ENV-413: Thermodynamics of the Earth systems

Exercises 2: Introduction, Composition

1. Nitrogen dioxide (NO_2) cannot be obtained in pure form in the gas phase because it exists as a mixture of NO_2 and N_2O_4.   At 25°C and 0.98 atm, the density of this gas mixture is 2.7 g/L.   What is the partial pressure of each gas?

2. On Mars the atmosphere is mainly CO_2, the temperature is 220°K and the acceleration of gravity is 3.7 m/s^2.   What is the scale height of the Martian atmosphere? Compare the scale height to the Earth's atmosphere and explain why they scale heights are different.

3. At what temperature do He atoms have to be cooled (or warmed) so that they have the same root mean square speed as O_2 at 25°C?

4. Calculate the pressure in a column of seawater in atmospheres at depths below the surface of 10 and 1000m.   You can assume that the pressure at the surface is 1 atm, and the density of seawater is 1.0g/cm^3.

5. A barometer with a cross sectional area of 1.00 cm^2 at sea level measures a pressure of 76.0 cm of mercury. The pressure exerted by this column of mercury is equal to the pressure exerted all the air on 1 cm^2 of earth's surface. Given the density of mercury of 13.6 g/cm3 and the average radius of the earth of 6371 km, calculate the total mass of the Earth's atmosphere in kilograms.

6. Evaluate the thickness of a layer of atmosphere between 800 and 900 mb with average temperature of 300°K and a specific humidity of 20 g/kg.   Compare the thickness determined with the vitual temperature versus that determined without the virtual temperature correction.