4. (a) Give rough estimates of the fraction of oxygen molecules in the upper atmosphere that are moving at escape velocity or above. (The temperature can reach 1000K.)

(b) Do the same for any helium atoms in the upper atmosphere.

(c) Do the same for hydrogen molecules.

(d) Mars is at about 0°C. Would you expect it to have any atmosphere? What of the common gases would you expect to find, if any? Give reasons.

(e) We know the Moon has no atmosphere—is that consistent with what we know of its gravity and temperature?

***\*\*\*\*\* For this question, I e-mailed them to say that the only important factor was and in fact since  this factor can be written where is the root mean square velocity at the gas temperature. We figured out in class that the average speed of nitrogen molecules at room temperature is 500 m/sec, so at 1000K (possible upper atmosphere temperature) it would be close to 1 km/sec. But escape velocity is 11 km/sec, so the fraction is of order exp(180), no molecules will ever escape. For hydrogen, the same kinetic energy means the v2 is up be a factor of 14, so exp(180) becomes exp(13), more than one part per million, so all the molecules will eventually escape.***

***Mars can hang on to CO2.***