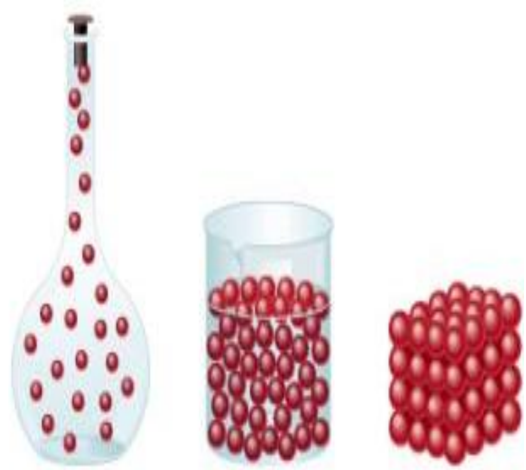
UNIT EIGHT: Chapter 10 ~ Physical Characteristics of Gases

Kinetic-Molecular Theory

* A theory developed in the late 19th century based on the idea that particles of matter are ____.

    * All particles also have ______________________________________.

* Can be used to explain the properties of _________________, _________________, and _____________ by the _______________ of the particles and the _______________ that act between them.



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    * _________________ have enough KE to _________________, but not to __________ out of position.

    * _________________ have enough KE to __________ over and around one another, but the particles are still _____________ together.

    * _________________ have enough KE to _________________________________ from one another.

Kinetic-Molecular Theory of Gases

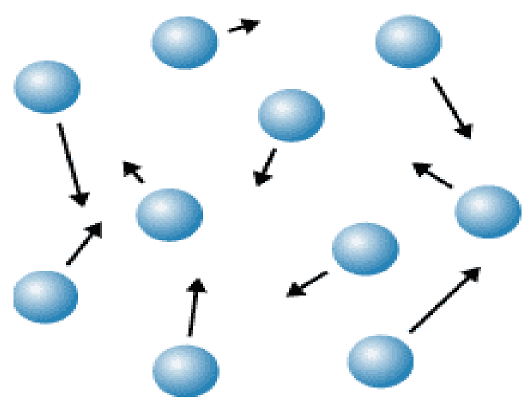
* Provides a model of an ______________________________

* An ______________________________ is an ______________________ gas that perfectly fits all the assumptions of the kinetic-molecular theory (K-MT).

* Ideal gases ___________________ consider the interactions between the gas particles and ________________________ how gases actually exist.

Assumptions of Kinetic-Molecular Theory

* 1. Gases consist of _______________ numbers of ____________ particles that are _____________________ relative to their ____________.



http://www.mit.edu/~kardar/teaching/projects/chemotaxis(AndreaSchmidt)/gas_particles.gif

   ✧ Molecules of gases are much ______________________________ than those of _____________________________________.

   ✧ Most of the ______________________ occupied by a gas is ____________ space.

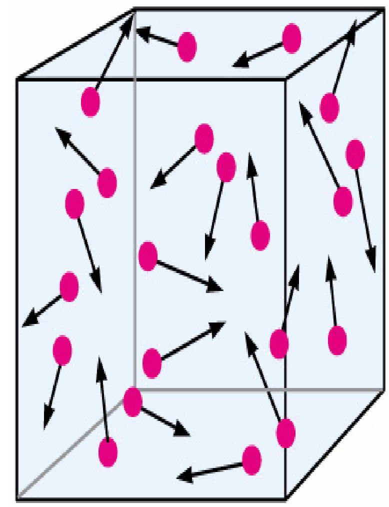
* 2. Collisions between ____________ particles and between particles and container _________________ are ___________________ collisions.

   ✧ Meaning, there is no net loss of ____.

★ 3. Gas particles are in ________________________________

____________________________. They therefore possess KE

(____________________________________).



