this third sense, a rubber band is more "elastic" than a steel wire because it is easier to stretch and will stand a proportionately greater elongation), in addition to the more general sense of (4) the property of returning to original dimensions after distortion. Why do these conflicting senses cause no problem and evoke no impassioned letters to physics journals? Simple! With no conscious effort by anyone, *elasticity* as the name of a *quantity* has quietly disappeared from our technical vocabulary: if elastic modulus (sense 1) is meant, one specifies shear modulus, bulk modulus, or whatever, as needed for the occasion; and "73% elasticity" in the context of partially elastic collisions refers unambiguously to sense 2.

With these examples to give perspective and to sharpen our concepts, we now come to the word *weight*. As in the examples noted above, there is no confusion with the nontechnical senses. The trouble is that the word refers to heaviness without any concern about whether its quantitative expression is m or $m\mathbf{g}$. After all, the word had already been current for centuries before Newton said "$\mathbf{F} = m\mathbf{a}$." Thus weight has two intrinsically different technical senses, and this double meaning is what causes all the confusion.

Confusion? *What* confusion?! Physicists and engineers—and others who understand $\mathbf{F} = m\mathbf{a}$ and the need for consistent units—have no problem in selecting m or $m\mathbf{g}$ as needed for the problem in hand. In the English System, saying that a body "weighs" 16 lb does not in the least specify whether the problem is to be solved with pounds force and slugs or with pounds mass and poundals; and in SI units, the weight is stated in kilograms even though newtons are required when the gravitational force enters the problem. So the only ones confused are the least able Physics I students—and their confusion comes much less from the double technical sense of the word *weight* than from their lack of understanding of $\mathbf{F} = m\mathbf{a}$. Surely this is inadequate to occasion the longstanding dispute.

As seen from the above examples of words with multiple technical senses, any genuinely confusing ones soon fall out of technical use. Thus *the continuing use of* weight *in technical discussions shows that this is harmless and useful for most purposes.* Weight in its ambiguous sense of either m or $m\mathbf{g}$ becomes awkward only in definitions, in sharp distinctions, in close association with mathematical expressions, and in other explicit formal statements. For example, the statement that "weight means either m or $m\mathbf{g}$" is fine if one is willing to speak algebra. But though m is readily replaced by the compact word "mass" when one wants to speak English (that is, there is no need to beat about the bush with some such phrase as "inertial property"), the only adequate synonyms for $m\mathbf{g}$ have been "gravitational force" (2 words, 6 syllables, 18 letters) or "gravitational attraction" (2, 8, 23) or "force of gravitational attraction" (4, 10, 30)! Though these circumlocutions say exactly what is meant, they have the feel of using a meat axe to kill a spider.

So why hasn't the awkwardness been resolved by officially ruling that, in the technical context of mechanics, weight is $m\mathbf{g}$, not m? It isn't for lack of trying! For example, such a ruling was made in the 1901 declaration of the General Conference on Weights and Measures; physics texts have long been unanimous on the point, and as recently as 29 January 1979 to 26 January 1982 the American Association of Physics Teachers censured National Bureau of Standards publications that accept the occasional use of weight as a synonym for mass. But the problem remains unresolved as of December 1982 with the Thomson and Goldman letters; objects are still "weighed" on a beam balance or a grocery scale (honest "weight," no springs) to determine *mass*. Why?! The reason is that *weight* is a long-established and widely used word that belongs to all speakers of English; a dictionary reflects their current usage of the word. Thus if some scientific, technical, or governmental body presumes to legislate a *technical sense that clashes with the everyday dictionary sense*, it can expect to be ignored even (most of the time) by most members of the profession(s) concerned, as illustrated by the long and futile rumpus over the use of the word *weight*. In fact, I doubt that even the US Congress has the Constitutional authority to legislate such matters (especially not for other English-speaking countries); and certainly I can't imagine that it would want to bite off such a can of worms—not even to provide an occasion for this lovely mixed metaphor. So what needs to be done?

