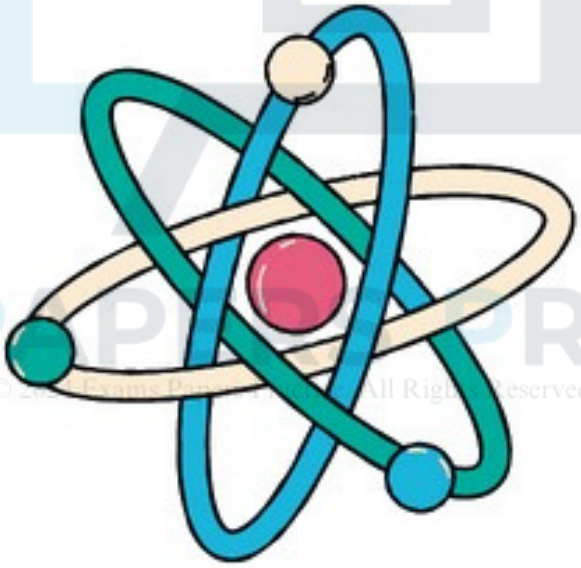
Chapter 17

Static Electricity

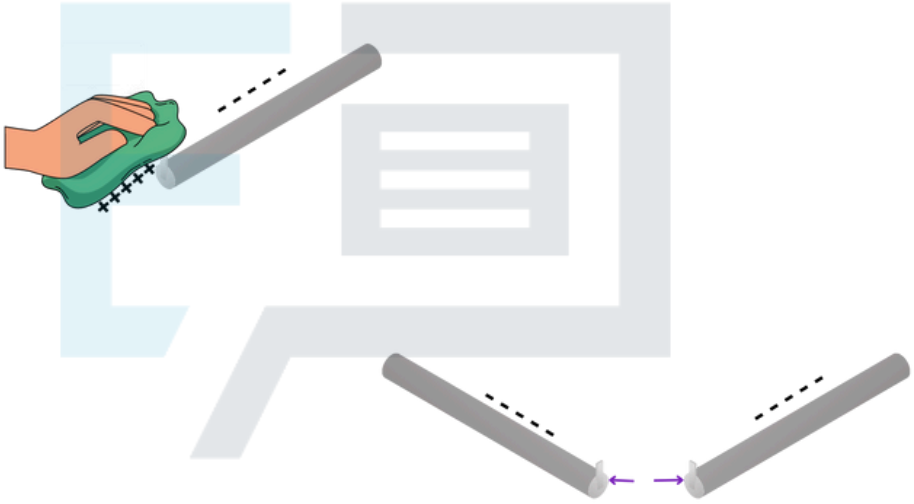


17.1 Charging and discharging

1. Static electricity

> Static electricity is the build-up of electric charge on the surface of objects, which can be discharged suddenly as a spark or shock upon contact with a conductor or another object of different electrical potential.

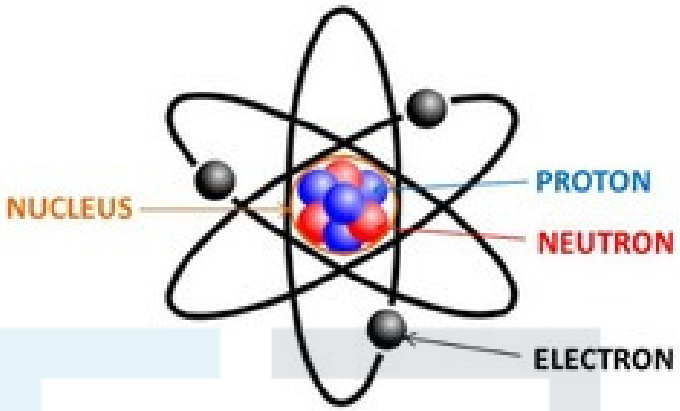
2. One way to generate static electricity is via friction, for instance, rubbing a plastic object with a cloth.
3. The figure below shows one way of investigating this phenomenon.



   a. Rubbing a plastic rod with a cloth causes both to become charged, with electrons transferring from the cloth to the rod.
   b. When the cloth is brought near the rod, they attract each other.
   c. If a second rod is rubbed similarly and brought close to the first, they repel each other, causing the first rod to move away.
4. We have seen both attraction and repulsion, this means that there are two types of static electricity there:
   a. Positive charge
   b. Negative charge
5. Magnetism and static electricity are distinct phenomena: magnetism results from magnetic poles, whereas static electricity originates from electric charges.

17.2 Explaining static electricity

1. Before we understand how things are “charged”, we need to understand how an atom is like:



   a. The nucleus of an atom contains protons and neutrons, with protons being positively charged particles.
   b. Electrons are negatively charged particles that are relatively loosely held within the atom.
   c. Importantly, the positive charge from protons and the negative charge from electrons in an atom balance each other, resulting in the atom being electrically neutral overall.

2. It is the force of friction that causes charging. Here are the details:

   a. When a plastic rod is rubbed against a cloth, friction transfers small particles known as electrons from one material to the other.
   b. If an atom loses an electron, it acquires a positive charge.
   c. Conversely, if another atom gains an electron, it acquires a negative charge.

Conductors and insulators

Conductor:

A substance that allows the flow of electrons. For examples: Metals, gold, and copper.

Insulator:

A substance that inhibits the flow of electrons. For examples: Glass, plastic, and amber.

1. Charge can move through conductors and not insulator.
    - Reason: In insulators, the electrons are tightly bound to their atoms and not easily removed.
    - This is how the insulator remains uncharged.

