NIST Summer Institute for Middle School Science Teachers Day One
July 18, 2011

NIST in Your Community Tour led by Jennifer Huergo

As a non-regulatory part of the federal government, NIST works with industry to meet their measurement needs. For example, manufacturing a car requires more than 15,000 parts and accessories. These parts must fit and work together perfectly even if made by many different companies, in different countries. NIST provides U.S. automakers with the tools to ensure that a centimeter in Milwaukee is the same as a centimeter in Malaysia.

What's in that refrigerator? What does food have to do with NIST? NIST makes several Standard Reference Materials (SRMs) including peanut butter, chocolate, and spinach, that are used as benchmarks by food manufacturers to make sure they're measuring the amounts of proteins, carbohydrates, minerals, vitamins, etc accurately.

Jennifer talks about NIST work in making sure bullet-resistant vests really can stop the bullets they are designed to stop. Law enforcement agencies rely on National Institute of Justice standards for testing the performance of bullet-resistant helmets, shields, and vests. These standards help protect police officers by ensuring that manufacturers use reliable methods to test the quality of their products.

At the Keeping Time with Atoms exhibit, this replica of NIST's fountain clock (NIST-F1) shows how atoms are used to determine the duration of one second. One of the two most accurate clocks in the world, NIST-F1 subdivides the second into more than 9 billion equal parts. It will neither gain nor lose a second in more than 100 million years. NIST's ultra-accurate time services help navigate spacecraft through the solar system, synchronize telecommunications and computer operations, and measure fundamental processes like the speed of chemical reactions.

Keith Martin, NIST Librarian and Museum Tour Guide, shows teachers around the many exhibits of NIST work, starting with the first American metrologist, Ferdinand Rudolph Hassler, who was appointed the first Superintendent of the Survey of the Coast by President Madison in 1816.

A NIST exhibit at the Louisiana Purchase Exhibition in 1904 included modified laboratory instruments (glass tubing) containing neon gas. When electricity was applied, the glass tubing lit up with a reddish glow. Today, the neon sign industry is worth more than $1 billion. Who knows how the measurement science advances that NIST is currently working on will be used?

And out to the apple tree, a Flower of Kent variety, a direct descendant of the fabled Woolthorpe, England, apple tree that inspired Sir Isaac Newton's theory on gravitational forces.

Teachers check out the tools for estimating length, mass, volume, and area prior to playing the metrics estimation game.

How much does a crayon weigh in grams? Quick – hot potato – pass it along!

Do five rolls of nickels weigh about the same as a liter of water? Hard to tell because the density confuses the issue.

A bowling ball – watch out, it's heavy! And who's George?

Elizabeth Gentry talks about how volume is standardized throughout the United States through the work of the state and municipal Weights and Measures Departments. Now a gallon of milk in MD has the same volume as a gallon of milk in Chicago – within the stated tolerance, of course!

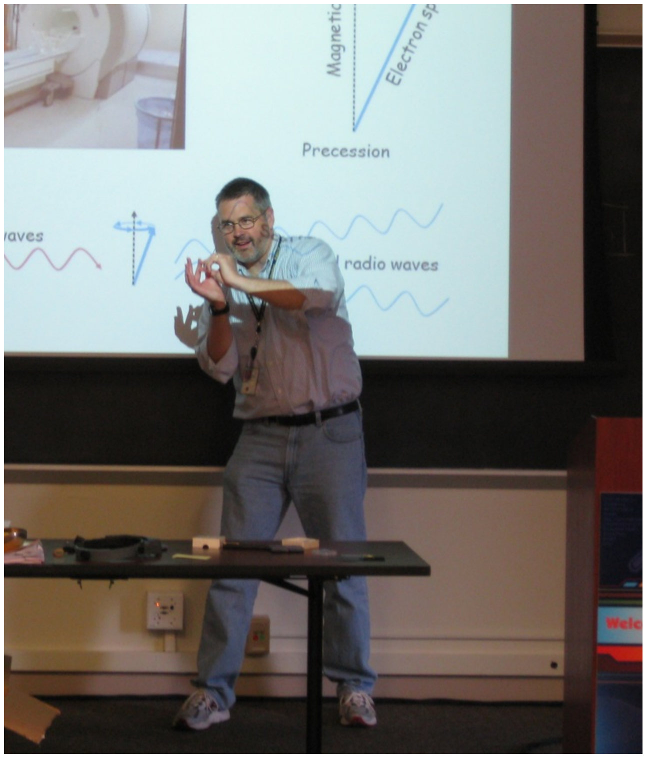
Georgia Harris discusses the different ways of measuring length and the challenges of ensuring traceability to the Système international or SI.

It’s all about equity in the marketplace – and being a savvy consumer.

NIST Summer Institute Day 2: Tuesday, July 19, 2011

We started off the morning with Mary leading an activity in which we calculated the number of nanometers on the edge of a sugar cube. Turns out that sugar cubes really aren't "cubes" and that there are ~1.3×10^7 nanometers, or 13 million nanometers along the edge – wow! Also interesting to consider that since a sugar molecule is about a nanometer in diameter that each edge of that sugar cube is comprised of 13 million sugar molecules. Now we're getting an idea of just how small a nanometer is!

Tom LeBrun, a physicist in the Nanoscale Metrology Group gave a talk on Nanotechnology and Measurements, explaining how it is possible to move from measurements at the bulk scale to measurements at the nano scale. And remember 1 meter = 10^9 nanometers!



Bob McMichael, a Physicist in the Electron Physics Group, followed with a highly interactive presentation and series of activities designed to explain how he measures magnetic forces at the nanoscale with his ferromagnetic resonance force microscope. His work is applied in the electronics industry with the idea that the alignment of tiny magnets can serve as stable computer memory. Bob's work is to develop measurement techniques to make the magnets on computer chips behave as we desire – although at this point we're spending more time learning how they behave. First the understanding, then the control.

Kendra Mallory works with her just-made magnetic force microscope to probe the magnetic fields of a refrigerator magnet, using the same cantilever principles of Bob's ferromagnetic resonance force microscope.

Bob had made a couple of magnetic "puzzles" for teachers to figure out using their magnetic force microscopes. Probing the magnetic fields of the puzzle the idea was to determine the layout of the magnets and match what they sensed to a picture that Bob had taken with his instrument. Easier said than done, which illustrates the sometimes difficult transition between data taken to "see" something that can't been "seen" any other way and interpretation. Oh, the wonders of working at the nanolevel!

