Video
1003
(2:40)

Gases

AP Chemistry Lecture Outline

Name: ________________________

Basics on Gases

composition of the atmosphere:

properties of gases:

-- due to gas particles being… 1)

2)

<u>vapors</u>: gases of substances that are normally liquids or solids

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Equation for pressure:

Standard pressure: 1 atm, i.e.,

Standard temperature: 0^{o}C, i.e.,

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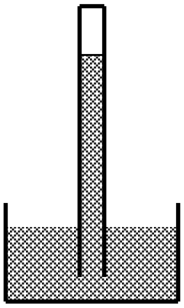
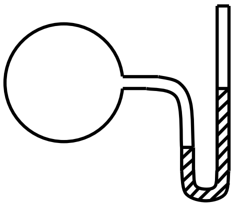
A <u>manometer</u> measures the pressure exerted by a confined gas.

BAROMETER



OPEN END MANOMETER



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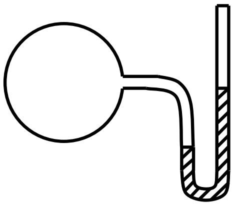
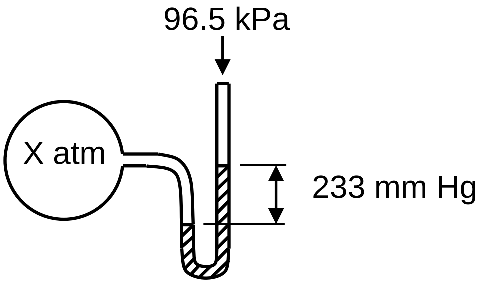


EX. Atmospheric pressure is 96.5 kPa;
mercury height difference is 233 mm.
Find confined gas pressure, in atm.



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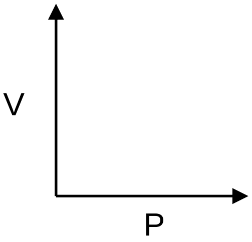
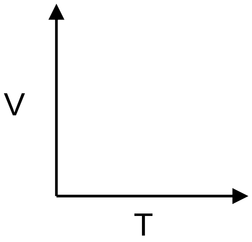
The Gas Laws

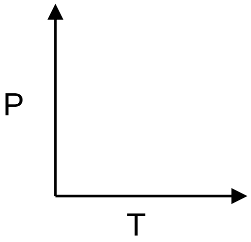
Boyle's law:



Charles's law:



Gay-Lussac's law:



***Avogadro's hypothesis*:** Equal volumes of gas at the same temperature and pressure have the same number of particles, e.g.,

***Avogadro's law*:**

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***Combined Gas law*:** merges Boyle's, Charles's, and Gay-Lussac's laws into one equation.

**NOTE: For all gas law calculations, use the absolute temp., i.e.,

EX. A sample of methane occupies 126 cm^3 at –75°C and 985 mm Hg. Find its vol. at STP.

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***Ideal Gas law*:**

n = number of moles of gas

R = 8.314 L-kPa/mol-K = 0.08206 L-atm/mol-K

EX. 0.250 g carbon dioxide fills a 350. mL container at 127^{o}C. Find pressure in mm Hg.

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Equations for gas density:

EX. Find density of nitrogen dioxide at 75^{o}C and 0.805 atm.

EX. Find density of argon at STP.

EX. A gas has density 0.87 g/L at 30^{o}C and 131.2 kPa. Find density at STP.

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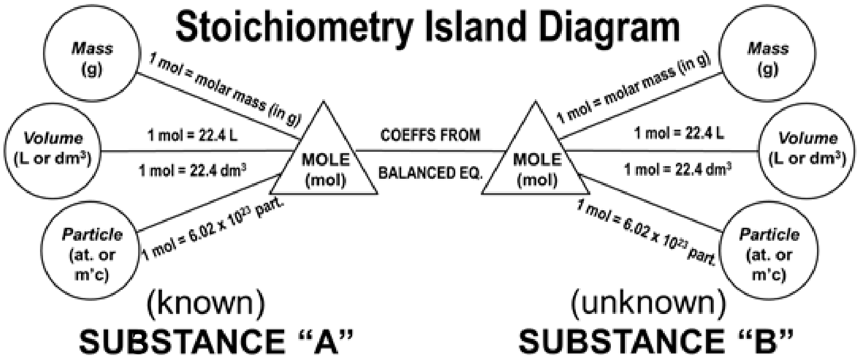
To solve problems involving volumes of gases NOT at STP in chemical reactions:



EX. What volume of hydrogen reacts ^{w}/carbon at 981 torr and 334^{o}C to yield 42.0 g of n-pentane?

