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Gas Models – Supplemental Worksheet

1. Calculate the pressure exerted by 0.4891 mol of N_2 in a 1.0000 L container at 27.0°C. (Find a van der Waals constants table).

A. Use the ideal gas law.
B. Use the van der Waals equation.
C. Compare the results from a and b.

A. PV = nRT

$$P = \frac{0.4891\ mol \times \frac{0.08206\ L\ atm}{K\ mol} \times 300K}{1.0000L} = 12.04\ atm$$

B. a = 1.390 atm L^2/ mol^2 b = 0.0391 L/mol

$$\left(P + \frac{1.390\ atm\ L^2}{mol^2} \times (\frac{0.4891 mol}{1.0000L})^2\right)\left(1.0000L - \left(0.4891 mol \times \frac{0.0391L}{mol}\right)\right) = 12.04\ L\ atm$$

$$(P + 0.333 atm)(0.9809L) = 12.04\ L\ atm \qquad P = 11.94 atm$$

C. The ideal gas law is higher by 0.1 atm.

2. From the van der Waals constant *a* for the gases H_2, CO_2, N_2, and CH_4, predict which molecule shows the strongest intermolecular attractions.

$$H_2 = \frac{0.244\ atm\ L^2}{mol^2} \qquad N_2 = \frac{1.39\ atm\ L^2}{mol^2} \qquad CO_2 = \frac{3.59\ atm\ L^2}{mol^2} \qquad CH_4 = \frac{2.25\ atm\ L^2}{mol^2}$$

a is a measure of intermolecular attractions. Therefore higher a is a greater attraction. CO_2 has highest a.

3. Calculate the temperature of a container with 10.76 atm pressure exerted by 1.502 mol of CO_2 in a 3.5000 L.

a = 3.59 atm L^2/ mol^2 b = 0.0427 L/mol

$$\left(10.76atm + \frac{\frac{3.59\ atm\ L^2}{mol^2} \times 1.502 mol^2}{3.5L^2}\right)\left(3.5L - \left(1.502 mol \times \frac{0.0427L}{mol}\right)\right) = 1.502 mol \times \frac{0.08206\ atm\ L}{mol\ K} \times T$$

$$11.4 atm \times 3.4\ L = \frac{0.123\ atm\ L}{K} \times T$$

$$T = 318K$$

4. A sample of 7.50 kg gaseous oxygen fills a 100 L flask at 289°C. What is the pressure of the gas, calculated from the van der Waals equation of state?

a = 1.360 atm L^2/ mol^2 b = 0.03183 L/mol

$$\frac{7.5\times10^3 g}{32 g/mol} = 234\ mol$$

$$\left(P + \frac{\frac{1.360\ atm\ L^2}{mol^2}\times 234 mol^2}{100 L^2}\right)\left(100L - \left(234mol \times \frac{0.03183 L}{mol}\right)\right) = 234mol \times \frac{0.08206\ atm\ L}{mol\ K} \times 562K$$

$$(P + 7.45\ atm)(92.6L) = 10791\ atm\ L \qquad P = 109atm$$