Bob brought in some of the cantilevers he uses in his ferromagnetic resonance force microscope, along with magnifying devices so that teachers could see the tiny magnet on the tip that is used as the probe. Hard to see at first – and to use those funny glasses! – and then suddenly there it is!

Cynthia taking notes as Bob explains the magnetic resonance that is used to convert the magnetic forces to optical forces, allowing us to “see” what’s going on in the magnetic fields at the nano level. The swing analogy really helped; this is complicated stuff!


After lunch it’s off to hear Ross Haynes, Biologist in the Biochemical Science Division talk about his work developing a Standard Reference Material (SRM) for Cytomegalovirus (CMV). Teachers learn about the polymerase chain reaction (PCR) and how new technology is making possible absolute quantitation using digital PCR in addition to the relative quantitation using the more traditional instruments.

And the other half of the teachers are learning from Paul DeRose, Chemist in the Biochemical Science Division, about NIST work in standards for spectrophotometers which enable comparability of data from instruments made by different manufacturers.

So what is spectroscopy anyway? And how is it important in everyday lives? Steve Choquette, Chemist in the Biochemical Science Division, started by talking about the current challenges of determining if a material is impure or adulterated, a shift from the outdated paradigm of working to measure smaller and smaller amounts of something. Using spectroscopy we can now determine if a pharmaceutical is really what the bottle says it is, or if a grain crop is ready to be harvested or if a white powder found by a first responder is hazardous or just baby powder – and all without destroying the sample!

Then we built our own High Accuracy Spectrophotometers III (following HAS II which NIST operates) using paper towel rolls and diffraction grating. Although not as sophisticated (!!) as its predecessors it's still possible to differentiate among the light given off by different excited gases and to distinguish between the continuous spectrum from sunlight and from fluorescent and incandescent light bulbs. And to think that what we're seeing is only a small section of the electromagnetic spectrum!

Looking at fluorescent light – is it really continuous? What's in there anyway? Mercury!

Calibration adjustments of the spectrometers.

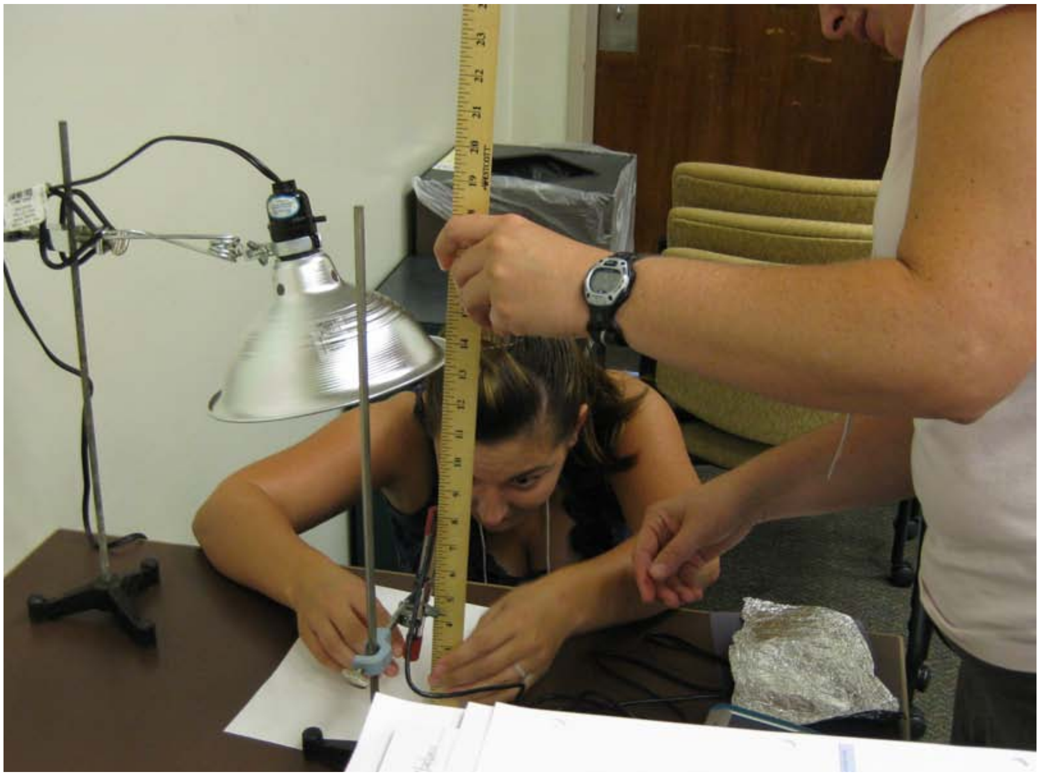

Lights off, lasers on with the red and green overlapping. At least that's how they look to the naked eye – with the spectrometer separation of the red and green colors is clear.

Next: examination of excited gases: argon, hydrogen, helium. Remember to start with helium: it's the flashiest and easiest to see. And that unmarked gas tube: it's oxygen. Too bad they're no pictures – too dark.

NIST Summer Institute for Middle School Science Teachers Day 3
July 20, 2011
Nus Hisim of Vernier (www.vernier.com) and also a high school physics and chemistry teacher at Walkersville HS in Frederick County, MD, joined us to lead a workshop on use of the LabQuest and the probes that come with the Middle School Science Deluxe Package.

Heidi and Tania work on the first experiment with the LabQuest: Reflectivity of Light. Do teachers follow instructions better than their students? We'll find out…

Erica and Brooke adjust the height of the lamp and make sure that everything is constant: only one variable, please.



More adjustments by Anne and Amy for just the right height. And watch out that the light sensor is in the right place!

And as the sun shines (really the clamp light) on Matt and Mary, they ponder where to place their thermometers to study the difference in seasons between the northern and southern hemispheres.


Christina and Michele puzzle over the LabQuest reading.


Natalie Bier, Summer Undergraduate Research Fellow, gives her best elevator pitch to Pat Gallagher, Director of NIST.

Pat and the teachers discuss the current state of education on the middle school level.

The afternoon began with a presentation and activity on Measurement and Perception by Ryan Fitzgerald, a physicist in the Ionizing Radiation Division. Wood and aluminum blocks: don't teachers know everything already about these two materials?

Dana and Cynthia use the LabQuest temperature probes to measure the temperature of both blocks simultaneously: same temperature right? Maybe, maybe not.

Consultation with the scientist. Amy and Anne begin to question what they're observing.

Becca and Jenn discuss their results with Ryan.

Barbara and Betsy work together to make sure the probe is in the right place.