17.3 Electric fields

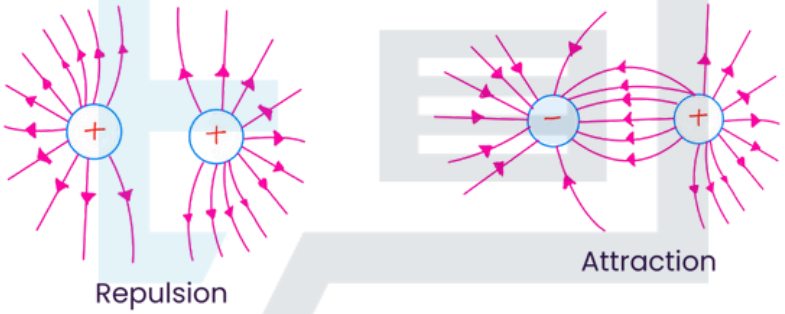
1. There is an electric field around a charged object.

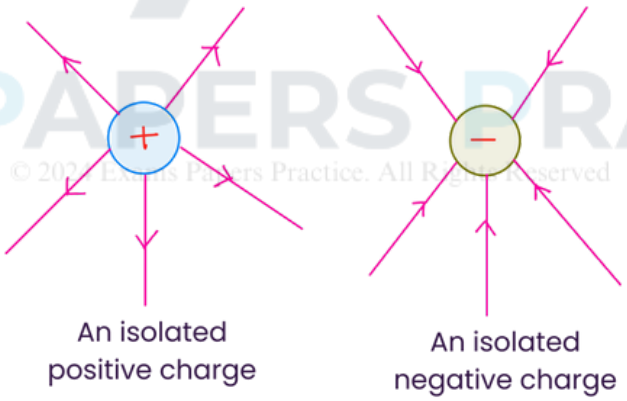
   Definition of electric field:

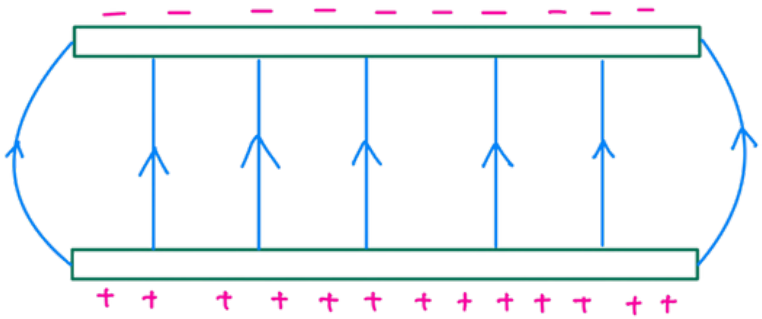
An electric field is a region around electrically charged particles or objects where electric forces are exerted on other charged particles or objects.

2. If a charged object enters the electric field of another charged object, it will undergo a force, either attraction or repulsion..

Representing an electric field





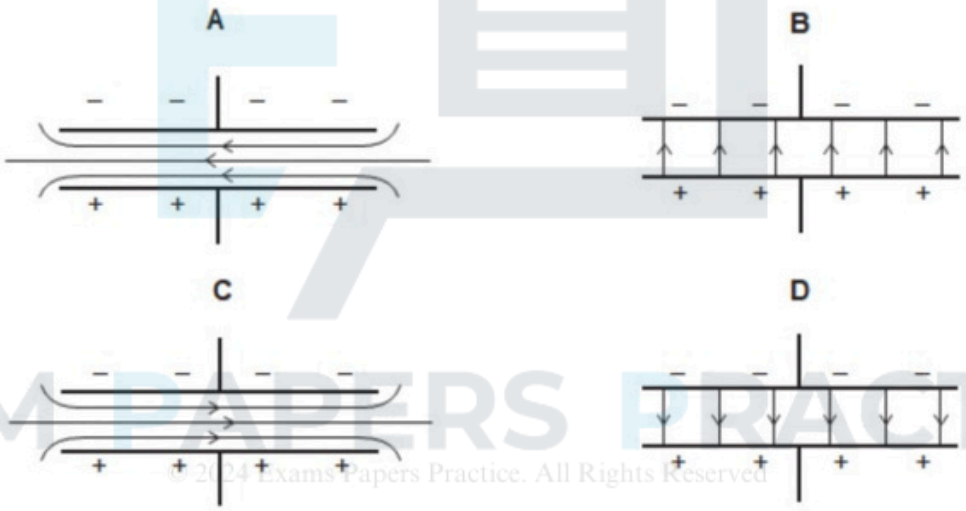


Charged particles

1. Electric charge is quantified in coulombs (C), a unit named after Charles-Augustin de Coulomb.
2. Coulomb discovered that the force between two charged objects depends on the magnitude of their charges and the distance between them.

Electron	-1.6 x 10-19 C
Proton	1.6 x 10-19 C

Past Year Questions

No 1	What is the definition of an electric field? **A** A region in space in which a mass experiences a force due to the Earth's mass. **B** A region in space through which electromagnetic radiation is passing. **C** A region in space in which a compass needle experiences a force. **D** A region in space in which an electric charge experiences a force.
2	Which of the diagrams below shows the correct electric field pattern for oppositely charged parallel plates? 
3	A PVC (plastic) rod is rubbed with a nylon cloth. This process causes electrons to be transferred between the rod and the cloth, causing both objects to become charged. Which of the rows in the table below correctly gives the nature of the charges on both the cloth and the rod, and the effect the objects have on each other after becoming charged? **A** — charges on rod and cloth: the same; effect: repel **B** — charges on rod and cloth: the same; effect: attract **C** — charges on rod and cloth: opposite; effect: repel **D** — charges on rod and cloth: opposite; effect: attract

4	A student rubs a polythene rod with a cloth, giving it a negative charge. She then holds it near an earthed, conducting sphere as shown in the diagrams below. Which of the diagrams shows the correct distribution of charges on the conducting sphere?