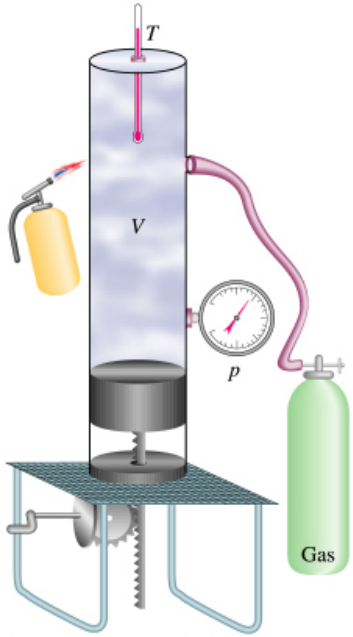
Ch 18. Thermal Properties of Matter

18-1. Equations of State

State variables: Variables that define the state of a system

e.g., pressure p, volume V, temperature T, mass m or mole number n.

Equilibrium state: System variables uniform in space & not changing w/ time



Equation of state:

The relationship among p, V, T, m (n)

Study analytical expressions for simple cases.

Ideal Gas Law

$$pV = n_{mole} RT$$

Universal Gas Constant R=8.315 J/(mol-K) = 0.08206 L atm/(mol-K)

Mole number n_{mole}= mass (gram)/Molecular mass (g/mol)

At constant T	pV = constant $p_1V_1 = p_2V_2$	Boyle's law
At constant P	$V \propto T$ $V_1/V_2 = T_1/T_2$	Charles' law
At constant V	$p \propto T$ $p_1/p_2 = T_1/T_2$	Gay-Lussac's law
General	pV/T=constant $p_1V_1/T_1 = p_2V_2/T_2$	

Standard Temperature & Pressure (STP): 0ºC

1atm=1.013x10^5N/m^2=1.013x10^5Pa

Avogadro's Number

Avogadro's hypothesis:

Equal volumes of gas at the same *p* and T contain equal number of molecules.

Number of molecules in 1 mole:

$N_A = 6.02 \times 10^{23}$

Ideal Gas law: $pV = nRT$

$= (N/N_A)RT$

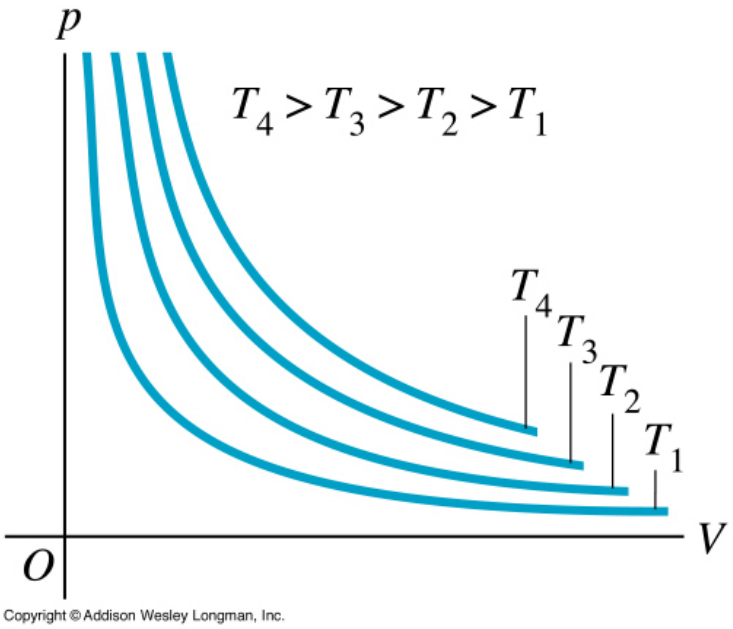
$= N(R/N_A)T$

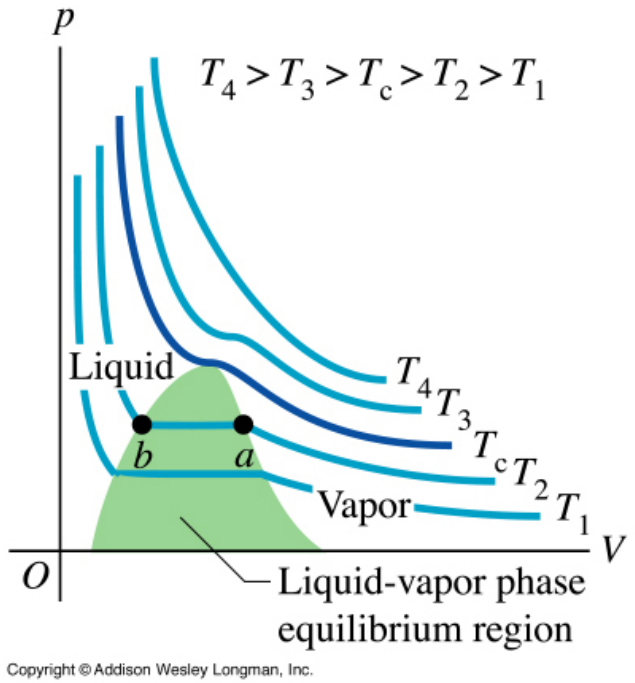
$= Nk_BT$

Boltzmann's constant

$k_B = R/N_A = 1.38 \times 10^{-23}$ J/K

pV-Diagrams





Each curve, representing behavior at a specific T, is an isotherm.
Isolated system of ideal gas, along each isotherm, pV=constant.