Next Gen PET

UNIT SE

Summary Ideas

MODEL OF CHARGES IN MATERIALS

Historical Perspective

Many of the same scientists who studied magnetic interactions also studied static electricity. In fact, we owe the very word 'electricity' to the ancient Greeks. In their studies they rubbed samples of fossilized tree resin (which we call amber) with fur to charge them. The Greek word for amber is 'elektron'! As early as the 4th century B.C. Plato wrote about the effects of rubbed amber and magnets and tried to use exactly the same ideas to explain both magnetic and electric effects..

Observations of electrical effects continued well into the 16th century when scientists such as William Gilbert and others noted many similar effects with many other types of materials and the effect of repulsion was also added to the list of observed electrical phenomena. Early models assumed that static electric phenomena were due to a special electric substance that was separate from the material substance of objects themselves. This was still true of the different 'electrical fluid' models proposed by du Fay and Franklin in the 18th century, but they do both contain features that are also recognizable in the models of today. One big difference is that we now think of electrical charge as being a fundamental property of the constituent particles (protons and electrons) of atoms that make up a substance, rather than that of a special separate substance in itself.

Summary Ideas

Here are the ideas about static electricity developed by our class. These are likely very similar to those developed by scientists as they are based on much the same evidence. Make any notes you wish, such as the evidence you saw that supports each idea, in the spaces provided.

Idea SE1 - Kinds of materials involved in static electric interactions:

A static electric interaction occurs between two charged objects, or between a charged object and **<u>any</u>** other uncharged object. There is always an attraction between a charged object and an uncharged object. Whether one, or both, of these objects moves as a result of this attraction depends on whether each one is held still or allowed to move.

Notes:

Idea SE2 – Static Electric Interactions between two charged objects

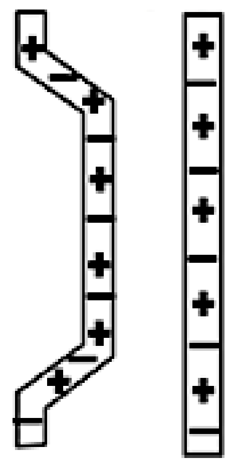
There are two types of electric charge which, by convention, we call positive (+) and negative (–). Two objects with like charges (+ and +, – and –) will repel each other. Two objects with unlike charges (+ and –) will attract. (This idea is sometimes called the *Law of Electric Charges*.)

Notes:

Idea SE3 – Class Model of Charged Entitites in Materials:

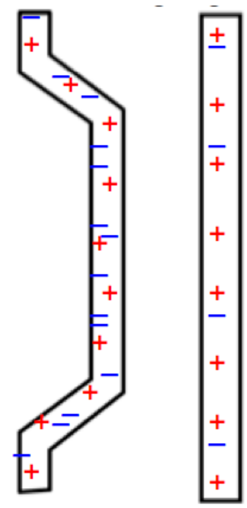
Static electric effects can be explained using a model developed by the class.

a) All materials are made of atoms. An atom has a nucleus that contains positively (+) charged particles called protons. (The nucleus also containes uncharged particles called neutrons, but they play no role in static electric phenomena.) Surrounding the nucleus are negatively (–) charged particles called electrons. (The charge associated with a proton and an electron is equal and opposite.) In an uncharged object the individual atoms are neutral, meaning they contain equal numbers of protons (+) and electrons (–). This is represented by drawing such objects with equal numbers of + and – symbols.



Notes:

b) Because they are tightly bound in the nucleus the protons (+ charges) cannot be moved around. However, since they are more loosely bound on the outside of the atoms, it is possible to remove an electron (– charge) from an atom, or to add an extra electron to it. Therefore the model accounts for all phenomena by the movement of only – charges, leaving the + charges where they are. No charges are created or destroyed, just moved. (This idea is sometimes called the *Law of Conservation of Charge*.)



Thus a negatively (–) charged object has more – than + charges, whereas a positively (+) charged object has fewer – than + charges.

Notes:

c) An uncharged object can be charged in two different ways.

i) It can be rubbed with another uncharged object of a different material. (Peeling apart of a sticky surface may work also.) When this is done some – charges (electrons) will be transferred from one object to the other, leaving one of the objects positively (+) charged, and the other negatively (-) charged by an equal amount. Which of the two objects becomes + charged and which – charged depends on the relative ease with which electrons can be removed/added to each material, the ordering of which can be represented with a tribolectric series.

Notes:

ii) It can be touched with a charged object. When this is done, – charges (electrons) will be transferred either to or from the charged object to leave the original uncharged object with an overall + or – charge. (This will also levae the originally charged object with a smaller excess of either + or _ charges than before.)

Notes:

d) Two different types of materials are identified.

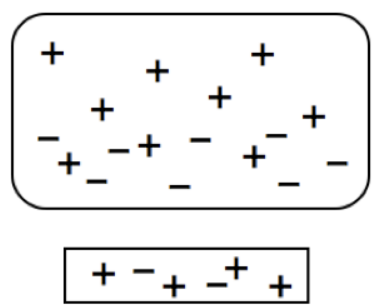
In **conducting** materials (all metals and a few special non-metals) at least some of the electrons (– charges) are free to move through the material. This means any free electrons will repel each other and so distribute themselves evenly thoughout the material. This means any excess + or – charge will lie on the surface of the material. A charged conducting material can be discharged by making contact anywhere on its surface with a large conducting object. (This is called 'grounding')

In **insulating** materials (all other non-metals) none of the electrons (– charges) are free to move through the material. This means any extra electrons transferred to such a material will stay wherever they are put on the surface. Similarly, any + 'gaps' left when an electron is removed will also stay where they were created on the surface. Thus, a charged **insulating** material must be touched all over to discharge it.

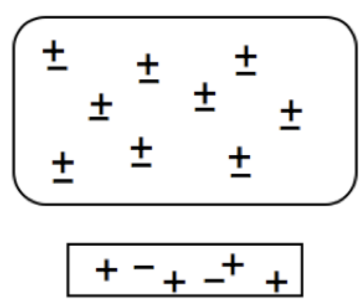
Notes:

e) Attraction between charged an uncharged materials can be explained using the idea of **polarization**, which occurs when the – charges in an uncharged object are redistributed due to the influence of a nearby charged object.

When an uncharged **conducting** material comes close to a charged object, the free electrons (– charges) are either attracted or repelled by the object (depending on whether it is + or – charged) and so move through the object in response. This results in opposite ends/sides of the **whole object** becoming oppositely charged in such a way that there is an attraction between it and the charged object.



When an uncharged **insulating** material comes close to a charged object, the electrons (– charges) in each atom move very slightly in response, while still remaining attached to the same atom. This results in opposite sides of **each**



individual atom becoming oppositely charged in such a way that there is an attraction between them all and the charged object.

Notes: