UG SEM II (MJC-2T), Physical chemistry

1. Gaseous state

Evaluation of the gas Constant, R :

You Can get the numerical value of gas Constant R, from the ideal gas equation, $PV = nRT$. At standard temperature and pressure, where temperature is 0°C or 273.15 K, pressure is at 1 atm, and with a Volume of 22.4140 L,

$$R = \frac{PV}{nT} = \frac{1\ \text{atm} \cdot 22.4140\ \text{L}}{1\ \text{mol} \cdot 273.15\ \text{K}}$$

$$= 0.082057\ \text{L} \cdot \text{atm} \cdot \text{mol}^{-1}\text{K}^{-1}$$

$$R = \frac{PV}{nT} = \frac{1\ \text{atm} \cdot 2.24140 \times 10^{-2}\ \text{m}^3}{1\ \text{mol} \cdot 273.15\ \text{K}}$$

$$= 8.3145\ \text{m}^3\ \text{Pa} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$$

General Gas Equation:

In an ideal gas situation, $\frac{PV}{nRT} = 1$ (assuming all gases are "ideal" or perfect). In Cases where $\frac{PV}{nRT} \neq 1$ or if there are multiple sets of Conditions (Pressure, P; Volume, V; number of gaseous atoms or amount of gas, n and Temperature, T then use the general gas equation:

Assuming 2 set of Conditions:

Initial Case : Final Case

$$P_i V_i = n_i R T_i \qquad P_f V_f = n_f R T_f$$

Setting both sides to R (which is a Constant with the same value in each Case), One gets:

$$R = \frac{P_i V_i}{n_i T_i} \qquad R = \frac{P_f V_f}{n_f T_f}$$

If one substitutes one R for the other, one will get the final equation and the general gas equation:

$$\frac{P_i V_i}{n_i T_i} = \frac{P_f V_f}{n_f T_f}$$

Standard Conditions: If in any of the laws, a variable is not given, assume that it is given, for constant temperature, pressure and amount:

1. Absolute Zero (Kelvin): 0K = −273.15 °C
   T(K) = T(°c) + 273.15 (unit of temperature must be Kelvin)
2. Pressure: 1 atmosphere (760 mm Hg)
3. Amount: 1 mol = 22.4 Liter of gas
4. In the ideal gas law, the gas constant
   $R = 8.3145$ Joules · $mol^{-1} \cdot K^{-1} = 0.082057$ $L \cdot atm \cdot K^{-1} \cdot mol^{-1}$

Note: Ideal gas is a theoretical gas because it is not possible to have no interaction between the particles. Moreover, there is always a loss in the kinetic energy during the collision of particle and with the wall of the container.