Introduction:
The classic method of determining absolute zero depends upon the kinetic theory of gases. The pressure of a gas is caused by the momentum of the gas molecules, so at absolute zero where the kinetic energy of the molecules is zero the pressure will be zero. This method assumes that the gas in question is ideal with a linear relationship between temperature and pressure at constant volume.

Experimental goals:
After completing this experiment, students will be able to describe the method and practice of determining absolute zero. They will be able to determine the value of absolute zero by creating and interpolating a graph of temperature/pressure data. They will be able to evaluate the accuracy of their measurements and cite possible sources of errors in the experiment.

California Science Standards addressed in this laboratory activity:
Academic:
3(a) Students know heat flow and work are two forms of energy transfer between systems.
3(c) Students know the internal energy of an object includes the energy of random motion of the object's atoms and molecules, often referred to as thermal energy. The greater the temperature of the object, the greater the energy of motion of the atoms and molecules that make up the object.
3(g) Students know how to solve problems involving heat flow, work, and efficiency in a heat engine and know that all real engines lose some heat to their surroundings.

Investigation & Experimentation:
1(a) Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
1(b) Identify and communicate sources of unavoidable experimental error.
1(c) Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
1(d) Formulate explanations by using logic and evidence.
1(l) Analyze situations and solve problems that require combining and applying concepts from more than one area of science.
**Equipment:**
Vernier Gas Pressure Sensor
Vernier LabPro Interface
i-Book computer

Aluminum Air Chamber Assembly with temperature sensor
(3) water containers

**Key words:** temperature, pressure, volume, absolute zero

**Procedure notes:**
Each lab group needs a minimum of 2 students
There are two different connectors for the Gas Pressure Sensor, be sure to use the correct one; they’re labeled.

Students must be patient while waiting for the gas in the aluminum air chamber to reach equilibrium. This is important to getting good data.

**Answers to questions:**

1. The accepted value for absolute zero is -273C. How well did your value correlate with the accepted value?

   *Typically, student errors might seem large. Values from -350 to -200 are to be expected.*

2. Would the effect of small errors in measurement be magnified in finding absolute zero? Explain why or why not.

   *Since the data is extrapolated quite a large distance from the collected data, small errors in that data will result in large errors in the calculated results.*

3. How could the experiment be modified to improve the accuracy of its results? You need not limit yourself to the equipment at hand.

   *The accuracy of the experiment could be greatly improved by taking data over a wide temperature range. Student suggestions might be to use boiling water to collect data at higher temperatures and to use dry ice or liquid nitrogen to collect data at lower temperatures. Any of these suggestions would result in a wider range of data that is more likely to be extrapolated to yield an accurate value for absolute zero.*

**References**
Vernier equipment guide
California Science Standards