General Gas Laws

Instructions: Copy all slides on separate paper so that it can be put in your notebook.

Work the example problems (Ideal Gas Law) on separate paper and show your work. (These are called **plug and chug problems** because you plug the values in the formula and grind them out on the calculator.)

General Gas Laws

- Deals with gases in a non-standard state
- A gas is defined as having indefinite shape and volume.
- Deals with the kinetic energy of gas based on its temperature.
- In gas law problems:

  T = temperature

  P = pressure

  V = volume

Remember:

- molar volume of a gas @ STP= 22.4L/mol
- STP= 1 atm. Pressure and 0^{o}C temperature
- SI unit for pressure is pascal (kilopascal)
- 1atm = 14.7 psi = 760 mmHg (torr) = 101.3 kpa
- All gas law problems are worked using the kelvin temperature scale

  0^{o}C = 273 k

  it is the absolute scale because of no negative numbers

Ideal Gas Law:

formula: PV= nRT

P = pressure

V = volume

n = number of moles

R = 0.0821 atm-L/mol-k

(gas constant derived from STP)

T = temperature

Ideal gas law is the link used to calculate the mol value of a gas at non-standard conditions.

Gas Laws

Must learn this: Kinetic-molecular Theory

1. A gas consists of small particles that have mass.
2. Distance between gas particles is very large.
3. Gas particles are always in constant, rapid, random motion.
4. Collisions between gas particles or the walls of the container are perfectly elastic.
5. Average kinetic energy of gas particles is dependent on temperature.
6. Gas particles exert no attractive force on each other.

Properties of a gas

1. Gases have mass.
2. Gases can be easily compressed due to the large distances between particles.
3. Gases totally fill their container.
4. Gases can move through each other easily.
5. A gas can exert pressure on its container.
6. The pressure that is exerted by a gas on its container is determined by the temperature of the gas.

Ideal gas	Real Gas
Made of small particles that have MASS	SAME
Gases are mostly empty space	SAME
Low density	SAME
Gas particles are in constant random, straight line motion, therefore they have kinetic energy.	SAME
Average kinetic energy of particles depends on temperature.	SAME
There are no attractive or repulsive forces between particles.	There are VERY small attractive and repulsive forces between particles.
Particles have NO volume.	Particles have a VERY small volume
Collisions are ELASTIC (no loss in total kinetic energy)	Collisions are INELASTIC. (When gas particles collide they will lose energy.)

Deviations from Ideal Behavior

Likely to behave nearly ideally	*Likely not to behave ideally*
Gases at high temperature and low pressure	**Gases at low temperature and high pressure**
Small non-polar gas molecules	**Large, polar gas molecules**

General gas formulas

Gas Law: Formulas *(These laws solve gases that are in a* ***container.****)*

a. Boyle's Law $P_1V_1=P_2V_2$ (constant temperature)

b. Charles Law $V_1/T_1= V_2/T_2$ (constant pressure)

c. Gay-Lussac's Law $P_1/T_1=P_2/T_2$ (constant volume)

d. Combined gas Law $P_1V_1/T_1=P_2V_2/T_2$ (Is the combination of a,b,c. Can be used to solve all gas law problems exempt mol value)

e. Dalton's Law of Partial Pressures

$P_T= P_a + P_b + P_c$ + etc.

Gas Laws continued:

Avogadro's Law:

equal volumes of gases at the same pressure and temperature contain equal numbers of particles.

Law of combining gas volumes:

gases at the same temperature and pressure react in small whole-number ratios by volume.

Ideal Gas Law Practice (Put on separate paper and Show all work.)

formula: PV= nRT *convert Temp: ^oC to kelvin*

R = 0.0821 atm-L/mol-k

Given the following sets of values, calculate the unknown quantity.

1a) P = 1.01 atm

V = ?

n = 0.00831 mol

R = ?

T = 25°C

1b) P = ?

V= 0.602 L

n = 0.00801 mol

R = ?

T = 311 K

Ideal Gas Law Practice (Put on separate paper and Show all work.)

Follow the same set-up as in #1a & 1b

2) At what temperature would 2.10 moles of N_2 gas have a pressure of 1.25 atm and in a 25.0 L tank?

3) What volume is occupied by 5.03 g of O_2 at 28°C and a pressure of 0.998 atm?

4) Calculate the pressure in a 212 Liter tank containing 23.3 kg of argon gas at 25°C?