amide and β-naphthoxyacetic acid resulted in a decrease in the amount of scald which developed when the fruits were transferred to a temperature of 70° F. That another type of scald which occurs on Anjou pears (Henry Hartman. *Ore. agric. exp. Sta. Bull.*, 1931, 280, 1–8) can be controlled by treatment with 2,4-D is indicated by the results of experiments conducted during the 1945–46 season.

Anjou pears obtained from the Medford, Oregon, district were treated by immersion for 2–3 seconds in 0.1 per cent aqueous solutions of Carbowax 1500 containing 10, 100, 500, and 1,000 ppm 2,4-D. The control fruits were treated with 0.1 per cent Carbowax solution only. Following treatment, the fruits were allowed to dry, packed in plain paper wraps, and stored at 31° F. At 2-month intervals during a period of eight months samples from each treatment were transferred to 65° F. and ripened for 7–8 days.

No scald developed on any of the treated or untreated pears ripened following, 2, 4, or 6 months storage. After 8 months storage, however, severe scald developed during ripening on the control fruits and on the sample treated with 50 ppm of 2,4-D. None developed on the pears treated with 500- or 1,000-ppm solutions, and only a slight amount on the 100-ppm sample. While these data are considered to be preliminary, they indicate that 2,4-D used at an optimum concentration has a positive inhibiting action on the development of the type of scald peculiar to the Anjou pear.

In addition to the effect on the inhibition of scald, treatment with 2,4-D in concentrations of 100 ppm and higher resulted in the development of a more uniform yellow color during ripening. This was especially apparent on the samples ripened late in the storage season.

ELMER HANSEN

*Oregon State College, Corvallis*

### Comments on "A Relativistic Misconception"

C. Roland Eddy's Letter to the Editor (*Science*, 1946, 104, 303) convinced me that the law of conservation of mass holds for elementary particles, but I must reserve doubts about this law applying to matter by the beakerful or universeful.

Most physical chemistry textbooks state that when an exothermic reaction takes place, there is a loss of mass that can be calculated from Einstein's equation, $E = mc^2$, and that this loss is much too small to be measured on present-day balances. This assertion is not incompatible with Mr. Eddy's statements concerning the conservation of mass in elementary particles, but the two points of view taken together lead to an interesting conclusion.

The reason that the reactants, when weighed in their beakers, should have less weight after reacting is that this weighing determines the sum of the *rest* masses of the particles, which sum *does* decrease when energy is released.

However, as Mr. Eddy has shown, the sum of the masses of the particles which have engaged in the reaction is the same. Increases in their velocities make up for decreases in their rest masses.

Therefore, except for bodies at a temperature of absolute zero, as far as mass is concerned the whole (mass of an entire body) is less than the sum of its parts (masses of the individual particles composing the body)!

MARSHALL E. DEUTSCH

*2391 Davidson Avenue, New York City 53*

The article by Eddy (*Science*, 1946, **104**, 303) was read with interest. It seems to the author that Eddy's views would have been much clearer if he had stated in what sense he was using the term mass. In current textbooks and articles, mass is used sometimes to mean quantity of matter, *i.e.* electrons, protons, neutrons, and various combinations of these elementary particles, and at other times mass is used to mean inertia. It is also to be noted that all matter has inertia and that radiation has inertia, though radiation is not matter according to our present concepts.

Apparently Eddy, in his article, is using mass in both senses without distinguishing how the term is being used. For example, he says the equation $E = mc^2$ "does not state that a mass, *m*, can be converted into an energy, *E* . . ."; and later he says that "it was assumed that *M* is essentially at rest," where "*M* is the mass of the fissionable nucleus plus the neutron added to trigger it off." In these cases it is evident that mass is being used to mean matter. Near the end of the article he says that "the mass of a photon is $h\nu/c^2$," where evidently mass is used to mean inertia. Thus, would not the article be clearer if the term mass were used in only one sense, e.g. mass being defined as inertia? The main points of the article then would be as follows:

Einstein's equation, $E = mc^2$, states that a body of inertia (mass) *m*, can be converted into energy, *E*, and it also states that a body of inertia *m* contains an amount of energy, $E = mc^2$. Examples of the transfer of inertia of matter to energy are found in nuclear reactions and in the annihilation of a positron and an electron.

According to our present theory, when a fission occurs, there are the same kind and number of elementary particles of matter after fission as before, but the sum of the inertias of the remaining particles is less than the sum of the inertias of the initial particles. The difference in these inertias is called the mass (inertia), *m*, that has disappeared; and the energy that appears in the form of kinetic energy and gamma radiation equals $mc^2$. This may be thought of as a transfer of energy from one form to another form, or as the mass (inertia), *m*, being converted into energy. The quantity of matter in this case remains unchanged.

According to our present theory, when a positron and an electron unite, these two pieces of matter disappear, and usually two photons appear. If the positron and electron had no kinetic energy when they united, the energy of each photon equals $mc^2$, where *m* is the rest mass (inertia) of the electron as well as of the positron. This is another case of mass (inertia) *m* being converted into energy. But in this case matter disappears or is annihilated. The converse is also found to be true. A photon of sufficient energy in a strong electric field disappears, and a positron and an electron appear. $E = 2mc^2$, where $E$ is the energy of the photon, and $2m$ is the sum of the inertias of the electron and of the positron formed. Energy in this case is converted into matter, and the inertia of the photon equals the inertia of the matter formed. In these two cases the quantity of matter is changed.

