problem were solved by providing the option of receiving them on microfiche.

RODMAN E. DOLL
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7/82

Differences between physicists

The contrasting emphases on show-and-tell, computer-assisted, and pen-and-paper approaches to learning physics, so well portrayed in July (page 11) by the letters of Julius Miller, and of W. P. Allis, A. Bers and L. P. Harten, brought to my mind an anecdote that seems pertinent concerning William Rowan Hamilton, the great Irish mathematical physicist.

Hamilton's mathematical analysis of the propagation of light in a birefringent medium led him to predict that "conical refraction" should be observable. Not being an experimenter, he asked his friend Humphrey Lloyd to look for the effect. After about six months, Lloyd succeeded in observing it. Their separate papers, published in the same issue of the *Proceedings of the Royal Irish Academy* in 1833, attracted great interest. Many experimenters, however, were unable to observe the phenomenon, and one distinguished optical worker—either Brewster or Airy, I think—told Hamilton that he would not have believed the effect existed had he not seen it with his own eyes. Hamilton is reported to have said "How different we are!" Because his eyes had deceived him so often, he believed that it existed only because he had proved it must.

To me this seems to say that the advance of physics today, as then, is dependent upon the complimentary coordination of men and women with widely differing gifts. Not to take advantage of what each approach can give is to the detriment of physics instruction.

E. SCOTT BARR
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8/82

Communicating with the public

I read with great interest the editorial in July (page 96) concerning the Commission on Pre-College Education in Science, Mathematics and Technology. Although I agree totally that something must be done about the dismal failure of scientists to communicate with the general public, I am skeptical about the efficacy of yet another national commission to study the problem.

Nonetheless, I would like to suggest that the Commission include in its study not only established academic programs, but also the fine example set by the "Exploratorium," a "hands-on" science and technology museum in the Palace of Fine Arts in San Francisco. This museum, operated by Frank Oppenheimer and an enthusiastic cadre of students and technicians, is a marvelous example of what is lacking in most science courses. The story of the museum was recently featured on PBS television. Clearly one important ingredient in the success of the Exploratorium is the high priority placed on interacting with the "students," namely the public. Exhibits that don't communicate well are quickly replaced by others that do. This feedback process is probably the reason that microcomputers (and video games) also are so popular today. Perhaps the Commission on Pre-College Education could do worse than recommend that other cities be encouraged (and possibly funded?) to set up their own exploratoria.

I have no connection with the Exploratorium except that of an enthusiastic fan.

K. MORIYASU
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8/82

Fletcher and the oil drop

Regarding Harvey Fletcher's "My Work with Millikan on the Oil-Drop Experiment" (June, page 43), I want to share a few thoughts.

When I was Ernest Kempton Adams Precision Laboratory Assistant at Columbia University, 1935–1938, graduate students did the "Millikan Oil-Drop Experiment." After reading Harvey Fletcher's posthumous autobiographical excerpt, I wondered if the experiment might not better be called the "Millikan–Fletcher Oil-Drop Experiment."

I think of a misnomer I would not have known about except for Erich Hausmann and F. P. Slack, who in their *Physics*, third edition, page 388, say: "The Wheatstone Bridge . . . method devised in 1833 by S. Hunter Christie, was brought to public attention by the English physicist, Sir Charles Wheatstone (1802–1875) and has remained associated with his name."

It is commendable that PHYSICS TODAY has published Fletcher's account of this remarkable experiment on the determination of the electron charge.

DON KIRKHAM
Iowa State University
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8/82

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I was delighted to see the most interesting article—an historical gem!—by Harvey Fletcher on his work with

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letters

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Millikan on the oil-drop experiment. Having done the experiment myself (as a student, in a lab course at Göttingen), I still remember my excitement when I saw that some of the oil drops went slowly up and others went faster down, each with a velocity that obviously came from a small set of quantized velocities. This is an experiment that shows, as few others do, a fundamental quantum effect on a macroscopic scale in a most direct manner to the human eye.

Mark B. Gardner, a long-time associate at Bell Laboratories, and the editors of PHYSICS TODAY are to be congratulated on safeguarding Fletcher's story and making it now available. It is not often that we benefit in such a way from scientists like Harvey Fletcher, who contributed to the history of physics both as experimenter and diarist.

MANFRED R. SCHROEDER
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9/82 *Göttingen, West Germany*

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I was impressed by the ring of truth in Harvey Fletcher's posthumous description of the Millikan–*Fletcher* oil-drop experiment. By excluding Fletcher from coauthorship in the 1910 *Science* paper, Millikan stretched scientific ethics beyond its breaking point. ("A PhD for you, a Nobel for me, is that okay with you, Mr Fletcher?") I hope that Nobel Prize committee members and historians of science will take notice. Not to mention graduate students . . .

P. HALEVI
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Minimum physics degree

I would like to pose a question for the physics community: "What do you consider the bare minimum to be for a undergraduate degree in physics?" My answer would be as follows:

- E & M for about one year at the level of Corson & Lorrain
- mechanics for about one year at the level of Marion
- quantum mechanics at the level of Anderson or Eisberg
- thermodynamics and statistical mechanics at the level of Zemansky's classic and Kittel's undergraduate text.
- three semester's of advanced lab (Melissinos).

Better universities would demand more, but no college should demand less. If a college demands less, then the degree should not be called purely a physics degree but rather, as for example in the case of UCLA, a degree in