What scientists do: develop a model such as the idea that both blocks are the same temperature, then test it. Both blocks aren't the same temperature? As Ryan said, "It's not wrong, we just need to understand what it's telling us." So a scientist continues to do experiments and modify the model until the two match. Possible answers here include the uncertainty, or tolerance, between the two probes, the effect of the room temperature, or or or or: more research needed!

Take-home Lesson:
The teacher with one thermometer knows the temperature, the teacher with two thermometers isn't sure. What is the real, absolute value? If you had a thermometer traceable to the Système international, or SI, you would know, within a given uncertainty.

More LabQuest experiments: Sumaya, Jenn, and Sammi Jo test the heat absorption properties of different materials: water vs. air.

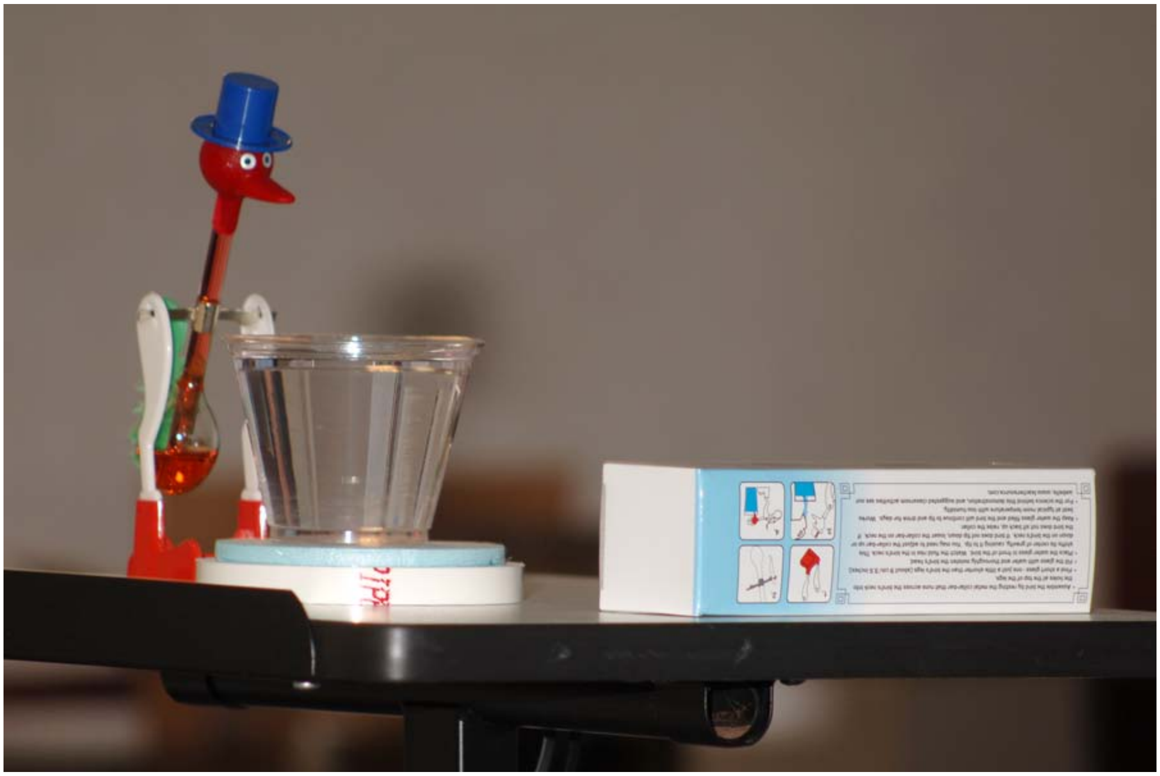
Amy, the Ship Captain of the cart mapping the ocean floor (really a series of boxes), and others mull over the results of using the motion detector.

Karoline and Kendra work to figure out the motion detector: what does that noise mean?

Pam Pennington, former NIST Summer Institute participant, shares her experiences using the LabQuest in the classroom – and learns from the class new ways to inexpensively expand the number of stations possible!

Kristen Weaver, another NIST Summer Institute alumnus, shared her experiences and how she modifies labs to suit her classes.

NIST Summer Institute for Middle School Science Teachers Day Four
Thursday, July 21, 2011



The day began with a drinking bird and the use of toys in the classroom. Seems appropriate to consider the effect of evaporation and how temperature changes result in pressure changes when the temperature is predicted to reach the upper 90s today!

And then we're off to make cement in the Building and Fire Research Laboratory with Clarissa Ferraris, Physicist by training and now working as a Materials Scientist. Interesting how so many of us use our background training in fields different from those we originally studied; a sign of the collaboration and teamwork required for scientific research these days

Clarissa discusses the different components of concrete with Sumaya.

Teachers self-assembled into small groups dividing up tasks and choosing to mix compenents in an organized way. “You use Pepsi as the liquid and I’ll use water. You use baking soda and I’ll use sugar – wonder what difference that’ll make?”


Clarissa inspects Erica's sample, judging whether or not it had set, or the chemical reaction begun yet. How could you tell? It gets hot: an exothermic reaction!


Messy, fun, and successful – what more could you ask of a middle school science activity?

Heidi displays her successful sample.

