

Chemistry 413

Physical Chemistry: Thermodynamics, Kinetics and Statistical Mechanics

Endurance Problem 1

First attempt due: Friday, Feb. 10.

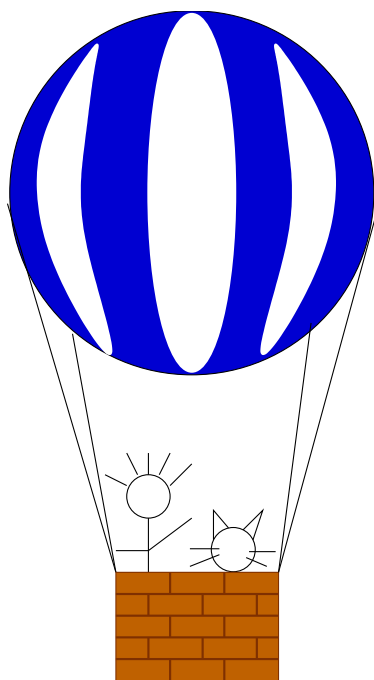
Second attempt due: Friday, Feb. 17.

Third and final attempt due: Friday, Feb. 24.

Show all your work and justify all your assumptions. Cite the sources of any data or equations used.

A nylon hot air balloon is filled with air heated to 82.5°C . The mass of the balloon is 1000 kg (bag and basket). A 65 kg person and his 6 kg cat Samantha are in the basket. The balloon may be assumed to be a sphere with a diameter of 85 ft. This is a typical hot air balloon and thus is open at the bottom.

- How high will the balloon rise in an isothermal atmosphere at 70°F ? (The barometric pressure formula will be useful here.) Though it is possible to solve this in other ways, solve this problem algebraically.
- In the Earth's troposphere, temperature decreases as altitude increases. (see for example: http://scipp.ucsc.edu/outreach/balloon/atmos/The_Earth.htm) Assume a temperature decrease of 6.0°C per kilometer. How high will the balloon rise in this atmosphere? (Try making a plot of air density outside minus air density inside vs. altitude.)
- Propane is commonly used to heat up the gas in hot air balloon. Assume this is the case for our balloon and all of the oxygen has been converted to CO_2 and $\text{H}_2\text{O}_{(g)}$. What is the composition and molecular weight of the gas in the bag? How would this affect how high the balloon rises (qualitatively, not quantitatively)?



NOTE: All graphs and plots should span a whole page unless otherwise indicated. Guidelines for graphs can be found in Barrante's *Applied Mathematics for Physical Chemistry* chapter 11. Graphs not following the format described in Barrante will generate a redo.

Computer graphing with Excel or a similar program is acceptable, however, please make sure the font sizes for axes/titles are small enough that the graph itself covers the majority of the page. Graphing by hand is also acceptable. Hand graphs should be drawn on 1 mm^2 graph paper and cover the entire page.