# Anticipation Guide: Math & Measurement

**Before Reading:** In the space to the left of each statement, place a check mark (✓) if you agree or think the statement is true or an (X) if you disagree or think the statement is false.

**During or After Reading:** Add new check marks or cross-through the X’s for which you have changed your mind. Keep in mind that this is not like the traditional “worksheet”. You may have to put on your thinking caps and “read between the lines.” Use the space under each statement to note the **page, column, and paragraph(s)** where you have found information to support your thinking (evidence).

\_\_\_\_ 1. The motion of a train traveling along a straight route is an example of one-dimensional motion.

\_\_\_\_ 2. There are two types of physicists: experimental and theoretical.

\_\_\_\_ 3. Theoretical physicists run careful investigations of natural phenomena.

\_\_\_\_ 4. Experimental physicists develop models and theories to explain, using math, theoretical observations.

\_\_\_\_ 5. Classical physics includes mechanics, electricity & magnetism, while modern physics deals with light and atoms.

\_\_\_\_ 6. The three fundamental quantities of physics are length, mass, and volume.

\_\_\_\_ 7. We use the meter to qualify how much length we are quantifying (measuring) and the kilogram to qualify how much mass we are quantifying.

\_\_\_\_ 8. The unit of time is the minute.

\_\_\_\_ 9. The system of units used in physics is sometimes referred to as the mks system.

\_\_\_\_ 10. The prefix nano is 10-3

\_\_\_\_ 11. The prefix kilo is 103

\_\_\_\_ 12. Nuclear physics is a form of classical physics.

**Introduction to Physics**

Physics is often described as the study of matter and energy. It is concerned with how matter and energy relate to each other, and how they affect each other over time and through space. Physicists ask the fundamental questions of how the universe began. How and of what is it made? How does it change? Which rules govern its behavior?

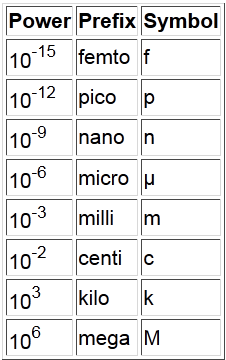
Physicists may be roughly divided into two camps: experimental physicists and theoretical physicists. Experimental physicists design and run careful investigations on a broad range of phenomena in nature, often under conditions which are atypical of our everyday lives. They may, for example, investigate what happens to the electrical properties of materials at temperatures very near absolute zero (­460 degrees Fahrenheit) or measure the characteristics of energy emitted by very hot gases. Theoretical physicists propose and develop models and theories to explain mathematically the results of experimental observations. Experiment and theory therefore have a broad overlap. Accordingly, an experimental physicist remains keenly aware of the current theoretical work in his or her field, while the theoretical physicist must know the experimenter's results and the context in which the results need be interpreted.

It is also useful to distinguish classical physics and modern physics. Classical physics has its origins approximately four hundred years ago in the studies of Galileo and Newton on mechanics, and similarly, in the work of Ampere, Faraday, Maxwell and Oersted one hundred fifty years ago in the fields of electricity and magnetism. This physics handles objects which are neither too large nor too small, which move at relatively slow speeds (at least compared to the speed of light: 186,000 miles per second!).

The emergence of modern physics at the beginning of the twentieth century was marked by three achievements. The first, in 1905, was Einstein's brilliant model of light as a stream of particles (photons). The second, which followed a few months later, was his revolutionary theory of relativity which described objects moving at speeds close to the speed of light. The third breakthrough came in 1910 with Rutherford's discovery of the nucleus of the atom. Rutherford's work was followed by Bohr's model of the atom, which in turn stimulated the work of de Broglie, Heisenberg, Schroedinger, Born, Pauli, Dirac and others on the quantum theory. The avalanche of exciting discoveries in modern physics continues today.

Given these distinctions within the field of experimental and theoretical, classical and modern physics, it is useful to further subdivide physics into various disciplines, including astrophysics, atomic and molecular physics, biophysics, solid state physics, optical and laser physics, fluid and plasma physics, nuclear physics, and particle physics.

The study of physics deals with the fundamental laws of nature and many of their applications. These laws govern the behavior of all physical phenomena. We describe the behavior of physical systems using various quantities that we create for this purpose. However, there are three quantities, length, mass, and time, that we take as fundamental quantities and we use these three to create other quantities.

Along with the quantities must come a way to qualify them, that is, a way to specify how much length, mass, or time you have. This quantification is accomplished with a system of units. An officially adopted system of units starts out by specifying the units for the three fundamental quantities. The unit of length is the meter (m), the unit of mass is the kilogram (kg), and the unit of time is the second (s). The system of units based on these choices is called SI units which stands for System International. This system of units is still sometimes referred to by its old name, the mks system.

As you probably noticed, SI units is based on the metric system. An important aspect of this system is its hierarchy of prefixes used for quantities of different magnitudes. Certain of these prefixes are used very frequently in physics so you should become very familiar with them. Some of the more common ones are listed in the chart to the right.

Formative assessment questions:

Exercise 1.1 Metric Prefixes: Write the following quantities using a convenient metric prefix. (a) 0.00025 m, (b) 25,000 m, (c) 250 m, (d) 250,000,000 m, (e) .0000025 m

**Answer: (a) 0.25 mm (b) 25 km (c) 0.25 km (d) 250 Mm (e) 2.5 µm**

