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Excerpts from: *Boiling as a Cooling Effect*

I always found it frustrating to use the classic demonstration of boiling water in an evacuated bell jar to show that liquids cool as they boil. By the time you re-pressurize the bell jar and take the water out maybe one student can feel that the liquid did actually cool. A second frustration with this demo is that students must take it on faith that lowering the pressure will reduce the boiling point. The LabQuest computer has allowed me to take data as the bell jar is evacuated. I performed studies on two different liquids (water and ethanol) that have helped me show students that boiling is a cooling process and that lowering pressure will lower the boiling point. I ran the LabQuest using the Gas Pressure Sensor and Temperature Probes as I reduced the pressure in a bell jar using a standard two-stage pump. I used 50 ml of liquid placed in a standard 100 ml beaker to compare cooling rates.

Results:

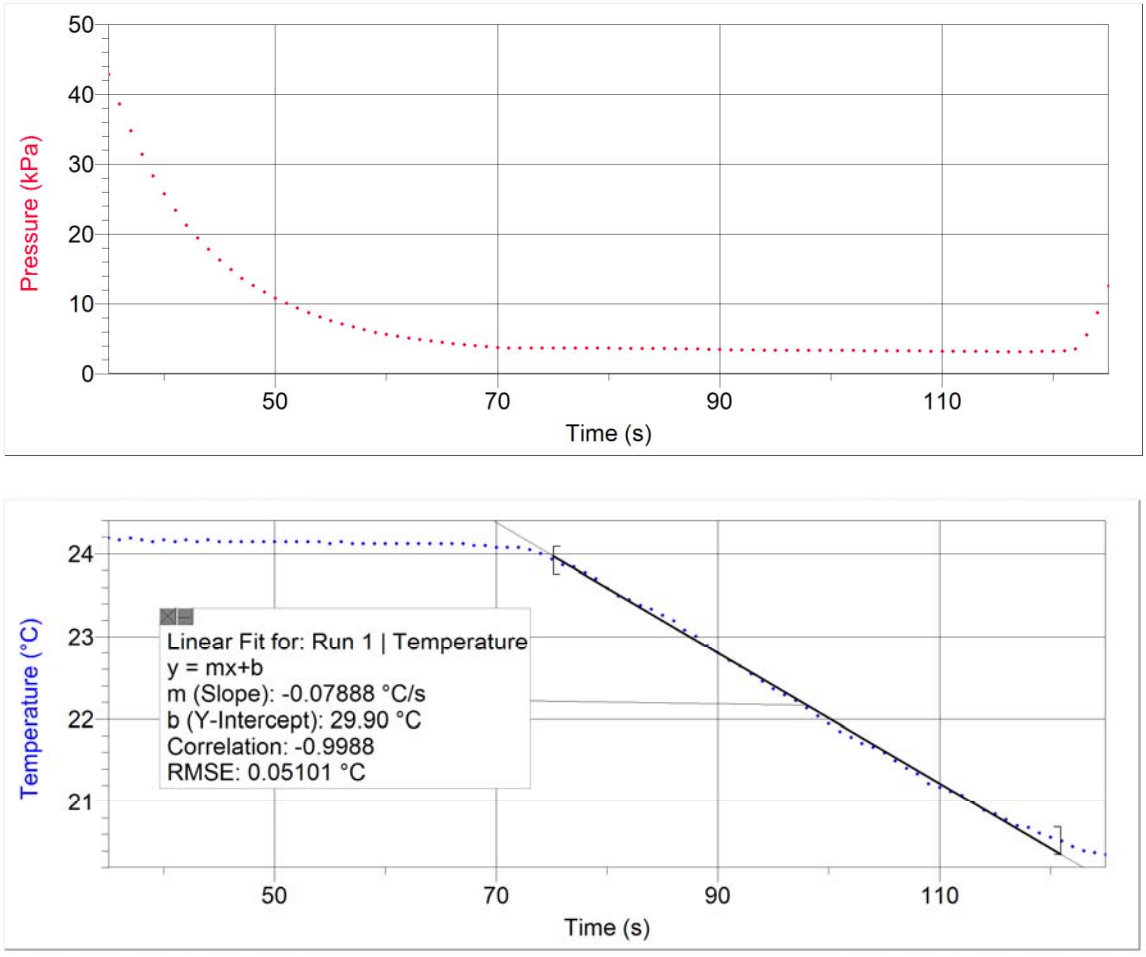

Fig 1. The pressure and temperature of a beaker of water as the two-stage pump evacuates a bell jar. The pressure levels off as molecules from the liquid begin to enter the gas phase.

