NOTES ON ELECTRICITY AND MAGNETISM.

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If the air be at a positive potential and a conductor be surrounded by the air but placed in connection with the earth, the conductor will be at potential zero, and will be negatively electrified. In order to bring the conductor to the potential of the air, it must be placed on an insulating support and then deprived of its electrification.

If it were possible to remove the whole of the outer surface of the conductor, the induced electrification might be carried off with it and the conductor left unelectrified, and therefore at the potential of the air around it. On connecting the conductor with an electrometer the latter would not, however, attain the potential of the air unless the capacity of the conductor were very great compared with that of the electrometer.

If the conductor be insulated and connected with the electrometer, and if a very sharp point be attached to the conductor, electricity will pass off the point so long as there is any considerable charge induced upon the conductor that is, so long as the potential of the conductor differs considerably from that of the surrounding air; but unless it is extremely sharp the point will become inefficient before the potential of the conductor approaches very closely to that of the air.

If a burning match or gas flame be in communication with the conductor, the flame will form part of the conductor itself, and will be negatively electrified so long as the potential of the conductor is less than that of the air immediately surrounding the flame. But the negatively electrified flame is continually being dissipated into the air, carrying its negative electrification with it, and being replaced by another flame, as it were, which in turn becomes electrified at the expense of the conductor, and this process goes on until the conductor, and the quadrants of the electrometer connected with it, are raised to the same potential as the air which *immediately surrounds the flame.* In connection with his portable electrometer, Sir William Thompson employs a burning slow match to raise the potential of the plate of the instrument to that of the air in the neighbourhood.

Sir Wm. Thomson's water dropping collector, as employed for the determination of the potential of the air at fixed observatories, consists of a metal tank of water supported on an insulating stand and connected with one electrode of a quadrant electrometer, the other electrode of which is put to earth. A long tube, suspended by insulating strings, conveys the water from the tank to the point at which the potential of the air is to be measured. At this point the water is allowed to escape from a jet and break up into drops. If the potential of the tank is lower than that of the air at the point where the drops fall, each drop, being in connection with the conductor, will be negatively electrified, and in falling will carry off its negative electrification with it. This action will continue until the potential of the tank is equal to that of *the air immediately surrounding the drops at the point where they break away*, and when this is the case the drops will fall away unelectrified, and the potential of the tank will undergo no further change. The electrometer, therefore, will register the potential of the air at the point where the drops fall away from the jet; or if a continuous stream of water fall for some distance, the potential registered would be that of the air where the stream breaks up into drops. If the tank be originally at a higher potential than the air at the point where the drops fall, the drops will be positively electrified until the potential of the tank has been sufficiently reduced.

If a Leyden jar is so constructed that its inner or outer armatures (or coatings) can be removed by means of insulating handles, and if the jar be charged and then stripped of its armatures, the latter will be found to be almost unelectrified, but upon replacing them in their proper positions the jar can be discharged. If, instead of replacing the same armatures, a new pair of armatures were fitted to the jar, the discharge could be obtained with equal facility. This experiment indicates that the energy of the charged Leyden jar does not reside upon its armatures but upon or within the glass itself.

When a Leyden jar is charged to a very high potential, a spark will sometimes pass through the substance of the glass, destroying the jar and frequently pulverising the glass in the neighbourhood of the perforation. Before the glass can yield to the electric forces it is clear that it must be strained beyond its elastic limits and up to its ultimate strength. Hence we may conclude that before the jar is charged sufficiently for a spark to pass the glass must be in a state of strain. To produce this strain work must have been done, and the glass, like a bent spring, in relieving itself from this state of strain, is able to do an amount of work equivalent to that which has been done upon it (if its elasticity be perfect). We are thus led to regard the strained condition of the glass as the form which the energy of the charged Leyden jar assumes, and as all the electrified systems with which we are concerned in the study of electrostatics differ from a charged Leyden jar only in the nature of the dielectric and the forms and relative positions of the electrified surfaces, we naturally infer that the energy of all electrified systems is due to a state of strain of the dielectric or insulator, which separates the oppositely electrified surfaces. According to this view the conductors in an electrostatic system simply serve to bring the electric charges to their surfaces. The dielectric is the arena of all electrostatic phenomena.

Faraday supposed that the particles of a dielectric in an electric field are thrown into a state of polarization, each particle being electrified positively on one side and negatively on the other, and that in this way the electric force is communicated from point to point in the field. Maxwell showed that electric phenomena can be accounted for by supposing that there is a tension in the dielectric in the direction in which the electric force acts, accompanied by an equal pressure in every direction at right angles to the force, and that such a system of stresses is compatible with the equilibrium of the dielectric. The energy of the dielectric due to the state of strain into which it is thrown is the energy of the electrified system. The mechanism by which Maxwell supposed this state of strain to be brought about is consistent with Faraday's theory of polarization.

When a Leyden jar is charged we must regard the glass as thrown into a state of strain, being exposed to a tension in the direction of its thickness, and an equal and opposite pressure at right angles to this direction.