Chapter 9 Part 1

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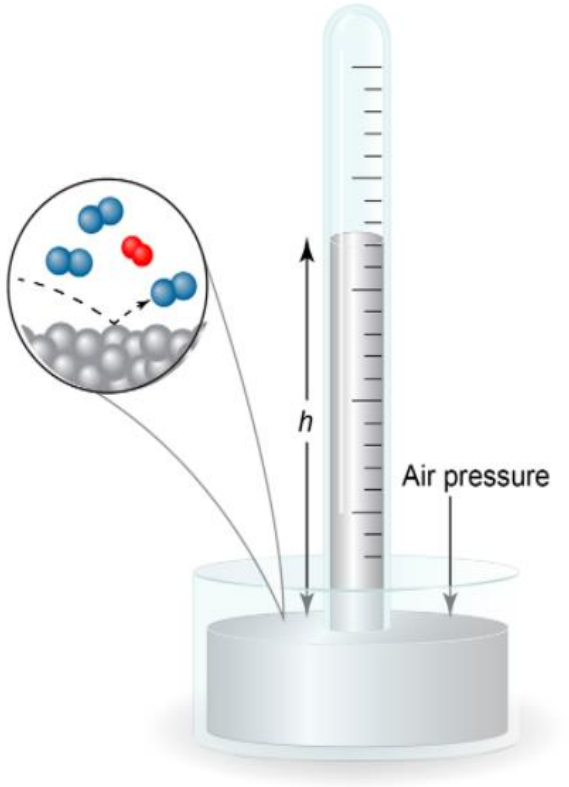
Properties of Gases

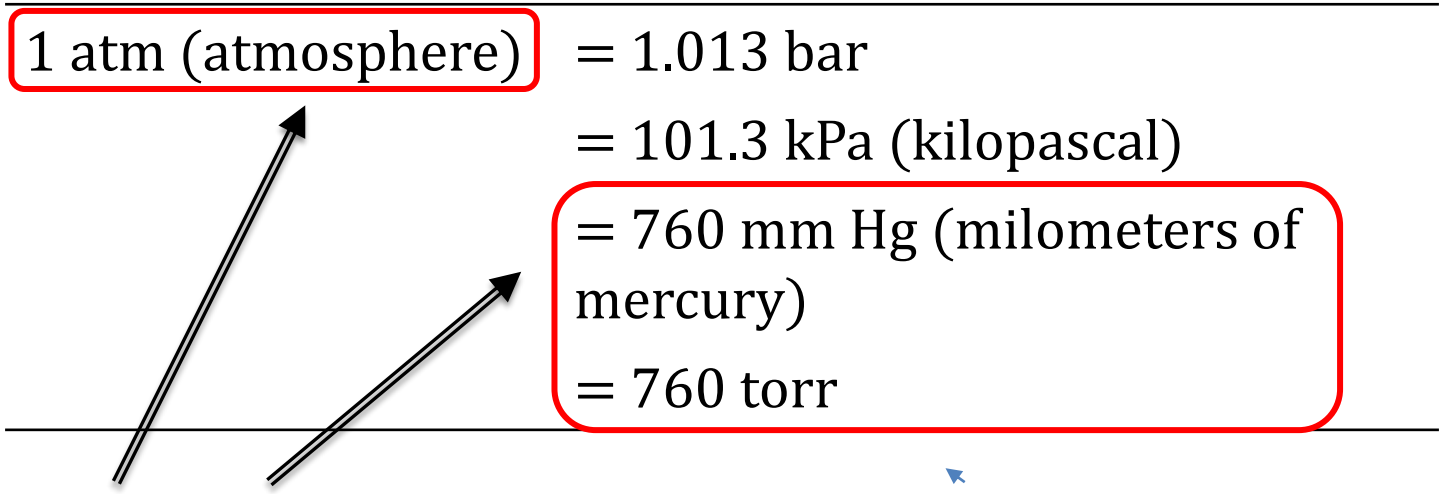
- Matter occurs in three states, or phases: solid, liquid, and gas.
- A gas does not have a definite volume; a gas expands to fill the entire volume of its container.
- Gas particles are far apart; gases have much lower densities than solids or liquids.
- Gas particles are in constant motion and collide with each other and with any surfaces in contact with the gas sample.

Simple Barometer

- This type of barometer is a glass tube filled with liquid mercury which is placed, open end down, in an open dish of liquid mercury
- The force exerted by gas particles in the atmosphere opposes the force of gravity, keeping the mercury in the tube.
- The height of the column of mercury in the tube is the atmospheric pressure.



Units of Pressure



Memorize these! (I will give you any other pressure conversions.)

Pressure Conversions

Convert a pressure of 648 torr to atm.

Pressure Conversions

Convert 105 kPa to atm if 1 atm = 101.325 kPa.

Ideal Gas Law

$$PV = nRT$$

- P is pressure and must be in units of atmospheres (atm)
- V is volume and must be in units of liters (L)
- n is the number of moles of gas (mol)
- R is the ideal gas constant $\left(0.0821 \frac{\text{L atm}}{\text{mol K}}\right)$
- T is the temperature and must be in units of Kelvin (K)

Ideal Gas Law

Which quantities are inversely proportional to each other?

A. pressure and temperature
B. pressure and moles
C. volume and temperature
D. volume and moles
E. pressure and volume

Ideal Gas Law

What volume is occupied by 0.445 mol of CO_2 at 397.0 K and 973 mmHg?

Ideal Gas Law

A sample of carbon dioxide gas has a pressure of 1.89 atm and a volume of 21.5 mL at a temperature of 76.2 °C. How many molecules of carbon dioxide gas are in the sample?

Using mass in the Ideal Gas Law

$$PV = nRT$$

$$\text{Note that } MM = \frac{g}{mol}, \text{ so } MM = \frac{g}{n}$$

$$\text{This can be rearranged to } n = \frac{g}{MM}$$

$$\text{Thus, } PV = \left(\frac{g}{MM}\right) RT$$

$$\boxed{PV(MM) = gRT}$$

Memorize this

Ideal Gas Law

What pressure is exerted by 129.5 g of CH_4 in a 0.3900 L steel container at 215.7 K?

Ideal Gas Law

How many grams of oxygen, O_2, are there in a 50.0-L gas cylinder at 21.00 °C when the oxygen pressure is 15.7 atm?

Using density in the Ideal Gas Law

$$PV(MM) = gRT$$

This is mass divided by volume which is density in g/L.

$$P(MM) = \left(\frac{g}{V}\right)RT$$

$$P(MM) = DRT$$

Memorize this

Using density in the Ideal Gas Law

A 6.00 mole sample of helium is confined in a container with a pressure of 3.0 atm and a density of 5.3 g/L. What is the temperature of the sample?

Using density in the Ideal Gas Law

A laboratory technician forgot what the color coding on a commercial cylinder of gas meant, but remembered that the tank contained one of the following gases: He, Ne, Ar, or Kr. Density measurements at STP were made on the gas from the cylinder, and was found to be 0.178 g/L. Which of these gases was present in the tank?