Unit 5: Gases

* All gases behave according to the Kinetic Molecular Theory - pg 421

*We consider all gases as "ideal" gases

* All gas particles behave the same way (doesn't matter their size or chemical formula)

* Each gas particle acts independently of other gas particles

Jan 20-12:42 PM

Properties of **any** sample of gas

1. Volume - depends on the size of the container
   -measured in Litres

2. Temperature - a value that describes the average kinetic energy of the particles
   -measured in Kelvin [Kelvin = Celsius + 273]
   0 K = -273 °C (absolute zero)

3. Pressure - a force, caused by collisions of those particles against the sides of the container
   -measured in kPa, mmHg, atm
   101.325 kPa = 760 mmHg = 1 atm

4. Mass - determined by the number of particles (moles) and its particle mass

Jan 18-8:02 AM

Standards in Chemistry

STP: Standard Temperature and Pressure:
0 (273K) and 101.325 kPa

SATP: Standard Ambient Temperature and Pressure:
25°C (298K) and 100 kPa

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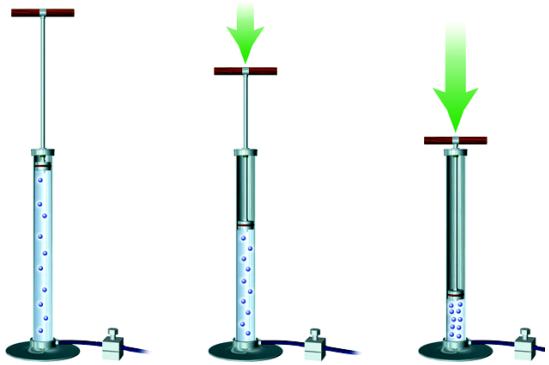
Boyle's Law:



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"As volume decreases, pressure increases"
or "As volume increases, pressure decreases"

Volume and pressure are inversely proportional

Or

Volume is directly proportional to 1/P

$$V \propto \frac{1}{P}$$

Jan 13-12:33 PM

This happens because as volume decreases, the gas molecules travel less distance before colliding, which leads to more collisions per second which is an increase in pressure.

Jan 13-12:35 PM

We can use this idea to derive Boyle's Law
(Note: Temperature must be constant)

$$PV = \text{constant}$$

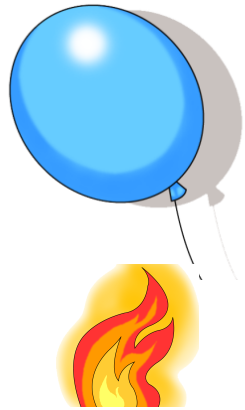
$$P_iV_i = P_fV_f$$

Jan 20-1:19 PM

Ex 1. If 8.25L of hydrogen is placed in a balloon at room temperature and standard atmospheric pressure and is then submerged in a pool of water that is also room temperature such that its pressure increases to 110.2 kPa, what is the final volume of the balloon?

Jan 13-1:13 PM

Charles' Law



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Charles' Law:

As temperature increases, volume increases

V T

volume is directly proportional to temperature

Jan 20-1:21 PM

For every 1 increase, the volume expands by 1/273 of its original volume.

Lord Kelvin realized the huge impact of this.

If you decrease the temp. by 273 then the gas has no volume.

Jan 20-1:27 PM

This led to the development of the Kelvin scale where -273 (0 K) represents absolute zero.
We use the Kelvin scale for gas chemistry.

$$T_k = {}^{o}C + 273$$

Jan 20-1:29 PM

Using the same strategy as before, we can derive Charles' Law when the pressure is constant.

$$\frac{V}{T} = \text{constant}$$

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

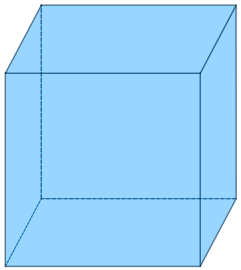
*Temperatures must be in Kelvin

Jan 20-1:24 PM

Ex. 2. A 2L Pepsi bottle is filled with air at 21°C and placed in the freezer over night. The next day the bottle is removed and has decreased in volume to 1.73L. What is the temperature of the freezer?

Jan 17-8:45 AM

Gay-Lussac's Law:



Jan 18-8:43 AM

Gay-Lussac's Law:

As temperature increases, pressure increases.

Jan 20-1:32 PM

At constant volume, we can derive Gay-Lussac's Law:

$$\frac{P}{T} \quad \text{constant}$$

$$\frac{P}{T} \qquad \frac{P}{T}$$

* Temperatures must be in Kelvin

Jan 20-1:47 PM

Ex. 3 The fire extinguisher in your house may be designed to withstand 2500 kPa of pressure. The pressure gauge on the extinguisher reads 1519.5 kPa at 22°C. If a fire in your house heated the extinguisher to 95°C would the extinguisher explode?

Jan 17-12:32 PM

Combined Gas Law Calculations

To solve gas related problems where all 3 variables change, the gas laws need to be used together. This results in the COMBINED GAS LAW:

Jan 17-12:34 PM

Ex. 4 At Miss. Allen's birthday party she tied balloons to her car. That particular day, the weather changed as a warm low-pressure front moved in that had a temperature of -4°C and a pressure of 100.7 kPa. The original temperature was -15°C and the pressure was 103 kPa. What happened to the volume of the 3.9L balloons? By how much did the volume change?

Jan 17-12:36 PM

Ex. 5 A 10.0L sample of gas is collected at 175°C and 200 kPa. What pressure must be applied to this gas sample to reduce its volume to 2.0L at 25°C?

Jan 17-12:37 PM

Try the Boyle/Charles worksheets online plus there are practice problems on pages:

434, 446, 449 and 457 (21 Questions total).

Jan 21-11:04 AM