

reserve. No confidence can ever be placed in them beyond the limits of the data from which they are derived: and even within those limits they require a special and severe scrutiny to examine *how nearly* they do represent the observed facts; that is to say, whether, in the comparison of their results with the observed quantities, the differences are such as may fairly be attributed to error of observation. When so carefully examined, they become, however, most valuable; and frequently, when afterwards verified theoretically by a deductive process (as will be explained in our next chapter), turn out to be rigorous laws of nature, and afford the noblest and most convincing supports of which theories themselves are susceptible. The finest instances of this kind are the great laws of the planetary motions deduced by Kepler, entirely from a comparison of observations with each other, with no assistance from theory. These laws, viz. that the planets move in ellipses round the sun; that each describes about the sun's centre equal areas in equal times; and that in the orbits of different planets the squares of the periodical times are proportional to the cubes of the distances; were the results of inconceivable labor of calculation and comparison: but they amply repaid the labor bestowed on them, by affording afterwards the most conclusive and unanswerable proofs of the Newtonian system. On the other hand, when empirical laws are unduly relied on beyond the limits of the observations from which they were deduced, there is no more fertile source of fatal mistakes. The formulæ which have been empirically deduced for the elasticity of steam (till very recently), and those for the resistance of fluids, and other similar subjects, have almost invariably failed to support the theoretical structures which have been erected on them.

(188.) It is a remarkable and happy fact, that the shortest and most direct of all inductions should be that which has led at once, and almost by a single step, to the highest of all natural laws,—we mean those of motion and force. Nothing can be more simple, precise and general, than the enunciation of these laws; and