microLAB

COMPUTER DATA ACQUISITION
AND ANALYSIS TOOLS
FOR THE CHEMICAL SCIENCES

FEATURING THE FS-522 WITH *FASTspec*™
LAB INTERFACE, ASSOCIATED SENSORS
AND WINDOWS BASED SOFTWARE

E-Newsletter

May 2010

Volume I, Number 2I,

In This Issue

Join us at ACS in Boston!

You can find MicroLab at **Booth #634** of the Expo at the August ACS meeting. Stop by to see the FS-522 with *FASTspec* in action.

See MicroLab at Other Upcoming Meetings :

NW Regional ACS
June 20-23, Washington State U., Pullman, WA

BCCE 2010 August 1-5, University of North Texas, Denton, TX

2YC3 Sept. 10-11, Portland Community College, Portland, OR

Quick Links...

Website
Catalog
MicroLab support
See us in the ACS
Buyer's Guide
Summer Workshop

Save time, save chemicals, learn more!

Welcome to Issue 2 of the MicroLab E-newsletter! We have lots of goodies in this issue with two featured lab applications that use our integrated high precision 16 bit pressure sensor to obtain great data quickly and inexpensively. We hope that you will take the time to read it at your leisure and give us your feedback.

MicroLab has emerged as a leader in facilitating learning in the lab. MicroLab's well conceived, user friendly software, its 16 bit resolution (translate: 1 part in 65,000 precision), its rugged sensors and modules, its well tested collection of experiments, and its team of college chemistry educators backing it all up combine to help you make the most of your lab time, your lab space, and your lab budget in facilitating learning.

Summer Workshop in Bozeman, Montana
July 19-21, 2010

**"Integrating Computers into Laboratory Instruction:
Balancing Content, Inquiry Skills, and Increasing Enrollment."**

There is still time to register for the two and a half day workshop that will be held at Montana State University for faculty in the chemical sciences. Participants in this hands-on conference and workshop will work together with national leaders in chemical education to explore, practice, and evaluate new instructional strategies and the use of computer technologies to improve learning; to use limited lab time and space more effectively; and to reduce chemical costs and increase safety. They will also have an opportunity to enjoy Montana's gorgeous Mountain West.

Click on the link in the Quick Links box.

Featured Products:
MicroLab FS-522 Built-in 0-2 atm Pressure Sensor and new Model 116 Gas Pressure Measuring Kit

Gas law experiments are an intrinsic part of most first year chemistry courses: Boyle, Charles, Gay Lussac, Avogadro's Hypothesis.

MicroLab Experiments

Ideas? Suggestions?
We want to hear from you!

If you have a question about the capabilities of the FS-522, please ask us. You may be surprised at its potential in your situation! Email us (info@microlabinfo.com) or click the MicroLab Support in the Quick Links box (above) for other contact information.

If you have an interesting application of the MicroLab system in your lab, we would love to hear from you! Send us an email - just click on the link above.
If you want to contribute a featured lab application to the E-Newsletter, please contact the editor!
mjcollins@viterbo.edu

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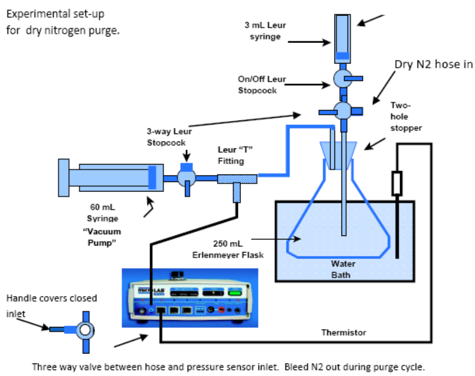
What some of our colleagues using the FS522 say:

"It used to be that students would spend a three-hour lab gathering data. Now, students can focus on what the data means; this enables them to decide quickly whether or not they need to do the

These are easy to do with the MicroLab's high precision built-in pressure sensor. But gas phase measurements do not end with the first year course. In a typical PChem lab manual you will find several experiments dealing with pressure change measurements: gas phase reaction kinetics, heats of vaporization of volatile liquids, the Joule-Thomson coefficient, and heat capacity ratios of gases. Synthesis courses often require students to be able to do continuous pressure monitoring during vacuum distillation, rotary evaporation, and sublimation.

