1.3 Physical laws.

Most everyone has heard the term *laws of physics*, but what is a law of physics? How does it come about? What makes it a law? Let us say that you have been thinking about the relationship between the pressure, the volume, and the temperature of a gas. After a while you become so curious that you do some experiments and measure the pressure of a gas for different volumes at some constant temperature. You find that the pressure, symbolized by *P*, is proportional to the inverse of the volume, symbolized by *V*, we write this,

$$P \propto V^{-1}$$
. (1)

Where \propto is the proportionality symbol. After some more analysis we note that (1) is exactly true when the volume is multiplied by some constant, determined by the gas under study, symbolized by *c*, so we have,

$$P = cV^{-1}.$$
(2)

We can rewrite this,

$$PV = c. (3)$$

This is called Boyle's law. It is one of the basic gas laws.

All such laws are similar in two ways. First, they are similar in that they are all true within what I call their *region of applicability*, that is when the assumptions that were made when they were discovered are still valid. Second, they all break down in some way when those assumptions are no longer valid, in other words when the law is used outside of its region of applicability.

So, is physics just a collection of such physical laws? No, such a collection is an absolute statement of fact and is unable to extend itself beyond the regions of applicability of the laws. There is no hint in Boyle's law that it is not universally applicable. Any list of physical laws by itself fails to explore the relationships between the various laws in the list. Any list of laws of physics will, by necessity, be restrictive.

Does this mean that physical laws should not be considered? No, it means that we must be aware of the regions of applicability of the laws we want to use. In fact, when we discover what we think is a law of physics beyond a current realm of applicability, one test is to make sure that the new law duplicates the old when it is within the old law's realm of applicability.

So we can expand our definition of physics: Physics is the process of considering some physical phenomena, establishing a theory, applying and/or comparing the theory to the relevant physical laws, predicting the consequences, and either confirming or refuting it. How, then, does physics advance into regions not covered by existing laws?