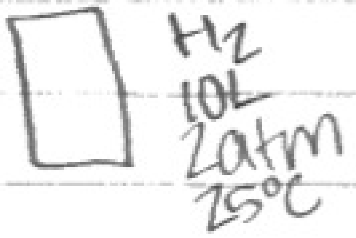
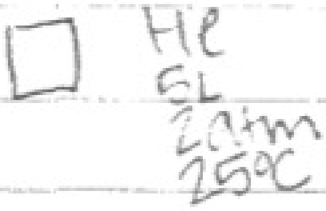
9/5/13

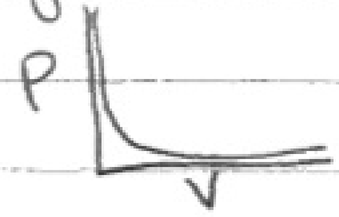
Macroscopic & microscopic views of gases
Ideal Gas Law
Use ideal gas law - identify unknown gas.





$\frac{V_1}{n_1} = \frac{V_2}{n_2}$ ← Avogadro's Law

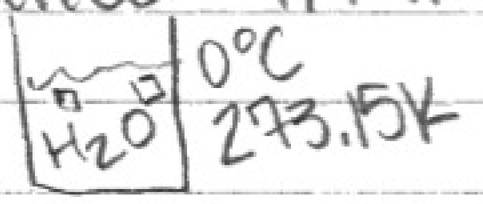
Boyle's Law

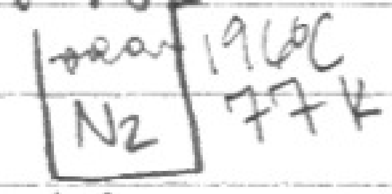


Pressure & volume - inversely proportional

Physical description of gas
Gas laws quantify the relationship of the properties. Equation form of law-give ability to predict conditions @ new state.

Charles's Law - Balloon in ice water vs. balloon in liquid N_2





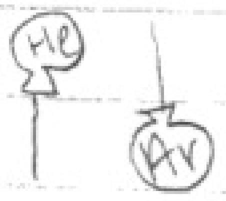
Always use absolute scale (Kelvin) when calculating

- At lower temp & pressure - particles move slower
- When pressure stays constant, if temp decreases, volume <u>must</u> decrease.
- Pressure due to collisions between particles.
- Decrease vol, increase pressure

Ideal Gas Law: $PV = nRT$
$R = .08205746 \text{ L atm K}^{-1} \text{mol}^{-1}$
$R = .08314472 \text{ L bar K}^{-1} \text{mol}^{-1}$
Constant (R) depends on units of measure
$\frac{PV}{nT} = R$

PV=nRT

- Given 3 properties of the state, calculate the 4th
- Predicts every single gas should have the same # density. P,T identical mol per vol (# density).
- <u>molar volume</u> - vol for 1 mol
- Particles have different masses. Mass density different.
- Given P, T, & molar mass, calculate mass density
- " " & density -



- Ar has higher mass density than He.
- They have the same # density $\frac{n}{V} = \frac{P}{RT}$
- w/ 2 identical containers, same T & mass density. He has more pressure - lighter, more particles, more collisions.

PV=nRT mass density equation:

mass density = $\frac{mass}{vol}$

number density = $\frac{n}{V} = \frac{P}{RT}$

$$\frac{g}{mol} \cdot \frac{n}{V} = \frac{P}{RT} \cdot \frac{g}{mol} = \boxed{\rho = \frac{P(mm)}{RT} = \frac{mass}{V}}$$ ☆