In each of these experiments, the pressure apparatus is greatly simplified by replacing a mercury manometer with an electronic pressure sensor. Not only do you eliminate mercury, but you gain precision. The built in 0 to 2 atm pressure sensor in MicroLab's FS-522 unit, with its 16 bit precision, can measure pressure changes with a typical standard deviation (SD) of only 0.03 torr. This means that changes in pressure of 10 torr can be measured with relative SD of only 0.3%, and changes of 1 torr with RSD of 3%. Try that with a mercury manometer!

And now we have made it even easier with the our inexpensive new Model 116 Gas Pressure Apparatus kit - with syringes, petcocks, T-fitting, hose connectors, and hoses - to assemble your apparatus safely and leak free. You still need to take the usual precautions when dealing with pressure and vacuum, of course. But our kit and high precision digital pressure measurement make each setup less cumbersome and a lot easier to use, which lead to improved safety.



A sketch of our new Model 116 gas pressure kit. It does not include the container, temperature bath, temperature sensor, or MicroLab unit.

Another significant advantage to digital pressure measurement is that you reduce the risk of mercury spills. Mercury contamination is serious business. The US EPA regulates maximum levels for mercury in drinking water, currently at 2 ppb, and in air. A small spill of elemental mercury in a drain trap can cause problems with local water treatment. Any pedagogical advantage to using mercury as a pressure measuring or controlling fluid is offset by its environmental hazards. Thus, many colleges and businesses are going mercury-free

It is time to rethink pressure measurement. MicroLab's 0-2 atm pressure sensor may not replace a high vacuum pressure gauge for millitorr systems, but it has plenty of resolution for most routine applications. Two of those are detailed in this newsletter. Use your imagination and your MicroLab FS-522 to put it to use in your experiments. Feel free to contact us at MicroLab for assistance.

experiment over. The discovery process - how the numbers relate to a concept - takes place in the lab, not when the students are
writing their lab reports."
Dr. Carolyn Mottley
Luther College

"I have been using the MicroLab FS-522 in our general and physical chemistry laboratories. I am impressed with the versatility and the low cost of this interface, it opens new possibilities for experiments."
Dr. David Saiki
California State University Bakersfield

"MicroLab's software is an enormous aid for non-major students to visualize data collection in real time, and leads them to clearly understand the concept of the lab."
Dr. Angie Sower
Montana State University

"I'm continually amazed at the research quality data we get from MicroLab. We can

Two Featured Lab Applications:
1. An Improved and Affordable Procedure for a Rapid and Accurate Estimate of Absolute Zero

Doug Schumacher and Kiran Kurmi (class of 2011),
Luther
College, Decorah, IA

One of the most common activities in first semester general chemistry lab is the study of ideal gas law. The topics that these investigations cover include determinations of the molecular weight of a gas, studies of Dalton's law of Partial Pressures, gas phase reactions, and the determination of absolute zero using pressure and temperature measurements. While these experiments generally produce acceptable results, they are not without problems and limitations. In particular, either the experiments must be done at atmospheric pressure or one must be able to measure the pressure accurately within the particular setup. In the latter case, the vessel that is used must be rated for the range of pressures that the procedure uses.

One experiment done in the general chemistry course at Luther College extrapolates the temperature-pressure relationship of a gas to determine an experimental value for absolute zero. The setup is very simple: a 25-mL side-arm flask is immersed in a room temperature water bath set on top of a stirring hotplate. This flask is connected to a MicroLab unit (at Luther, we still use our older model 402 units, but of course the newer FS-522 can also be used), which is used to follow the pressure inside the flask and the temperature of the water bath as the temperature of the water bath is slowly increased.

After the data are collected, the students plot temperature (*y*-axis) vs. pressure (*x*-axis) and extrapolate back to zero pressure for their value of absolute zero. This method produces results typically within ±20% of the accepted value of absolute zero: not too bad, but actually not so good either. Unfortunately, this setup suffers from a number of issues that caused us to thoroughly examine what we do. The most important of these are (1) most side-arm flasks are not rated for any sort of excess internal pressure and (2) the internal temperature of the flask is assumed, often incorrectly, to be the same as the temperature of the water bath.