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★ 4. There are no forces of ____________________ or

____________________ between ___________ particles.

★ 5. The average ________________________ of gas particles depends on the

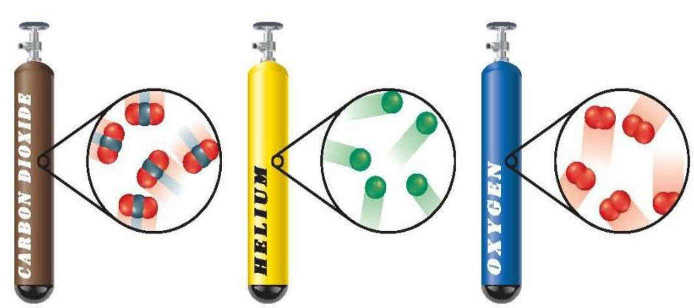
____________________ of the gas.

✧ Since all of the particles of the same ___________ have the same ____________, the kinetic energy depends on the ______________.

- $KE = \frac{1}{2} mv^2$
- Average speed and kinetic energy will ____________________ with ____ and vice versa.

So if they aren't ideal, what are they?

★ Gases that deviate from ______________ behavior are called ___________ ____________________________.



Mrpownder.org

✧ ________________________: a gas that ___________________________________ completely according to the assumptions of the K-MT.

- How gases ____.

Ideal Gas vs. Real Gas

Ideal Gas	Real Gas
There are _________ attractive or repulsive forces between particles.	There are ____________________ attractive and repulsive forces between particles.
Particles have _________ volume.	Particles have a ____________________ volume.
Collisions are ____________________ (no loss in total kinetic energy)	Collisions are ___________________________ (gas particles lose energy when they collide)

Real Gases

* The conditions in ____________ gases that make them ____________________ from ____________________ behavior (and the K-MT assumptions) are:
  - ✧ ____
  - ✧ ____
  - ✧ ____
* These conditions make the gas particles move ____________________ together which will ____________________ their collisions and the attractive ________________ between them.

Physical Properties of Gases

http://web.princeton.edu/sites/ehs/cylinders.jpg

* _____________________________
  - ✧ Gases do not have ____________________________________.
  - ✧ Gases ________________________ fill any container in which they are enclosed and will ____.

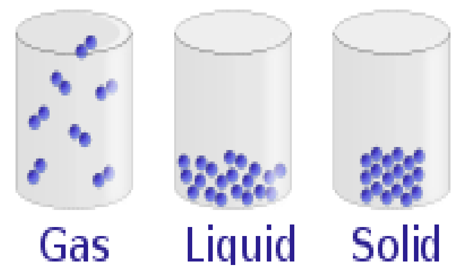
* ______________________

✧ Gas particles ______________________ past one another.

- **Property similar to ___________________.**

✧ Gases and liquids are both referred to as fluids because they _____________.

* ______________________



http://upload.wikimedia.org/wikipedia/commons/thumb/8/89/States_of_matter_En.svg/220px-States_of_matter_En.svg.png

✧ Gases are ___________ dense than the

____________ or ___________ state of the

_____________ substance.

- Particles in a _________ are about _________ times farther apart than

  those in a _________________________________.

  - Therefore, there is a lot of ______________ space between the

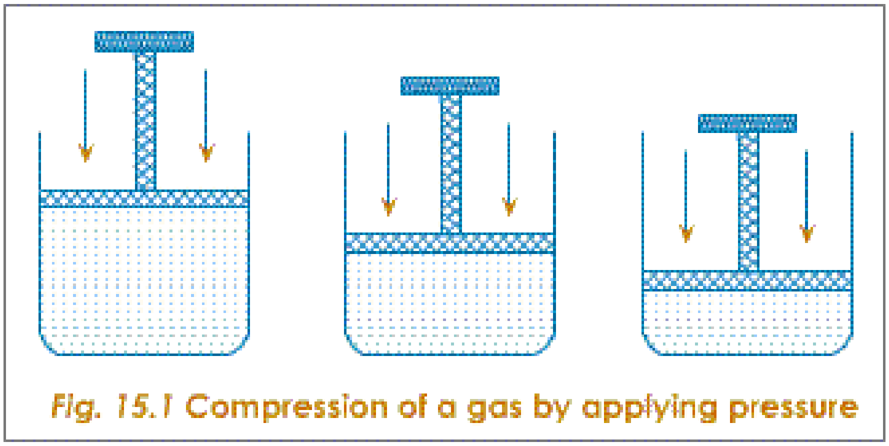
    particles.

