**PHYS 1220** **Spring 2020**

# 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.

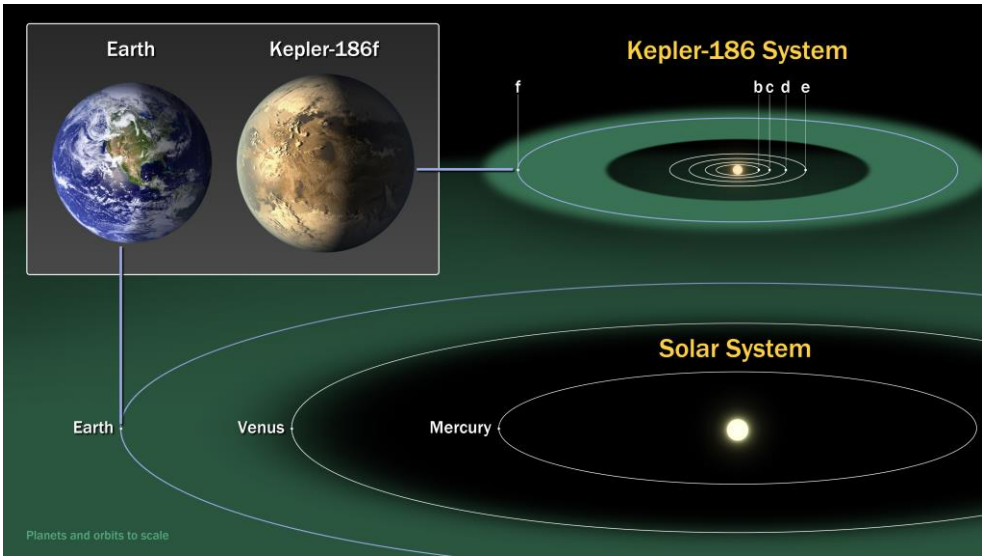
**Available materials:**

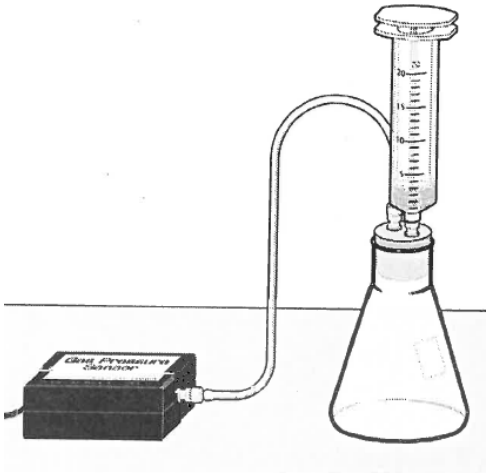
| | | | |
|---|---|---|---|
| gardyloo | GPS unit | thermometer | pressure sensor |
| *Logger Pro* software | the atmosphere | stairs | |

**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 be worth 4% of the lab grade and will help to promote a successful experience.



**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 $\alpha$ = 0.6 degrees Celsius per 100 meters.