

## Manual: 7.1.1. Concept of a Model

A model of a measurement is a formula that computes that measurement from other data such as other measurements. A simple example is the well-known ideal gas law from thermodynamics  $PV = nRT$ . For an ideal gas, this formula relates the pressure  $P$  and volume  $V$  to the temperature  $T$  and the amount of the gas  $n$ . The relationship depends on a parameter  $R$  that must be determined in some other way. This is called the ideal gas constant and is known to be a universal constant that can be determined by experiments. The fact that this law applies to real physical systems can be motivated by theory and determined by experiments in practice.

As a practical application, we could easily measure the volume, pressure and temperature of our gas and determine how much gas is in the vessel using this formula without having to measure that via some complex flow measurement. Such a model is thus useful in practice if we have the data for the other unknowns.

This is where we have to review a bit of vocabulary. We call something a variable if we have to determine it by measurement or computation because it changes over time, e.g. pressure or temperature. Other things are called parameters because they stay constant and require determination only once, e.g. the ideal gas constant. A variable is dependent if this is the variable we want to compute from other variables that are then called independent. It is the independent variables that must be measured and then the dependent variable may be computed.

In the example above, if we want to compute the amount of gas, then  $n$  is the dependent variable that can be computed by setting  $n = PV/RT$  where  $P$ ,  $V$ , and  $T$  are independent variables and  $R$  is a parameter.