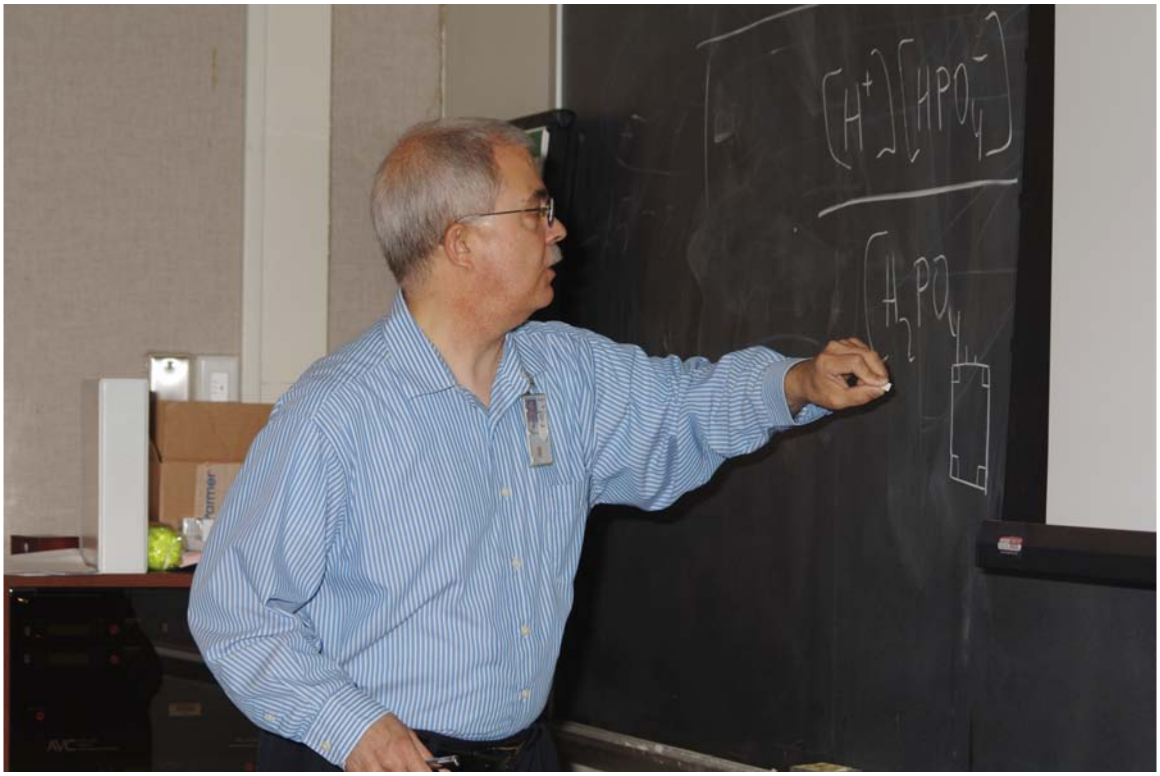
After questions from Karoline about how concrete is tested, Clarissa takes us around the corner to see the machine used. As might be expected, it's big and cumbersome and not amenable to science fair experiments. Or is it? Clarissa suggests that teachers contact nearby universities or research facilities to see if some science fair work could be done.

And who knew concrete could be porous? The latest “green” concrete allows water to flow through, and although not suitable for roads does allow trees and other greenery to survive. No more impervious cover! Anne wondered about the effect of freeze/thaw cycles; Clarissa says that the filter effect is a greater concern with the concrete filling up with sand after some time. Progress in concrete to make the world a better place; what a great idea!

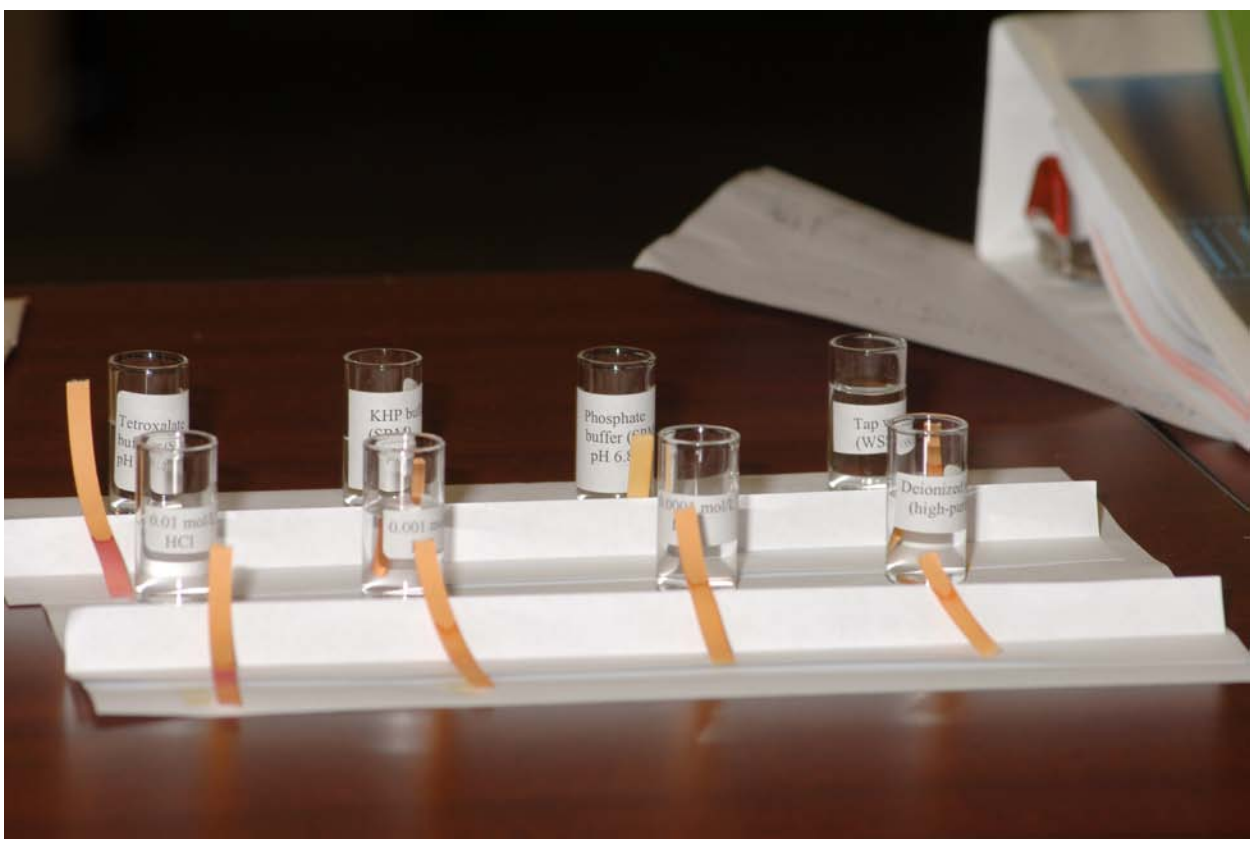
And then it’s back to Lecture Room A to learn about “The Perils of pH” led by Ken Pratt, a chemist in the Analytical Chemistry Division. Ken asks teachers to consider how they use pH paper and why it’s so difficult to accurately measure the pH of water. Or is it? What is the measurement trying to tell us?

Jenn and Dana examine the results of testing the pH of various acids and buffers.

What is a buffer anyway? How come the pH doesn't change much even when a strong acid is added? Buffers have a unique capacity to produce hydrogen ions or absorb hydrogen ions, thus stabilizing the pH



… as Ken explains with a quick chalk-talk. (the error in the ionic charge of HPO_4^{2-} was subsequently corrected).



