Additional Demonstrations/Experiments

1. **The sublimation of ice at various pressure.**

   Vacuum systems are used by the food industry for freeze drying. Moisture is removed by sublimation. Use an ice cube to demonstrate sublimation. As the pressure drops, whiskers grow out from the ice and visible clouds of fog can be observed. Weighing the ice before and after expose to reduced pressure shows the weight loss due to sublimation.

2. **Thin film evaporation.**

   Thin metallic films can easily be grown using a low melting point metal such as indium. A chamber with two electrodes is required. An example of an easy non-destructive way to add electrodes to a simple vacuum jar is show in the Appendix. The metal can be evaporated from a tungsten wire or boat. Be sure to use proper eye protective gear when looking at a bright filament. Also, shield the walls of the vacuum chamber from the depositing metal, Issues to investigate include the effect of substrate surface preparation on adhesion, the effect of evaporation rates on the physical properties of deposited films, and the determination of film thickness.

3. **Buoyancy of air - Archimedes' Principle.**

   Construct a simple balance in a vacuum chamber with a glass bulb on one end and counter weights on the other end of the beam. Under vacuum the system becomes unbalanced because air no longer buoys up the bulb. The true weight of an object can only be determined in a vacuum. Determine the error involved in weighting the bulb in air.

Additional Demonstrations/Experiments

Additional experiments involving vacuum and pumping technologies may be found dispersed through physics and chemistry lab texts in most university and reasonably sized high school and public libraries. The only requirement for most of the experiments is that you do not exceed the safety requirements for your pump and vacuum jar. The following list is only a sampling of the types of sources that are available. Many of the experiments listed in them may require more complicated equipment to perform correctly.

Experimental Vacuum Science and Technology, American Vacuum Society Education Committee eds., Marcel Dekker, Inc., New York, 1973

700 Science Experiments for Everyone, Compiled by UNESCO,Doubleday & Co., Inc., Garden City, New York

A Demonstration Handbook For Physics
G. D. Freier and F. J. Anderson

A Users Guide to Vacuum Technology
J. O'Hanlon
Wiley, New York, 1989

"Pumping Speed and Boyle's Law: Two Vacuum Experiments" , B.R.F. Kendall, *The Physics Teacher, Volume 34*, December 1996, pp 538-542.

"Educational Outreach at the 42nd National Symposium of the American Vacuum Society", *AVS Monograph Series M16*, Patricia A. Thiel and David E. Fowler eds., 1996.