# Ideal Gas Law

- Pressure, volume, and temperature of a gas are related to how much of the gas (N, # of molecules): $pV = NkT$

Boltzmann constant,
k = 1.38 X $10^{-23}$ J/K

- Alternate form (Chemistry): $pV = nRT$
- Reminder: T absolute, in Kelvins

# of moles

# Using Ideal Gas Law

- Usually # of molecules constant, so Nk is constant
  → $\frac{pV}{T} = const$
  - E.g., new temp if pressure, volume change:

$$T_{new} = \frac{p_{new} V_{new}}{p_{old} V_{old}}$$

- Changing between # of molecules and mass:
  - Atomic mass unit (~avg. mass of proton/neutron):
    1 u = 1.66 X $10^{-27}$ kg
  - Look up how many amu for a particular atom
  - Add all the atoms in a molecule: get mass of molecule

# Energy/speed of Gases

- Temperature is really just a measure of “internal” (non-macroscopic) energy
- Gases: temperature directly related to (translational) kinetic energy

$$K_{tot} = \frac{3}{2} N k T$$

- Average kinetic energy per molecule:

$$\overline{K} = \frac{3}{2} k T = \frac{1}{2} m \overline{v^2}$$

- Root of average square speed (**thermal speed)**:

$$v_{th} = \sqrt{\overline{v^2}} = \sqrt{\frac{3 k T}{m}}$$