And what is the difficulty with measuring the pH of water? Turns out that the measurement tool affects the measurement. The amount of acid or base in the water is insufficient to react with the amount of indicator contained in the paper. So no color change!

Sumaya and Sammi Jo clean up by pouring everything into a waste bottle. Yes, mixing acids and bases, but in small amounts and at low concentrations. Disposal method: down the sink with lots of water.

At lunch we attended a panel discussion on inventions and technology transfer with panelist from NIST, the US Patent and Trademark Office, and the Smithsonian Lemelson Ctr.

Lots of interest from teachers – they asked the most questions – and also the SURF students, and other NIST staff present.

After lunch the patent examiners and staff from the USPTO spent time with just the teachers, sharing a video, *Extreme Inventions*, and asking for feedback regarding the best ways to encourage their students to consider themselves inventors.

Amy has suggestions and the conversation builds from there.

Karoline suggested that the USPTO have resources – people to contact – available when students have ideas about inventions and teachers need someone to turn to.

Playing “IP (for Intellectual Property) Grab Bag” in which each person takes an item and identifies whether the item has a trademark, patent or patent pending, trad secret, or copyright. Another easy to take into the classroom activity!

And then the full day ended with an ice cream social hosted by the Organic Metrology Group, providing an opportunity to relax and visit with scientists at NIST working on developing measurement methods and Standard Reference Materials for foods, vitamins, nutraceuticals, and materials of environmental concern.


REUSE

2011 NIST Summer Institute for Middle School Science Teachers Day Five
Friday, July 22, 2011

Since the day's going to be super-hot we begin with a demonstration of a handboiler, containing a liquid that has such as low boiling point that the heat of your hand can make it boil, as Brooke demonstrates.

Dat Duthinh, a structural engineer currently detailed to work in the Metallurgy Division on the causes of the Minneapolis bridge collapse, presents a seminar on building to resist earthquakes. In this picture he shows how to use one of the props he designed, with the goal of explaining how potential energy builds up along fault lines.

Karoline examines a concrete core cut in half to show the different kinds of aggregates used.

Dat prepares to be the earthquake (with a swift kick to the end of the box) and to illustrate the earthquake effect on buildings (balsa wood) on soft soil (jello).

Teachers work together to build the props Dat designed. Here a group organizes to build I-beams, made stronger due to the way they're put together.

Another group works to build the reverse pendulums, designed to show how the natural frequency of earthquake waves resonates with buildings of a certain height.

And the third groups works to create bridge supports with cross beams: this is most time-consuming and messiest job!

Have glue, popsicle sticks and pins: now all that's needed is patience and attention to detail.

At lunch Bill Newhouse, Scientific Advisor in the Computer Security Division led a discussion of cybersecurity issues and career opportunities.

Then it was off to the lab for a discussion with a scientist.

After teachers returned Judy Prozonic of the NIST Safety Office led a discussion of safety in the middle school classroom. Michele describes an incident in her classroom with a student who lost consciousness during a dissection lab, while Kendra explained where she got the nickname, "Mercury Mallory".

Seemed like everyone had a story of safety mishaps in the classroom.

Sumaya tells her safety horror story…

…as does Teana. Safety is definitely not something to take for granted!

The day ends with a quick lesson on the aerodynamics of flight, given by Chandler Becker, Materials Scientist in the Metallurgy Division.

And then the teachers build airplanes …

and play!

How do you tell the different planes apart?

All together now!

2011 NIST Summer Institute for Middle School Science Teachers Day Six
July 25, 2011

We spent the entire day at the NIST Center for Neutron Research, a unique facility with the capability to use neutrons as a research tool. The day started with a welcome by Jack Rush, the former NCNR Director who was at NCNR when it opened 42 years ago.

Boualem Hammouda gave a lecture on making neutrons and using them, introducing the teachers to how neutrons could be produced from atoms that have many more neutrons than protons, such as uranium-238.

As an illustration of nuclear fission, the mousetrap demonstration went off without a hitch – at least, the second time!

Jeff Krzywon explained how he calculated the work done by the mousetraps being all set off at once, and how it compared to the neutron source. The NIST Center for Neutron Research produces 20 MWatts of power and it would take 8 x 10^7 mousetraps to do that much work! And the reactor works year round while the mousetraps took about 3 s: lots more mousetraps needed!

Chuck Majkrzak gave a talk on diffraction and how diffraction patterns produced by interaction with neutrons are used to determine structure and location. Reflect, refract, and diffract.

Jeff Lynn led a tour of the different instruments in the Guide Hall. We saw the different beam lines and the multiple different instruments that use neutrons in different ways.

At the triple axis spectrometer Joel Hilton explained how the instrument is used to determine what atoms do, such as in high temperature superconductors by measuring changes in neutron energy.

At the Spin Echo instrument Yun Liu explained how the instrument is designed to study soft matter, such as lipid membranes, on the order of 1-100 nm in size. When Michele asked about the appearance of the data from the instrument and how it was interpreted, Yun spoke of correlation functions, and soon produced a handout going from data to model.

A group photo in front of the Spin Echo instrument.

And then it's back to the classroom for an activity growing alum crystals. Why? Because many of the instruments used at NCNR need what they examine to be in the form of crystals.

NCNR scientists help the teachers make sure the solution is saturated before suspending the crystal in it. The hardest part? Tying the seed crystal to a string!

Teachers and SURF and SHIP students join together for a pizza lunch and a discussion of research experiences at NCNR.

Dana wants to know if there was anything the students wished their teachers had done. Reply: to be allowed to make discoveries and to get rid of the labs for which you already knew the answer!

And then it’s back to the classroom for an explanation of how Small Angle Neutron Scattering works ….

… and the opportunity to look at the diffraction patterns produced by the diffraction grating and laser.

Then back to the Guide Hall and a visit with Jason Simmons at the disc chopper spectrometer that examines materials using elastic and inelastic scattering. Jason's samples have to be in crystalline form and sometimes those crystals are finicky and hard to form.

At NG7, the Reflectometer, Brian Maranville explains how the instrument can be used to look at different layers of materials, such as in computer hard drives…

… and then Yiming Qiu, the photographer, asks us all to look up and smile.

At the Small Angle Neutron Scattering instrument Paul Butler explains how it can be used to determine structure, size, shape, and orientation of materials up to 0.5 micrometers in size. One use has been to examine explosives for pore size and stability to determine the difference between stable explosives and those that require little energy to explode – good things to know!

And then from practical applications using neutrons as tools to a fundamental physics section with Jeff Nico, studying properties of neutrons. One of his aims is to measure the neutron lifetime and answer the questions of how elements came to be in the time following the Big Bang. How did protons and neutrons join together to form hydrogen and helium?

