Lab 2: Ideal Gas Law

Background

You are on an interstellar voyage to Kepler-186f, an Earth-size planet 500 light years away in the Cygnus constellation. Your crew consists of an atmospheric scientist, a chemical engineer, a mechanical engineer, and an astronomer. Kepler-186f is in the "habitable zone" where water would be in the liquid phase. Your first task is to **characterize the atmosphere** (find its molar mass). Your second task is to **calibrate the volume of your gardyloo** (a glass flask plus rubber tubing connected to the pressure sensor), a critical piece of equipment for further analyzing the atmosphere.

Available materials:

gardyloo	GPS unit	thermometer	pressure sensor
Logger Pro software	the atmosphere	stairs	

Technical details

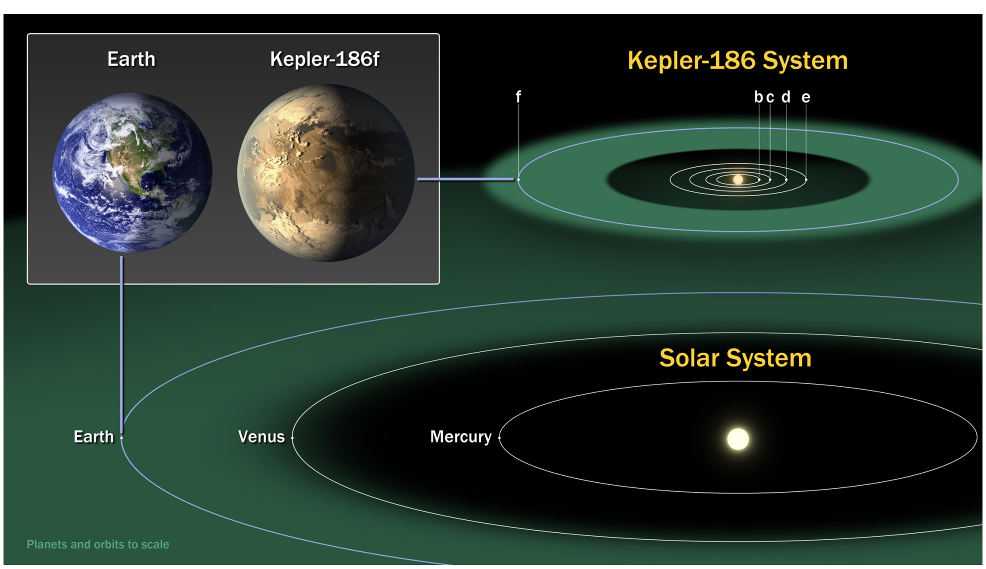
You must find a non-liquid-based calibration technique.
Note: a gardyloo will melt if exposed to liquid!
Be patient and allow the GPS unit to pick up enough satellites for a relatively stable measurement.
Avoid strong winds affecting your pressure measurements.

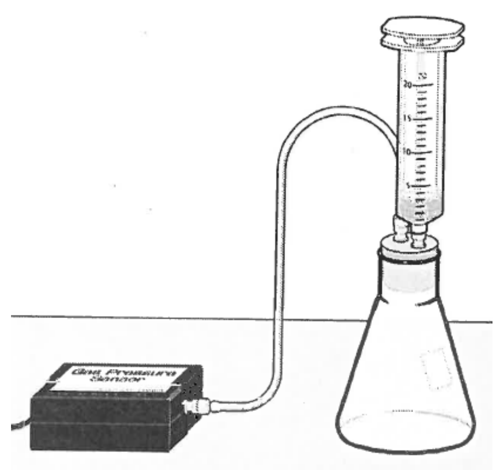
Lab report considerations

A first-order approximation is to assume an *isothermal* temperature profile of the planet's atmosphere.
An improved (second-order) approach assumes the temperature decreases with increasing altitude.
Use the dataset to report both an average *error* and its *uncertainty*.
A photo of the lab setup must also be included.

Teacher signatures

Please get your TA to sign your experimental plan and the completion of the lab. These signatures will help to promote a successful experience.





Gardyloo

Theoretical considerations

Assuming that the atmosphere has the same temperature T and chemical composition (and hence the same molar mass M) at all altitudes y, the pressure p as a function of altitude is

$$p(y) = p_0 \exp(-Mgy/RT)$$

where subscripting with "0" implies at y=0.

If the temperature decreases with altitude, then a more appropriate expression is

$$\ln(p/p_0) = [Mg/(R\alpha)] \ln((T_0-\alpha y)/T_0)$$

where α = 0.6 degrees Celsius per 100 meters.