What is there in an equation?

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In physics, an equation shows the relationship between a set of variables that affect a physical property. It is a binding feature that interconnects different factors towards a physical property. When making an equation, all the factors whose changes can affect the property has to be included in the equation. While doing this, certain constant factors may be found to be involved that also need to be included. This can be demonstrated using the equation for viscosity of a fluid through a pipe discovered by Jean Léonard Marie Poiseuille and can provide some insight.

In 1827 German physicist Georg Ohm had discovered the Ohm's law that Current (I) = Potential difference (V)/ Resistance (R). Between 1938 to 1946, Poiseuille might have used the same principle to arrive at the equation for flow through the pipe, where Flow = Pressure difference (Δp)/ Resistance. The value of pressure difference between the ends of a pipe can be measured. But the value of the resistance depends on various factors. So Poiseuille had to identify all those factors and identify how each factor contributes to the resistance. Poiseuille would have carried out large number of experiments where he would have changed one parameter at a time. He identified two parameters - length and radius of the pipe. He found that the resistance is proportional to the length of the tube and inversely proportional to 4th power of the radius. Resistance $\propto L/R^4$.

Now he had to set up an equation. He needed to introduce a coefficient of viscosity (η) that varies depending on the nature of the fluid. Ideally one would assign a value of 1 to that for water at room temperature and estimate related values for other fluids. More viscous the fluid, higher will be the value of η. Poiseuille would have examined the rate of flow of a viscous solution and its serial dilutions (with water). At this stage he had found out that Resistance $\propto \eta L/ R^4$. However, when the flow of serially diluted solutions were measured, he would have found that Resistance is not equal to $\eta L/ R^4$. This is because he would have found that flow $\neq (\Delta p)R^4/ \eta L$. At this time, it is reasonable to imagine that Poiseuille would have difficulties in assigning values for η. The rate of flow of serially diluted viscous solutions would have made sense only when he used ~2.55 times (*more precisely 8/π times. There would have been a moment when Poiseuille enjoyed the beauty of π! I assume. Trial of π is justified since it is a pipe*) the assignable values of η. This would have given Poiseuille his final equation for the flow: Flow = $(\Delta p)\pi R^4/ 8\eta L$.

In summary, while making an equation, all the factors whose changes can affect the defining property have to be introduced in the equation. While incorporating all the variables, one may find the need to introduce coefficients for certain properties. Even at this stage, it was required to assign proper value for η to serial dilutions of a viscous solution, and then find out the multiplication factor (and its relation with π) to get comparable flow. Therefore, a solution to a system requires incorporating all the factors and constantly adjusting the backbone of the principle axiom so that a perfect fit is obtained. This scientific method is inevitable for the discovering the solution to any system.