And back to the classroom where teachers are given shake gels and the protocol to make them. The mechanism behind shake gels was discovered using SANS.

What a great day learning all the things neutrons can teach us!

2011 NIST Summer Institute for Middle School Science Teachers Day 7
Tuesday, July 26, 2011

Sound: what is it? And what does it have to do with law enforcement? Turns out that John Jendzurski, an electrical engineer with the Office of Law Enforcement Standards, designed a way to calibrate radar detectors with a tuning fork, an experiment which could be easily adapted to measure the speed of sound. Teachers spent part of the morning finishing up the circuits and then using them with their computers and discovering all the ways Audacity could be used to teach about waves and sound.

Teachers worked together to figure out how to hook the circuits up to the computer – each computer is subtly different! – and take data to measure the speed of sound.

We were fortunate that there are enough talented people in the class to figure out most of the problems, from determining if a computer really was wireless-enabled to finding out how to convert from mono to stereo, and lots more!

Fortunately, John Jendzurski was there to troubleshoot and assist. Remember to keep the sound maker in line with the microphones!

Teachers used different kinds of sound makers, from dog training clickers to tuning forks to snapped fingers to a distinct clap.

Mary and Sammie Jo used their boomwackers to play a recognizable Twinkle Twinkle Little Star to an appreciative audience. Another group analyzed the spectra of the boomwackers using Audacity.

More troubleshooting – how can we get this to work?

As an unrelated-to-sound activity, Anne brought in some of her “magic water beads” that “disappear” in water because they contain so much water that they have the same index of refraction as water. Teana invites Matt to stick his finger in the vial of water…

… who discovers that the “water” really contains some gel-like substance
– the magic water beads …

… and then shares the joke with everyone!

Figuring out if this activity will work on a netbook: it does!

Jenn and Dana point out some of the cool tricks that Audacity can do with sounds. Here's how Dana figured out how to remove background noise:

Go to Effects
Go to Noise removal
Select the period of noise you want to isolate then select "Get Noise Removal" then hit record. Stop when it collected the same period of time you selected.
Preview the sample to hear if you removed what you want.
Then you can select to remove more of less of the background using the scale.
When you're happy, hit remove noise.

After lunch with an overview of how the physical kilogram will soon be replaced by the watt balance experiment, teachers went on a tour of the Ballistics Testing Facility or the Million Pound Force Machine.

Teachers returned to find statisticians Dennis Leber and Hung-kung Liu ready to lead teachers in an activity called How Big is Pi? Teachers were asked to measure the circumference and diameter of three objects, a copper ring, a basketball, and a bicycle tire.

Teachers used various methods to measure the basketball and bicycle tire.

An innovative method used by Karoline and Anne to measure the basketball diameter.

Using calipers, with Hung-kung's assistance, to measure the copper ring diameter.

Waiting in line to enter data. Teachers later suggested that various technologies are now available to remotely enter data or answers. Maybe we'll use poll.com next year!

As for the data analysis, a comparison of the 2011 data showed that this group's data is noisier than in previous years. Is this an effect of the increased number of teachers? Or maybe the fact that this session was offered in the second week instead of the more usual first week? Or is it due to less assistance from Hung-kung and Dennis? Whatever the reason, the take-home lesson remains:

Measurement is not necessarily easy.

2011 NIST Summer Institute for Middle School Science Teachers Day 8
Wednesday, July 27, 2011

At the start of the day Becca Epling passed out fortune telling fish purportedly to tell the holder's characteristics based on the way the fish reacts in the hand.

Amy, Anne, and Heidi learn more about themselves using the fish – which really work based on moisture!

Then teachers traveled to the Physics Bldg for a lecture by Greg Strouse, a Physicist with the Temperature and Humidity Group, in which teachers were led to consider how thermometers are calibrated and made traceable to the SI. Greg also talked about some of the projects the group is involved in, including a program to eradicate mercury thermometer use led by Dawn Cross and a program to study the effect of temperature fluctuations on vaccine stability, led by Michal Chojnacky.

Then teachers went to the lab to work on three stations studying common phase changes but with uncommon materials. Yes, water was used, but so was dry ice and soap. Dawn Cross, Michal Chojnacky, Karen Garrity, and Wyatt Miller all led different activities and assisted as needed.

Fun with dry ice and nitrile gloves! And so cold that condensation forms and sometimes freezes on the fingertips! Dawn promises that the glove will not explode.

And then there's the activity with dry ice, a little water, and dish soap – resulting in lots of bubbles everywhere. No worries; it's good clean fun!

At another station teachers try to measure the temperature of the steam just above the boiling water.

Others work with ice water and added ingredients to see the effect on the freezing point.

Greg demonstrates a water hammer for measuring the triple point of water. The device has very little air in it and so when the water moves from one end to the other the water "hammers" the other end with an audible thunk.

And then a practical application of the phase changes study: making ice cream with liquid nitrogen! Christina and Dana use liquid nitrogen judiciously to mix with their cream, sugar, etc. Result: delicious ice cream!

Next half the teachers headed to the Million Pound Force Lab while the other half went to the Ballistics Testing Facility. Kevin Chestnutwood, a mechanical engineer in the Mass and Force Group gave the Million Pound Force Lab Tour.