During the past semester, we examined several replacement vessels for our absolute zero determination experiment. The most important considerations in our search were that the container must be inert to any reaction we wished to carry out in it, it must tolerate internal pressure, it must be easy to connect to the MicroLab 16-bit 0-2 atm pressure sensor, and (most of all) it must be very affordable. Our candidates ranged from PVC pipe, plastic bottles, copper tubing of various diameters, and glass soda bottles. Each of these items was tested by performing our absolute zero experiment with the container and analyzing the results.

do things in teaching and in under-graduate research at a small institution that we never dreamed possible."
Dr. Tom Kuntzleman, Spring Arbor University

"You have an exceptional product. Money is very tight, and I wouldn't be spending this much of it if I didn't think that the MicroLab units were the best such devices on the market. I think that they will transform and reinvigorate the way we teach chemistry at Oglethorpe."
Dr. Keith Aufderheide Oglethorpe University

"MicroLab has given us a great step forward in the Physical Chemistry lab."
Dr. Clemens Heske The University of Nevada Las Vegas

"We used the built-in spectrophotometer to study the absorption/ transmission properties of different food dyes. The students really

After all of the analysis was done, we settled on a glass 10oz Schweppes™ ginger ale bottle for our experiments. This container met all of our requirements, and it was extremely affordable at $4.50 for 6 re-usable bottles (which include the ginger ale as an added bonus). As you can see in Figure 1, the size of the mouth of the bottle easily accepted a # 3 rubber stopper with a single ¼" hole in it. This allowed us to connect the bottle (filled with air) to the MicroLab pressure sensor and follow the internal pressure of the bottle. Additionally, we drilled a 1/8" hole in the stopper to accept a MicroLab Model 103 thermistor, which allowed us to measure the internal temperature of the bottle rather than the water bath. We obtained a value of absolute zero of -269.38°C (see Figure 2), which is within 1.3% of the accepted value of -273.15°C, with a correlation coefficient >0.998. MicroLab's high resolution, low noise data provided an excellent result considering the large extrapolation from the measured data. We also examined the effect of water vapor in the bottle by filling the bottle with dry nitrogen, but we did not observe a noticeable effect in the measured value of absolute zero. Most importantly, we found that the experiment itself was very fast. The data shown were collected in 30 minutes, which allows several determinations to be completed in a single lab period.

Figure 1. Setup of the ginger ale bottle showing detail of thermistor and pressure connector.

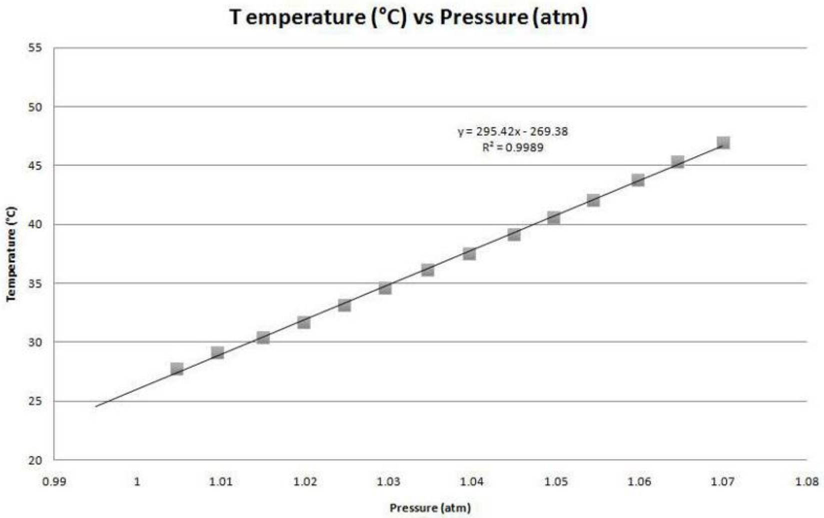


Figure 2. The improved accuracy and precision of the results obtained from measuring the temperature and pressure within the container are evident. Also evident is the sensitivity and low noise of the pressure sensor, with a range of 0.07 atm (<60 torr).

took to the graphs produced for transmittance and absorbance ... they all said it made the ideas we were talking about really clear to see the two graphs."

Dr. "Skip " Wiley Middlesex Community College

In short, replacing the side arm flask with a glass soda bottle has been a success. The setup is very affordable, easily replaceable, and gives excellent results. We believe that we have only touched on the potential of this setup for gas-phase experiments.

