4.1 CONDUCTORS AND INSULATORS

All materials can be broadly classified as conductors or insulators based on their electrical properties. One way to distinguish a conductor from an insulator is to observe what happens when you put some charge on it. Extra charges on a conductor move about and redistribute on the outside surface of the material as illustrated in Fig. 4.1. This does not happen with insulators. Instead, when you put extra charge at some place on an insulator, they just sit there attached to the molecules they land on.

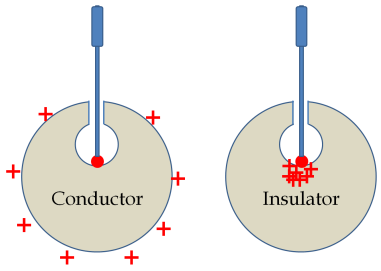

Figure 4.1: Electric charges on a conductor migrate to the outside surface of a conductor no matter where you put them initially. The charges on an insulator stay put in the location you place them.

Another way for distinguishing a conductor from an insulator is to notice what happens when you try to create a potential difference between two points on the object. We find that charges flow readily in conductors while not in insulators. The only time charges do not flow in a conductor is when there is no potential difference between any two points of the conductor. This means that a conductor in an electrostatic situation has same potential everywhere. That is, electric field in a conductor in an electrostatic situation is zero.

The difference in the electrical behavior of conductors and insulators can be traced to the presence of a large number of freely moving charges in conductors and their absence in insulators. For instance, in copper, which is a good conductor, there is one electron per atom that can freely move in the metal. On the other hand, in insulators such as a piece of plastic or glass, electrons are tightly bound to molecules, and cannot move macroscopic distances. Electrons in insulators, however, do move within a molecule, e.g. across a covalent bond. This causes molecules in an insulator to be polarized if atoms across a bond have different attraction for electrons, or a polarization can be induced if the material is placed in an external electric field. We shall study the effects of polarization of insulators in the next chapter. In the present chapter we shall concentrate our efforts at understanding conductors.