## 1.4. PROBLEMS

1. Given that the acceleration due to gravity decays with height from the centre of the Earth following an inverse square law, what is the percentage change in $g$ from the Earth's surface to an altitude of 100 km? (See also Problem 6 of Chapter 3.)

2. Compute the mean pressure at the Earth's surface given the total mass of the atmosphere, $M_a$ (Table 1.3), the acceleration due to gravity, $g$, and the radius of the Earth, $a$ (Table 1.1).

3. Express your answer to Problem 2 in terms of the number of apples per square meter required to exert the same pressure. You may assume that a typical apple weighs 0.2 kg. If the average density of air is 5 apples per $m^3$ (in apple units), calculate how high the apples would have to be stacked at this density to exert a surface pressure equal to 1000 h Pa. Compare your estimate to the scale height, $H$, given by Eq. 3.6 in Section 3.3.

4. Using (i) Eq. 1-4, which relates the saturation vapor pressure of $H_2O$ to temperature $T$, and (ii) the equation of state of water vapor, $e = \rho_v R_v T$ (see discussion in Section 1.3.2), compute the maximum amount of water vapor per unit volume that air can hold at the surface, where $T_s = 288$ K, and at a height of 10 km where (from Fig. 3.1) $T_{10\,\mathrm{km}} = 220$ K. Express your answer in kg $m^{-3}$. What are the implications of your results for the distribution of water vapor in the atmosphere?