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Dalton's law of Partial Pressure

$$\underset{\underset{\text{total pressure of gaseous mixture}}{\uparrow}}{P_{tot}} = \underbrace{P_1 + P_2 + \ldots}_{\text{partial pressures:}}$$

Other equations: Total moles of gas in a mixture:

The mole fraction (X) of a gas in a mixture:

EX. Find the total pressure exerted by 38.0 g of carbon monoxide and 38.0 g of hydrogen in a 6.00-L container at 25^{o}C.

What is the partial pressure exerted by each gas?

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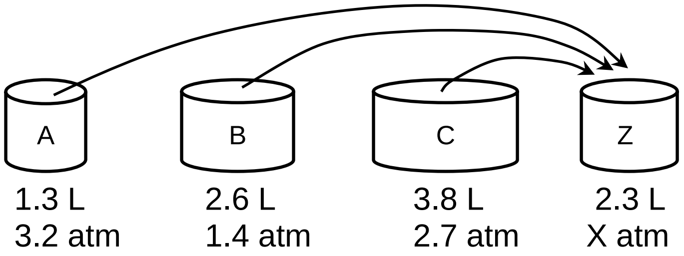
Find the total pres. of mixture in Container Z, assuming constant T.



	P_X	**V_X**	**V_Z**	**$P_{X,Z}$**
A				
B				
C				

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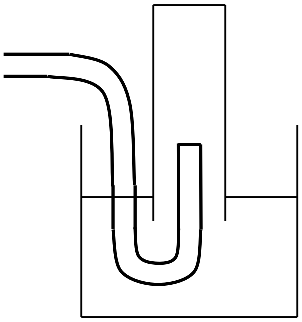
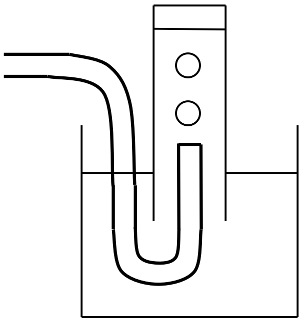
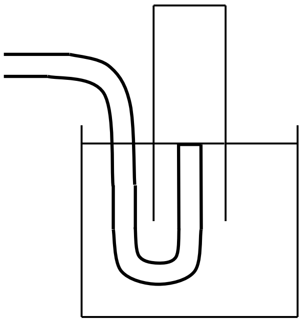
Collecting Gases over Water



before reaction



during reaction



reaction complete

After rxn. is complete, raise or lower collecting vessel so H_2O levels inside and out are the same. In this way…

EX. For the reaction $CaC_2(s) + H_2O(l) \longrightarrow C_2H_2(g) + CaO(s)$...

If 0.852 L of acetylene are collected over water at 20.0°C, find the moles of acetylene collected and grams of calcium carbide used. The barometric pressure is 732.0 torr.

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The Kinetic-Molecular Theory (the theory of moving particles)

1. Gas particles are in constant, random motion.
2. The volume of the particles is negligible compared to the container volume.
3. The attractive-repulsive forces between particles are negligible.
4. Collisions are elastic.
5. KE_{avg} of particles is proportional to absolute temperature.