$$\rho = \frac{P(mm)}{RT} = \frac{mass}{V}$$

$$\frac{60\,(mm)}{(62.36)(463)} = \frac{.320}{1}$$

$$9239.26 = 60(mm)$$

$$mm = 153.99\ g/mol$$

HW02 { LM 06 and 07
Tuesday Morning Due date

LM R[illegible] Version 1 - Posted today due Tues 9AM - Bonus Points

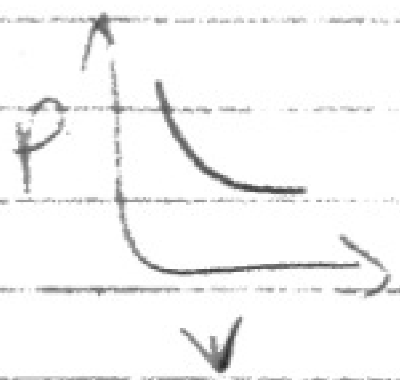
Free tutoring
RHSG [illegible]
All intro level Science/Math free tutoring
[illegible] Sunday - Thursday
7:30 - 10:30 pm
Southeast corner ← JCL and Kirsolving (South lounge)

---

* Macroscopic and Microscopic views of Gases * IDEAL GASES
* Use Ideal Gas law - Identify unknown gas

He	Ne
10L	5L
2atm	2atm
25°C	25°C

P/V



Pressure - most abstract property.

* Gas laws quantify's the relationship of the properties. Equation form of laws give ability to predict conditions at new state.

Gas - volume, Pressure, Temperature and Amount

H_2O 0°C → 273.15K

N_2 -196°C → 77K

[illegible] law [illegible] # moles of constant.

when you decrease volume, Pressure increases

$\downarrow$ volume = # of collision $\uparrow$.

$\downarrow$ Volume = speed of collision $\downarrow$.

$PV = nRT$

The value of R depends on the units of measure used for the state functions.

$R = .08205746 \, L \, atm \, K^{-1} mol^{-1}$

$R = .08314472 \, L \, bar \, K^{-1} mol^{-1}$

(R) $\Rightarrow$ constant } Value depends on the units.

$PV = nRT.$

↳ Given 3 properties $\Rightarrow$ calculate the 4^{th}

- predicts every single gas should have the same number density @ same P, T should be identical - moles per volume (# density)
- Molar Volume - volume / 1 mole useful for gas stoichiometry
- Particles have different masses, different gases, should have different mass densities under same conditions
- Given P, T, and molar mass calculate the mass density of a gas

Given P, T, & density $\Rightarrow$ molar mass of a gas.

density = $\frac{m}{V}$ Argon $\Rightarrow$ higher dense compared to Helium

density = $\frac{n}{V}$ when P & T = same ; # density is same regardless of gas particle

9/5/13

Day 3 - Gas Laws

Announcements:

HW2 posted - due Tues @ 9am

LM 6+7 posted - due Tue @ 9am ☆ Do these before HW

LM Reflection 1 ☆ Bonus Point ☆

Course Packets can be prepared @ Coop if not on shelf

today

- Ideal gas law
- Finding MM w/ ideal gas law
- Compare macroscopic view w/ microscopic view

Clicker 1

H_2	He
10 L	5 L
2 atm	1 atm
25°C	25°C

$$\frac{10ml}{n_1} = \frac{5ml}{n_2}$$

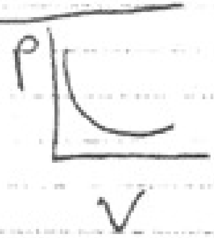
n_1 contains 2x more compared to n_2

$$\frac{10ml}{2} = \frac{5ml}{1}$$

Avogadro's law - V and amount of gas are directly proportional, if T and P is same.

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

Clicker 2



Boyle's Law pressure + volume are inversly related

when T is fixed.

$$PV = k$$

$$P_1V_1 = P_2V_2$$

Physical Description of Gas

Volumn
Pressure
Temp
Amount

- Gas laws quantify relationship of the properties
- Equation form of Laws give us ability to predict conditions in new state
  ↳ if behaving ideally → $P_1V_1 = P_2V_2$
  ↳ empiracle ~~[illegible]~~ model [state 1] [state 2]

Clicker 3

Charle's law

O_2 T = 10°C P = 1 atm

T = 20°C P = 1 atm

$\frac{V}{T} = k$ [where T is absolute temp]

① convert temps to absolute temp in °K
② compare to empiracle model

So, V_2 must be higher than V_1, but slightly.

