Letters
to the Editor

Whiteboards/Blackboards

I disagree with Professor Bartlett's Guest Editorial concerning blackboards.[1] Chalk, even the so-called dustless kind, *is* very messy. We noticed piles of chalk dust all over everything in the lab and classrooms. Some of our lab equipment has to be carefully cleaned of accumulated chalk dust before it will work properly. And this dust can really hurt computers. Also, when I first started teaching, I wore a sport coat and sometimes a tie. The yellow chalk dust made such a mess of my clothing that I eventually resorted to wearing a lab coat to all my classes. The chalk dust never washed out of my clothing and the blue lab coats developed a yellow tinge. We used to joke that teaching is truly a dirty business and teachers might develop "yellow lung disease." But it's really not funny—some people are very allergic to chalk dust. I don't know if I'm actually allergic, but I do sneeze a bit whenever I use blackboards. And regarding the problem of a felt marker unexpectedly running dry during class: This is no different from the student's problem of having a pen run dry while taking notes, and the solution is the same for both—just carry an extra pen or marker.

I believe that for many teachers the whiteboards and felt pens are a real improvement in teaching conditions and not some useless gimmick that was developed by cynical businessmen. Also, there are felt pens now available that are odorless and much safer than the ones described in the editorial.

On a lighter note: Professor Bartlett asked if anyone has ever seen a piece of chalk that would not write. The answer is yes! One time our maintenance staff washed the blackboards with the same liquid they used for the floors, which contained a wax. None of our chalk would write until the blackboards were thoroughly cleaned again. I believe that "waxing the blackboards" is a common prank in high schools.

1. Albert A. Bartlett, "A cautionary tale," *Phys. Teach.* **44**, 568–569 (Dec. 2006).

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Blackboards/Whiteboards

In response to Albert Bartlett's concerns about whiteboards versus chalkboards, I can only offer my own humble experience regarding this issue that rages within our district. For the past four years I have taken note of some of the differences from an experimental point of view and can comment on some of the hypothetical arguments offered by the article. My room assignment has changed a fair amount, and I have used both media (sometimes side by side). To enumerate my experience in light of the article's key points, I offer the following observations:

• ***Point 4:*** The shelf life of chalk is indeed much longer than whiteboard pens. Stored properly, the whiteboard pen's life span appears to be about five to six years, whereas chalk lasts nearly forever. This doesn't hold true if you happen to be from a humid environment, of course. The pens, being sealed, retain the same shelf life under humid conditions, whereas chalk, usually stored in cardboard containers, doesn't last quite as long.

• ***Point 5:*** When chalk doesn't break, most of the chalk winds up on the board. The whiteboard pen, on the other hand, only deposits a relatively small amount of pigment; the rest of the agent (ethyl acetate) simply evaporates. Gathering opinions from a variety of students over the last few years has revealed that under a wide variety of lighting conditions, whiteboards are much more visible. The contrast is much sharper; the small amount of pigment does a better job of covering the white surface than the chalk does covering a black surface. This is especially true when the illustration can be enhanced with different colors.

• ***Points 6 and 7:*** Chalk is indeed cheaper. A recent survey of a major stationary store chain indicates that a box of chalk (one semester's worth of writing) costs about $0.70 versus a package of pens at $2.98, which lasts about a whole year. Chalk doesn't always wind up on the board. Chalk breaks and becomes unusable once the piece becomes too small. Nevertheless the cost of whiteboard pens is probably about two to three times that of chalk for the same length of writing. It is certainly nothing close to one hundred times the cost. If that were true, companies who are truly disposed to the "bottom line" wouldn't be installing them in their office buildings and conference centers.

• ***Point 8:*** Ethyl acetate, the primary solvent used in most whiteboard pens, is benign. It is a solvent used in food processing as well as coatings. It is manufactured in your own body as a metabolic byproduct (esterification of ethanol and acetic acid). In large concentrated quantities it can be irritating, but at a low level it is considered harmless. The plastic casings of the whiteboard markers are a real concern and should be tossed into the plastics recycling bin along with all the other plastics we generate in our modern lives. My guess is that whiteboard markers don't constitute a major pollutant when measured against other things we use and discard daily.

I use many colors in my teaching. Ever step back from a monochrome presentation, after a discussion with your class, and ask what can they glean from what is left on the board? I have, and it is often incomprehensible. Using different colors becomes a valuable pedagogical tool that allows the students to see the overlay of different ideas as you progress through a discussion (consider the simple act of a free-body diagram). Try using colored chalk. Try erasing colored chalk. Whiteboards work a good deal better than chalkboards when it comes to presenting ideas to a whole classroom in terms of visibility and variety of expression. This improvement (like any advance) does come at a cost (economic and environmental) that we have to weigh when considering what tools we use to teach. The difference between these two media is not as stark as presented in "A Cautionary Tale."

