

LETTERS

Testing

On November 18 the Western Pennsylvania Section of the American Association of Physics Teachers discussed the article by Banesh Hoffmann ("Testing", *Physics Today*, October 1961, p. 38). Our conclusions may be summarized as follows:

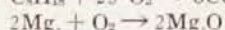
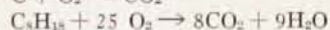
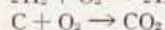
Question #64: "Colorless" glass implies no differential absorption at different wave lengths. Since the real and imaginary portions of the dielectric constant are connected by a pair of reciprocal integral equations, the imaginary component, which determines the ordinary index of refraction, can vary only if differential absorption exists. Therefore, the "colorless" glass prism would produce *no spectrum* because it has *no dispersion*. (C) is therefore the very best answer as to why *real* glass prisms can produce a spectrum from white light. Question No. 64, as it is phrased, is the question with *no correct answer*.

Question #54: (1) We equated "matter" with mass readings obtained by weighing. A weight scale does not read rest mass, but relativistic mass, including any radiant energy trapped in the object being weighed, cf., Harry Lustig, "The Mössbauer Effect", *Am. J. Phys.*, 29, 1 (1961). The contents of a container are weighed because molecules striking the bottom of the container have fallen through a gravitational potential and have greater relativistic mass and momentum than the ones striking the top of the container. Likewise, the radiation striking the bottom of the container has fallen through a gravitational potential and has been shifted toward the violet (higher frequency) so that it has greater relativistic mass and momentum than radiation striking the top of the container.

Because of the spark advance of an automobile engine and the speed of the reaction, "burning of gasoline" is complete before the start of the power stroke. The reaction is therefore one at nearly constant volume, with so short a duration that any heat conduction loss is compensated by the slight compression. Therefore (E) is a true answer. The energy transferred out of the system on the power stroke comes from the conversion of relativistic mass.

(2) Regarding (A) "reduction", over half the group concurred that

(a) Equations of the form



which start with covalent or metallic bonds and end with covalent bonds should be called "oxidation" and distinguished from reactions of the form $\text{CuO} + \text{H}_2 \rightarrow \text{Cu} + \text{H}_2\text{O}$ which are "reduction". This in no way invalidates the treatment of both types of reaction together under the heading "oxidation-reduction".

(b) Where valence changes are involved it seems preferable to speak of an increase in positive valence as "oxidizing", and an increase in negative valence as "reducing". This leaves the words "oxidation" and "reduction" free to retain their historical and important meanings as designations of the above-mentioned different types of reactions. This terminology is completely compatible with the usual specification of H_2 in the "reduction equation" as the "re-

ducing agent" or H_2O in its reverse reaction as the "oxidizing agent". Our available supply of words is too small to permit squandering them. Question No. 54 is the question with two correct answers.

Question #65: (1) We would not accept a substitution of "metallic atoms in a vapor" for the stated "metal". Consequently "work function" of the metal is the governing consideration, and the change of intervening medium from the vacuum of the photoelectric effect to the electrolyte of the electrochemical series does not alter work function differences between different metals. Consequently (C) is the correct answer both because it emphasizes the energy considerations and because it gives a true answer even when members of different groups of the periodic table are compared, which none of the other answers will invariably do.

Robert B. Gray
Erie, Pa.

More on Testing

On reading the article on testing in the October *Physics Today*, it occurs to me that item 65 can be criticized on grounds more fundamental and trenchant than Dr. Hoffmann's. Briefly, the root difficulty appears to be that the person who wrote the test item did not understand the nature of the photoelectric effect in solid metals, which is what the question deals with. The answers, however, are aimed at the problem of liberating an electron bound to a specific atom. The outer electrons in a metal are, roughly speaking, not bound to a specific atom, but circulate freely throughout the sample. Thus, when one looks at what is really happening inside a metal, all the answers are wide of the mark, and in particular the desired answer (B) is mainly nonsense.

Incidentally, it is too generous to assume, as Dr. Hoffmann does, that the test-maker was interested in individual atoms, as in the gaseous state. "Photoelectric effect" commonly implies the solid state. No experienced test-maker would have reinforced this impression by referring to "potassium metal" and "lithium metal" in the question if what he had in mind was potassium vapor or potassium gas.

