Chapter 13: Gases

These Notes are to SUPPLIMENT the Text, They do NOT Replace reading the Text Material. Additional material that is in the Text will be on your tests!

To get the most information, READ THE CHAPTER prior to the Lecture, bring in these lecture notes and make comments on these notes. These notes alone are NOT enough to pass any test!

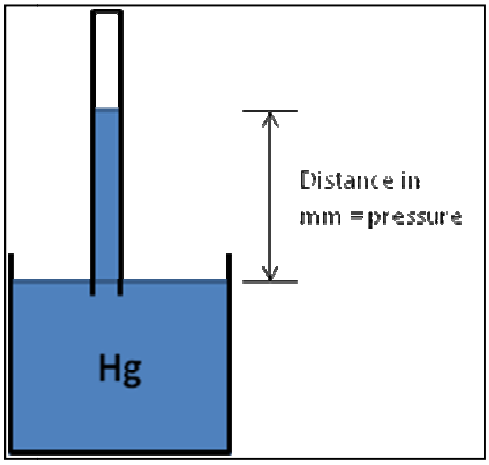
Barometer is a device for measuring absolute atmospheric pressure.

Standard atmospheric pressure is 1.0 atmosphere which equals 760 mm Hg [also called at torr].

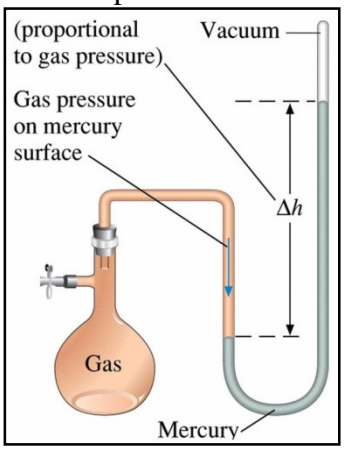
It will support a column of mercury 760 mm high or 29.92 inches high! See Picture below.

The SI unit of pressure is the Pascal and 1.0 atm = 101,325 Pa.

The America unit of pressure is the Pounds Per Square Inch and 1.0 atm = 14.69 psi

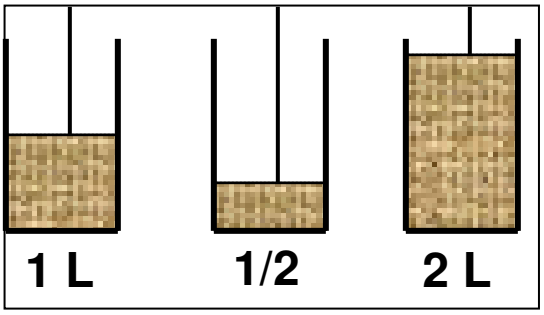


A manometer is a device for measuring the relative pressure inside of a container:



Go over the conversions of Atm → mm Hg → Atm

Boyles Law: The volume / pressure of a gas are related as: $\mathbf{P_1 V_1 = P_2 V_2}$



Assume in container 1, we have 1.0 Liter of air at 1.0 atm.

What is the pressure in Container 2?

From $P_1 V_1 = P_2 V_2$ we derive

$$P_2 = \frac{P_1 V_1}{V_2} = \frac{1.0 \text{ atm} * 1.0 \text{ Liter}}{\text{½ Liter}} = 2.0 \text{ Liter}$$

What is the pressure in Container 3?

$$P_2 = \frac{P_1 V_1}{V_2} = \frac{1.0 \text{ atm} * 1.0 \text{ Liter}}{2.0 \text{ Liter}} = 0.50 \text{ Liter}$$

PROBLEM 50.0 L of O_2 at 15.7 atm at 21°C. What is the volume at 1.00 atm and 21° C?

$$\mathbf{V_2 = \frac{V_1 P_1}{P_2}} = \frac{50.0 \text{ L} * 15.7 \text{ atm}}{1.00 \text{ atm}} = \mathbf{785. \text{ L}}$$

Note: The Volume vs Pressure rations [numbers in brackets]

PROBLEM 12.0 dm^3 at 98.9 kPa → 119.0 kpa. What is the new volume?

$$\mathbf{V_2 = \frac{V_1 P_1}{P_2}} = \frac{12.0 \text{ dm}^3 * 98.9 \text{ kPa}}{119.0 \text{ k Pa}} = \mathbf{9.97 \text{ dm}^3}$$

