CHEMISTRY 20: GASES

A. **Properties of Gases**

Chemical Properties (reactivity)

1. Halogen gases : _____ _____
2. Nobel gases :_____
3. Other gases : _____

Physical Properties

1. Gases do not have a fixed _____ or _____. Gases fill their containers.
2. Gases are highly _____
3. Gases _____
4. Three variables affect gases :
   a. Pressure: _____ measured by a _____
      The SI unit for pressure is _____
      Sea level is _____ = _____ atm = _____
   b. Volume: _____ measured by a _____
      The SI unit for volume is _____
   c. Temperature: _____ measured by a _____
      The SI unit for temperature is _____

B. **Behavior of Gases**

1. ***Effect of Adding or Removing Gas*** (Changing _____)
   ADDING GAS: * increases the _____
   * increases the number of _____&_____
   * if you double the amount of gas, _____
   * example: _____
   REMOVING GAS: * decreases the _____
   * remove half the gas, _____
2. ***Effect of Changing the size of the container*** (Changing _____)
   SMALLER CONTAINER: * decreases the _____
   * increases the _____ & _____
   * a container that compressed to half its size will _____
   LARGER CONTAINER:
   * increases the _____ & decreases the _____ & _____
   * a container that is doubled in size will _____
3. ***Effect of Heating or Cooling the Gas*** (Changing _____)
   HEATING: * increases the _____
   * increases the number of _____ & _____
   * Double the amount of heat will _____
   COOLING:
   * decreases the _____,___ _____ & _____
   * Decrease the heat by half will _____

C. **Dalton's Law of Partial Pressure**

Introduction:

* most gases are_____

Air at Sea Level	**percent**	**mmHg**	**atmospheres**
Nitrogen	78%	593.4	0.7 81
Oxygen	21%	159.2	0.209
Carbon dioxide	0.04%	0.3	0.001
Others	0.96%	7.1	0.009
TOTAL	100%	760.0	1.000

* molecules of gases at the same temperature will have _____ kinetic energy
* pressure depends on the _____ of particles, not the _____ of particles
* if you increase your altitude then the pressure of the air _____
* each gas exerts its own _____

Dalton's Law: At constant _____ & _____, the total _____ exerted by a mixture of gases is equal to the sum of the partial _____.

Formula:

Example:

1. Determine the pressure of a gas mixture if the pressure of the oxygen is 150 mmHg, the nitrogen is 350 mmHg and the helium is 200 mmHg.

2. What is the pressure of oxygen in a gas mixture if the total pressure is 2.5 atm and the pressure of hydrogen is 1.7 atm?

3. Why do planes have to pressurize the cabin?

D. **Boyle's Law of Pressure-Volume Changes**

Introduction:

* STP: _____
* SATP: _____
* 1kPa = _____
* Gas Laws are important for a Scuba Diver.

- When a person dives into water, the deeper they go the _____ the pressure. The scuba equipment provides air to the lungs at a pressure that matches the pressure of the water.
- If a diver ascends to the surface without exhaling steadily, the air in the lungs will _____ as the pressure drops and the lungs will _____.
- gases under pressure are _____ so the length & depth of dive are important
- If the diver ascends to quickly, he can get the _____. What happens is the gases are less soluble when the pressure drops and the gases form _____.

* Robert Boyle's (1627-1691) 1662 experiment:

PROBLEM: What is the mathematical relationship between the pressure & volume of a gas?

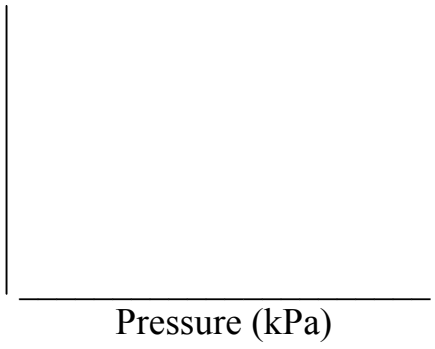
DESIGN: Pressure is exerted on a gas and the change in volume is measured.

MANIPULATED VARIABLE: **RESPONDING VARIABLE**:

DATA:

Pressure (kPa)	Volume (L)
100	5.00
110	4.55
120	4.16
130	3.85

GRAPH:



ANALYSIS:

Boyle's Law:_____

_____

Formula:_____

Comparing two sets of measurements on the same gas: _____

Example:

1. The pressure on 2.50 L of anesthetic gas is changed from 760 mmHg to 304 mmHg. What will the new volume be, if the temperature remains constant?

2. A balloon is filled with 30.0 L of helium at 1 atm. What is the volume when the balloon rises to an altitude where the pressure is 0.250 atm.