2. A Simple and Rapid Method to Determine the Moles of CO_2 Gas Produced in a Chemical Reaction Using the MicroLab FS522

Tom Kuntzleman and Scott Reese,
Spring Arbor University, Spring Arbor, MI

Reaction stoichiometry is one of the key concepts of any introductory chemistry course. There are lots of ways to investigate stoichiometry, including titrations, precipitations, colorimetry, and gas generation. Titrations and colorimetry are usually introduced in the context of analytical determinations. Most precipitation reactions involve metals and can be expensive - and very time consuming if mass measurement is involved. Our method, which involves the direct measurement of the change in pressure from a gas generated in a reaction, takes advantage of the 16-bit precision of the MicroLab FS522 unit to measure relatively small pressure changes rapidly, accurately, and precisely. We save money on reagents and still get excellent results with low risk from pressure buildup. An additional pedagogical advantage is that we use the Ideal Gas Law, PV=nRT, to convert P, V, T measurements to moles of gas produced.

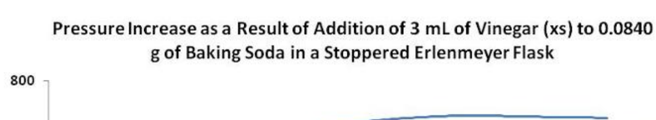
The reaction studied is the acid-base reaction between acetic acid (vinegar) and sodium hydrogen carbonate (baking soda):

CH_3COOH (*aq*) +$NaHCO_3$ (*s*) à H_2O + CH_3COONa (*aq*) + CO_2 (*g*)

P_{CO2} and T are found using the MicroLab FS-522 pressure and temperature sensors and MicroLab's software. The volume of the gas produced is measured by finding the volume of water required to fill the flask-stopper-hose assembly used in this experiment. R is the gas constant in units of L atm mol^{-1} K^{-1}. Students compare the number of moles produced in the reaction as calculated by PV = nRT with the number of moles expected based on the stoichiometry of the reaction and mass of $NaHCO_3$ used. Students complete the calculations by demonstrating that $NaHCO_3$ is the limiting reagent based on the stoichiometry of the reaction.

Apparatus:

A dry 250 mL flask is fitted with 2-hole rubber stopper. In one hole of the stopper is placed an on/off Luer Lock stopcock, to be fitted later into a 3 mL plastic syringe. A snug-fitting hose is placed into and through the second hole, the other end of which attaches directly to the MicroLab pressure sensor input. This should be tested for leaks to make sure that all seals are air tight. (**The Luer Lock fittings, tubing, and syringes are available from MicroLab for your convenience** or from various suppliers.)The volume of the gas, which must be measured when the reaction is complete, is the same as the volume of the flask assembly and hose to the pressure sensor connector on the MicroLab unit.



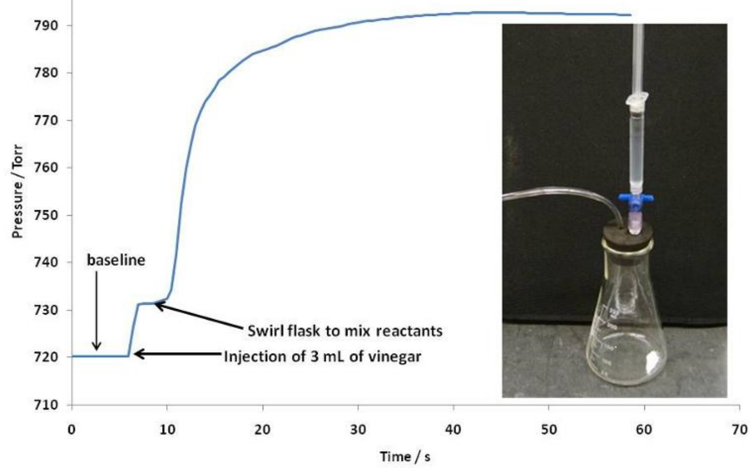


Figure: The plot shows a 7 sec baseline after which the vinegar was injected but not allowed to come in contact with the sodium bicarbonate. The pressure rise between 7-8 sec is due to the vapor pressure change and the ~1% decrease in air volume from adding the solution. At the 10 sec mark, the flask was swirled to initiate the reaction. The entire run took about 1 minute.

The MicroLab FS-522 Role:

To build this experiment in the MicroLab software, three sensors are used: pressure, thermistor temperature, and time. The pressure (torr) sensor is set up on the y-axis as well as in the spreadsheet and in the digital display. Time (sec) is placed on the x-axis. A thermistor is used to get the air temperature, which is a good approximation of the system temperature. Alternatively, the entire flask assembly can be placed in a large beaker of water to maintain a constant temperature.