The results shown in Fig. 1 illustrate that as the pressure measured in the bell jar approached the widely published values[3] for the partial pressure of water (3.67 kPa at a temperature of 24.1°C), boiling was observed. A corresponding linear temperature drop of a rate of -0.07888°C/s was measured.

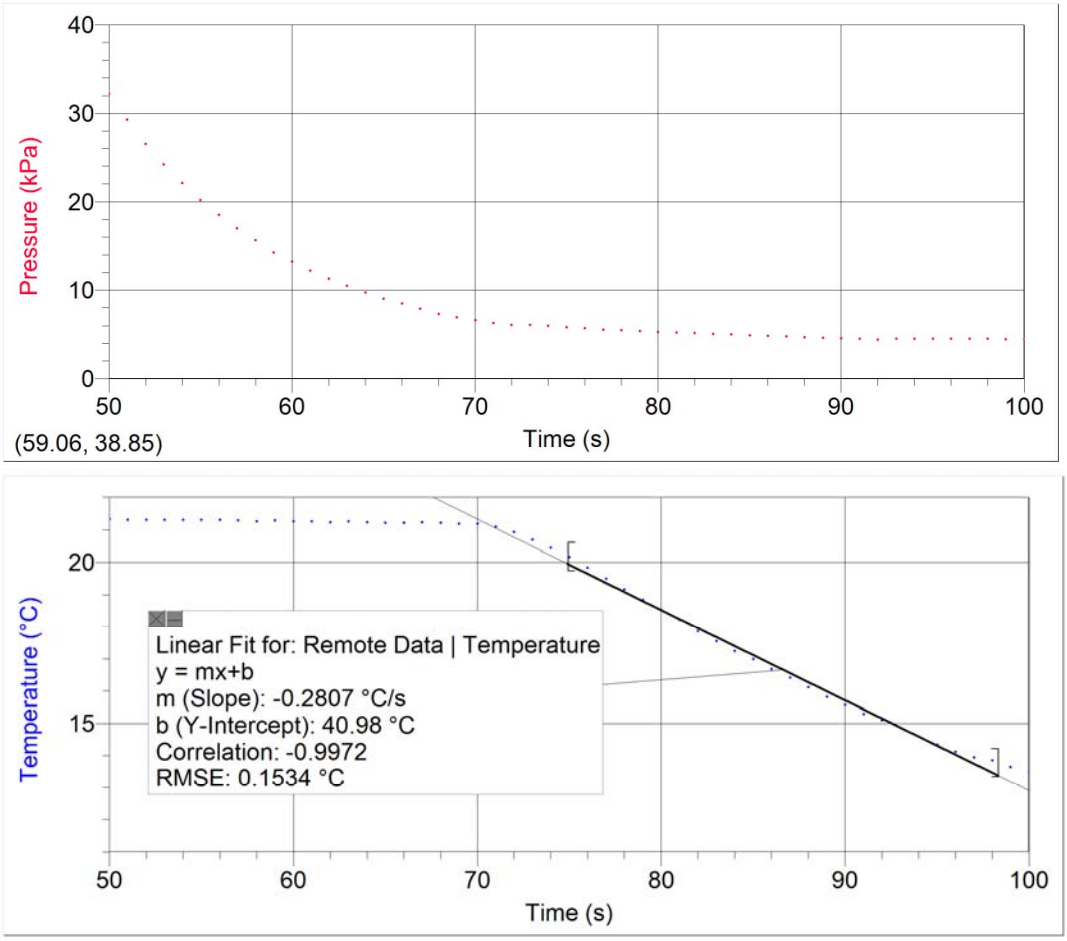

Fig 2. The pressure and temperature of a beaker of ethanol as the two-stage pump evacuates a bell jar.

A typical ethanol run in Fig. 2 shows similar behavior. Ethanol was observed to boil at a pressure of 6.61 kPa at 21.2°C, and it cooled at a rate of -0.2807°C/s.

References :

1,5 Hewitt, Paul. *Conceptual Physics.* 3rd ed. Boston: Addison-Wesley, 1997, 344-345.

2. During a personal conversation with David Vernier, he did not recommend the use of LabQuest at low pressures because the screen could be damaged. The experiment was run numerous times with no apparent effect on the LabQuest performance.
3. Ohe, Shuzo. Vapor Pressure Calculation web site, http://e-data.jp/vpcal1/e/
4. Nave, http://hyperphysics.phy-astr.gsu.edu/hbase/kinetic/vappre.html#c4