Problems on Chapter 1: Basics

Q 1.1: Why is mole fraction an alternative name for volume mixing ratio?

Q 1.2: What is the volume mixing ratio of Argon in dry air?

Q 1.3: Estimate a typical density of air at mean sea level in mid-latitudes given that the surface pressure is typically about 10^5 Pa .

Q 1.4: Show that $\frac{M}{\bar{m}} = \sum_i \frac{M_i}{m_i}$

Note that this is a formula which allows the average molecular weight of a mixture of gases to be found from the masses of individual constituents and their respective molecular weights.

Q 1.5: For a given temperature and pressure is the density of dry air greater or less than that of moist air?

Q 1.6: Find the relation between the mass mixing ratio and the volume mixing ratio in terms of molecular weights.

Q 1.7: (Optional difficult question) The virtual temperature of moist air is defined as the temperature of dry air with the same pressure and density. What is the virtual temperature of an air sample at 25°C with a mass mixing ratio of water of 30 g/kg?

Hint you will need the formula proved in question Q 1.4.

The concept of virtual temperature allows the same gas constant to be used in moist and dry cases, which can often lead to great simplifications in detailed working.