Name:____ Date:_____________________________

Atmospheric Retention

Go to http://astro.unl.edu/naap/atmosphere/atmosphere.html
and select the **Gas Retention Simulator.**

Add the gases nitrogen, oxygen, and helium and set the temperature to 300 K. Select "allow escape from chamber" and set the escape speed to the max permitted by the simulation (1900 m/s). In the upper right box, click "show draggable cursor" on. Notice that the draggable cursor will work for one gas at a time, which you can change by selecting the gas in the bottom far right.

1) Move the cursor to the peak of the oxygen distribution. What percentage of molecules are moving faster?

2) Check the speed at the peak of the oxygen distribution and the speed at the peak of the helium distribution. Provide an explanation for the observed ratio of peak speeds.

3) Run the simulation for a few minutes, until the helium all escapes.

a) Has any noticeable amount of N_2 escaped? How do you know?

b) Explain why the He leakage rate changed.

c) Increase the temperature to ~700 K and decrease the escape speed to ~1000 m/s. Now what happens when you run the simulation?

4) Try 300 K and the max on the escape speed and change your gases to water and methane. Should the Earth retain its water and methane?

5) Now hit the back button on your browser and go to **Gas Retention Plot**. On the right hand side, select "show" for gas giants, terrestrials, and icy bodies.

a) Click on the box to show hydrogen in the plot. What does the line show? Why is it 10 times the average thermal velocity? (Hint: why did all the helium escape and not just the few atoms which were initially traveling rapidly?)

b) Check water and methane; do the plots agree with your prediction from **4)?**

c) Where would you have to put an Earth so that it wouldn't retain water or methane? (play with the "custom object" box on the bottom.)

d) Could the Moon have an atmosphere of xenon? why doesn't it?

Take-away points:

Objects that are massive tend to have larger escape speeds; high escape speed helps you hold on to an atmosphere. Slow-moving molecules are more likely to hang around and create an atmosphere.

1) Objects that are farther from the Sun tend to have lower surface temperatures, leading to molecules moving more slowly;
2) heavy molecules move more slowly, making them easier to hold on to.

The math: $v_{esc}^2 = GM/r$ $v_{thermal}^2 = 3kT/m$ or 2 or √(8/ π) rather than 3, depending on how you take your averages; T can be estimated from the albedo and the distance from the Sun.