A huge amount of electric potential energy can be stored in clouds. In lightning, the voltage (= potential difference = ΔPE per charge) between the clouds and the Earth can be a hundred million volts. The electric field is related to the potential difference per unit length, and if it becomes high enough inside the cloud, electrons can reach a KE large enough to knock electrons out of atoms. The air becomes a conductor as the freed electrons and ionized atoms flow rapidly, colliding with more atoms, and causing more ionization. The massive flow of charge reduces the potential difference, and the "discharge" ceases. The ions and electrons recombine to form atoms. The light we see comes from electrons returning to lower states inside the atoms.

We discuss voltage and its relation to electric field, as well as electric energy storage, capacitors, and applications such as the cathode ray tube and ECG.

CHAPTER 17

Electric Potential

We saw in Chapter 6 that the concept of energy was extremely valuable in dealing with the subject of mechanics. For one thing, energy is a conserved quantity and is thus an important tool for understanding nature. Furthermore, we saw that many Problems could be solved using the energy concept even though a detailed knowledge of the forces involved was not possible, or when a calculation involving Newton's laws would have been too difficult.

The energy point of view can be used in electricity, and it is especially useful. It not only extends the law of conservation of energy, but it gives us another way to view electrical phenomena. Energy is also a tool in solving Problems more easily in many cases than by using forces and electric fields.

17–1 Electric Potential Energy and Potential Difference

Electric Potential Energy

To apply conservation of energy, we need to define electric potential energy as for other types of potential energy. As we saw in Chapter 6, potential energy can be defined only for a conservative force. The work done by a conservative force in moving an object between any two positions is independent of the path taken. The electrostatic force between any two charges (Eq. 16–1, $F = kQ_1Q_2/r^2$) is conservative since the dependence is on position just like the gravitational force, which is conservative. Hence we can define potential energy PE for the electrostatic force.