

DALTON'S LAW OF PARTIAL PRESSURES

$PV = nRT$

n can represent moles of mixed gases !!!

Calculate the pressure for each of the following gases: 32.0 g O₂ (g), 56.0 g N₂ (g), and 28.0 g of He (g) in a 10.0 L flask at 293 K.

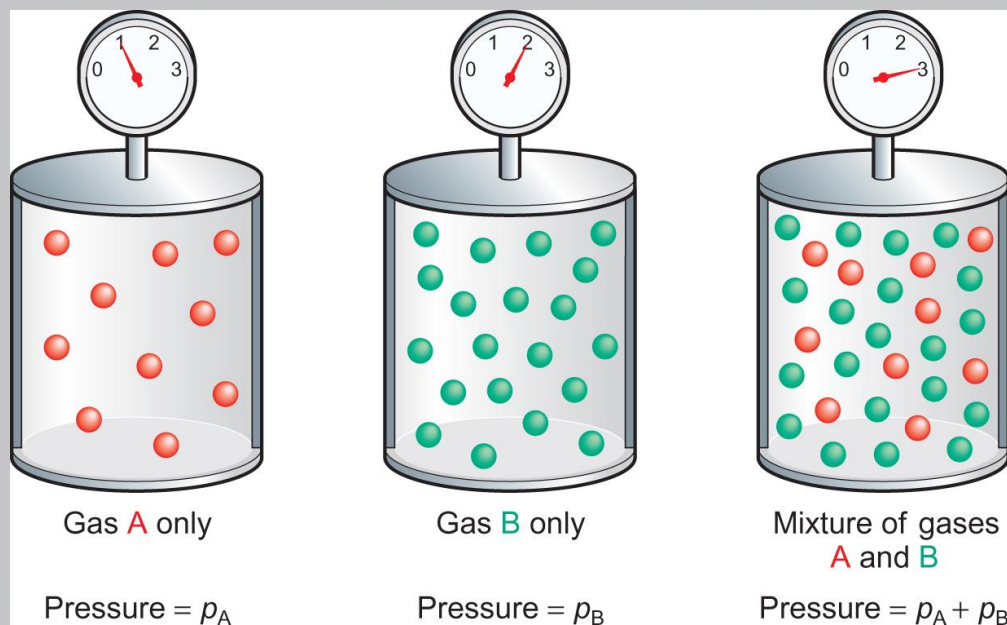
$$P = \frac{nRT}{V} = \frac{1\text{ mol} \times 0.08206 \text{ atm L mol}^{-1} \text{ K}^{-1} \times 293 \text{ K}}{10.0 \text{ L}}$$

(0.08206 atm L mol⁻¹ K⁻¹)

32.0 g of O ₂ = 1.0 mol O ₂ (g)	P O ₂ (g) = 2.41 atm	= (1/10) x 24.1
56.0 g of N ₂ = 2.0 mol N ₂ (g)	P O ₂ (g) = 4.82 atm	= (2/10) x 24.1
28.0 g of He = 7.0 mol N ₂ (g)	P O ₂ (g) = 16.84 atm	= (7/10) x 24.1
total 10.0 mol	total 24.1 atm	



DALTON'S LAW



Chemistry³ p.355

In a mixture of non-reacting gases, the total pressure exerted is equal to the sum of the partial pressures of the individual gases

$$P(\text{total}) = \sum P(\text{partial})$$

The partial pressure of each gas is equal to the total pressure multiplied by the mole fraction of that gas

$$P(\text{partial}) = P(\text{total}) \times \chi(\text{gas})$$



PRACTICE PROBLEMS

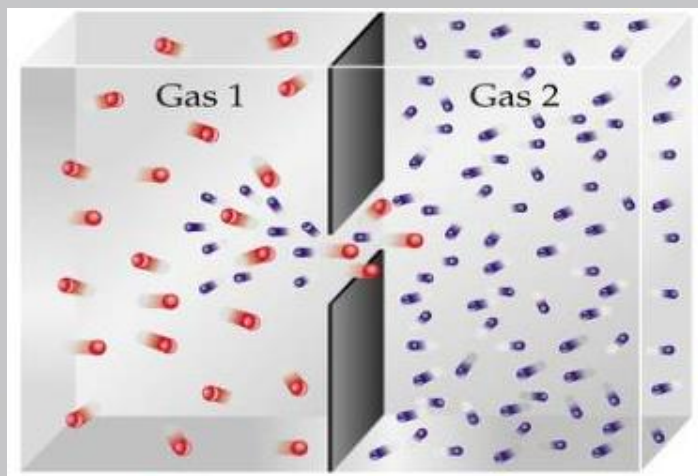
PRACTICE PROBLEM 1: calculate the partial pressure of each gas and the total pressure of the following mixture that occupies 500 mL at 0 degC: 0.020 mol N_2 and 2.33 g of O_2 .

