Fundamental Scientific Laws

The Law of Conservation of Matter

Matter (mass) is not (cannot) be created or destroyed.

The Law of Conservation of Energy

Energy is not (cannot) be created or destroyed.

This is not the same conservation as when we say "Conserve energy by turning off the lights when you leave the room."

These laws were combined when Einstein discovered that matter can be converted into energy

The Law of Conservation of Matter and Energy

These laws were combined when Einstein discovered that matter can be converted into energy in nuclear reactions by the equation $E=mc^2$.

Energy

Energy is not something that has physical properties. Energy is a “bookkeeping” method to describe observations that we make as matter changes.

The concept of energy is a human invention.

Things don’t posses energy like they do for color or mass or volume.

A common simple definition of energy is the ability to do work.

Energy

The metric unit of energy is called a joule which is the amount of work necessary to accelerate one kilogram by one m/s^2 for a distance of one meter.

Energy & Temperature

Temperature is defined as the measure of the average kinetic energy of molecules.

Temperature is measured in Kelvin (K). Temperature in Kelvin is related to the Celcius or centigrade (100 graduations) scale by the equation $°C = K - 273.15$

Temperature and energy are **not** the same thing but are related.

Something can be very hot (high temperature) but have a very low energy content.

Energy & Temperature

The amount of energy depends on three things:

The amount of matter (mass)

The temperature and

The specific heat (sometimes called heat capacity).

We are usually most concerned about energy changes in chemistry so we often relate energy changes to temperature changes.

Sample Problem

How much energy is required to change 63.2 grams of iron from 21°C to 73 °C? The specific heat of iron is 0.4495 J/g K.

In this situation we have two things we could start the problem with - the mass or the temperature - where to start?

Consider where we want to end (energy) - let's make sure that we have energy units (joules) on top.

Sample Problem

$$\frac{0.4495 \text{ joules}}{\text{g K}} \times \frac{63.2 \text{ g}}{} \times \frac{1 \text{ K}}{1 \text{ °C}} \times \frac{(73 \text{ °C} - 21 \text{ °C})}{}$$

1477 J