

Esim. Ilmapölyllä tilavuus on 250 l, lämpötila on 20°C ja paine 10 bar.

a) Laske hapon tilavuus NTP:llä. b) Paljonko happea on pullossa?

Ratk. a)

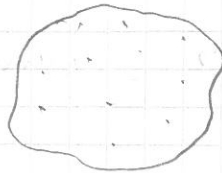


$$p_1 = 10 \text{ bar}$$

$$V_1 = 250 \text{ l}$$

$$T_1 = (20 + 273) \text{ K} = 293 \text{ K}$$

=>



$$p_2 = p_0 = 1,013 \text{ bar}$$

$$V_2 = ?$$

$$T_2 = 273 \text{ K}$$

Oletetaan että happi käyttäytyy ideaalikaasun tavoin.

Tällöin: $pV = nRT \quad | :T$

$$\Rightarrow \frac{pV}{T} = \underbrace{nR}_{\text{vakio}}$$

$$\Rightarrow \frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2} \quad | \cdot \frac{T_2}{p_2}$$

$$\Rightarrow V_2 = \frac{p_1 V_1 T_2}{T_1 p_2} = \frac{10 \text{ bar} \cdot 250 \text{ l} \cdot 273 \text{ K}}{293 \text{ K} \cdot 1,013 \text{ bar}} \approx 2299,5 \text{ l} \approx \underline{2300 \text{ l}}$$

b) Happi on molekyylimuodossa O_2

$$\Rightarrow \text{hapon moolimassa } M = 2 \cdot 16,00 \frac{\text{g}}{\text{mol}} = 32,00 \frac{\text{g}}{\text{mol}}$$

Idealikaasun yleinen tilanyhtälö: $pV = nRT = \frac{m}{M} RT \quad | \cdot \frac{M}{RT}$

$$\Rightarrow m = \frac{pVM}{RT} = \frac{p_1 V_1 M}{p_1 T_1} = \frac{10 \cdot 10^5 \text{ Pa} \cdot 250 \cdot 10^{-3} \text{ m}^3 \cdot 32,00 \frac{\text{g}}{\text{mol}}}{8,3145 \frac{\text{J}}{\text{mol K}} \cdot 293 \text{ K}}$$

($W = F \cdot s$)

$$\approx 3283,87 \text{ g} \approx \underline{3,3 \text{ kg}}$$

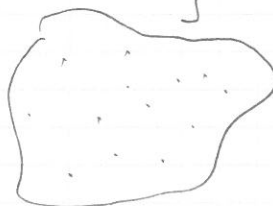
$$\left[\frac{\text{Pa} \cdot \text{m}^3 \cdot \text{g}}{\frac{\text{J}}{\text{mol K}} \cdot \text{K}} = \frac{\frac{\text{N}}{\text{m}^2} \cdot \text{m}^3 \cdot \text{g}}{\frac{\text{Nm}}{\text{mol}}} = \text{g} \right]$$

K33
(K30)



$$V_1 = 40 \text{ l}$$

$$p_1 = 100 \text{ bar}$$



$$V_2 = ?$$

$$p_2 = 1,0 \text{ bar}$$

Oletetaan että happi käyttäytyy ideaalikaasun tavoin. Tällöin

$$pV = nRT \Rightarrow p_1 V_1 = p_2 V_2 \quad | : p_2$$

$$\Rightarrow V_2 = \frac{p_1 V_1}{p_2} = \frac{100 \text{ bar} \cdot 40 \text{ l}}{1,0 \text{ bar}} = 4000 \text{ l}$$

$$p_3 V_3 = p_4 V_4 \quad | : V_4$$

$$\Rightarrow p_4 = \frac{p_3 V_3}{V_4} = \frac{1,0 \text{ bar} \cdot 3200 \text{ l}}{40 \text{ l}} = \underline{80 \text{ bar}}$$



$$V_3 = 3200 \text{ l}$$

$$p_3 = 1,0 \text{ bar}$$



$$V_4 = 40 \text{ l}$$

$$p_4 = ?$$

4.32

(c) (0.10) Γ_{TA1} :



$$p_1 = 100 \text{ bar}$$

$$V_1 = 40 \text{ l}$$

$$M_1 = \frac{p_1 V_1}{RT}$$



$$p_2 = 1,0 \text{ bar}$$

$$V_2 = 800 \text{ l}$$

$$M_2 = \frac{p_2 V_2}{RT}$$



$$p_3 = ?$$

$$V_3 = 40 \text{ l}$$

$$M_3 = \frac{p_3 V_3}{RT}$$

$$pV = nRT \quad | : RT$$

$$\Rightarrow n = \frac{pV}{RT}$$