* ______________________

✧ Gas particles that were initially _______________ can be

_____________________________ together.

- ______________________ of the gas can be greatly ____________________.



http://images.tutorvista.com/content/gas-laws/gas-compression-by-pressure.gif

* ____

✧ Gases _________________________ and _____________ with one another, even without being _____________________.

✧ __________________________: the spontaneous _______________________ of the particles of _______________________ gases caused by their random motion.

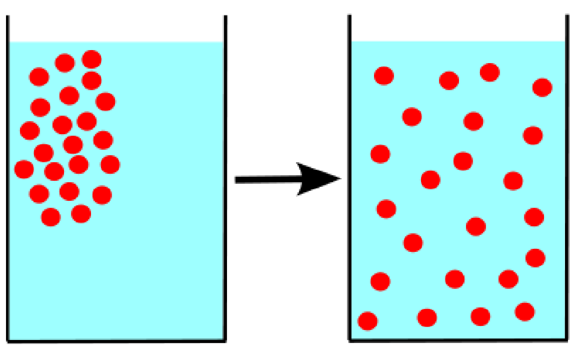
- ________________ of diffusion depends on:
    - The particles' ________________
    - The particles' ________________________________
    - The _______________________ forces between the particles

✧ ____________________________: a process by which ___________ particles pass through a __________________________________.

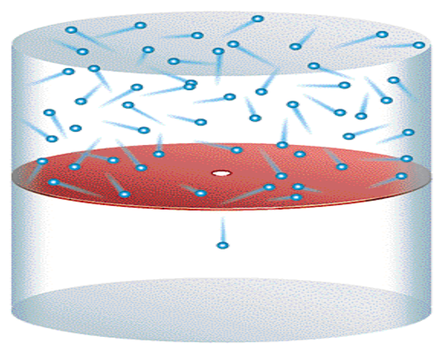
- _________________ of effusion depends on:
  - The particles' _________________
  - The particles' __________________________________
- Molecules of ____________ mass effuse faster than molecules of ________________ mass.

★ Diffusion vs. Effusion

✧ __________________________________ __________________________________



http://www.wikipedia.com



http://upload.wikimedia.org/wikipedia/commons/thumb/1/12/Diffusion.svg/410px-Diffusion.svg.png

What is Pressure?

★ Pressure can be defined as the ____ ____.

* Gas molecules exert ______________________ on any surface with which they

____________________.

  - Depends on ________________, _________________________, and the number of

    _________________________ present.

* The _______________________________ also exerts pressure.

How is Pressure Measured?

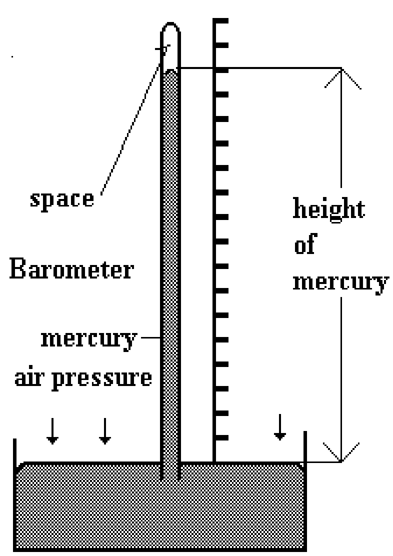
* There are two devices used to measure pressure:

