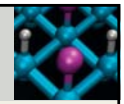
Homework Assignments:



- Chapter 5 HW due October 11 at 11:55 pm
- My office hours:
  - M (10:00 – 10:50 am)
  - W, F (12:00 – 1:00 pm)

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Example Problem

1) An empty 49.0 L methane storage tank has an empty mass of 55.85 kg and, when filled, has a mass of 62.07 kg
   a) Calculate the pressure of CH_4 in the tank at 21° C using both the ideal gas equation and the van der Waals equation
   b) What is the percentage correction achieved by using the more realistic van der Waals equation?

Answer:

$$\text{Mass of } CH_4 = \text{Mass of full cylinder} - \text{Mass of empty cylinder}$$
$$= 62.07 \text{ kg} - 55.85 \text{ kg} = 6.22 \text{ kg} = 6220 \text{ g}$$
$$\text{Moles of gas} = 6220 \text{ g } CH_4 \times \frac{1 \text{ mol } CH_4}{16.04 \text{ g } CH_4} = 388 \text{ mol } CH_4$$

Ideal gas:

$$P = \frac{nRT}{V} = \frac{(388\ \mathrm{mol})\,(0.08206\ \mathrm{L\ atm\ mol^{-1}\ K^{-1}})\,(294\ \mathrm{K})}{49.0\ \mathrm{L}} = 191\ \mathrm{atm}$$

Van der Waals:

$$a = 2.253\ \mathrm{L^2\ atm\ mol^{-2}},\ b = 0.04278\ \mathrm{L\ mol^{-1}}$$

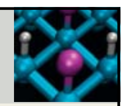
$$P = \frac{nRT}{V-\mathrm{nb}} - \frac{n^2 a}{V^2}$$

$$= \frac{(388\ \mathrm{mol})(0.08206\ \mathrm{L\ atm\ mol^{-1}\ K^{-1}})(294\ \mathrm{K})}{49.0\ \mathrm{L}-(388\ \mathrm{mol})(0.0428\ \mathrm{L\ mol^{-1}})} - \frac{(388\ \mathrm{mol})^2(2.25\ \mathrm{L^2\ atm\ mol^{-2}})}{(49.0\ \mathrm{L})^2}$$

$$= 148\ \mathrm{atm}$$

Percentage correction:

$$\frac{191-148}{191} \times 100\% = 23\%$$



Which postulate of the kinetic theory of gases do you expect to be most problematic?

- Gas is mostly empty space
- Random motion
- Elastic collisions
- No attractions

Answer: No attractions

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Finding density (ρ) using ideal gas law:-

$$PV = nRT$$

$$P = \frac{n}{V} RT$$

$$P = \frac{mass}{MM} \times \frac{1}{V} RT$$

$$P = \frac{mass}{V} \times \frac{1}{MM} RT$$

$$P = \frac{\rho RT}{MM}$$

$$\rho = \frac{MM \cdot P}{RT}$$

$$\boxed{P = \frac{\rho RT}{MM}, \text{or } \rho = \frac{MM \cdot P}{RT}}$$

P- pressure
ρ – density
R – gas constant
T – absolute temperature
MM – molar mass