Homework 1 – Gas Properties

Name: _____

Excercise 1A.3 (10 points)

(a) A perfect gas undergoes isothermal compression which reduces its volume by $2.20\ dm^3$. The final pressure and volume of the gas are $5.04\ bar$ and $4.65\ dm^3$, respectively. Calculate the original pressure of the gas in (i) bar, and (ii) atm.

(b) A perfect gas undergoes isothermal compression which reduces its volume by $1.80\ dm^3$. The final pressure and volume of the gas are $1.97\ bar$ and $2.14\ dm^3$, respectively. Calculate the original pressure of the gas in (i) bar, and (ii) atm.

Exercise 1A.9 (10 points)

(a) The density of a gaseous compound was found to be $1.23\ {}^{kg}/_{m^3}$ at $330\ K$ and $20\ kPa$. What is the molar mass of the compound?

(b) In an experiment to measure the molar mass of a gas, $250\ cm^3$ of the gas was confined in a glass vessel. The pressure was $152\ Torr$ at $298\ K$, and after correcting for buoyancy effects, the mass of the gas was $33.5\ mg$. What is the molar mass of the gas?

Exercise 1B.7 (10 points)

(a) Assume that air consists of N_2 molecules with a collision diameter of $395\ pm$. Calculate (i) The mean speed of the molecules, (ii) the mean free path, and (iii) the collision frequency in air at $1.0\ atm$ and $25°C$.

(b) The best laboratory vacuum pump can generate a vacuum of about $1.0\ nTorr$. At $25°C$, and assuming that air consists of N_2 molecules with a collision diameter of $395\ pm$, calculate (i) The mean speed of the molecules, (ii) the mean free path, and (iii) the collision frequency

Excercise 1C.9 (10 points)

(a) A certain gas obeys the van der Waals equation with $a = 0.50\ {}^{m^6 Pa}/_{mol^2}$. Its volume is found to be $5.00 \times 10^{-4} {}^{m^3}/_{mol}$ at $273\ K$ and $3.0\ MPa$. From this information calculate the van der Waals constant b. What is the compression factor for this gas at the prevailing temperature and pressure?

(b) A certain gas obeys the van der Waals equation with $a = 0.76\ {}^{m^6 Pa}/_{mol^2}$. Its volume is found to be $4.00 \times 10^{-4} {}^{m^3}/_{mol}$ at $288\ K$ and $4.0\ MPa$. From this information calculate the van der Waals constant b. What is the compression factor for this gas at the prevailing temperature and pressure?

Problem 1C.3 (5 points)

At $273\ K$, measurements on argon gave $B = -21.7\ {}^{cm^3}/_{mol}$ and $C = 1200\ {}^{cm^6}/_{mol^2}$, where B and C are the second and third virial coefficients in the expansion of Z in powers of $\frac{1}{V_m}$. Assuming that the perfect gas law holds sufficiently well for the estimation of the second and third terms of the expansion, calculate the compression factor of argon at $100\ atm$ and $273\ K$. From your result, estimate the molar volume of argon under these conditions.

Discussion Question 1C.1 (5 points)

Explain how the compression factor varies with pressure and temperature and describe how it reveals information about intermolecular interactions in real gases.