Ideal Gas Law

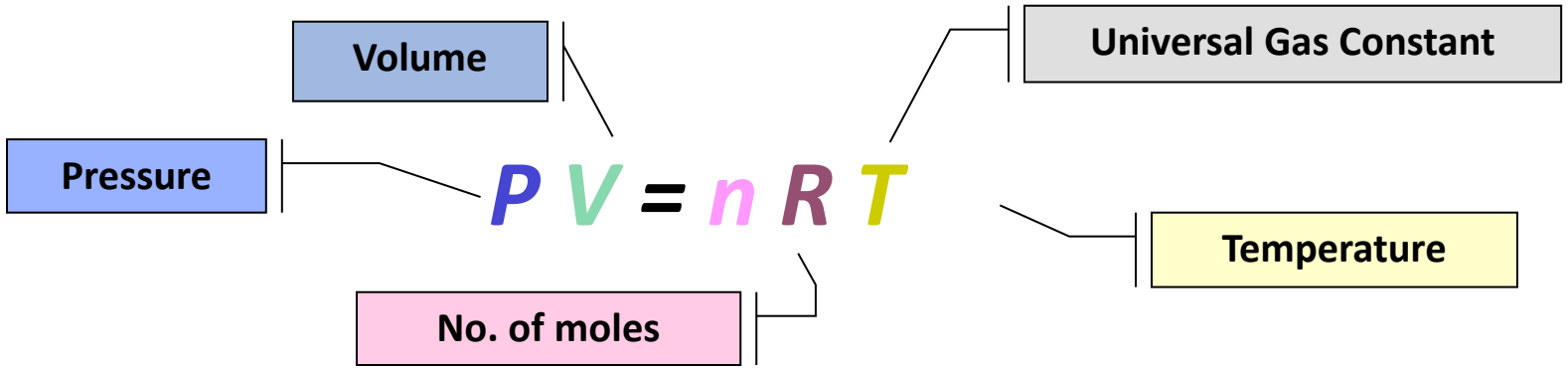
Ideal Gas Law

$$PV = nRT$$

P*V is Proportional to T

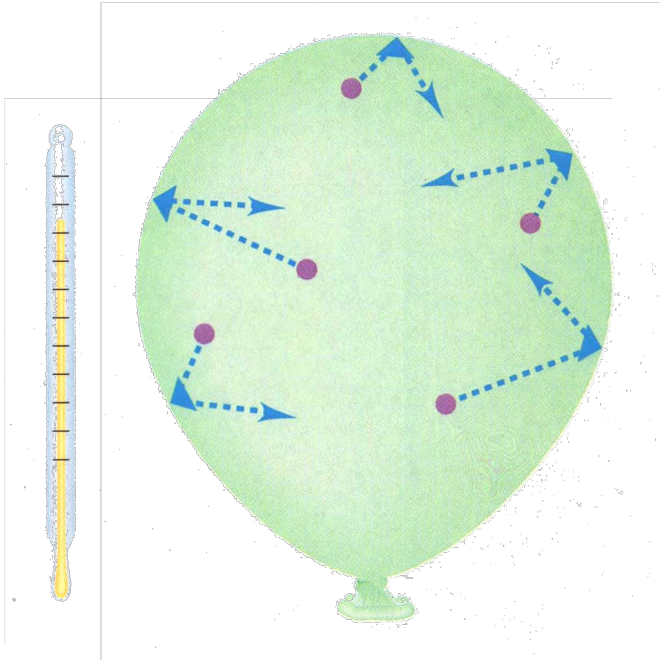
Brings together gas properties.

Ideal Gas Equation



R = 0.0821 atm L / mol K

R = 8.314 kPa L / mol K



PV = nRT

P = pressure
V = volume
T = temperature (Kelvin)
n = number of moles
R = gas constant

***Solve for constant* (R)**

$$\frac{PV}{nT}$$

Substitute values:

$$\frac{(1\ atm)\ (22.4\ L)}{(1\ mole)(273\ K)} = R$$

Standard Temperature and Pressure (STP)

T = 0 °C or 273 K

P = 1 atm = 101.3 kPa = 760 mm Hg

1 mol = 22.4 L @ STP

Recall: 1 atm = 101.3 kPa

$$R = 0.0821\ \frac{atm\ L}{mol\ K}\ \frac{(101.3\ kPa)}{(1\ atm)} = 8.31\ \frac{kPa\ L}{mol\ K}$$

R = 0.0821 atm L / mol K **or** **R = 8.31 kPa L / mol K**

Find R in J/kmol.K

Ideal Gas Law

What is the volume that 500 g of iodine will occupy under the conditions:
Temp = 300^{o}C and Pressure = 740 mm Hg?

