LETTERS TO THE EDITOR

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[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Radiant Light and Heat

I AM sure that all students must be grateful to Prof. Balfour Stewart for his exposition in last week's NATURE (p. 322) of the errors and absurdities into which recent scientific men had fallen, and out of which they are now groping their way. But if it be not trespassing too much on his good nature, may I ask him one or two questions in order to further educe his views on points which he cannot but have given much thought to, though they are points which, without further explanation, some of us are liable to misunderstand. We have some of us had the "advantage of being wrong first," combined with the further advantage of thinking ourselves right, but I for one will now gladly admit that I was wrong, if I may thereby hope to join "the generation which is right."

The following are the five points I wish to receive help in understanding:—

(*a*) "It is absurd to suppose that particles of air are shot . . . with a constant velocity of 1100 feet a second."

I am disposed to agree; but am unable to see clearly how far this absurdity destroys the validity of the so-called "kinetic theory of gases," and of the mode in which sound is considered to be conveyed by such a medium, if indeed it is still so considered at all.

(*b*) "Can it be thought that hot bodies emit myriads of very small particles, which pass through space with the enormous velocity of 187,000 miles per second? Or again, is it likely that this velocity should be precisely the same for all bodies and for all temperatures?"

I should say it was highly *un*likely, in fact, that the idea is ludicrously absurd. This is a triumphant refutation of the corpuscular theory, but I am rather troubled by the thought that the argument seems equally to refute the wave-theory, if for "particles" in the above sentence, we substitute the word "waves." I know it is only my stupidity which causes me to feel this difficulty.

Again, it sometimes seems to me that the undulatory theory itself requires a good deal of "propping up;" and that several phenomena—for instance, "aberration"—explain themselves more easily and simply on the corpuscular.

(*c*) In speaking of the "transmutation of *visible energy* into heat," we are surely justified in calling heat "*invisible* energy" in contradistinction to the other; but, suppose the blow is so intense as to make a flash, are we to consider that flash as part of the invisible energy which has been "created," or are we to consider it a portion of the visible energy which has escaped destruction? The notion of a certain quantity of visible energy disappearing from the universe at one place, and an equivalent quantity of invisible energy being simultaneously created at another, is so beautifully simple and satisfying that I am sure the process can be made quite clear to any mind of common intelligence with a little more trouble.

(*d*) "This train of thought enables us . . . to assert that there is a definite mechanical relation between the amount of heat which leaves a hot body as it cools, and the radiant energy which accompanies the act of cooling."

I fear I am too stupid to understand this sentence. As I read it, it sounds like the following:—"There is a definite mechanical relation between the number of people which leave a train as it empties, and the number of people who get out of it and go away during the act of emptying." And the paragraph seems to go on thus:—"If, for instance, ten people get out of a train, and all of them enter an omnibus so as to be entirely absorbed by it, then, while the train has become ten people emptier, the omnibus has gained an equal number and has become ten people fuller."

I know that this is absurd, but I am unable to seize the point properly, and therefore venture to put my difficulty in this plain and outrageous way.

(*e* "Radiant heat is physically similar to radiant light, the only difference being that its wave-length is greater, and its refrangibility less, than those of light."

May I ask if it is known *how much* greater "the wave-length of radiant heat" is than "those of light"? The modern distinction between them is evidently so simple and numerical that it must be possible to definitely draw the line and to specify the exact wave-length which characterises each, or at any rate which partitions the one from the other.

Similarly it would be a help to us students to have the refrangibility of radiant heat specified and distinguished from those of light, too.

There are one or two other matters concerning which I should have been glad of further information; but I will not now trespass further upon your space or upon the good nature of the professor.

A STUDENT

IN reply to the remarks of a student I may state as follows:—

(*a*) In the kinetic theory of gases the pressure of a gas is regarded as being due to a bombardment by the molecules of the gas, and the velocity of sound in any gas can by this theory be shown to be definitely related to the velocity with which these molecules move about.

(*b*) It is no doubt true that the demonstration of "aberration" on the corpuscular theory of light is of a simpler nature than its demonstration on the undulatory theory, but I have yet to learn that the geometrical simplicity of a demonstration is always a characteristic of truth. The question is rather, Can "aberration" be shown to be a legitimate consequence of the theory of undulations quite apart from the mathematical difficulty or easiness of demonstration? If the demonstration is *valid* its *easiness* can wait.

(*c*) While admitting that our nomenclature regarding energy is of a temporary nature, I have hitherto confined the term "invisible energy" to that kind of energy the motions constituting which are on so small a scale and so rapid that they cannot by any means be rendered visible. No doubt we see a red-hot body, but we do not and cannot see the motions of the individual molecules of the hot body.

(*d*) The train of thought referred to was that which concluded that the particles of a hot body (like those of a sounding body) are in a state of vibration and (in both cases) communicate their energy of vibration to a medium which surrounds them. It is thus a question regarding energy, therefore a mechanical question, and we are thus entitled to assert that there is a definite mechanical relation of equivalence in energy between the amount of absorbed heat which leaves a hot body as it cools and the radiant energy which accompanies the act of cooling.

We have now so clear and definite a conception regarding energy that "A Student's" simile of a train and an omnibus represents the truth, and it may perhaps look a trifle ridiculous to assert such an obvious equivalence. But my remarks were partly historical, and to the physical student of a past generation the equivalence would not be equally clear. The meaning is that the radiant heat and light given out by a body when cooling, measured in any way you like and used up in any way you like, will always be mechanically equivalent to the amount of ordinary heat which the body has lost.

(*e*) Your correspondent asks how much greater the wave-length of radiant heat is than that of light. Let me refer him to a diagram which was given in a recent number of NATURE in illustration of a lecture by Prof. Langley, and which will likewise be reproduced in the course of this present series of articles.

BALFOUR STEWART

Pulsation in the Veins

THE writer of a very long and exhaustive article on "The Heart," occupying forty-one pages in Rees's "Cyclopædia," quotes, among other authorities, Bichat, who says "that the blood, when it has arrived at the veins, is no longer influenced by the heart's action; *consequently these vessels have no pulsation*" . . . "that the blood's return in the veins is involved in an obscurity;" and he propounds as a "contrast" "the fact of general pulsation in the arteries, the absence of this in the veins." The writer of the article states that "many authors, particularly Haller, considering that this [the venous] system has no agent of propulsion, have ascribed to the veins some peculiar structure" of which the evidence is insufficient; also "that there is no analogy to the course of the blood in the