Answer on Question #43049-Physics-Molecular Physics-Thermodynamics

A tank having volume of 0.1m^3 contains helium gas at 150atm and fixed temperature at 27c calculate

1-how many balloons can the tank blow up if each field balloons is a sphere 0.3m in diameter at an absolute pressure of 1.2atm at the same temperature

Solution

At constant temperature $P_1V_1 = P_2V_2$. (Boyle's law)

$P_1 = 150\ atm = 1.515 \cdot 10^7 Pa.\ V_1 = 0.1\ m^3.$

$P_2 = 1.2\ atm = 1.212 \cdot 10^5 Pa.$

$$V_2 = \frac{P_1V_1}{P_2} = \frac{1.515 \cdot 10^7 \cdot 0.1}{1.212 \cdot 10^5} = 12.5\ m^3.$$

Let n is number of balloons and V_b is the volume of each blown-up balloon.

$$V_b = \left(\frac{4\pi}{3}\right)r^3 = \left(\frac{4\pi}{3}\right)\left(\frac{0.3}{2}\right)^3 = 1.414 \cdot 10^{-2} m^3.$$

$$n = \frac{V_2}{V_b} = \frac{12.5}{1.414 \cdot 10^{-2}} = 884.$$

The tank can blow up 884 balloons.

2-the work done and which do the work

Solution

In isothermal process gas expands to the new volume and work is done by the gas is

$$W = \int_{V_1}^{V_2} PdV,$$

where $P = \nu RT \cdot \frac{1}{V}$.

$$W = \int_{V_1}^{V_2} \nu RT \cdot \frac{1}{V} dV = \nu RT \ln\frac{V_2}{V_1} = P_1V_1 \ln\frac{V_2}{V_1} = 1.515 \cdot 10^7 \cdot 0.1 \ln\frac{12.5}{0.1} = 7.31 \cdot 10^6\ J = 7.31\ MJ.$$

W have sign "+", so the gas do the work.

3-the change in internal energy

Solution

Since the temperature and amount of gas is constant internal energy doesn't change:

$$\Delta U = 0.$$

4-the quantity of heat and is this must added or removed

Solution

Since the internal energy doesn't change according to the First law of thermodynamics:

$$Q = W = 7.31\ MJ.$$

As the gas expands, heat must be added.