Empirical Gas Laws

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Factors that Affect Gases

* Pressure
  * the amount of force exerted on a gas
* Temperature
* Volume
  * the amount of space that object takes up

Boyle's Law

$$P_1V_1=P_2V_2$$

* Assuming constant temperature

Example

* A 1.5 L tank is filled with compressed air at pressure 20 atm. If the tank is emptied, what volume of gas would be released at ambient pressure 0.92 atm?

Solution

* Given:
  * P_1= 20 atm
  * P_2= 0.92 atm
  * V_1= 1.5L
  * V_2=?

Solution

$P_1V_1=P_2V_2$

$(20\ atm)(1.5L) = (0.92\ atm)(V_2)$

$$\frac{(20\ atm)(1.5\ L)}{0.92\ atm} = V_2$$

$V_2 = 33L$

There will be 33L of gas released.

Charle's Law

$$T_1V_2=T_2V_1$$

* Assuming constant pressure

Example

* A balloon at a birthday party is 2.5L. If the house is 22 C and then taken outside where it is -25 C, how large will the balloon be?

Solution

* Given:
  * $T_1 = 22\ C$
  * $T_2 = -25\ C$
  * $V_1 = 1.5L$
  * $V_2 = ?$

Solution

* Given:
  * T_1= 22 C
  * T_2= -25 C
  * V_1= 1.5l
  * V_2=?

ALWAYS convert to Kelvin.

$T_k = T_c + 273$

Solution

* Given:
  * $T_1 = 22\,C + 273 = 295\,K$
  * $T_2 = -25\,C + 273 = 248$
  * $V_1 = 2.5L$
  * $V_2 = ?$

Solution

$T_1V_2=T_2V_1$

$(295\ K)(V_2) = (248\ K)(2.5\ L)$

$$\frac{(248\ K)(2.5\ L)}{295\ K} = V_2$$

$V_2 = 2.1\ L$

There balloon will have a volume of 2.5L.

Gay Lussac's Law

$$T_1P_2=T_2P_1$$

* Assuming constant volume

Example

* A sealed pot is placed on a stove. It's temperature is raised from 21 C to 113 C. What is the pressure inside the pot at 1.1 atm?

Solution

* Given:
  * P_1= 1.1 atm
  * P_2= ?
  * T_1= 21 C
  * T_2= 113 C

Solution

* Given:
  * P_1= 1.1 atm
  * P_2= ?
  * T_1= 21 C + 273 = 294
  * T_2= 113 C + 273 = 386

Solution

$T_1P_2=T_2P_1$

$(294\ K)(P_2) = (386\ K)(1.1\ atm)$

$$\frac{(386\ K)(1.1\ atm)}{386\ K} = V_2$$

$V_2 = 1.4\ atm$

The inside of the pot has a pressure of 1.4 atm.