Homework 1

1. The water in the open tube of a manometer connected to an incubator was 3.55 cm lower than the water on the manometric (sample) side, and the atmospheric pressure was 758 Torr. What is the pressure inside the incubator?

2. Given that the Celsius and Fahrenheit temperature scales are related by \( \theta / ^\circ C = (\theta / ^\circ F - 32) \times 5/9 \), what is the temperature of absolute zero \( (T = 0) \) on the Fahrenheit scale?

3. 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 (a) bar, (b) atm. (Ex. 1A.2(a)).

4. A car tyre (i.e. an automobile tire) was inflated to a pressure of 24 lb in\(^{-2}\) (1 atm = 14.7 lb in\(^{-2}\)) on a winter’s day when the temperature was -5\(^\circ\)C. What pressure will be found, assuming no leaks have occurred and that the volume is constant, on a subsequent summer’s day when the temperature is 35\(^\circ\)C? (Ex. 1A.3(a)).

5. In an attempt to determine an accurate value of the gas constant, \( R \), a student heated a container of volume 20.000 dm\(^3\) filled with 0.25132 g of helium gas to 500\(^\circ\)C and measured the pressure as 206.402 cm of water in a manometer at 25\(^\circ\)C. Calculate the value of \( R \) from these data. (The density of water at 25\(^\circ\)C is 0.99707 g cm\(^{-3}\)). (Ex. 1A.7(a)).

6. The density of a gaseous compound was found to be 1.23 g L\(^{-1}\) at 330 K and 20 kPa. What is the molar mass of the compound? (Ex. 1A.11(a)).

7. Calculate the pressure exerted by 1.0 mol C\(_2\)H\(_6\) behaving as (a) a perfect gas, (b) a van der Waals gas when it is confined under the following conditions: (i) at 273.15 K in 22.414 dm\(^3\), (ii) at 1000 K in 100 cm\(^3\). For (b) use the data in Table 1C.3 (see the Data Section of the textbook). (Ex. 1C.1(a)).

8. 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\times10\(^{-4}\) m\(^3\) mol\(^{-1}\) 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? (Ex. 1C.9(a)).

9. A vessel of volume 22.4 dm\(^3\) contains 2.0 mol H\(_2\) and 1.0 mol N\(_2\) at 273.15 K initially. All the H\(_2\) reacted with sufficient N\(_2\) to form NH\(_3\). Calculate the partial pressures and the total pressure of the final mixture. (Pr. 1A.6).

10. Derive an expression for the compression factor of a gas that obeys the equation of state \( p(V - nb) = nRT \), where \( b \) and \( R \) are constants. If the pressure and temperature are such that \( V_m = 10b \), what is the numerical value of the compression factor. (Pr. 1C.16).