ESS 100 Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Hot Air Balloon Project

**Density and Temperature Calculations**

Record the atmospheric conditions when the balloon was flown (or today’s conditions, if you flew your balloon last week).

* Classroom temperature = \_\_\_\_\_\_ °F [from the thermometer near the classroom door]
* Air pressure = \_\_\_\_\_\_\_ inHg [from the Weather Underground website <https://www.wunderground.com/weather/us/vt/essex%20junction/05451>]
* Dewpoint = \_\_\_\_\_°F [from Weather Underground – same as above]

1. Based on those numbers, what was the density of the air in the room? Use the calculator at <https://www.omnicalculator.com/physics/air-density> to find the answer. Make sure that you adjust the pressure units to *inHg* and adjust the density units to *kg/m3.*

 Air density = \_\_\_\_\_\_\_\_kg/m3

Enter the rest of your balloon data:

* Fill time using the shop vac = \_\_\_\_\_\_\_\_ seconds
* Envelope and Fuel Platform mass = \_\_\_\_\_\_\_\_ g [This is the mass of your balloon with no fuel, and the air squeezed out of it. Zero a tray on the balance; then place your balloon on the tray.]
* Fuel mass: assume 3g
* “Mass lifted” = \_\_\_\_\_\_\_\_ g $[Mass Lifted=mass of weight on scale-scale reading$]
* Shop vac fill rate = 0.0025 m3 per second.

2. Calculate your balloon volume. [$Balloon Volume = Fill Time ×Fill rate$]. Units should be m3.

For numbers 3-9, suppose your balloon was actually hovering in the air, free from the ground, with the “lifted mass” attached to its string. In reality, this isn’t much different from what it was really doing.

3. If your balloon were really hovering in place, what would its overall density be?

4. Calculate your balloon’s overall mass [$mass=density ×volume]$. Units should be kilograms.

5. Add up all of the mass in your hot air balloon that was not hot air. $[Total Non Air Mass=Envelope and Platform Mass+Fuel Mass+"mass lifted"]$ Units should be in grams.

6. Convert your non-air balloon mass (from the previous question) to kilograms.

$$[grams ÷1000=kilograms]$$

7. Calculate the mass of the hot air in your balloon. $[Hot air Mass=Total Mass-Non air Mass]$

8. Calculate the density of the hot air in your balloon. $[Density=mass ÷volume]$

9. What was the temperature of the air in your balloon? Use the calculator at <https://www.omnicalculator.com/physics/air-density> to find the answer. Enter today’s pressure and dewpoint. Then use the “guess and check” method of trying different temperatures until you get the right air density. When you get the right air density, you have found the correct temperature of the hot air.

10. What was your balloon’s actual mass (not including the string, paper clip, and “mass lifted”)? $[Actual Mass=Hot Air Mass+Fuel Mass+Envelope and Platform Mass]$

11. What was your balloon’s actual density? $[Actual Density=Actual Mass ÷Volume]$. How does that compare to the density of the air?