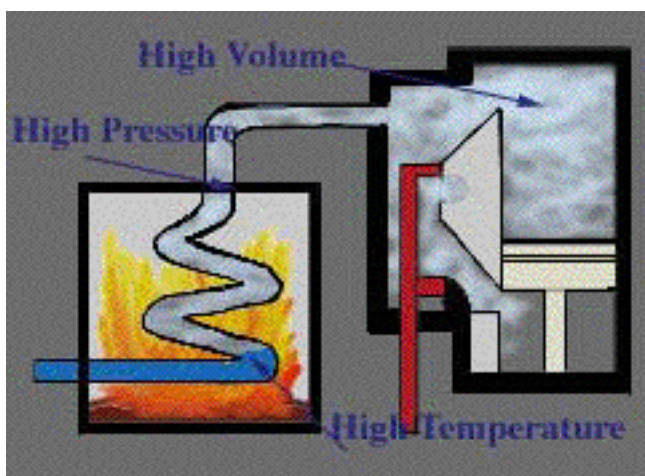


Gases

In order to understand how gases such as steam operate, it is necessary to look at the properties associated with gases. By definition, a gas is a substance that moves freely without resistance to motion, and does not have a specific volume in open space. In contrast, a solid has a specific volume because its molecules can not move freely. The three properties of of gases are temperature, pressure and volume. These are important to understand when examining how an engine or a turbine operates.

The space that molecules of matter occupy is called volume. Another definition of volume is the space displaced by the matter being described. When a gas is not contained the gas has an indefinite volume. But when the gas is trapped within a canister, its volume is exact because its molecules can move only in a defined space.

Temperature is measured in degrees, Celsius degrees according to the SI system, and Farenheit according to the English system. To convert between these systems, use the converter applet found on the [accessories](#) page. As the temperature of matter increases, the particles in the matter expand and increase in their velocity. This relationship can be shown by the following steam engine diagram:



Another characterizing property of matter is pressure. Consider a can that is filled with helium and is used for blowing up balloons. The helium gas is "compressed" to fit enough molecules into a small space. When a gas or other form of matter is compressed, the pressure is built up keeping the molecules of the gas close together, and keeping them within an enclosed area. When the volume of a gas decreases, the pressure of the gas inevitably will increase because there is less space for the gas to occupy.

These three properties of matter can be related by using a single formula, that is just a variation of a larger equation, called the ideal gas law. This equation is $PV = nRT$, where P is pressure in atmospheres, V is volume in Liters, n is the number of [moles](#) of the gas, R is the ideal gas constant equal to $0.082057 \text{ L} \cdot \text{atm} / \text{K} \cdot \text{mol}$, or $8.3145 \text{ J} / \text{K} \cdot \text{mol}$, and T stands for the temperature in kelvins. By this formula, the next two equations are derived. Remember to convert temperature to kelvin, add 273.15 to itself in Celsius degrees.

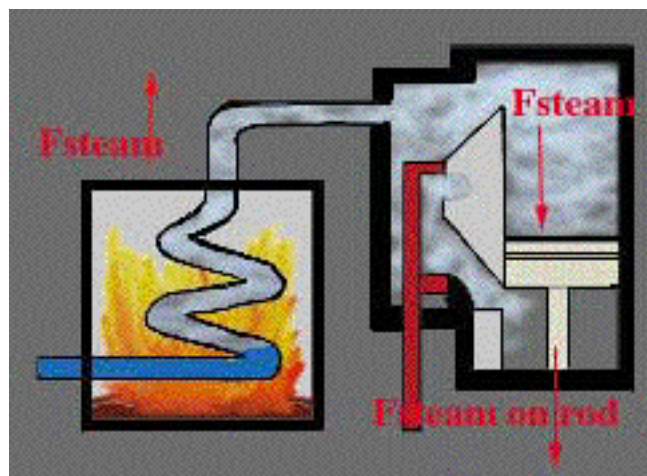
$$P_1 \cdot P_2 = V_2 \cdot V_1, \text{ called Boyle's Law, and}$$

$$V_1 / T_1 = V_2 / T_2, \text{ called Charles' Law}$$

When someone blows up a balloon, the helium (or oxygen) is forced into the restricted volume of the balloon. The gas within the balloon has a definite pressure that is higher than the gases outside of the balloon. What happens when someone tries to tie a balloon accidentally lets his finger slip and the knot does not tie correctly? The gas that was inside of the balloon is forced out because of the pressure that existed on the gas inside the balloon. This pressure that makes the gas exit the balloon is called a force. The relationship between the pressure of the balloon and the force exerted when the gas leaves the balloon is summarize here:



Similar to the situation described using the balloon, the forces exerted by steam, water, or wind or some other force are the principal method behind energy creation in water, wind, and nuclear power. The next pictures first show a basic design for a steam engine that generates power. Nuclear power, wind power, and water power are all related to this diagram:



Take a brief [quiz](#) on this material, or try the [numeric problems](#) for the ideal gas law, Charles' Law, and Boyle's Law.