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Author's Response

There are probably no classroom board systems that fit every taste and preference. The few times I've used whiteboards and pens, I have found the fumes of the ink solvent were strong. With whiteboards, teachers have to breathe the vaporized solvents from the pens year after year through a professional lifetime of teaching. I worry about the cumulative effect of many years of breathing the fumes of organic solvents. If there are now odorless pens, I wonder if the solvent is water, in which case there should be no problem. Does anyone know for sure if some whiteboard pens use water as the solvent for their inks?

In early December 2006 I saw a local television news story featuring kindergarten children preparing Christmas posters. The children were using colored marker pens instead of the more conventional crayons, and as small children do in their intense concentration on their work, they had their faces down really close to the pens and paper. I just hope that the solvent in the pens the children were using was water and not a potentially hazardous organic chemical.

Here is a comment from a friend at a major Midwestern engineering school:

> "Thank you for your articles. Our department just moved to a new building and the issue of chalkboards and whiteboards came up during the planning stage. The cost calculations favored the chalkboards, as you note in your article…. One more thing about the whiteboards. *The pen slides too easily and the handwriting is usually worse on the whiteboard than on chalkboard"* (emphasis added).

We are all asked to do our part to help slow the rise in global warming. I applaud the people who would prefer to drive a Hummer but choose instead to drive a hybrid in order to make a small personal contribution toward reducing the burden they, as individuals, put on the environment. The evidence indicates that chalk boards and chalk are much more environmentally friendly than whiteboards and marker pens, so the use of chalkboards is a small sacrifice we can make in order to do our part in reducing the rate of increasing global warming. In return for this small sacrifice, chalkboards provide us with proven benefits in cost and convenience.

In response to Paul Beeken's letter, I suspect that the business "bottom line" plays very little role in decisions to use the more expensive whiteboards instead of the less expensive chalkboards. Whiteboards are often prescribed by consulting "experts" whose clients have to pay the higher costs. Conference centers don't blink an eye at serving bottled water at around $6 a gallon to their guests when tap water is practically free. From my experience it seems as though whiteboards are prescribed and are accepted uncritically as the "modern" way to do things with little or no thought about the costs or functionality.

Visibility of chalkboards is always a problem. For decades we had white chalk on blackboards to get the maximum contrast for best visibility. Then, about 50 years ago, "experts" invented the idea that white chalk on blackboards was hard on the eyes because the contrast was too great. So the "experts" prescribed green boards, which were to be used with yellow chalk in

order to reduce the contrast and not be so "hard on the eyes." Now, as part of the promotion of whiteboards, a cited benefit is the increased contrast and visibility. Fads seem to be cyclic.

For years I was concerned about visibility in my use of the chalkboards in our two large lecture halls that seat 222 and 340, respectively. When we built the building around 1970,[1] we specified BLACK chalkboards for maximum contrast. There was a mix-up, and we found that fixed GRAY boards were installed. Someone may have thought that gray went better with the décor than black. When we later were able to replace the fixed boards with moving boards,[2] I made very sure that the new boards were really black.

But then real black becomes gray after being erased once. For maximum visibility, the boards have to be wet-washed before every use, and I often wet-washed the boards myself before lecturing.

The university supplied a standard white hard "dustless" chalk. Even with a modest force it wrote a narrow line that was marginally legible on the blackboards when viewed from the rear of the halls, a distance of about 18 meters. So I found "Railroad Crayon" at a machine-shop supply store.[3] These sticks of chalk are about 2.5 cm in diameter and 12 cm in length. The chalk is soft. Now, with a modest force one gets a wide line that is easily legible at 18 meters. The railroad crayon is available in several colors, so I carried about three or four different colored pieces of railroad crayon in my left hand while I wrote with my right hand so as to give colorful chalkboard presentations. I wonder if writing on a whiteboard with a normal pen can be read at 18 meters.

A word of caution is in order about colored chalk. The colored chalk used by artists to write on paper or on sidewalks seems to contain some sort of wax to increase the lifetime of the art work. If this chalk is used on a chalkboard, the wax makes it extremely difficult to erase.

References

1. A.A. Bartlett, "The Frank C. Walz lecture halls: A new concept in the design of lecture auditoria," *Am. J. Phys.* **41**, 1233-1240 (Nov. 1973).
2. A.A. Bartlett, "Movable chalkboards in the science lecture hall," *Am. J. Phys.* **55**, 719-722 (March 1987).
3. A.A. Bartlett and Michael A. Thomason, "Legibility in the lecture hall," *Phys. Teach.* **21**, 531 (Nov. 1983).