  - ________________________________: used to measure atmospheric pressure

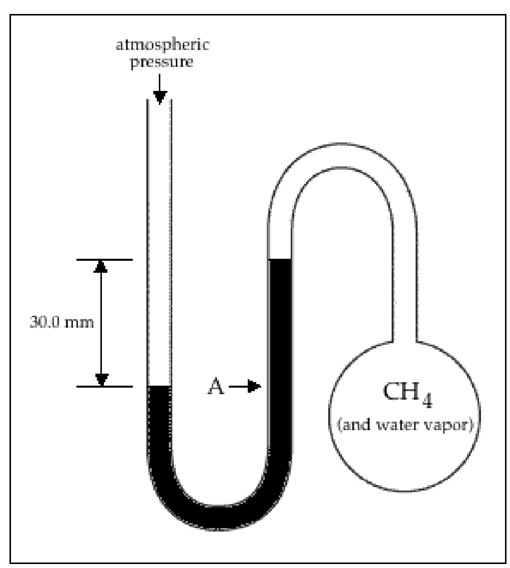
  - ________________________________: used to measure the pressure of an enclosed gas

    sample

BAROMETER



MANOMETER



Units of Pressure

* ____

* ____

* ____

* ____

✧ SI unit of pressure

✧ More convenient to represent pressure in ____________________________

Unit Equivalents

1 atm =

760 mm Hg =

760 torr =

101.3 kPa =

1.013×10^5 Pa =

MEMORIZE!

Standard Temperature and Pressure

- Used for purposes of ______________________________ among scientists

- Abbreviated ______________

- At STP, the temperature is __________°C (or __________ K) and the pressure is

  __________ atm (or __________ kPa).

Temperature

- Temperature is a measure of the ____

  in an object.

- Temperature scales:

  - __________________________→ based on boiling point and freezing point of water

  - __________________________→ based on absolute zero

Temperature Conversions

- Celsius (t) to Kelvin (T)

  - ______________________________

- Kelvin (T) to Celsius (t)

  - ______________________________

Temperature Conversion Practice Problems

Ex. 1:

Ex. 4:

Ex. 2:

Ex. 5:

Ex. 3:

Ex. 6:

The Gas Laws

* Simple ______________________________ relationships between gas variables of:
  - ✧ ______________________________ (V)
  - ✧ ______________________________ (T)
  - ✧ ______________________________ (P)
  - ✧ ______________________________ (n)

Boyle's Law

* ____

http://www.mit.edu/~kardar/teaching/projects/chemotaxis(Andrea Schmidt)/gas_particles.gif

* States that the __________________ of a fixed mass of gas varies _____________________ with the ___________________ at constant _________________________.
  - ✧ k = __________ where k is a _____________________ value
* **Variables:** ____
* **Constants:** ____

* Boyle's Law can be used to compare changing conditions for a gas, where:

    - ______________________ = initial conditions

    - ______________________ = final conditions

How to Solve Boyle's Law

* The equation for Boyle's Law:

* Units of pressure (P_1 and P_2) must be the ____________________

    - Can be ____

* Units of volume (V_1 and V_2) must be the ____________________

    - Can be ____

* Must show all of your work!

Practice Problems!!

1. Nitrous oxide (N_2O) is used as an anesthetic. The pressure on _________ L of N_2O changes from __________ kPa to __________ kPa. If the temperature does not change, what will the new volume be?

2. A balloon initially had a volume of _________ L. When the gas inside the balloon was allowed to expand to a volume of _________ L, the pressure was _________ atm. Assuming constant temperature, what was the initial pressure of the gas in the balloon, in atm?

Charles' Law

http://www.rapidonline.com/catalogueimages/Module/M075368P01WL.jpg

- ★ ____

- ★ States that the ________________ of a fixed mass of gas at constant ________________ varies ________________ with the ________________ temperature

  - ✧ k = __________ where k is a ____________________ value

- ★ **Variables:** ____

- ★ **Constants:** ____

- ★ Charles' Law can be used to compare changing conditions for a gas, where:

  - ✧ ____________________ = initial conditions

  - ✧ ____________________ = final conditions

How to Solve Charles' Law

- ★ The equation for Charles' Law:

- Units of volume(V_1 & V_2) must be the ___________________

    - Can be ______________________________________

- Units of temperature (T_1 & T_2) ___________________ be in Kelvin!

