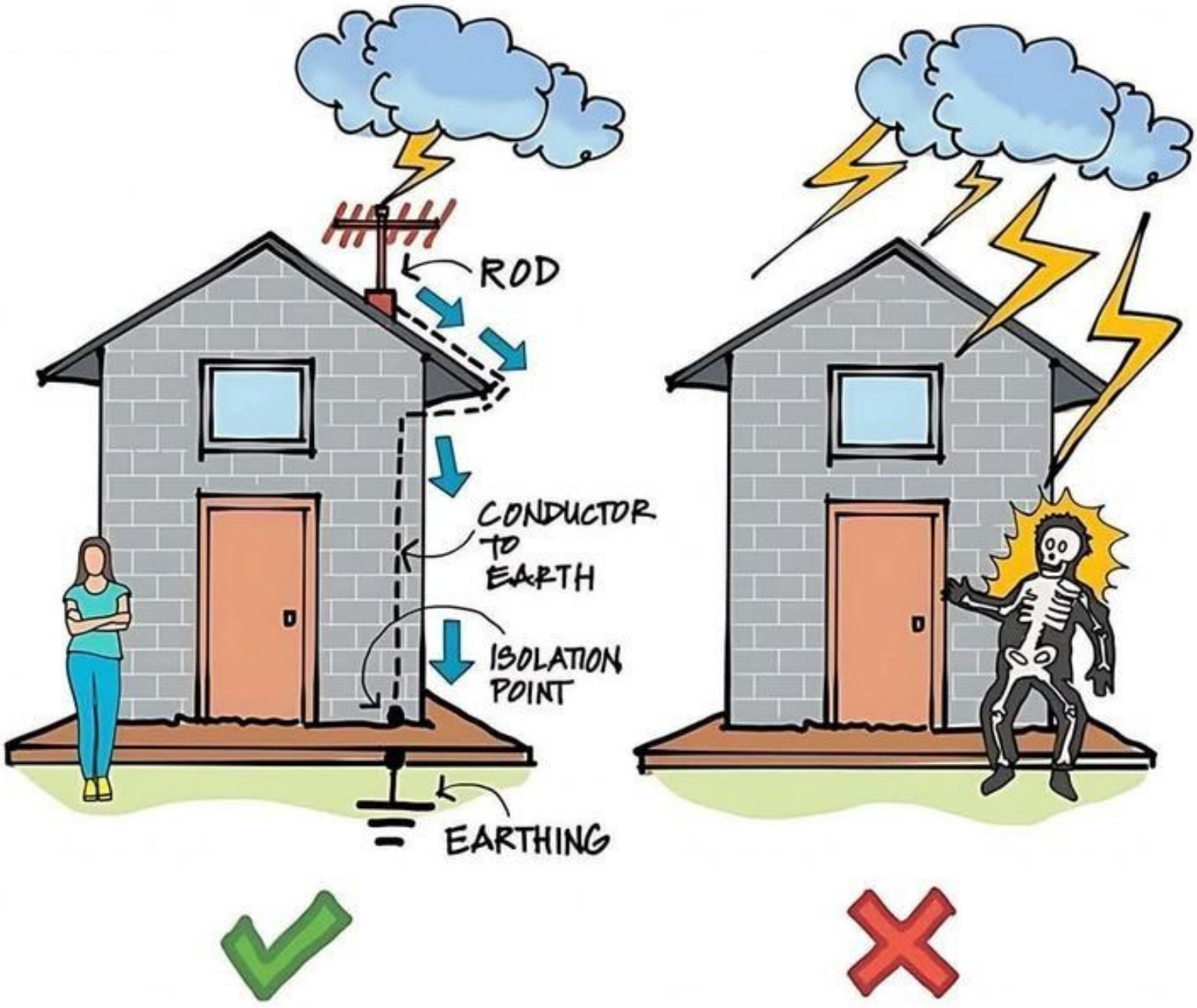
- 2 conductors (metal spheres) on insulating stands touching each other
- a negatively-charged rod near A
- electrons in both A & B repelled to right end of B.
- left of A induced positively
- right of B induced negatively
- A has excess +ve charges
- B has excess -ve charges
- with rod in place, pull B away from A
- A & B now have an equal number of opposite charges
- A is negatively charged
- B is positively charged
- A & B have been charged by induction.

② Charging a Single Metal Conductor by Induction



- bring a positively charged rod near metal conductor
- negative free electrons move towards the rod as unlike charges attract.
- left side induced negatively
- right side induced positively
- earth the positively-charged end of the conductor by touching with hand or a earth wire
- this neutralises the positive charges on the right side
- with rod still in place, remove hand or earth wire.
- remove rod
- excess negative charges redistribute throughout the conductor
- conductor is now negatively charged

LIGHTNING PROTECTION



What Causes Thunder and Lightning?