PRACTICE PROBLEM 2: A sample of dry air of total mass 1.0 g consists of 0.76 g of nitrogen and 0.24 g of oxygen.

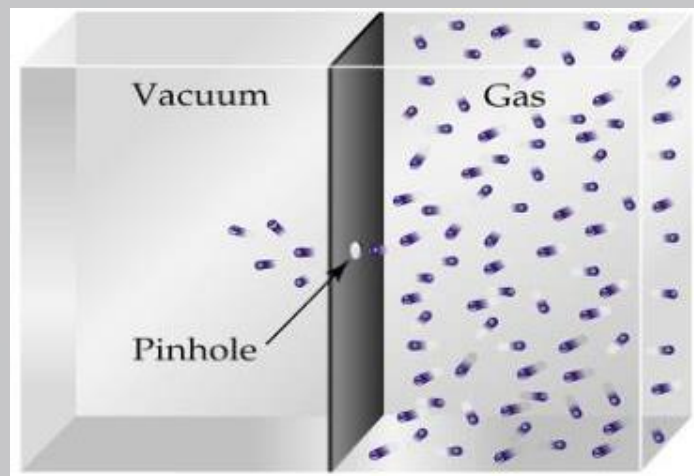
- Calculate the partial pressures of these gases and the total pressure in atm when this sample is in flask of volume 1.00 L at 20 degC
- The sample of air is heated until the total pressure is 1.00 atm. What are the partial pressures of oxygen and nitrogen in the heated sample.



GRAHAM'S LAWS



DIFFUSION: different gases mix



EFFUSION: gas escapes through a hole

Average velocity of gas is inversely proportional to the square root of the molar mass

$$\text{average velocity} \propto 1 / \sqrt{\text{MM}}$$



GRAHAM'S LAWS - EXAMPLES

How much faster will methane diffuse than sulfur dioxide?

molar mass of CH_4 is **16.0 g/mol**

molar mass of SO_2 is **64.0 g/mol**

What do you expect?

CH_4 to be faster,
but how much faster?

Ratio of **molar masses** = $16/64 = 1/4$

Ratio of sqrt (**molar mass** of the gas) = **1/2**

Ratio of **velocity** = $1 / (1/2) = 2$



For any two gases A and B:

$$\frac{v_A}{v_B} = \sqrt{\frac{\text{molar mass of B}}{\text{molar mass of A}}}$$

$$\left(\frac{v_A}{v_B}\right)^2 = \left(\sqrt{\frac{\text{molar mass of B}}{\text{molar mass of A}}}\right)^2$$

$$\left(\frac{v_A}{v_B}\right)^2 = \frac{\text{molar mass of B}}{\text{molar mass of A}}$$

$$(\text{molar mass of A})(v_A)^2 = (\text{molar mass of B})(v_B)^2$$

KE of any gas is equal at given temperature

KE of any gas is proportional to temperature

IDEAL GAS - ASSUMPTIONS

KE of any gas is proportional to temperature

Graham's law as discussed on previous slide

Gas particles have no volume

@ SATP: 1 mole of liquid water (18.0 g) occupies 18 mL (approximate volume of all particles)

@ SATP: 1 mole of gas water (18.0 g) occupies 24.8 L

1378 times more !!!