What is wanted is a good monosyllabic Anglo-Saxon word that means $m\mathbf{g}$ and *not* m. Fortunately, such a word with exactly the right meaning exists. The noun *heft* (like the related verb *to heft*) derives from the verb *to heave*. It is the weight of a body, explicitly as measured by the force to lift it. Thus the proposed technical definition *heft* = $m\mathbf{g}$ is completely compatible with the ordinary dictionary senses. The fact that *heft* has largely fallen out of everyday use makes it all the more suitable for adoption in a specialized technical sense. The purpose of the foregoing argument is to suggest that the appropriate committees representing American physicists should consult with the appropriate governmental and international agencies to adopt *heft* as the explicit technical word for $m\mathbf{g}$—to be used at least (and perhaps almost exclusively) in the explicit formal statements mentioned above. But in less demanding discussions (even technical ones in mechanics) we should be free to continue to use *weight* casually in its widely useful everyday senses of *heaviness*, as expressed impartially by either the mass m or the heft $m\mathbf{g}$, and a *heavy object*, such as a paperweight or a calibrated 20-gram weight.

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Superconducting electronics

With reference to Theodore Hartwig's letter (March, page 102), I would like to note that the International Cryogenic Materials Conference to be held in Colorado Springs, 15–19 August 1983, will also feature another event of interest to solid-state physicists. The program for 18 August includes a one-day symposium on Materials and Processing for Superconducting Electronics that is devoted to refractory superconducting films and artificial tunneling barriers. The plenary paper by M. R. Beasley from Stanford University will be followed by sessions on Josephson tunnel junctions, films, barriers, film surfaces and interfaces. The detailed program of the symposium is available from me.

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Pseudo-QCD

In the news story, "A look at the future of particle physics" (January, page 19), many predictions of the standard model, claimed testable in present and future accelerators, are reported to have come out of two high-energy physics conferences during 1982. It should be pointed out that many of the predictions about the strong interactions are not honest predictions of the theory, since quantum chromodynamics (QCD), the component of the standard model essential to describe strong interaction dynamics, is still far from being solved. The problem arises from the fact that the perturbative part of QCD, which is calculable, only describes the behavior of quarks and gluons but not the behavior of hadrons; a prescription of how quarks and gluons turn into hadrons (called "hadronization") becomes necessary to predict observations. Many so-called pre-

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John Wiley & Sons

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Bi-Braze
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Delta Ultra Sense
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dictions of QCD are actually the predictions of pseudo-QCD models that are mixtures of the perturbative QCD and arbitrary assumptions about hadronization. A good example of the claim of verifying QCD based on such pseudo-QCD models is the well-publicized claim of the discovery of gluon jets in e^+e^- annihilation.[1] The sensitivity of this claimed discovery of gluon jets on the underlying assumptions of hadronization has been pointed out and some remedial measurements urged by the author.[2] These remedial measurements can be carried out both in PETRA at DESY and PEP at SLAC, but have yet to be performed. It is clear that the essential step in the process of verifying QCD is not in piling up more predictions based on pseudo-QCD models but rather in the willingness of experimentalists to carry out the objective measurements necessary to reduce the arbitrariness of the assumptions about hadronization. Also the ability of theorists to solve the theory of QCD will eventually become overwhelmingly important in the process to verify QCD.[3] Before QCD is confirmed beyond reasonable doubt, predictions of grand unified theories can only stay at the level of the usual high-risk speculation of some theorists. The best motivation for constructing new accelerators seems still to be their potential for discovering radical phenomena beyond the imagination of theorists. At a time when the costs of future accelerators are approaching the level of small-arm systems for the Pentagon, I believe that an honest view of the present status of high-energy physics theory is not only essential for high-energy physicists, but is also important for the physics community as a whole.

References

1. PHYSICS TODAY, February 1980, page 17.
2. C. K. Chen, Phys. Rev. **D23**, 712 (1981); "Why the discovery of gluons in e^+e^- annihilation is not reliable," Purdue University Preprint (1981).
3. C. K. Chen, PHYSICS TODAY, May 1982, page 123.