    - Gas ___________________ and Kelvin (not Celsius) ___________________ are ___________________ proportional to each other.

- Must show all of your work including temperature conversions!

Practice Problem!

1. A balloon was inflated in a room at ______°C. The balloon was then heated to a temperature of ______°C and reached a volume of ______ liters. What was the original volume of the balloon if the pressure remained constant?

Gay-Lussac's Law


http://www.chemistryexplained.com/images/chfa_02_img0361.jpg

- ____

- States that the ________________ of a fixed mass of gas at constant ________________ varies ________________ with the ________________ temperature

    - ✧ k = __________ where k is a ___________________ value

- **Variables: ____**

- **Constants: ____**

- Gay-Lussac's Law can be used to compare changing conditions for a gas, where:

    - ✧ ___________________ = initial conditions

    - ✧ ___________________ = final conditions

How to Solve Gay-Lussac's Law

- The equation for Gay-Lussac's Law:

* Units of pressure (P_1 & P_2) must be the ______________________

  * ✧ Can be ____

* Units of temperature (T_1 & T_2) **must** be in ______________________ !

* Must show all of your work including temperature conversions!

Practice Problem!

1. The pressure in a car tire is _______ kPa. After a long drive, the tire has a pressure of _______ kPa and a temperature of _______°C. Assuming the volume did not change, what was the temperature, in °C, of the air in the tire before the drive?

The Combined Gas Law

- ____

- Expresses the relationship between ______________________, ______________________,, and ______________________, of a fixed ______________________, of gas

  - k = ___________ where k is a ______________________ value

- **Variables: ____**

- **Constant: ______________________**

- Combined Gas Law can be used to compare changing conditions for a gas, where:

  - ______________________ = initial conditions

  - ______________________ = final conditions

How to Solve Combined Gas Law

- The equation for Combined Gas Law:

Units of volume(V_1 & V_2) must be the ____________________

- ✧ Can be ____

★ Units of temperature (T_1 & T_2) **<u>must</u>** be in ____________________!

★ Units of pressure (P_1 & P_2) must be the ____________________

- ✧ Can be ____

★ Must show all your work including temperature conversions!

4 Laws in 1

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Constant Temperature

$$P_1V_1 = P_2V_2$$

Boyle's Law

Constant Volume

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

Gay-Lussac's Law

Constant Pressure

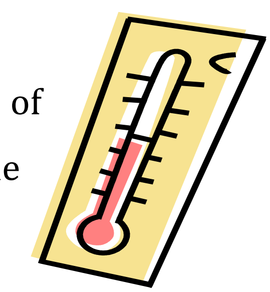
$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Charles' Law

Practice Problems!!

1. The volume of a gas filled balloon is _________ L at _________ K and _________ kPa of pressure. What would the volume be at STP?

2. A _________ L air sample has a pressure of _________ kPa at a temperature of _________°C. If the temperature is raised to ___________°C and the volume expands to ___________ L, what will the new pressure be?



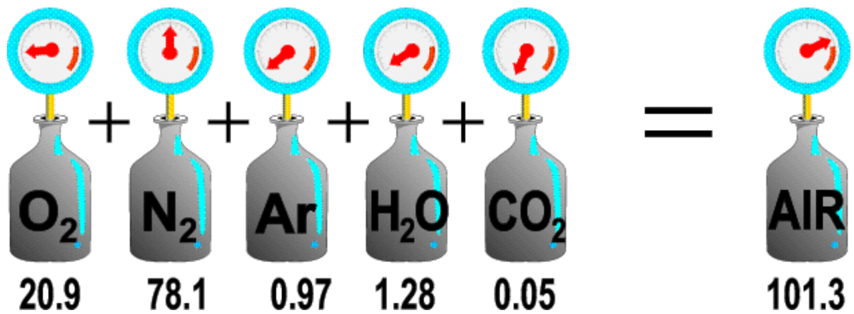
Dalton's Law

http://scienceworld.wolfram.com/biography/pics/Dalton.jpg

* ______________________________

* States that the ____________ pressure of a ________________ of gases is __________ to the ________ of the ___________ pressures of the component gases