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{V_1}{283} = \frac{V_2}{293}$

Liquid Nitrogen example

(293K) RT → 77°K 200°C → big change in Volumn

293K → 273K 10°C → not a large change in volumn

Remember, this is only a 10° change in Kelvin

At absolute 0°K, volumn of gas is 0 → it is not moving.

°C and °K have same size of degree, but they are offset by 273.135.

Back to Gas Law Simulator
- Cool down, T↓, V↓, small particals move slowly, Pressure remains the same

Why are particals moving slower?
Particals are moving slower so there are fewer collisions and less kinetic energy. In order to maintain pressure, the volumn must reduce.

clicker 4

Macro

In syringe expt, when volumn decreases, and T and amount of gas same, pressure increase.

clicker 5

Micro

What is small partical explination?
# of collisions increases!
less area for small particals to move in = more collisions w/ container.

Combine Gas Law - IDEAL GAS LAW

$PV = nRT$ $R = \frac{PV}{nT}$ = universal gas constant

An gas behaving ideally will follow this law.

☆ R depends on units used for P, V, n, T
(P: bar, kPa, torr; V: L; n: # of mols; T: K°)

For example, $R = .08205746 \, L \, atm \, K^{-1} \, mol^{-1}$

$R = .08314472 \, L \, bar \, K^{-1} \, mol^{-1}$

☆ Be mindful of units in calculations! ☆

can learn a lot of relationships from looking at empiracle model.

- $n\uparrow$ then $P\uparrow$
- $P\uparrow$ then $T\uparrow$

Ideal Gas Law con't
From PV=nRT we can know:
① Given 3 parameters of state, calculate 4th.
for example # of moles → hard to count!
$$n = \frac{PV}{RT}$$
② Every gas should have same # density
Same P, T should be identical - moles per volumn
(# density) $\frac{n}{V} = \frac{P}{RT}$
③ Molar volumn - volumne per one mole
$$\frac{V}{n} = \frac{RT}{P}$$
④ Particals have diff mass (O_2 + H_2) so
diff gasses should have diff mass densitres
under same ~~ga~~ conditions

Clicker 9
Which balloon has higher mass density?
mass density = $\frac{mass}{volumn}$ $\left(\frac{g}{L}\right)$
Ar ↑ mass, both balloons have
same volumn so Ar has
greater mass density.

Clicker 10
Which balloon has higher # density?
They are the same!
$\frac{n}{V} = \frac{P}{RT}$ P, R, T are same AND V
is same! So n is same!
all are behaving ideally

Ch301 Gas Laws 9-5-13

Ex - 10° C at 1atm. If it ~~decreases~~ increases to 20°C at 1atm, how would the volume change?
· ~~Changes~~ increases by less than ~~half~~ double

· For Charles's Law, you must have units in Kelvin (absolute). If you need final temp. in C°, do the math in Kelvin first

When you lower temperature and pressure remains constant, volume decreases because you need to decrease area inside the container to maintain a constant pressure. Otherwise, the pressure would decrease since particles move

In the syringe, when volume decreased, pressure increases because the number of collisions increases

In the balloon in liquid nitrogen, volume decreases because the speed of the particles decrease

Ideal Gas Law - $PV=nRT$ *The value of R depends on the units of measure

*Temp. must be in Kelvin

$R = .08205746 \ L\,atm\,K^{-1}\,mol^{-1}$

$R = .08314472 \ L\,bar\,K^{-1}\,mol^{-1}$

Number density
↓
$\frac{n}{V} = \frac{P}{RT}$ $\frac{V}{n}$ - Molar volume, amount of space 1 mole of gas occupies

Mass density - $\frac{m}{V}$

$\frac{m}{V} = \frac{MM\,P}{RT}$

Argon has a higher mass density than Helium
Argon and helium has the same # density

When Ar and He has the same mass density in a container, He has higher pressure because there are more moles of He