

# The Philosophy of Science and Meaning of Terms

©2012 Robert Chuckrow

**The Purpose of Science** is to explain, predict, and establish cause and effect (e.g., forensics, medicine, nutrition). Laws explain on a low level, and they predict. Theories explain and predict laws, plus they make additional, unexpected predictions.

**The Verifiability Theory of Meaning:** If a statement is incapable of being proven either true or false, it has no meaning in the realm of science and is inadmissible as a scientific statement. An example of a scientifically meaningless statement (cannot be tested): "When I hold a stick in a north-south direction it has one length. When I hold it in an east-west direction, it doubles in size." This statement cannot be tested because to measure the stick in each direction requires a ruler, which would also change correspondingly and show no change.

## Scientific Terms\*

- **Definition:** A *definition* is an expressed agreement of the meaning of a term or a word. Definitions must be useful and unambiguous. *Useless definition:*  $Hage \equiv \text{height} \times \text{age}$  (Note that  $\equiv$  is a symbol for *defined as*).
- **Quantity:** A *quantity* is anything that can be expressed in terms of numbers. Some examples of quantities: time, length, mass, weight, temperature, volume, speed, force.
- **Well-Defined Quantity:** A quantity is *well-defined* only if any two methods of calculating the quantity, consistent with its definition, yield the same numerical value. An example of a non-well-defined quantity is: *the age of the class is defined as the age of any student in the class.*
- **Fundamental Quantity:** A *fundamental quantity* is a quantity that cannot be defined in terms of other quantities. The three fundamental quantities are length, time, and mass.
- **Operational Definition:** An *operational definition* is a definition of a quantity based on a procedure by which that quantity is measured. For example, since *length* is a fundamental quantity and, therefore, cannot be defined in terms of other more-primitive quantities, its meaning is contained in the manner in which it is measured.
- **Hypothesis:** A hypothesis is a tentative statement. If the hypothesis is corroborated, conclusions may be drawn from it. If the hypothesis is shown to be false, it is abandoned or modified—or conclusions may be drawn based on its falsity.
- **"Truth"** In science, a conclusion that has been repeatedly confirmed is eventually accepted as "true." Truth in science, however, is never final and what is accepted as true today may be modified or even discarded tomorrow (although such a turn-about is unusual).
- **Law:** A law is a generalization, often in mathematical form, about the behavior of a class of natural phenomena. The statement, "Copper is shiny," though true, is not general enough to be a law.
- **Examples of Laws:** (1) Boyle's law: When a gas is held at constant temperature, if its volume is decreased, its pressure correspondingly increases. (2) Kepler's first law: Each planet orbits the sun in an ellipse whose focus is at the sun. (3) Weber's law: The minimum perceptible increase in a stimulus is proportional to the intensity of the stimulus.
- **Theory:** A theory is collection of suppositions to which analytic reasoning is applied for the purpose of predicting and explaining one or more laws. Theories start with postulates, which are assumptions the truth of which is assumed without a need for direct proof. The truth of the postulates is borne out by the success of the theory in explaining and predicting not only the law but new phenomena. Theories are not thought of as true or false. If the theory is useful it is accepted, and if it is not useful it is not accepted.
- **Postulate:** A *postulate* is a statement that serves as a basic assumption of a theory. Its truth can be verified only indirectly, through consequent predictions by the theory. A postulate is an assumption that does not have to be directly testable but, combined with other such postulates and mathematical reasoning, gives rise to assertions that are directly testable.
- **Example of a Theory:** The kinetic theory of gases explains Boyle's law. Postulates: 1. A gas consists of molecules that are far apart compared to their sizes. 2. The molecules are in random motion. 3. When a molecule of the gas collides with the walls of its container, it bounces off without any loss in energy. Applying mathematical reasoning to these postulates gives rise to Boyle's law plus additional, unexpected or otherwise unexplained relationships. Similarly, the theory of gravitation gives rise to Kepler's laws, plus it explains and predicts that all bodies fall at the same rate in the absence of air friction.