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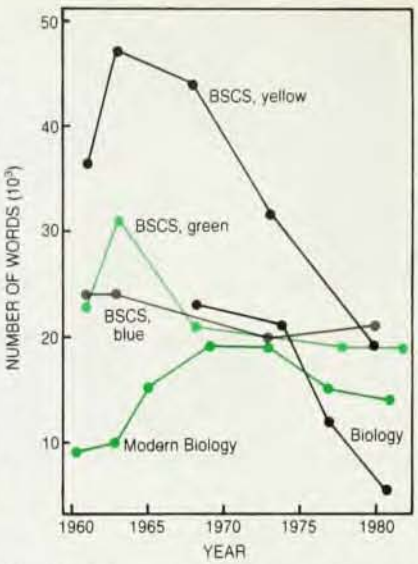
2/83

Creationism once more

In April (page 82) Wayne Newquist asks where "efforts to eliminate the teaching of evolution" may be found. One answer is in our public schools. One needs only to look at the changes made by publishers of high-school biology texts who have apparently yielded to creationist influences in recent years. The accompanying graph is a plot of the number of evolutionary



Number of references to evolution in consecutive editions of five high-school biology texts versus date of publication. *Biology Science Curriculum Studies*, Yellow cover, published by Harcourt Brace Jovanovich (except 1961, by BSCS); *BSCS*, Green cover, published by Rand McNally (except 1982, by Houghton Mifflin); *BSCS*, Blue cover, published by Houghton Mifflin (except 1980, by Heath); *Modern Biology*, published by Holt, Rinehart & Winston; *Biology*, published by Silver Burdett.

words or phrases contained in five major texts over several editions each versus year of publication. These data were collected by Gerald Skoog.[1] Textbook policies requiring qualifications with any references to evolution, such as those of the Texas State Board of Education, sanction this gradual erosion of quality, accurate textbook material. The effect can only be called censorship,[2] since no corresponding deemphasis of evolution has occurred in the life sciences. To draw an analogy, it is as if references to Newton's laws were being removed from secondary-school physics texts. Thus does creationism contribute to poor-quality science education in this country, and public-school students become its victims.

References

1. "Converge of Evolution in Secondary School Biology Textbooks: 1900–1982," Gerald Skoog, Dept. of Education, Texas Tech University, paper delivered to American Biology Teachers' Assn., October 1982.
2. "Censorship of Evolution in Texas," Steven Schafersman, *Creation/Evolution*, Issue X, Fall 1982, page 30.

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4/83

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If the creation scientists should win out and we have to begin teaching the Bible in the classroom, physics need not be left out of what has been heretofore a domain of biology. The Flood, for example, offers several simple problems which can be considered at say the high-school level:

▶ Using data from the World Almanac and assuming an average height for the land of 1.5 mi, calculate the total volume of water needed to cover the entire Earth to the altitude of Mt. Everest. (Answer: 972 million cubic miles.)

▶ Using the answer to problem 1 and data from the World Almanac, find the ratio of volume of rain which fell during the Deluge to the volume of water currently in all the oceans of the world. (Answer: 3.09.)

▶ Using the answer to problem 1 and allowing 40 days and nights to cover the Earth, find the rate at which rain must have fallen during the Deluge. (Answer: 5.60 inches/minute.)

▶ If a heavy rain (say during a thunderstorm) is defined to fall at the rate of 2 inches per hour, what is the ratio of the rate of rainfall during the Deluge to that of a thunderstorm? (Answer: 156.)

The teacher is to be discouraged from asking the student to think about such unanswerable questions as: Where did all that water come from and where did it go? How did life forms not taken into the Ark survive submersion under the heavy pressure of 5 miles of water? Why are there not traces remaining, even after several thousand years, of erosion brought on by such a heavy rainfall? Why did God choose such a difficult method by which to destroy mankind, when all he needed was to invent a deadly virus (something perhaps man himself will soon learn to do) to wipe him out?

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4/83

List of refusniks

One may wonder if the space in a professional journal like PHYSICS TODAY is well spent debating such polemical matters as whether a Jew can be a Russian (See letters of Mark Azbel, Ernest Silver, Vladislav Bevc in February, pages 97–101) and whether Academician Anatoly A. Logunov did his best to favor the exit of Victor Brailovsky.

The professional treatment of physicists throughout the world is, however, a clear matter of concern to PHYSICS TODAY and its audience—I therefore believe that it might be of interest to publish a biennial list (more frequent if necessary) of the names of *all* physicists from *all* countries who have been refused attendance at international meetings to which they have been