Hence, Eddy's conclusion that the law of conservation of mass (inertia) still holds is correct. But it is also correct that matter and energy are interconvertible, as evidenced in the cases where the positron and electron unite and disappear, the photon or photons appearing, and where the positron and electron appear at the disappearance of a photon. At least, these are the present interpretations of the experimental evidence.

VOLA P. BARTON

*Goucher College, Baltimore, Maryland*

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In a recent note (*Science*, 1946, **104**, 303), C. R. Eddy discusses a supposed "misconception in the minds of some scientists" concerning the meaning of the equation, $E = mc^2$, and the question of conservation of mass. To present a different view, I will recall a few definitions.

In proceeding from kinematics to dynamics, a third primary quantity is defined, namely, *rest mass* of a particle, denoted by $m_0$; the standard magnitude for this quantity is the rest mass of the International Kilogram. The secondary quantity, $m_0(1 - v^2/c^2)^{-\frac{1}{2}}$, is called the *relativistic mass m* of a particle, by definition. Omitting all definitions not pertinent to the present discussion, we come next to definitions of energy. Various quantities having the dimensions $[ML^2T^{-2}]$ are defined in such a way as to satisfy a law of conservation of energy. Or, to put it another way, it has always been found possible to define physical quantities representing individual forms of energy such that the total energy of an isolated system is conserved, where, by definition, *total energy* is the sum of all the energy quantities of various types identified with the system. The following are examples of individual forms of energy encountered in one way or another: kinetic energy of a particle; potential energy of a conservative system; heat energy; internal energy of a thermodynamic system; radiant energy; energy of a photon; molecular, atomic, and nuclear binding energies; etc. Another such quantity of immediate interest is the quantity $mc^2$ which, for convenience, I shall call the *inertial energy* of a particle (kinetic energy plus rest energy $m_0c^2$). In atomic disintegrations there occurs a change in individual amounts of inertial energy, and frequently there occurs a transformation of inertial energy into radiant energy or vice versa. Energy and momentum are conserved in all instances. Now, what does $E = mc^2$ mean? A perfectly legitimate and fruitful point of view is this: In order to maintain the law of conservation of energy, the quantity $mc^2$ is called the inertial energy of a particle, by definition; letting $E$ denote this particular form of energy, the definition is expressed by the equation $E = mc^2$.

The conclusion of Eddy that "the law of conservation of mass still holds" is purely a question of definition. It may readily be seen that $m = m_0 + \Delta m$, where $\Delta m$ is a kinetic increment equal to the kinetic energy of a particle divided by $c^2$. In atomic disintegrations, rest mass $\Sigma m_0$ is not conserved in any case, and relativistic mass $\Sigma(m_0 + \Delta m)$ is not conserved when radiation is emitted. In the case of radiation, the quantity $h\nu/c^2$ has the dimension $[M]$. In accord with disintegration phenomena, $h\nu/c^2$ is called the *equivalent mass* of a photon. It is desirable to maintain a distinction between mass of a particle and equivalent mass of a photon in order to preserve appropriate distinction between matter and radiation. However, if we should choose to define a quantity, $Q$, having the dimension $[M]$, by the equation $Q = \Sigma(m_0 + \Delta m) + \Sigma h\nu/c^2$, we might then state a law of conservation of $Q$ (a quantity which Eddy calls the total mass). That this procedure is not accepted practice may not be attributed to a misconception on the part of those who do not follow it. Conservation of $Q$ is not employed as a specific law simply because association of the three types of quantities, $m_0$, $\Delta m$, and $h\nu/c^2$, on an equal basis would be a source of confusion without contributing anything toward clarification or simplification in our thinking; such conservation is already stated in more tangible terms by the laws of conservation of energy and momentum.

AUSTIN J. O'LEARY

*Department of Physics, The City College of New York*

## Use of Shorthand by Scientists

Have many scientists adopted the use of shorthand to save time and to enable them to make more complete notes?

Steinmetz learned a Swedish system at college and later developed a system of his own which he thought was better. Hugh Callendar, physicist, also developed a new system for his use, measuring the time required for making each symbol. Callendar's system was adopted in mid-life by his colleague, Sir Joseph Thomson.

It would be interesting to have other instances reported in this section of *Science.*

DONALD A. LAIRD

*Homewood, Lebanon, Indiana*

## Correction on the Nomenclature of Human Plasmodium

In the nomenclatorial and zoological confusion in the names for the human malaria parasites (Sabrosky and Usinger. *Science*, 1944, **100**, 190–192; Beltran. *Gaceta Med. Mexico*, 1944, *74*, 61–74), one further point has been discovered.

It has usually been considered that there were only two different proposals involving *malariae* as a new specific name—*Oscillaria malariae* Laveran, 1881, and *Haemamoeba malariae* Feletti and Grassi, 1890. Actually it now appears that there were *three*!

Careful reading of Marchiafava and Celli (*Fortschr. Med.*, 1885, 3, 791–797) shows that they too were proposing what they regarded as a distinct new form, quite unlike any previously described: "Aus dem Gesagten geht hervor, dass die beschriebenen Körperchen nicht verwechselt werden dürfen mit irgend welchen zufälligen oder pathologischen Dingen, die man bisher in den roten Blutscheiben bemerkt hat. . . . so scheint es uns nicht fernliegend, sie als parasitäre Organismen anzusprechen und