Gas particles do not attract each other

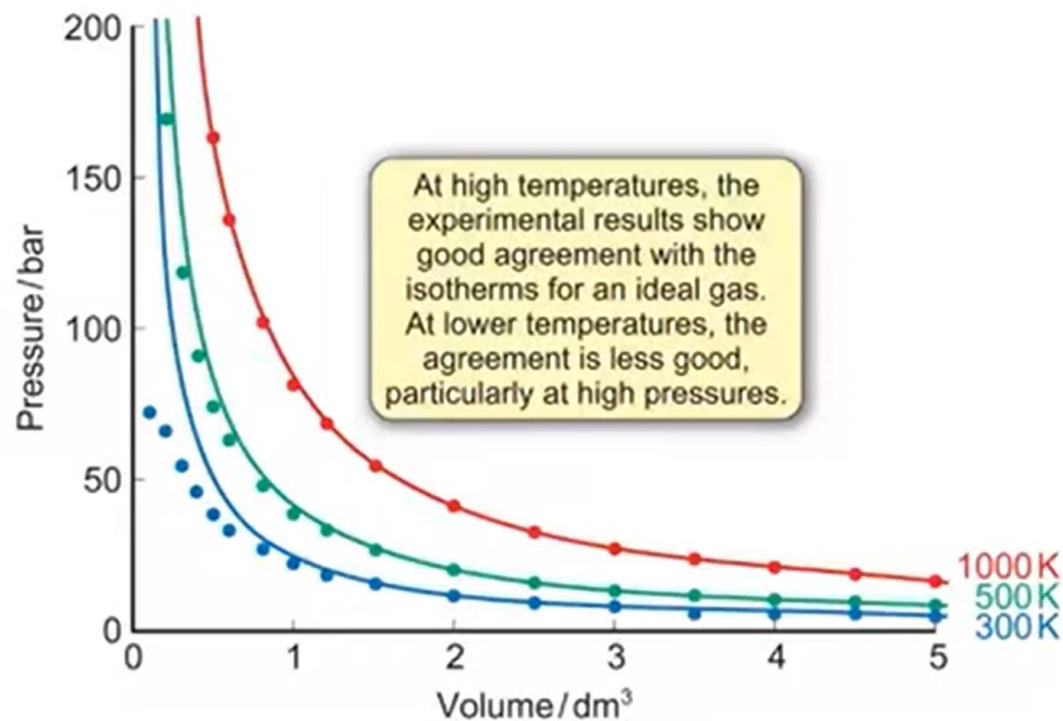
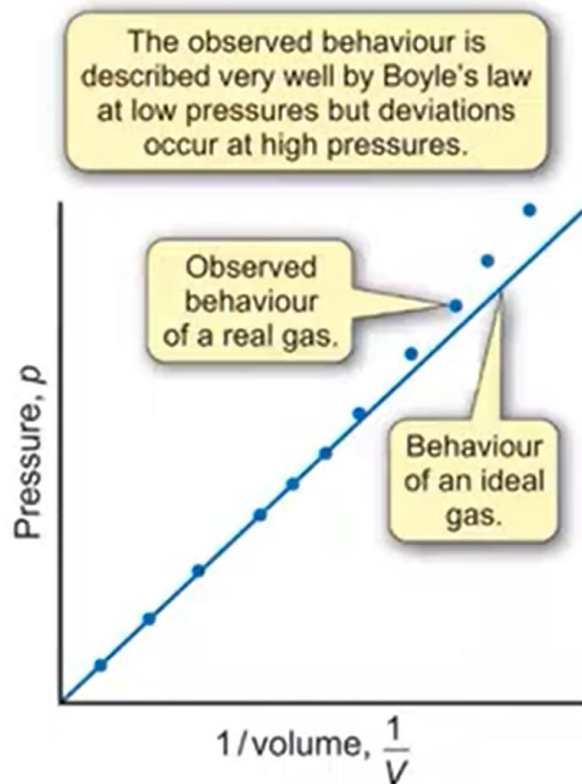
Pressure would depend upon nature of molecules
Dalton's Law

All collisions must be perfectly elastic

Graham's Law



REAL GAS CORRECTIONS



Chemistry³ p.372

DEVIATIONS WITH:

High pressure

Low temperature

Low volume



REAL GAS CORRECTIONS

Van der Waals Equation

Gas particles have no volume

$$\text{actual } V = V_{\text{container}} - nb$$

b depends on gas

Gas particles do not attract each other

$$\text{actual } P = P_{\text{observed}} + (n/V)^2 a$$

a depends on gas

$$PV = nRT$$

$$(P_{\text{observed}} + (n/V)^2 a) (V_{\text{container}} - nb) = nRT$$



SAMPLE PROBLEM

Helium and methane, CH_4 , are both found in natural gas and can be separated by diffusion. What is the ratio of the diffusion rates for the two species (rate of diffusion for He divided by the rate for CH_4)?

- a) 16.06
- b) 0.499
- c) 2.00
- d) 4.01
- e) 0.249

Consider two 1-L samples of gas, one H_2 and one O_2 , both at 1 atm and 25°C . Compare the samples in terms of the characteristics listed.

time for a given fraction of O_2 molecules to effuse ____ time for a given fraction of H_2 molecules to effuse

- a) is unrelated to
- b) is greater than
- c) is equal to
- d) None of these
- e) is less than

At a particular pressure and temperature, it takes 4.55 min for a 1.5-L sample of He to effuse through a porous membrane. How long does it take for 1.5 L of F_2 to effuse under the same conditions?

- a) 0.324 min
- b) 1.48 min
- c) 3.081 min
- d) None of these is within 5% of the correct answer.
- e) 14.0 min



SAMPLE PROBLEM



SAMPLE PROBLEM



SAMPLE PROBLEM

