Gas Laws

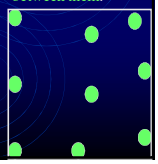
Gases

Phases of matter

Solids
~tend to be the most compact and orderly. The atoms only vibrate!

Liquids
~are more random than solids. The molecules flow around one another, and are scattered about more.

Gases
~are the most random. Molecules fly around randomly with large spaces in between them.



Volume- amount of space something takes up.

Density of phases

- Density is mass per volume.
- For the diagrams, all phases had the same number of molecules, therefore the same mass (mass is the amount of matter present).
- Gases have significantly less density than liquids or solids.
- Generally solids are the most dense with liquids very close in density; gases are significantly less dense.

Gases float on everything

- Gases are less dense than other phases so buoyant forces make them float.
- **Gases do have mass** (and **weight**) though.
- Gases are not weightless!
- Helium is lighter than air (nitrogen/oxygen mix), but it still has a weight!
- Think of a **full** propane tank (gas grill) compared to an **empty** tank.
- The same applies to a helium tank. A full tank is heavier than an empty tank.

Exception to the rule

- Water actually is most dense at 4° C (water), ice is less dense than water.
- Hydrogen bonding pulls everything in tighter when it is a liquid.
- Buoyant forces make things less dense float on things that are more dense.
- Ice floats on water.

Gases exert a pressure

- Pressure is the force per unit of area.
- Since gas molecules fly around randomly, they run into things.
- Each time they hit something they apply a force.
- More times they hit the more force (therefore the more pressure) they apply.

Kinetic Energy

- Kinetic energy is ½ mass (velocity)^2
- The average kinetic energy is temperature.
- The sum of KE is the heat energy.
- The more heat energy present the faster these are moving.
- The faster they are moving the harder they will hit.

Pressure

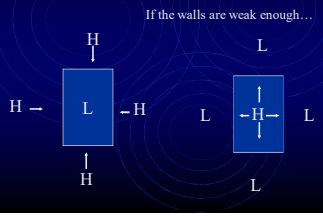
Atmospheric Pressure

- ~pressure caused by the atmosphere.
- Atmospheric pressure squeezes on everything from every direction and attempts to fill in empty spaces.
- If you have less pressure inside something and more pressure outside, the outside pressure will squeeze it.
- It could implode depending on the strength of the wall. The reverse is also true.

Gases can be compressed

- Neither solids nor liquids can be compressed (squeezed to a smaller size) but gases can be easily compressed.
- It can be done with an air pump (into a bike tire or basketball or anything that is inflatable.
- If the compression force is larger than the force (pressure) of the gas, it can be made smaller.
- The reverse is also true.

H is high pressure L is low pressure



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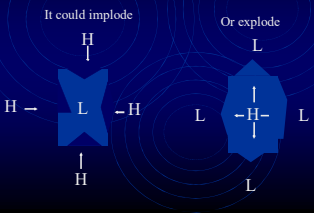

Volume and Pressure

- If you seal a container and decrease the volume (squeeze it) the pressure inside will
- increase.
- If you increase the volume the pressure will decrease.
- This is **Boyle's Law**
- The volume of a gas is inversely proportional to the pressure of the gas.
- Standard pressure is 101 kPa or 29.9 inches of mercury (Hg)

Other units of Pressure

Name	Abbreviation	Standard Pressure	Where it is used.
Torr	mm Hg or torr	760	weather
Kilopascal	kPa	101	metric standard
Atmospheres	Atm	1.00	deep sea diving
Pounds per square inch	psi	14.7	anything inflatable

Boyle's law

- Volume of a gas is inversely proportional to the pressure on a gas.
- V α 1/P
- Therefore VP = k (some constant for each gas)
- $V_iP_i = V_fP_f$
- $_i$ is initial $_f$ is final

Boyle's Law

- You have 145 mL of a gas at 67 kPa. What volume will it occupy at 127 kPa?
- VP = VP

Boyle's Law

- You have 145 mL of a gas at 67 kPa. What volume will it occupy at 127 kPa?
- VP = VP
- 145 mL (67kPa) = V (127 kPa)
- V = 76 mL

Boyle's Law

- You have 164 mL of a gas at 1.2 atm. What pressure will it occupy 215 mL?
- VP = VP

Boyle's Law

- You have 164 mL of a gas at 1.2 atm. What pressure will it occupy 215 mL?
- VP = VP
- 164 mL (1.2 atm) = 215 mL P
- P = 0.92 atm