AIR 161 *HVACR Calculations* **A161X1**

Ideal Gas Law Exercise

Meteorological balloons are invaluable data gathering tools that allow short-, medium- and long-term weather forecasting to be something more substantial than educated guesses. The construction of a weather balloon (specifically the ability to accommodate large volumetric expansion) is a critical issue in the attainment of data at high altitudes. Without the practical application of the works of Robert Boyle and Jacques Charles, meteorology would not be the same.

To demonstrate an application of the ideal gas law, we will use data from an experiment executed by Oklahoma State University in October 2005. Students launched an ozone sounding, or 'ozonesonde,' from a rural site near Tulsa, Oklahoma. Weather balloons routinely burst at altitudes in excess of 25,000 meters. The balloon launched in this experiment was made of latex and had a mass equal to 600 grams.

Manufacturer specifications indicate an inflated balloon diameter of 1.77 meters at standard temperature and pressure (25° C, 1,015 mbar).

At launch, the ground level atmospheric pressure equaled 975 mbar and the temperature equaled 11° C. At these conditions, the balloon's initial diameter equaled 1.78 meters. The number of moles of helium (n) and the specific gas constant of helium (R) remain constant within the enclosed volume of the balloon through the atmospheric column; so, you may state the ideal gas law in terms of *p, V* and *T.*

An onboard GPS receiver determined the maximum burst pressure to be at an altitude equal to 28,981 meters. Atmospheric conditions at that altitude were 13 mbar pressure and -51° C.

As a weather balloon gains altitude, it will expand in response to declining atmospheric pressures. Your project is to find the initial balloon volume (at ground level), the final balloon diameter and the final balloon volume at an altitude of 28,981 meters. Also, express the changes in volume and diameter as percentages. Show all of your calculations on your final deliverable. Your deliverable must be on 8 ½ inch x 11 inch paper without spiral edges. Identify the deliverable with your name, the due date and the acronym A161X1. You must complete all work in pencil.

You will use the following formulas to complete this assignment:

$V = (4/3)\ (\Pi)\ (r^3)$ ~ Equation 1

$P_1 \times V_1 \times T_2 = P_2 \times V_2 \times T_1$ ~ Equation 2

Fig. 1 Preparation of the ozonesonde balloon for launch, 8 October 2005 (© 2005 Scott Mayes)