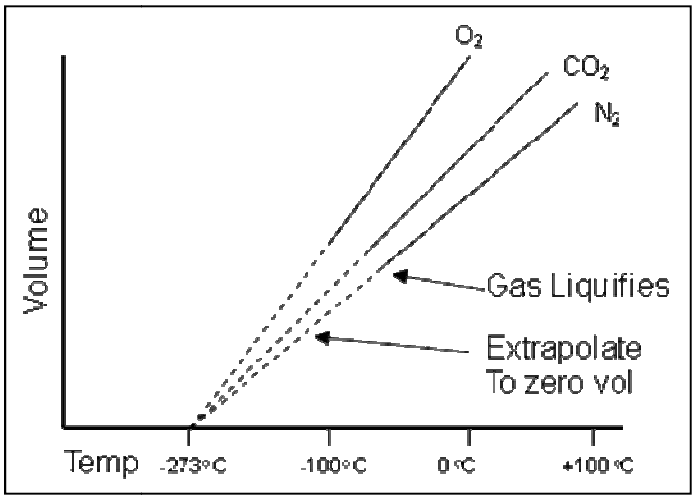
Exercise 13.2 Neon in a neon sign has a volume of 1.5 L at 635 torr. What is the volume of gas after it is pumped into a glass tube at a pressure of 785 torr?

Example 13.3 A car engine has a cylinder volume of 0.725 L when the piston is down. During the compression stroke, the volume is reduced to 0.75 L. The air / fuel mixture was originally at 1.0 atm. What is the compressed pressure in mm Hg?

Charles Law

A gas contracts when cooled and expands when heated. Plot the volume of a gas at various temperatures [^{o}K]. You get a straight line, as the temp is lowered, the volume decreases. But, at low temp, the gas liquifies – the dotted lines. Extrapolate the values to zero volume and the temp is **– 273.15 degrees C** [or 0 deg K] !
Plot shows the volume of a gas at constant pressure is directly proportional to the ABSOLUTE temp [^{o} K].

V / T = CONST -or- $\mathbf{V_1 / T_1 = V_2 / T_2}$



Example 13.4 2.0 L of air is at 298 K, it is cooled to 278 K at constant pressure. What is the new volume.

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ or, solve for $V_2 = \frac{V_2 * T_2}{T_1}$ = 2.0 L * 278 K / 298 K = 1.86 = 1.9 L

Example 13.5 A gas at 15 ^{o}C has a volume of 2.58 L, what is its volume at 38 ^{o}C?

Example 13.6 A gas has a volume of 0.675 L at 35 ^{o}C and 1 atm. What is the temperature in ^{o}C if the volume is reduced to 0.535 L at 1 atm.

Dive Tanks. I'm a diver. My tank has a volume of 2.0 L. If it is filled with 120. Cu ft [@ 2832 L] of air what is the change in temperature of the dive tank? Assume it started at room temperature is 20 ^{o}C.

Avogadro's Law: Move onto the more popular Ideal Gas Law

Ideal Gas Law: P * V = n R T

Pressure * Volume = Number-of-Moles * 0.08206 $\frac{\text{L Atm}}{\text{Mole } ^{o}\text{K}}$ * Temp ^{o}K

Where n = g / Mw of compound.

Pressure * Volume = $\frac{g}{Mw}$ * 0.08206 $\frac{\text{L Atm}}{\text{Mole } ^{o}\text{K}}$ * Temp ^{o}K

Example 13.8 A sample of Hydrogen Gas has a volume of 8.56 L at 0 ^{o}C and 1.5 atm. How many moles of Hydrogen is there?

Start with $P * V = n R T$

Convert 0 ^{o}C to ^{o}K. $^{o}K = {}^{o}C + 273 = 0\ {}^{o}C + 273 = 273\ {}^{o}K$

Rearrange it to $$n = \frac{P V}{R T} = \frac{1.5\ atm * 8.56\ L}{0.08206\ L\ atm / Mole\ {}^{o}K * 273\ {}^{o}K} = 0.573\ L$$

Example 13.9 What is the volume of 0.250 mol of Carbon Dioxide at 25 ^{o}C and 371 torr?

Start with $P * V = n R T$

Convert 0 ^{o}C to ^{o}K. $^{o}K = {}^{o}C + 273 = 25\ {}^{o}C + 273 = 298\ {}^{o}K$

Rearrange it to $$V = \frac{n R T}{P} = \frac{0.250\ mol * 0.08206\ L\ atm / Mole\ {}^{o}K * 298\ {}^{o}K}{371\ torr / 760\ torr / atm} = 12.5\ L$$

More TBD later this week!