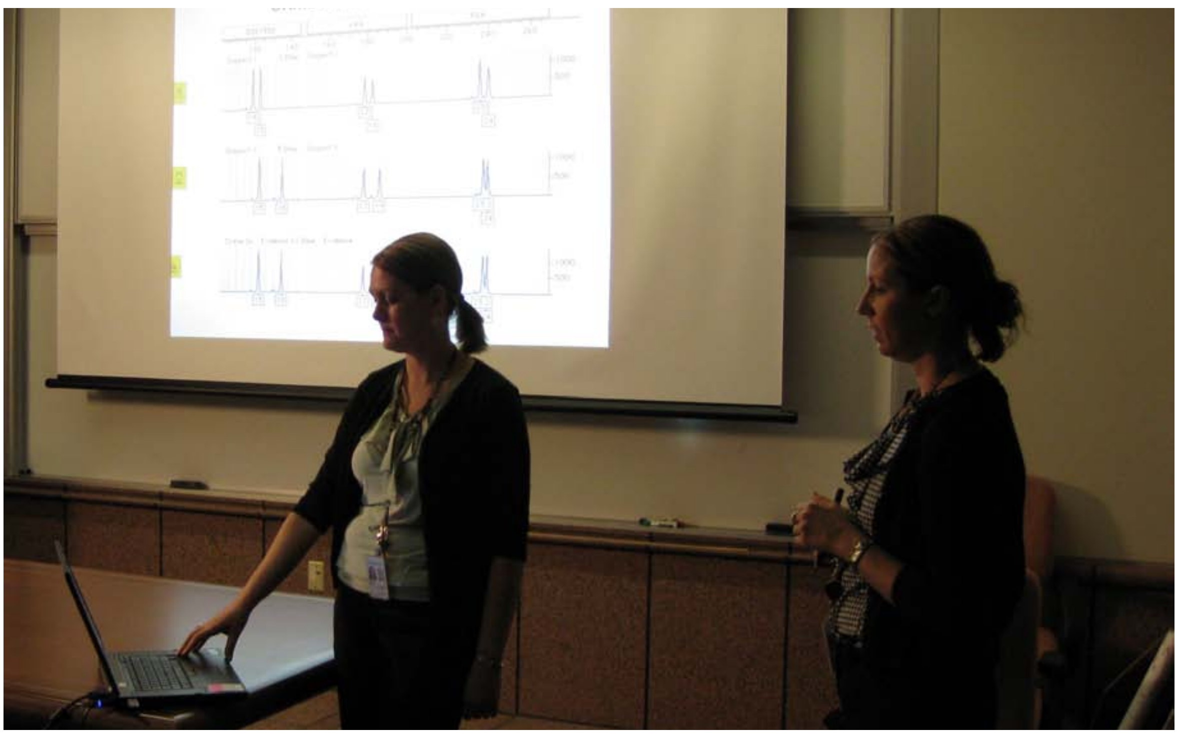
After lunch Bryan Duncan of NASA Goddard Space Flight Center talked about the experiment measuring air pollutants in Baltimore-Washington corridor. Who knew the level of pollutants had been higher in preceding decades and has actually gone down? However, with new recommended levels even lower, some tough measures will have to be made.

Leslie Garrison of the NASA Outreach Center talked about the NASA resources available.


And the day ended with tours by Jerry Rhoderick or Steve Maxwell on the NIST efforts to improve climate change measurements. Improved measurements methods are necessary to detect small changes.

2011 NIST Summer Institute for Middle School Science Teachers Day 9
Thursday, July 28, 2011

We began the day with a toy that can detect a complete circuit, demonstrated by Mary Biggers and Anne Fichter. Great way to teach the difference between series and parallel circuits!



And then it was off to learn about the use of DNA in forensics for human identification with Becky Hill and Erica Butts. What an interesting talk, lots of applications to everyday life (at least on TV!)

Teachers split into two groups to observe gel electrophoresis using a flash gel that runs in less than seven minutes. Becky Hill led one group and Jenny McDaniel the other, both using the same DNA sample, which Becky promised would work and be interesting. The sample is one examining a new marker used by the Chinese and which may eventually be adopted in the United States. Different populations have different Short Tandem Repeat (STR) ratios possible, and there is interest in learning more about the possible ratios in the Chinese population. Standardizing for forensic analysis around the world!

In Jenny's lab, after an explanation of the basic process, teachers mixed the ladder, which acts as a calibrant, and DNA under Jenny's watchful eye. Interesting to know that the gloves are more to protect the sample than to protect the wearer.

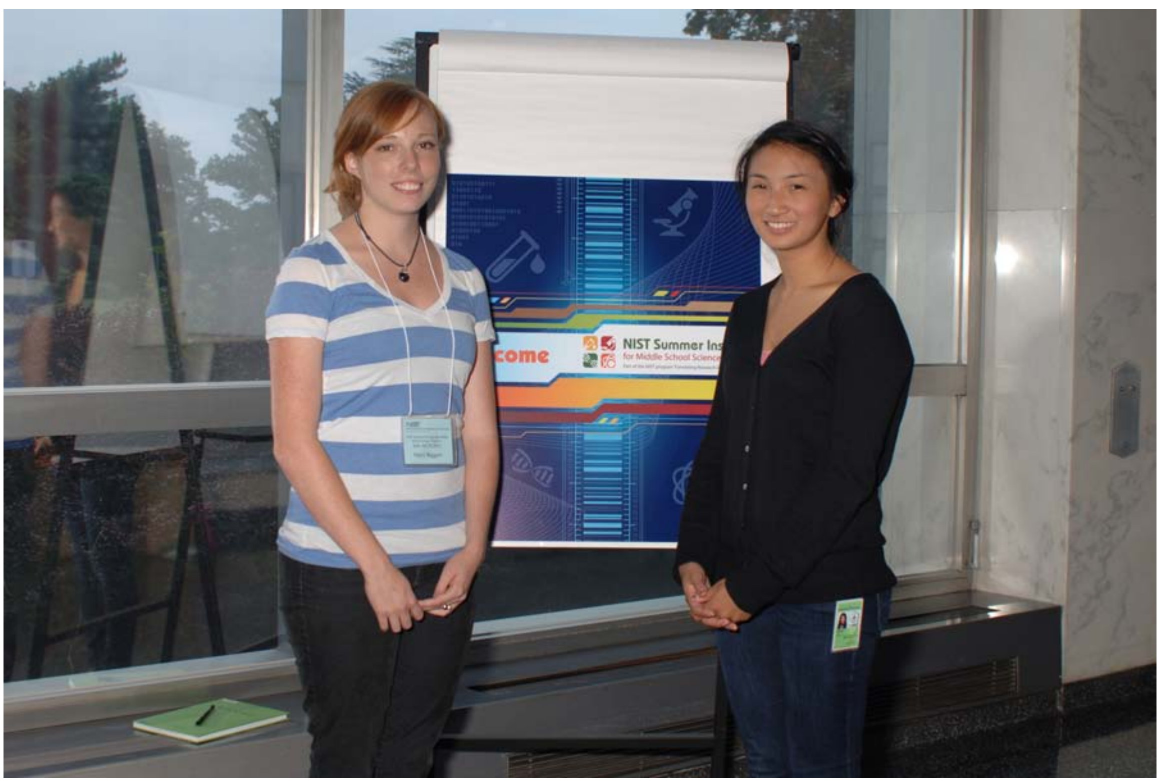
Barbara gives it a try.

Jenny makes suggestions about Karoline's technique.

Can you tell anyone's in there? This was taken in Becky's lab with the lights off and the UV light on the gel to look at the separated bands. It worked!