Step 1) Write down given information.

mass = 500 g iodine

amu of I_2=2*126.9=253.8 gm/mol

T = 300^{o}C

P = 740 mm Hg=740/760=0.97 atm

R = 0.0821 atm · L / mol · K

Step 2) Equation: $PV = nRT$

Step 3) Solve for variable

$$V = \frac{nRT}{P}$$

Step 4) Substitute in numbers and solve

$$V = \frac{(500\ g)(0.0821\ atm \cdot L / mol \cdot K)(300^{o}C)}{740\ mm\ Hg}$$

n of 500 g iodine? n=mass/a.m.u
n=(500g)/(2*126.9 g/mol)=1.97 mol
300 C= 573 K

V = (1.97 mol)*(0.0821 atm.L/mol.k)* 573k/0.97 atm
= 95.54 L/(1000) =0.095 m^3 .

Ideal gas properties

- State of Matter
- P,V,T Defines the state of gas

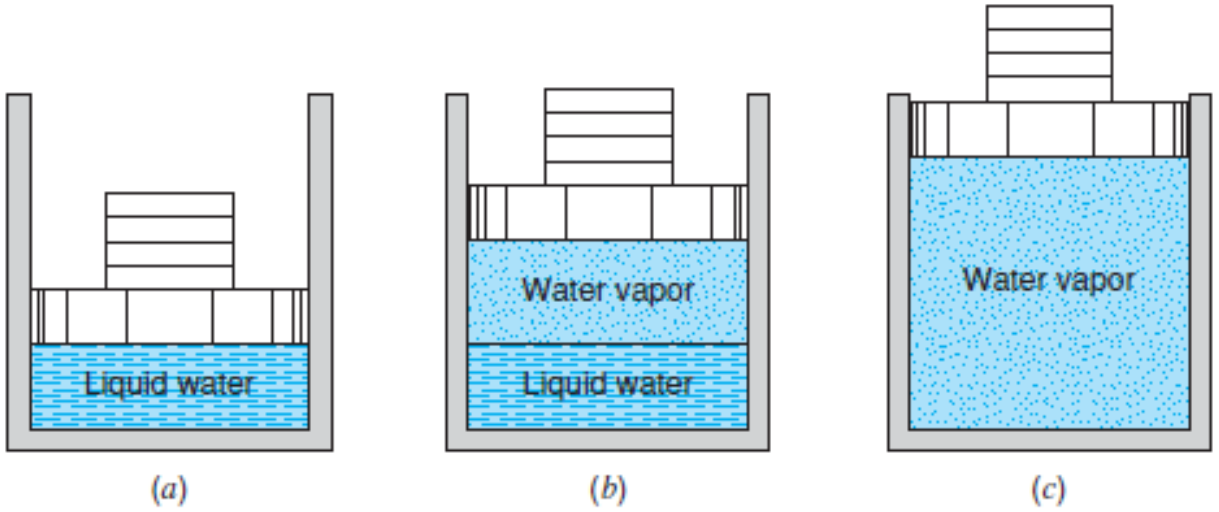


FIGURE 2.1 Constant pressure change from a liquid to a vapor.

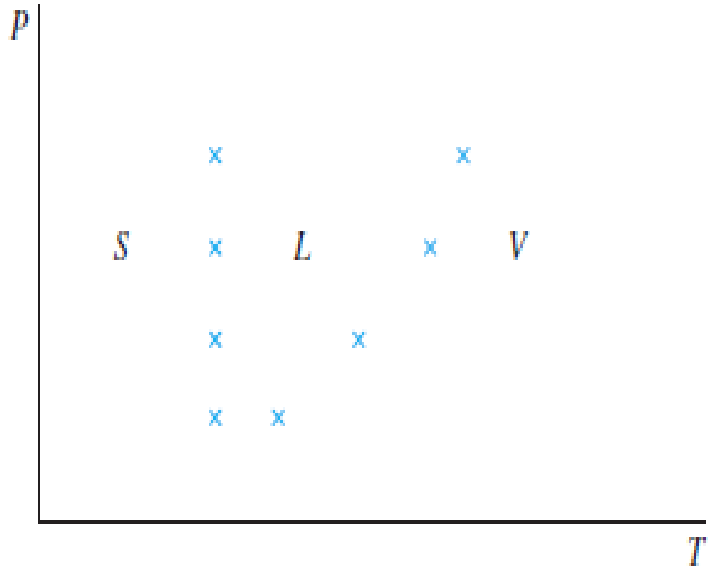


FIGURE 2.2 The separation of the phases in a *P–T* diagram.