Lightning is an electrical discharge caused by a buildup of static electricity in clouds.



Thunder is the sound produced by the rapid heating and expansion of air by a lightning strike.

Lightning occurs within and between clouds and between the clouds and ground.

The typical purple-blue color of lightning comes from the ionization of nitrogen and oxygen in air.

sciencenotes.org

Lightning Safety Tips

How to protect yourself during lightning storms.

✓ Go Indoors

Move into a building or vehicle at the first sign of lightning.



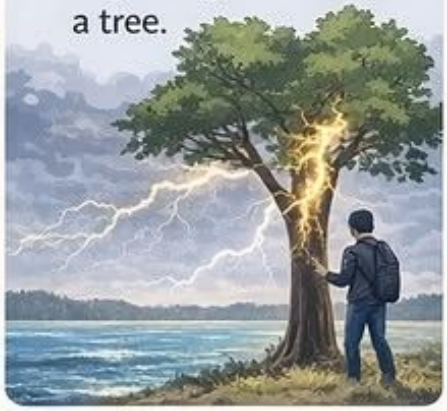
✓ Avoid Open Areas

Avoid fields, hilltops, and wide open spaces.



✓ Stay Away from Trees

Lightning can jump to you if you're under a tree.



✓ Stay Off Water

Get out of and away from water when storms threaten.



✓ Stay Away from Windows

Stay away from windows, doors, and porches.



✓ Avoid Electrical Equipment

Unplug electronics and avoid corded devices



✓ Don't Use Plumbing

Avoid sinks, showers, and bathtubs.



✓ Stay Inside Vehicles

Stay in a metal-topped vehicle. Close the windows.



✓ Wait 30 Minutes

Wait 30 minutes after the last thunder to go back outside.



REMEMBER: When thunder roars, **go indoors!**

CLASS NOTES

→ Charged and Uncharged Objects: If an object acquires the property of attracting light objects, it is said to be electrically charged or ‘charged’. But most of the substances are uncharged.

→ When an object is rubbed against another object, both of them may become charged. This happens because of transfer of charges from one object to another. Following table shows some objects which can get charged on rubbing.

→ Conductors: Metallic materials allow electric charges to flow through them and hence are called conductors. As electric charge can flow through them, so they do not get charged up on rubbing.

→ Insulators: Non-metallic materials do not allow electric charges to flow through them and hence are called insulators. As electric charge cannot flow through them, so they get charged up on rubbing.

→ Properties of Charged Objects:

- A charged object exerts a force not only on uncharged objects but also on charged objects.
- When the charge on two objects is similar, they repel each other.
- When the charges on two objects are different, they attract each other.
- Like charges repel each other, while unlike charges attract each other.
- Charges are of two kinds, viz. positive and negative.
- Charges are always produced in pairs. This means that when two objects charge each other, one of them becomes positively charged and another becomes negatively charged.

→ Methods of Charging Up:

- Charging by rubbing or friction.
- Charging by contact or conduction.
- Charging by induction.

→ Earthing: Putting a charged object in contact with the earth causes it to lose its charge. This process is called earthing. Earth wire is used in household wiring to protect appliances from damage and to prevent accidental electric shocks.

→ Electrical Induction: When a charged object is brought near an uncharged object, the charges get transferred to the uncharged object. The opposite charges move to the nearer end and the like charges move to the farther end of the uncharged object. This process of separation of charges is called electrical induction.

→ Charges in Nature:

→ Lightning and Thunder: The bigger and heavier droplets in clouds tend to acquire negative charges. The smaller and lighter droplets tend to acquire negative charges. The negative and positive charges in the clouds exert a strong force of attraction on each other. Air is a bad conductor of electricity. But when the charges accumulate in the clouds to a great extent, the charge is passed down to the earth. This is called electric discharge. We witness this in the form of a streak of light and this is called lightning. Lightning is also accompanied by thunder.

→ Advantages of Lightning: Lightning converts nitrogen into its oxide which then comes down along with rains. This helps in nitrogen fixation in soil. Lightning also helps in conversion of oxygen into ozone and thus helps in formation and maintenance of ozone layer in the atmosphere.

→ Lightning Conductor: This is a device which is installed on buildings to prevent the building from harmful effects of lightning. It is made up of a long flat strip of metal. A conducting wire is attached to it which goes deep into the ground. When lightning strikes, the electric charge is transferred via the metallic wire to the earth. Thus, building is saved from harmful effects of lightning. Lightning conductor can be seen on tall buildings, telephone towers, temples and churches.