Then it was back for a SURF Panel on motivating SURF students. Some technology innovations work in the classroom; others do not. Videos as part of a lesson, yes; e-books and on-line classes, at least for these undergraduates, no.

After lunch NIST scientists came by to pick up their teacher for an hour long visit on research and work at NIST; an opportunity to develop a relationship with a scientist. In this photo, Teana Fields and Mihaela, or Miki, Tanase.



Mary Biggers and SURF student Janice Lin

Betsy Steel and her former 5th grade student, Jennifer Au, now a SURF student at NIST.

Becca Epling and Katrice Lippa

After the teachers returned from visiting their scientists Carolyn Holcomb, participant in the NIST Summer Institute last summer and currently participating in the Research Experience for Teachers program talked about how she uses the NIST materials.

The day ended with a conversation about what teachers learned from the scientists they visited and sharing teaching ideas amongst the teachers. A new goal for the NIST Summer Institute: building a network of *teachers*!

2011 NIST Summer Institute for Middle School Science Teachers Day 10
Friday, July 29, 2011

The final morning was devoted to learning more about nanomaterials and nanotechnology, starting off with a lecture by Debbie Kaiser, Division Chief of the Ceramics Division.

Bryce Marquis, a Postdoctoral Fellow in the Biochemical Science Division, followed with a talk, "From Pizza Delivery to Drug Delivery, My Path to Science." Bryce talked about his difficult background and how he became an analytical chemist, currently focusing on possible DNA damage caused by man-made nanoparticles. Not that we <u>know</u> that nanoparticles are toxic, but since we are producing new kinds and using them in unique ways the environmental, health, and safety aspects must be considered.

Then Bryce took half the teachers to the lab for a nanoencapsulation lab while half stayed behind and heard from Julian Taurozzi, of the Nanomechanical Properties Group with a presentation on why the properties of materials at the nano level differ from the bulk material. He used the color of gold and silver nanoparticles as an example…

… and did a demonstration of how when ~10 nm gold nanoparticles are increased in size, or aggregated, their color changes. Decreased surface area changes their optical properties, or the way light interacts with them. And by the way, none of the nanoparticle solutions looked like the gold or silver colors we are accustomed to seeing!

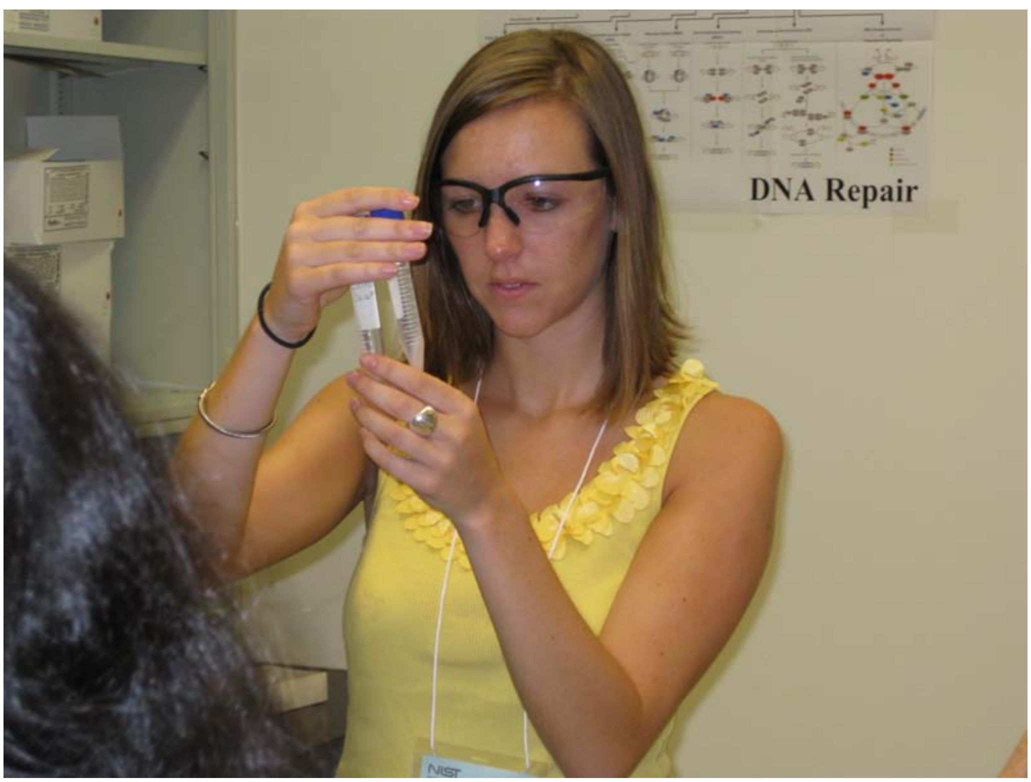
Teachers watch with fascination as the color changes and a discussion ensues about whether the change is physical or chemical. It’s a physical change because it’s still gold, just larger clumps of atoms – the confusing part is that we’re not used to thinking of physical changes resulting in color changes!

In the lab with Bryce, students made nanoparticles, loaded them with a dye, and then caused the nanoparticles to release the dye. Great opportunity to be in a working research lab and use the same tools as the scientists!

Bryce discusses the experiment with Matt while Sammi Jo measures out the correct volume of dye (food coloring) and Jenn makes sure the protocol is being followed.

Anne and Mary work carefully to add just the right amount of silicon nanoparticles.


Sumaya looks through a microscope to see the *C. elegans* that Bryce uses for nanotoxicity testing.



Brooke examines the two tubes after they've been centrifuged to see which conditions cause the nanoparticles to release their dye.

After the morning spent learning more about nanotechnology, teachers went out for a group lunch together, enjoying the social time. Then it was back once more to Lecture Room A for the closing ceremony with Chuck Romine, Acting Associate Director for Laboratory Programs. Mary presented each teacher with a poster based on the one in the classroom but personalized with a picture of each teacher in the NIST Summer Institute.

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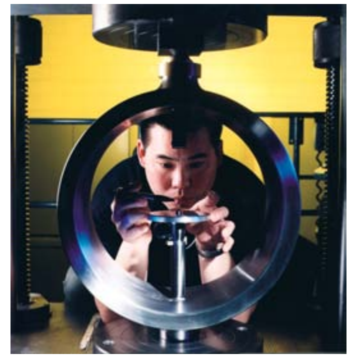

Metrology: the Science of Measurement

"To measure is to know."

Lord Kelvin 1824-1907

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