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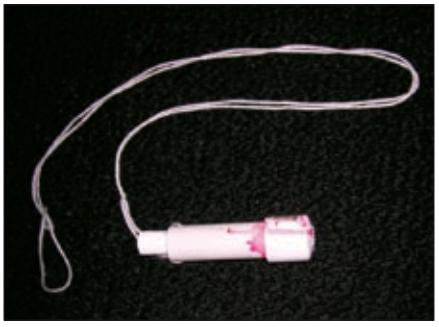
Extending the Life of a Marker

In the December 2006 issue of *The Physics Teacher,* Albert Bartlett wrote a very persuasive editorial against the adoption of whiteboards and whiteboard markers on environmental grounds. For those of us who have whiteboards already and use up scores of markers a year, I have a simple tool that both extends the life of the marker and provides a nice demonstration of centripetal force.

A whiteboard marker (of all the brands that I've tried) will fit snugly inside a ¾-PVC pipe. I fashioned a pen holder from 3½ in of ¾-in PVC pipe and a PVC end cap, drilled holes near the open end of the pipe, and attached about a meter of string (see photo above). By placing the pen



Author's pen holder.

in the holder with the cap pointing down and swinging the device rapidly about my head, the pen is subjected to a centripetal acceleration while the ink, because it is somewhat free to move inside the pen, moves to the outside of the circle into the tip of the pen. In this way, the remaining ink can be concentrated to a usable level and the marker's useful life extended a little further. Though I have not studied the life of the markers in a quantitative way, I find that I can extend the useful life of a marker by one to two days using this device. (Markers in my classroom usually last one to two weeks, though I have three to eight markers in circulation at any time, because students use them to prepare whiteboard presentations.)

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A Physics Lesson for the Prom

Prom and graduation are rites of passage for all high school students and represent a time for celebration. In some cases, the celebrations involve drinking and driving. The gravity of this scenario is borne out by the statistics:

- Motor vehicle crashes are the number one killer of teens, and over one-third of teen traffic

deaths are alcohol related.[1]

- A recent study reflected 11.3% of Caucasian high school students drove after drinking alcohol, compared to 10.5% for Hispanic, and 4.9% for African-Americans.[2]
- In 2000,[3] the National Highway Safety Administration found that more than 1200 alcohol-related fatalities occurred nationwide among teenagers from April to June—prom season.[4]

Because the outcome of such celebrations can be very devastating, I sought to educate the graduating seniors in a letter to the school newspaper about the consequences of drinking and driving by explaining the physics involved in drunk driving and the ramifications of an automobile accident. The letter, entitled "A Physics Lesson for the Prom," and the derivation/explanation of calculations included in the letter can be accessed through Ref. 5.

This letter received positive feedback from both students and faculty, and my hope is that science teachers can incorporate this meaningful application of physical principles into the science curriculum and consider drafting a similar letter at their school to inform their students, particularly graduating seniors, about the dangers involved in drinking and driving. This topic allows for the introduction and implementation of many aspects of physics, including motion, forces, work, energy, momentum, and impulse.

In addition to the letter, another learning opportunity involves exploring partnerships between classes and the national office or campus chapters of MADD or SADD (Students Against Destructive Decisions) to develop strategies to illustrate and publicize the physics involved in automobile accidents, particularly during Red Ribbon Week (observed the last week of October). By explaining the physics in terms of numbers and simple concepts, the students can readily appreciate the seriousness of drinking and driving. Although no one can force students to avoid drinking and driving, what we as physics teachers can do is educate students to make informed decisions and to understand the potential consequences of their decisions.

References

1. "Traffic Safety Facts 2004 Data: Alcohol" (NHTSA National Center for Statistics and Analysis, National Highway Traffic Safety Administration); http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/TSF2004/809905.pdf.
2. Centers for Disease Control and Prevention, "Youth Risk Behavior Surveillance–United States, 2005," MMWR, 55 (No. SS-5) (June 9, 2006); http://www.cdc.gov/MMWR/preview/mmwrhtml/ss5505a1.htm.
3. 2000 was the last and most current year for data collected under this category.
4. Mothers Against Drunk Driving (MADD Online: Youth Statistics); http://www.madd.org/stats/0,1056,1807,00.html.
5. See documents at http://ftp.aip.org/cgi-bin/epaps? ID=E-PHTEAH-45-005704. For more information on EPAPS, see http://www.aip.org/pubservs/epaps.html.

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Correction: "Issue with TI-83s," *Phys. Teach.* 44, 566 (Dec. 2006).

The sentence following the equation in David Doty's letter should read, "However, many of my students were simply answering $f = 4.57$ Hz."