  ✧ ______________________________: the pressure of each gas in a mixture



http://mcatprep.quora.com

Dalton's Law Equation

* Where, __________ = total pressure

  ____________ = partial pressures

* Pressures **must** be in the _______________ units

  ✧ Can be ____

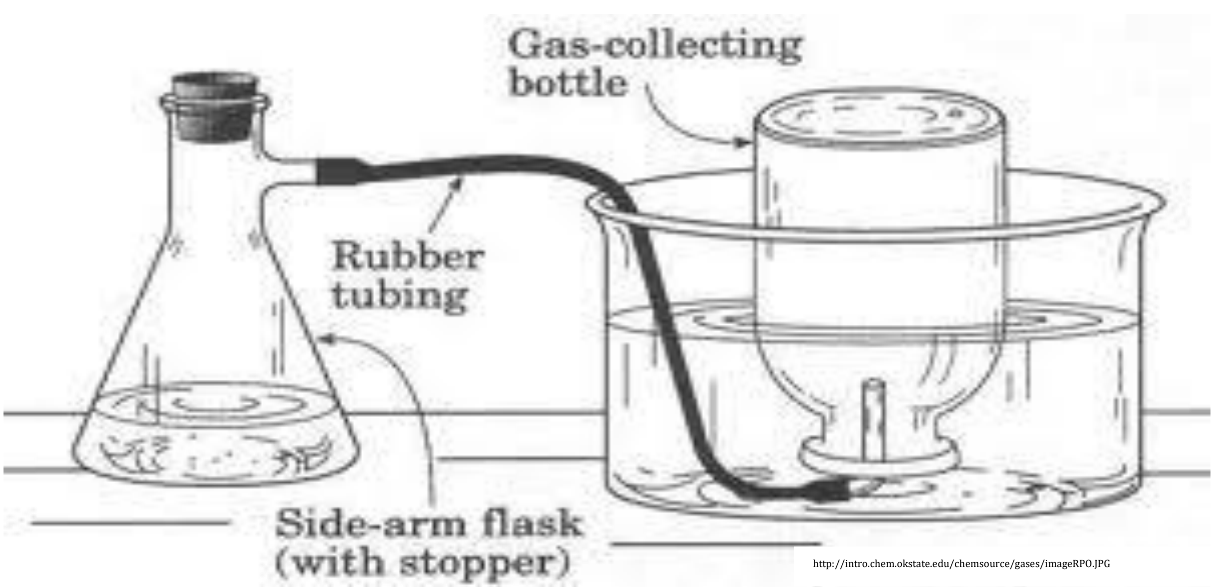
Practice Problem:

1. A mixture of three gases, A, B, and C, is at a total pressure of _________ atm. The partial pressure of gas A is _________ atm; that of gas B is __________ atm. What is the partial pressure of gas C?

Gas Collected by Water Displacement (Application of Dalton's Law)

★ A way of collecting ___________ in the laboratory

✧ Gas produced ____________________ the water



- Gas collected in this way is always mixed with ______________________ and is therefore not ____________

    - Water vapor also exerts a pressure (because it is a __________), known as ____.

- When the water levels inside and outside of the bottle are the ________________, the ________________ pressure inside the bottle would be the same as the __________________________ pressure.

How to Solve Water Displacement by Gas

- ___________ is read from a barometer in the lab

- ___________ can be found in a table

    - Table A-8 on page 899 in your textbook!!

Practice Problem!

1. A chemist collects a sample of $H_2S_{(g)}$ over water at a temperature of __________ºC. The total pressure of the gas that has displaced a volume of __________ mL of water is __________ kPa. What is the pressure of the H_2S gas collected?