Safety and disposal:

None of the reagents or products requires special disposal. The usual practice of wearing eye and hand protection should be observed. **There is no pressure release on the system, so the reaction should not be scaled up without including a pressure release vent to prevent an unsafe buildup of pressure within the system.**

Procedure:

Approximately 1 mmol of $NaHCO_3$ (1 mmol = 0.0840 grams), weighed precisely, is placed into one side of the bottom of the flask as shown in the photo, and the stopper attached. Next, 3 mL of white vinegar (5% CH_3COOH) are loaded into the syringe and, with the Luer Lock stopcock closed, the syringe is twisted tightly onto the stopcock. The "Start Experiment" button is pressed on the MicroLab screen. Once a baseline pressure is confirmed, the stopcock is opened and the vinegar is *injected into side of the flask opposite the $NaHCO_3$,* and the stopcock closed. (We like to tilt the flask to be certain the vinegar ends up on the side of the flask opposite the baking soda). This allows the system to adjust for any pressure change due to the injection and to the vapor pressure of the water in the vinegar solution. A new baseline pressure is confirmed. Next, the flask is gently swirled to allow the reagents to mix completely. Data are collected until the MicroLab pressure vs. time graph levels off (see the Figure). The experiment is stopped, and data are analyzed. P(CO2) is taken as the difference between the maximum, constant final pressure and the baseline pressure after injection of vinegar. The software can be used to get the average temperature. The volume is measured by obtaining the mass of the water needed to fill the empty flask assembly with water.

Sample calculations from an actual trial:

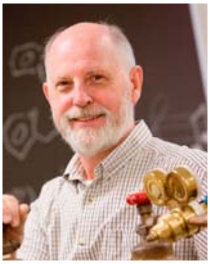
Mass of $NaHCO_3$ = 0.0840 g = 1.00 mmol
Volume of vinegar added: 3.0 mL (*ca*. 2.5 mmol)
PV=nRT and so n=PV/RT
P_{CO2} = P(final) – P(new baseline after Injection)
= (800.79-735.95) torr/760torr/atm = .0853 atm
V_{CO2} = V(flask assembly) = 292.3 mL=.2923 L

R= 0.0821 L*atm/K*mol
T= 23.783 ^{o}C = 296.933 K
n = (0.0853 atm)(0.2923 L)/(0.082144 L*atm/K*mol)(296.933 K)
= 0.00102 mol CO_2 formed
moles CO_2/moles $NaHCO_3$ = 0.00102/0.00100 = 1.02/1

Conclusions:

This experiment is a safe, easy to perform, and easy to understand application of pressure measurements to get accurate information about a chemical reaction involving a gas. There is time in lab to do multiple runs. Thus there is plenty of time in lab for doing calculations and discussing results in the context of limiting reagents, balanced equations, and sources of error. It is also possible to extend this lab by varying the amount of vinegar or the amount of $NaHCO_3$ to prepare a plot of P(CO2) vs. mole ratio of $NaHCO_3/CH_3COOH$ to determine reaction stoichiometry. Variations on this procedure can be extended to a whole host of gas-producing reactions. This experiment is a great example of how MicroLab can change how students learn in lab.

Meet the Editor: Michael Collins



Michael Collins is Emeritus Professor of Chemistry at Viterbo University in La Crosse, WI, USA. He taught undergraduate chemistry for 38 years at virtually every level - from introductory chemistry for liberal arts, nursing, pre-med, biology and chemistry majors to advanced courses for senior chemistry and biochemistry majors. He was the 1988 CASE Wisconsin Professor of the Year and has won awards at Viterbo for his scholarship, teaching, and service. He has been active in his local American Chemical Society section, and chaired the planning committee for the Great Lakes Regional Meeting that was held in La Crosse.

His interest in computer data acquisition began in the early 1980s, and he became convinced of its ability to enhance the lab experiences of his students as well as to prepare them to function in a modern lab setting. He has developed experiments across Viterbo's curriculum that use MicroLab for guided inquiry experiments as well as for more routine data logging and analysis. He has also given presentations on the role of computers in the laboratory to facilitate learning chemistry and in the assessment of lab outcomes. He has been using MicroLab products since they first arrived on the scene, and he continues to develop ideas for new applications of MicroLab in undergraduate teaching and research.

Please contact us at MicroLab for more information and to learn how simple it is to put these experiments and others just as exciting into your lab classes with the MicroLab FS522 and accessories.

Thanks for reading! We invite your feedback, ideas, and suggestions. As college educators ourselves, we on your MicroLab team value your feedback.

Sincerely,

Your MicroLab team
info@microlabinfo.com