Key ideas — Observations and Measurements

Observations are made with the **senses** (seeing, hearing, tasting, touching, smelling). For example, "This mineral is red." **Inferences** are **conclusions based on observations**. For example, "The rock is old because it contains fossils."

Using **instruments** for **measurements** extend the senses and makes observations more precise. Instruments may include a centimeter ruler, a triple beam balance, an electronic balance, etc. For example, "The book is 39 cm long" is more precise than saying that "The book is large."

Classification involves organizing observations in a meaningful way. For example, "The book is science fiction."

Density is an important property of **matter**, andimportant in many Earth processes. Density is defined as **mass / volume**, and may be expressed in units such as g/cm3 or g/mL. Movements of air and ocean water are often density-driven.

A substance always has the same density no matter how big or small the size of the piece, under the same conditions of temperature and pressure. When **pressure** increases, its density increases. (For example, this is why you can ride a bicycle on tires filled with air, which is gaseous and low-density. When the **temperature** of a gas increases, the density decreases. This explains why a hot air balloon can rise into the atmosphere. For most substances, as the temperature increases, it expands and the density decreases, and as temperature decreases, it contracts and density increases. This means that a **solid** sample has the greatest density, a **gaseous** sample has the least, and a **liquid** sample would be in between.

Water, an exception to this rule, expands when it freezes. The density of solid ice is less than the density of liquid water. That is why ice floats in water. Water achieves its greatest density at 4 degrees Celsius in the liquid phase.

Energy flows across an **interface** (boundary between regions with different properties).
The flow is usually **from an energy source** (object with greater energy) **toward the sink** (object with less energy). This is why your hand feel a hot metal surface.

Some changes in the environment are **cyclical**, such as lunar phases, seasons, movement of stars and planets, sunspot cycles). Other changes in the environment are **noncyclical**, such as volcanic eruptions and earthquakes.

Dynamic equilibrium occurs when a system is in equilibrium (balance) because of constant changes. For example, if one holds a cup under running water, the cup is constantly "full" because an equal amount of water is entering and leaving the cup at the same time. Another example may be water behind a dam. Water constantly flows in and out, but the water level behind the dam stays the same.

Pollutants are harmful solids, liquids, gases, biologic organisms, or forms of energy such as heat, sound, and nuclear radiation. Anything that can harm humans or other living things in the environment may be a pollutant. Some forms of pollution are natural.

Very large numbers and very small numbers may be expressed more conveniently using **powers of ten**. For example, $10^3 = 1000$

Percent deviation or percent error is the difference between the measured and accepted values divided by the accepted value X 100. It tells how far one's answer is from the accepted answer. For example, if the table's measured length is 12.0 cm and the table' actual length is 10.0 cm, the percent error is 2/10 X 100 = 20.0%. Most measurements are not truly exact, so including an estimate of the percent deviation provides greater understanding of how accurate the measurement may be.

Data can be organized in many ways, include **tables** and **graphs.** We often use **line graphs** to show a set of **continuous values** (such as temperature from day to day over a month or year)**; bar graphs** to show **discontinuous values** (such as monthly precipitation amounts); and **pie charts** (to show the percentages of components of a set.).

Data that are graphed may show several different relationships between the **x-axis** and **y-axis** components of the data. These may include a **"direct"** relationship, (x increases as y increases; x decreases as y decreases,) an **inverse** relationship (x increases as y decreases; x decreases as y increases,). Other patterns include situations where x is unaffected by y (as y changes, x remains the same,) or y is unaffected by x (as x changes, y remains the same.)

Imagery is another important way to represent the Earth and its processes. This can include photographs or their digital equivalent. Many Earth features and processes can be represented through maps that use patterns of **isolines** (connecting points having equal value) or **color-coding**.