

PHYSICAL CHEMISTRY 1: PROBLEM SET 1

TOPICS:

GENERALIZATIONS FROM IDEAL GAS BEHAVIOR

COMPRESSIBILITY FACTOR Z

VAN DER WAALS EQUATION OF STATE

1. Calculate the molar volume of chlorine gas at 350K and 2.30atm using (a) the perfect gas law and (b) the van der Waals equation.
2. A certain gas obeys the van der Waals equation with $a = 0.50 \text{ m}^6 \text{ Pa mol}^{-2}$. Its volume is found to be $5.00 \times 10^{-4} \text{ m}^3 \text{ mol}^{-1}$ at 273 K and 3.0 MPa. Solve for the van der Waals constant b . What is the compression factor for this gas at the prevailing temperature and pressure.
3. A vessel of volume 22.4L contains 2.0mol H_2 and 1.0 mol N_2 at 273.15K. Calculate the (a) the mole fractions of each component, (b) their partial pressures, and (c) their total pressure
4. Suppose that 10.0 mol C_2H_6 is confined to 4.860 L at 27°C. Predict the pressure exerted by the ethane from (a) the perfect gas and (b) the van der Waals equation of state. Calculate the compression factor based on these calculations. For ethane, $a = 5.562 \text{ L}^2 \text{ atm mol}^{-2}$, $b = 0.06380 \text{ L mol}^{-1}$
5. The density of water vapour at 327.6 atm and 776.4 K is 133.2 g dm^{-3} . (a) Determine the molar volume, V_m , of water and the compression factor, z , from these data. (b) calculate z from the van der Waals equation with $a = 5.536 \text{ L}^2 \text{ atm mol}^{-2}$ and $b = 0.03049 \text{ L mol}^{-1}$
6. In an industrial process, nitrogen is heated to 500 K at a constant volume of 1.000 m³. The gas enters the container at 300 K and 100 atm. The mass of the gas is 92.4 kg. Use the van der Waals equation to determine the approximate pressure of the gas at its working temperature of 500 K. For nitrogen, $a = 1.378 \text{ L}^2 \text{ atm mol}^{-2}$, $b = 3.183 \times 10^{-2} \text{ L mol}^{-1}$
7. Could 131 g of xenon gas in a vessel of volume 15 L exert a pressure of 2.0 bar at 30°C if it behaved as a perfect gas? If not, what pressure would it exert? (b) What pressure would it exert if it behaved as a van der Waals gas?
8. A gas at 250 K and 15 atm has a molar volume 12 percent smaller than that calculated from the perfect gas law. Calculate (a) the compression factor under these conditions and (b) the molar volume of the gas. Which are dominating in the sample, the attractive or the repulsive forces?

Problem Set 1 Episode 501 Chemistry Answers

Wolfgang Guggemos



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