5.11: Potential Energy

Because of the coulombic force of attraction or repulsion between them, *two charged particles will vary in energy as we alter the distance between them*. Suppose we have charges of +1 and –1 μC separated by 1 cm, for example. The charges could be separated by hand, and by the time the length of a football field lay between them, their attractive force would be negligible. Expenditure of muscle energy (0.898 J, to be exact) will be necessary to carry out such a separation. That is, because the charges attract each other, we must do work to pull them apart.

According to the law of conservation of energy, the muscle energy expanded to pull the opposite charges apart cannot be destroyed. We say that the 0.898 J is gained by the two charges and stored as potential energy. **Potential energy** (symbol E_p) is the energy which one or more bodies have because of their *position*. We can always regain this energy by reversing the process during which it was stored. If the two opposite charges are returned to their original separation of 1 cm, their potential energy will *decrease* by 0.898 J. The energy released will appear as kinetic energy, as heat, or in some other form, but it cannot be destroyed.

If we had taken two particles both of which had a charge of +1 μC for our example of potential energy, work would have been required to push them together against their repulsive force. Their potential energy would increase as they were brought together from the ends of a football field, and 0.898 J would be required to move them to a distance of 1 cm apart. Because the potential energy of like-charged particles increases as they are brought closer together, while that of opposite-charged particles decreases, it is convenient to assign a value of zero potential energy to two charged particles which are a long distance apart. Bringing a pair of positive charges (or a pair of negative charges) closer together increases E_p to a positive value. Bringing one positive and one negative particle together decreases E_p, giving a negative value.