Chapter 11 ~ Molecular Composition of Gases

Gay-Lussac's Law of Combining Volumes of Gas

* States that at constant ____________________________ and ____________________________, the ____________________________ of gaseous reactants and products can be expressed as _____________ of small whole numbers
    * Examples:

Avogadro’s Law

- States that equal ____________________ of gases at the same ____________________ and ____________________ contain equal numbers of ____________________
  - The gas volume is ____________________ proportional to the amount of gas, at given temperature and pressure.
- **Variables**: ____
- **Constants**: ____

Molar Volume of Gases

- According to Avogadro’s Law, one mole of any gas will occupy the same ____________________ as one mole of any other gas at the same ____________________ and ____________________, despite ____________differences.
  - The volume occupied by ____________________ of a gas at __________ is known as the ____ of a gas.
    - Molar volume = ________________

Memorize!!

The Ideal Gas Law

* ____

* Introduces ________________ of gas (measured in __________) as a 4^{th} variable, ___

* As the number of __________________ increases (at constant volume and temperature) the __________________ increases.

* As the number of __________________ increases (at constant pressure and temperature) the __________________ increases.

* Therefore, all four variables are _____________________________________.

What's the Ideal Gas Law?

* A __________________ relationship among __________________, ________________, __________________, and the number of ____________ of a gas.

* States that the __________________ of a gas varies __________________ with the number of ___________of a gas and its Kelvin __________________. The __________________ also varies __________________ with __________________.

How to Solve the Ideal Gas Law

- ★ The equation for the Ideal Gas Law:

- ★ Units of pressure (P) can be ______________________

- ★ Units of volume(V) **<u>must</u>** be in ______________________

- ★ Units of temperature (T) **<u>must</u>** be in ______________________!

- ★ Units of amount (n) **<u>must</u>** be in ______________________

  - ✧ May need to covert from ______________________ → moles

- ★ Must show all of your work including temperature conversions!

The Ideal Gas Constant

- ★ The constant ______ is known as the ____

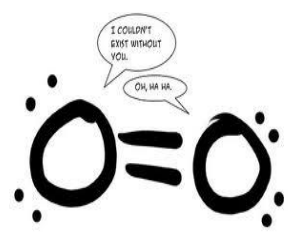
  - ✧ Value depends on the chosen units for ______________________.

$$R = 8.314\ \frac{L \cdot kPa}{mol \cdot K} \qquad R = 0.0821\ \frac{L \cdot atm}{mol \cdot K}$$

Practice Problems!

1. A child's lungs can hold __________L. How many grams of air do her lungs hold at a pressure of ____________kPa and a body temperature of _________°C? Assume the molar mass of air is 29.0 grams.

2. What is the volume _______ g of oxygen gas at _______ kPa and _______°C?



3. A _________ g sample of nitrogen dioxide gas occupies _________ liters at SP. What is the temperature of the gas in Kelvin? In Celsius?

4. When the pressure in a certain gas cylinder with a volume of _________ L reaches _________ atm, the cylinder is likely to explode. If this cylinder contains _________ moles of argon at _________°C, is it on the verge of exploding? Calculate the pressure in atmospheres.

Exam Date: ____

- **Physical Characteristics of Gases (Chapter 10)**
  - ✓ Kinetic-molecular theory / focus on energy of particles
  - ✓ ideal gas / real gas
  - ✓ 5 assumptions for ideal gases
  - ✓ physical properties of gases – expansion / fluidity / density / compressibility / diffusion / effusion
  - ✓ variables to measure - volume / pressure / temperature / amount in moles
  - ✓ pressure / units
  - ✓ STP
  - ✓ gas laws - Boyles / Charles / Gay-Lussac's / Combined / Dalton's partial pressures
- **Molecular Composition of Gases (Chapter 11)**
  - ✓ combining volumes of gases in reaction / Avogadro's law
  - ✓ molar volume
  - ✓ ideal gas law