E. **Charles' Law for Temperature-Volume Changes**

Introduction:

* Absolute zero: _____

* Kelvin temperature: _____

100 C _____ K

25 C _____ K

0 C _____ K

-273.14 C _____ K (Absolute zero - never attained)

*Jacques Charles'(1746-1823) 1787 experiment:

PROBLEM: What is the mathematical relationship between the temperature & volume of a gas?

DESIGN: Temperature is varied and the change in volume of the gas is measured.

MANIPULATED VARIABLE: **RESPONDING VARIABLE**:

DATA:

Temperature (C)	Volume (L)
25 (K)	5.00
50 (K)	5.42
75 (K)	5.84
100 (K)	5.26

GRAPH:

ANALYSIS:

Charles' Law: _____

_____

Formula: _____

Comparing two sets of measurements on the same gas: _____

Example:

1) A balloon is inflated in an air-conditioned room at 27 C, and has a volume of 4.0 L. If it is heated to 57 C, what is the new volume of the balloon if the pressure is constant. (Must use Kelvin.)

2) If a sample of gas occupies 6.9 L at 327 C, what temperature is required to reduce the gas to 3.4 L? (Convert 327 to K and then convert answer back to C.)

F. **Gay-Lussac's Law for Temperature-Pressure Changes**

Introduction:

* On a hot summer day the pressure in a car tire increases. Why?
* In 1802 Joseph Gay-Lussac (1778-1850) explained this relationship

Gay Lussac's Law: _____

_____

Formula: _____

Comparing two sets of measurements on the same gas: _____

Graph:

Example:

1) A gas in an aerosol can at a pressure of 1 atm at 27 C. The can is thrown in the fire. What is the pressure if the temperature reaches 927 C?

2) A gas has a pressure of 50.0 mmHg at 540 K. What is the temperature when the pressure is 18.5 mmHg?

G. **Combined Gas Law**

Introduction:

* Boyle's, Charles' and Gay-Lussac's laws can be combined

Combined Gas Law: _____

_____

Formula: _____

Comparing two sets of measurements on the same gas: _____

Example:

1) A balloon containing hydrogen gas at 20 C and a pressure of 100 kPa has a volume of 7.50 L. Calculate the volume of the balloon after it rises 10 km where the temperature is -36 C and the pressure is 28 kPa. (Assume that no hydrogen gas escapes.

2) A cylinder of compressed oxygen has a volume of 30 L and a pressure of 100 atm at 27 C. The cylinder is cooled until the pressure is 5.0 atm. What is the new temperature in C?

G. **Ideal Gas Law**

Introduction:

* Ideal gas: a hypothetical gas that _____ all the gas laws _____ under _____
  - does not condense into a _____ when cooled
  - graphs have _____ lines
  - composed of particles of _____ size that do not _____
  - real gases deviate from ideal gases at _____ temperatures & _____ pressure
* One can calculate the moles of a gas at _____. (n=v/V where V is 22.4 L/mol)
  - The molar volume of an ideal gas is 22.414 L/mol. The molar volume of helium is 22.426 L/mol. The molar volume of chlorine gas is 22.063 L/mol
  - Therefore the _____ the particle the closer the gas resembles an ideal gas
* Avogadro stated that equal volumes of gases at the same _____ and _____ contain equal numbers of molecules (moles)
* Summary
  - Boyle: volume of a gas is inversely proportional to pressure
  -Charles: volume of a gas in directly proportional to Kelvin temperature
  - Avogadro: volume of a gas is directly proportional to the number of moles
  - COMBINATION: v n T 1/P
  - Ideal gas law constant(R): At STP R = Pv/nT = (101.3kPa x 22.4L)/(1mol x 273K)

R = _____ $\frac{\text{L x kPa}}{\text{K x mol}}$ or _____ $\frac{\text{L x mmHg}}{\text{K x mol}}$ or _____ $\frac{\text{L x atm}}{\text{K x mol}}$

Ideal Gas Law: the product of the pressure and volume is directly proportional to the amount and absolute temperature of the gas.

Formula: _____

Example:1) What mass of neon should be introduced into an evacuated 0.88L tube to produce a pressure of 90 kPa at 30 C?

2) A cylinder containing 20.0 L of nitrogen gas is pressurized to 200 atm at 27 C. How many moles of nitrogen gas are present?

3) A cylinder contains 2.24 x 106 L of methane gas at a pressure of 15.0 atm and a temperature of 42 C. How many grams of methane are in the container?

H. Gas Stoichiometry

Steps of Stoichiometry

1.

2a.

2b.

3.

4.

5.

6.

Example:

In an industrial application known as the Harber process ammonia to be used as fertilizer results from the reaction of nitrogen and hydrogen. What is the percent yield of ammonia, if 12kL is produced at 450 kPa pressure and 80°C from the reaction of 7.5 kg of hydrogen with 7.0×10^{26} particles of nitrogen?