At a given temp., the gas particles of Sample A have the same avg. KE as the gas particles of Sample B.

pressure = "___ ________" and "___ _____" gas particles collide with the sides of the container

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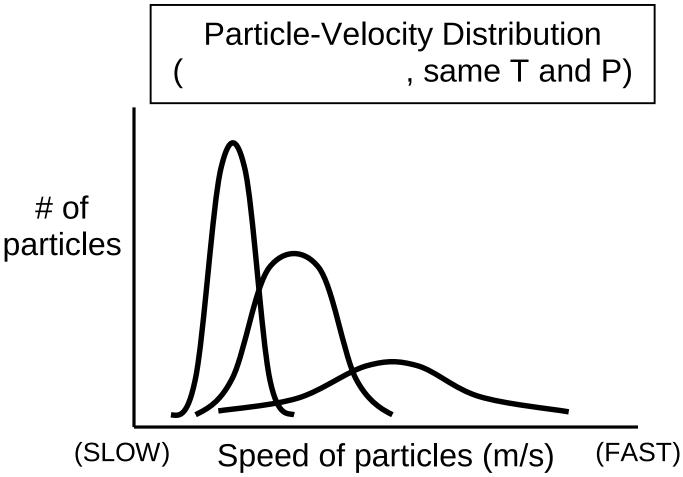
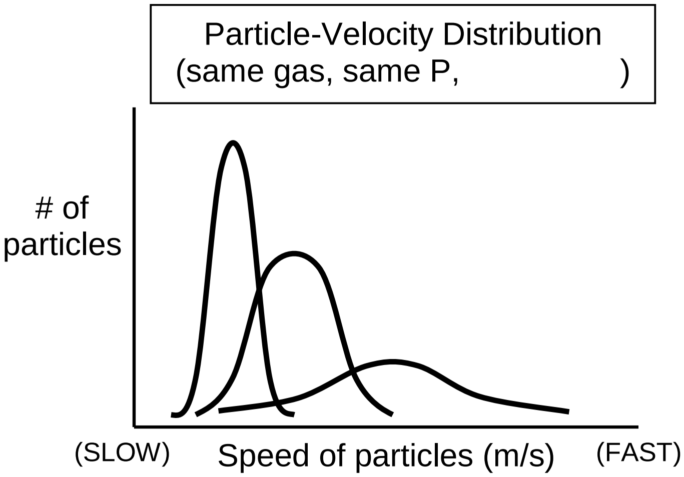
The Maxwell-Boltzmann Distribution


Particle-Velocity Distribution
(, same T and P)


Particle-Velocity Distribution
(same gas, same P,   )

Equation for the rms (root-mean-square) speed of a gas:

R = 8.314 J/mol-K

M = molar mass, in kg

For any particle, of any size,   KE =

EX. Find the rms speed of chlorine gas at 80.0°C.

EX. Find the KE of one 'typical' chlorine gas molecule at this temperature.

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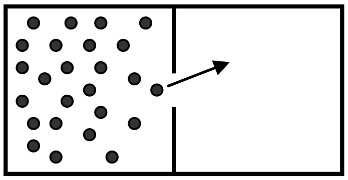
<u>effusion</u>: the escape of gas particles through a tiny hole into an evacuated space

<u>diffusion</u>: the net movement of a substance from high to low conc.



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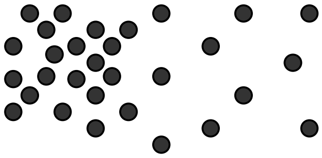

For gases, rates of diffusion & effusion obey Graham's law:

The rate of diffusion of gases is slower than the molecular speeds because of...

--

The <u>mean free path</u> is the average distance traveled by a particle between collisions.

-- it is shorter when the pressure is…

EX. CH_4 moves 1.58 times faster than which noble gas?

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Real Gases: Deviations from Ideal Behavior

All real gases deviate, to some degree, from PV = nRT. The deviations are most pronounced at...

Real gas particles... (1)

(2)

ideal gas (ideal gas equation): $PV = nRT \rightarrow \quad P = \frac{nRT}{V}$

real gas (van der Waals equation): $P = \frac{nRT}{V - nb} - \frac{n^2a}{V^2}$

Constants *a* and *b* are unique for each gas.

-- *a* is large when interparticle attractions are large

-- *b* is large for large gas particles

gas	a	b
He		
NH_3		
Ar		