The ability of a planet to hold onto an atmosphere depends mainly on two factors: **Temperature** and **Gravity**. The temperature of a planet is important because it is really just a measure of how fast, on average, the molecules of gas in the atmosphere are moving around. The higher the temperature, the faster the molecules are moving. The gravity of a planet is important because it determines the escape velocity of a planet. Any object with a velocity greater than the escape velocity will escape the gravitational pull of the planet.

The gravity of a planet is determined by its mass and radius. A planet with a stronger gravitational pull will have a higher escape velocity. The table to the right lists the escape velocities and distances for a few worlds in our solar system.

Planet	V_{escape} (m/s)	Dist (AU)
Earth	11,200	1.0
Moon	2,300	1.0
Jupiter	59,500	5.2

The temperature of a planet is determined mainly by its distance from the Sun. The table below shows the temperature a planet would have at various distances from the newly formed Sun. You can interpolate to find temperatures at other distances.

Distance (AU)	0.5	1	1.5	2	4	6	8
Temperature (K)	566	400	327	283	200	163	141

Finally, the speed of a molecule of gas in an atmosphere depends on its temperature and on its mass. A heavier molecule moves slower than a light molecule at the same temperature. In reality, gas molecules will have a range of different velocities, but the average velocity of a molecule of gas can be determined from the equation:

$$\text{Velocity (m/s)} = 157 \sqrt{\frac{\text{Temperature in kelvin}}{\text{molecule mass in atomic mass units}}}$$

A table of a few key molecules and their masses (in atomic mass units) are given in the table to the right.

Molecule	Symbol	Mass
Hydrogen	H_2	2
Water	H_2O	18
Nitrogen	N_2	28

A "rule of thumb" in planetary science is that a planet can hold onto a gas for the age of the solar system if the velocity of the gas is less than one sixth the escape velocity of the planet. In equation form this is:

$$V_{gas} < \frac{1}{6} V_{escape}$$

1. What is the velocity of a hydrogen molecule at 1 AU? [show your work]

2. Do you think the Earth can hold onto an atmosphere of hydrogen? Explain why or why not.

3. What is the velocity of a nitrogen molecule at 1 AU?

4. Do you think the Earth can hold onto an atmosphere of nitrogen? Explain why or why not.

5. What escape velocity must a world have in order to hold onto a hydrogen atmosphere at 5 AU (interpolate to get the temperature)?

6. Do you think Jupiter can hold onto hydrogen? Can it hold onto Oxygen? Water? Any element on the periodic table? Explain why or why not.