Units and Definitions

Units of Pressure

Force has units of Newtons

$F = ma$ ($kg\ m/s^2$)

Pressure has units of Newtons/meter^2

$P = F/A = (kg\ m/s^2/m^2 = kg/s^2/m)$

These units are also called Pascals (Pa).

1 bar = 10^5 Pa = 10^5 N/m^2.

1 atm = 1.01325×10^5 Pa

Units of Energy

Energy has units of Joules

1 J = 1 Nm

Work and energy have the same units.

Work is defined as the result of a force acting through a distance.

We can also define chemical energy in terms of the energy per mole.

1 kJ/mol

1 kcal/mol = 4.184 kJ/mol

Thermal Energy

Thermal energy can be defined as RT.

Its magnitude depends on temperature.

R = 8.31 J/mol-K or 1.98 cal/mol-K

At 298 K, RT = 2476 J/mol (2.476 kJ/mol)

Thermal energy can also be expressed on a per molecule basis. The molecular equivalent of R is the Boltzmann constant, k_B.

$$R = N_A k_B$$

$$N_A = 6.022 \times 10^{23} \text{ molecules/mol}$$

Converting Liter-atm to Joules

One important conversion that is frequently encountered in thermodynamics is the work in L-atm conversion to Joules. We can recall this conversion factor readily using the two definitions of the gas constant.

$$R = 8.31 \text{ J/mol-K}$$

$$R = 0.08206 \text{ L-atm/mol-K}$$

From these values we see that the conversion is:

$$1 \text{ L-atm} = 101.325 \text{ Joules}$$

Extensive and Intensive Variables

Extensive variables are proportional to the size of the system.

Extensive variables: volume, mass, energy

Intensive variables do not depend on the size of the system.

Intensive variables: pressure, temperature, density