Ideal Gas State

Name some common gas-
Oxygen, Chlorine, Methane, Nitrogen,
CO, Hydrogen, CO2, Xenon, Helium, Neon,
Ozone, Air (mixture of N2(79%) and O2(21%))

Oxygen =32 gm/mol, N2= 28 gm/mol

Molecular wt. of air=0.79*28+0.21*32
=28.9 gm/mol
=28.9 kg/kmol

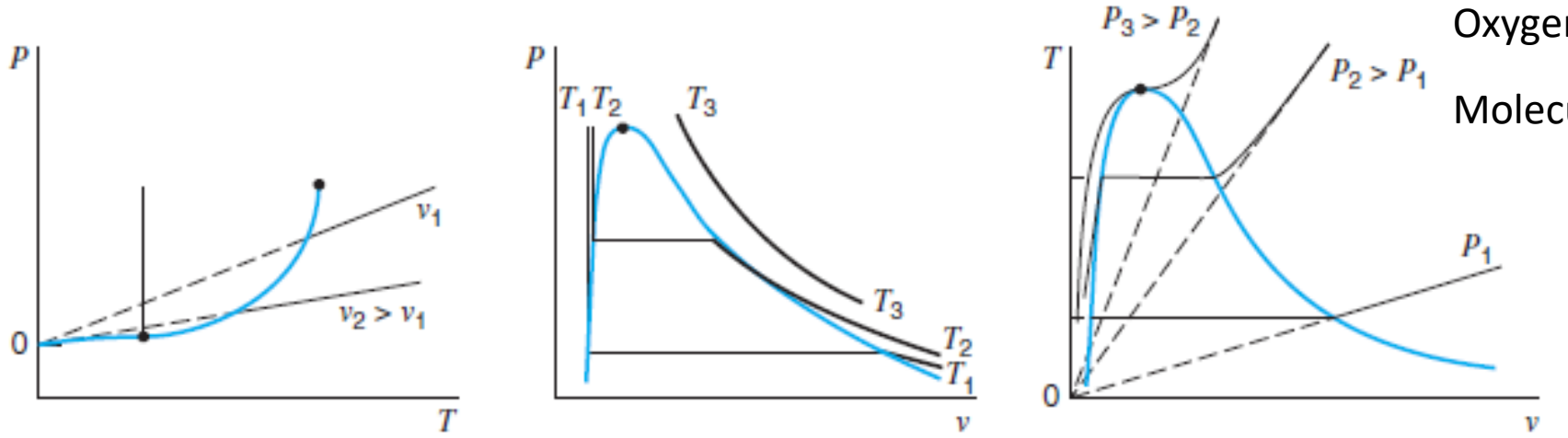


FIGURE 2.17 The isometric, isothermal, and isobaric curves.

- Pv=RT
  - P=Pressure
  - v=volume
  - R=R bar/M

$$R = \frac{\overline{R}}{M}$$

In this relation, $\overline{R}$ is the universal gas constant with the value

$$\overline{R} = 8.3145 \frac{\text{kJ}}{\text{kmol K}}$$

and in English units it is

$$\overline{R} = 1545 \frac{\text{ft-lbf}}{\text{lbmol R}}$$

M or n= molecular weight.
From universal gas constant
Find specific Gas Constant, R, for air.
Molecular wt of air= 28.9 kg/kmol
So, R=(8.3145*1000 J/kmol.k)/(28.9 kg/kmol)
=287.7 J/kg.k.=0.287kN.m/kg.k

Find the specific Gas constant of iodine (I_2) gas
Find the specific Gas constant of Nitrogen (N_2) gas

Practice Problem

1. Find the specific Gas constant of iodine (I_2) gas. R=8.3145*1000/(2*126.9*2)
- 2. Find the specific Gas constant of Nitrogen (N_2) gas R=8.3145*1000/(28)=296 J/kg.K

3. What is the mass of air contained in a room 6m by 10 m by 4 m if the pressure is 100 kPa and temperature is 25 C?

- Universal gas constant = 8.3145 kJ/Kmol.k

Ans-

- PV=m.R.T=n.R.T
- m=PV/R.T=(100kN/m^2)*240 m^3/((0.287kN.m/kg.k)*(298K))=280.5 kg

- Practice/Learn more about
- Periodic Table- Google
- Gas constant- Google
- Units of Pressure, Temp, vol, density, and more…… Google conversion
- For Example- 1 Kpa to Psi?

For Next Class

- Prepare with Ideal Gas Laws and Laws of thermodynamics.
- Architectural model prepared in Revit. Its in Openlab→Lab 1