→ Safety Precautions During Lightning
For a person caught outside in the open:

- At the first signs of lightning, immediately go to a safe place; such as a house or a building.
- Inside of car and bus is also safe; if the windows and doors are closed.
- Avoid open areas and sheds.

→ Stay away from trees.
For a person inside a house or building:

- Avoid contact with water.
- Do not use electric equipment’s. Electric lights can remain on.

- Do not use a phone with cord. Cordless phones are safer.

→ Charged body: When an object acquires the property of attracting light objects, it is called a charged body.

→ Electrical Induction: Separation of electric charges is called electrical induction.

→ Earthing: The electrical discharge to the earth is called earthing.

→ Lightning: The process of electric discharge from clouds to the earth is called lightning.

→ Thunder: The heavy sound; accompanied by lightning.

→ Conductors: Materials which allow electric charges to pass through them with ease.

→ Insulator: Material which does not allow electric charges to pass through it.

Material	Metallic/non-metallic	Electrical property
Plastic comb	Non-metallic	Gets charged
Metal comb	Metallic	Does not get charged
Drinking straw (plastic)	Non-metallic	Gets charged
Ebonite rod	Non-metallic	Gets charged
Glass rod	Non-metallic	Gets charged
Metal pan	Metallic	Does not get charged

SELF ASSESMENT QUESTION

Section A: Very Short Answer Questions (1 Mark Each)

1. What is an electric charge?
2. Name the two types of electric charges.

3. What is a charged object?
4. What is an uncharged (neutral) object?
5. What happens when a charged object is brought near small pieces of paper?
6. Define conductor.
7. Define insulator.
8. Give two examples of conductors.
9. Give two examples of insulators.
10. What is earthing?
11. What is lightning?
12. What is a lightning conductor?
13. What is static electricity?
14. Name the SI unit of electric charge.
15. What happens when two like charges are brought together?

Section B: Short Answer Questions (2 Marks Each)

16. Differentiate between charged and uncharged objects.
17. State two properties of electric charges.
18. Explain charging by friction with an example.
19. What happens when a glass rod is rubbed with silk?
20. Why does a plastic comb attract bits of paper after combing dry hair?
21. Why are metals generally good conductors?
22. Why are rubber and plastic used to cover electric wires?
23. What is the importance of earthing in buildings?
24. Explain how a lightning conductor protects a building.
25. Why should we avoid standing under a tree during lightning?

Section C: Competency-Based Questions

26. Riya rubs a balloon on her hair and sticks it to a wall.
- (a) Why does the balloon stick to the wall?
- (b) What charging method is involved?

27. Aman notices sparks while removing a woollen sweater in winter.
- (a) Why are sparks produced?
- (b) Which type of electricity is responsible?

28. During a thunderstorm, Mohan switches off all electrical appliances.
- Why is this a safe practice?

29. A school building has a lightning conductor installed on its roof.
- Explain its role during a thunderstorm.

30. A student touches a metal doorknob after walking on a carpet and feels a shock.
- Why does this happen?

31. A plastic ruler rubbed with wool attracts paper bits, but a wooden ruler does not.
- Explain the reason.

32. Why are electricians advised to wear rubber gloves while working?

33. During a storm, a person stands in an open field holding an umbrella.
- Is this safe? Give reasons.

34. A charged comb attracts neutral paper pieces.
- Explain the phenomenon.

35. Why are tall buildings more likely to be struck by lightning?

Section D: Descriptive Questions (3 Marks Each)

36. Explain the process of charging by friction.

37. Describe charging by conduction with an example.

38. Describe charging by induction with an example.

39. Write three properties of charged objects.

40. Explain the difference between conductors and insulators with examples.
41. What precautions should be taken during lightning?
42. Explain the working of earthing in electrical systems.
43. How is lightning produced in clouds?
44. Describe the structure of a lightning conductor.
45. Why is earthing necessary in homes and schools?

Section E: Long Answer Questions (5 Marks Each)

46. Explain the three methods of charging objects:
    - Friction
    - Conduction
    - Induction
47. Discuss the properties of electric charges. Include attraction, repulsion, and interaction between charges.
48. Write a detailed note on lightning:
    - Formation
    - Effects
    - Safety measures
49. Explain earthing and its importance in electrical safety. Give examples from daily life.
50. What is a lightning conductor? Draw a labelled diagram and explain how it protects buildings from lightning strikes.