I know from my own experience that occasional defective items are unavoidable—although, if Dr. Hoffmann's figure of 5% defective items in Educational Testing Service tests is correct, this would be high for items that may test some hundreds of thousands of students. What I find more distressing than ETS's error is their response to Dr. Hoffmann's criticism (*Harper's Magazine*, March 1961). This is contained in their "Explanation of Multiple-Choice Tests", the relevant portions of which are quoted in Dr. Hoffmann's article, and of which ETS kindly sent me a copy. ETS's explanation of this test item begins: "The technical terms must be considered in studying this question." Indeed, this is correct, but the next sentence displays the identical misunderstanding of the technical terms that motivated the test maker: "The photoelectric effect is exhibited by an element if, in atoms of the element, an electron is so loosely bound that visible light provides enough energy to free that electron from its atom." This belief that a photoelectron is liberated from a specific atom also permeates the rest of the explanation. (The additional misapprehension

that the photoelectric effect is restricted to visible light has already been dealt with by Dr. Hoffmann in his *Physics Today* article.)

I find the quality of ETS's response disquieting. Criticisms of ETS's tests are frequently answered by referring to the care with which the tests are prepared, and the competence and professional standing of those, including outside scientists, who devise and check them. (I am judging particularly by the transcript of the April 2, 1961 "Open Mind" television program, also kindly provided me by ETS, on which appeared Dr. Hoffmann and Dr. Henry Chauncey, the president of ETS. Such arguments are adduced perhaps five times during the program.) One would expect the defense of a challenged question to elicit the best of which ETS is capable. In view of the quality of ETS's defense, perhaps the kindest remark that can be made is that they did not take Dr. Hoffmann's criticism seriously. Some support for this view is provided by the identity of misunderstanding in the test item and their explanation. Instead of submitting the test item to a new and independent scrutiny, it appears that the same person or staff that devised the question was charged with writing the explanation.

Robert Hart
Chicago, Ill.

Brookhaven Didn't Do It

I am writing with respect to the reproduction of Commissioner Haworth's AGS dedicatory address in the December issue of *Physics Today*. We notice that, in line with your previous conversation with me, you scattered throughout the article pictures of various scientists who played important parts in development of nuclear and high-energy physics. Unfortunately, one of the pictures [on p. 24] and its caption do not seem to match. . . . The picture is definitely not that of Rutherford and it seems to be the general opinion of people here that the picture is that of Sir William Bragg. We would greatly appreciate it if this error would be pointed out in one of the future issues with a comment to the effect that pictures and captions were not supplied by BNL. . . . since we did not supply either the pictures or captions it is important to us to clear up any misconceptions that this mistake was made by BNL.

Charles E. Falk, Assistant Director
Brookhaven National Laboratory

I knew Rutherford well and the picture does not look at all like him. I think it is a picture of Bragg. There is a good picture of Lord Rutherford in Andrade's *Short History of the Royal Society*. He was not bald.

H. A. Wilson
Houston, Texas

You've done it this time! Page 24 of your December issue shows Sir William Bragg, not Lord Rutherford.

C. S. Wright
Victoria, B. C., Canada

This is not a photograph of Rutherford but of Sir William Bragg, father of Sir Lawrence Bragg, with whom he shared a Nobel Prize.

Paul Rosbaud
London, England

This man is certainly not Rutherford. He might be Lindemann.

Emilio Segrè
Berkeley, Calif.

I am very shaken by the picture of Ernest Rutherford on p. 24 of the December issue. I remember Rutherford when he must have been about the age of the individual in the picture who looks more like W. H. Bragg, and I really don't think he would have shaved off his hair just for the picture.

Ernest C. Pollard
University Park, Pa.

Having spent a year at the Cavendish Laboratory in the glorious days when Lord Rutherford was Director, I was greatly startled when I looked at the photograph alleged to be that of Ernest Rutherford. I am certain that the man in your photograph is not Rutherford, and I am inclined to believe it is Sir William Bragg, the elder.

William H. Crew
Los Alamos, N. M.

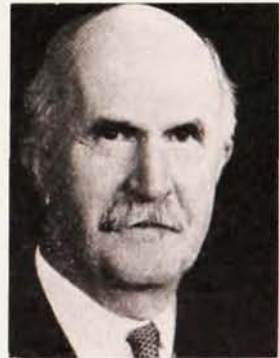
Dear Cobber:

Just don't believe those younguns who told you that was a pitcher of the Baron Rutherford of Nelson and Cam-



Lord Rutherford

The photograph reproduced at left is the second of a pair in our files labeled "Ernest Rutherford"; the first, we were dismayed to discover after the December issue had gone to press, is instead a likeness of Sir William Bragg. As the above letter from Dr. Falk makes clear, Brookhaven National Laboratory supplied neither the picture nor the caption and the responsibility for the fiasco is ours and ours alone.—ED.



Sir William Bragg