In a of Z is e
substitute X for Z,
and we have a of X is e.

Or (2) a combination of what Jevons calls Immediate Inference by Complex Conception (which I should like to class with some other Immediate Inferences as Extraversion, which is largely used in mathematics) and Mediate Inference; thus—

Z is X . . . . . (*a*)
∴ *a* of Z is *a* of X . . . . . (*b*)
But *a* of Z is *e* . . . . . (*c*)
∴ *a* of X is *e* . . . . . (*d*)

(*b*) is Inference by Complex Conception from (*a*); (*b*) and (*c*) are the premisses which give (*d*) as their (syllogistic) conclusion.

Cambridge, October 11. E. E. CONSTANCE JONES.

The Temperature of the Human Body.

MR. CUMMING'S second or "physical" query will, I think, require no answer if his first or "physiological" question is replied to. If an isolated muscle from which evaporation was prevented could go on working in a heat enclosure, and always remain at a lower temperature than the enclosure (which it could only do by transferring heat from itself to its surroundings), we should have to ask in good earnest how this was consistent with the Second Law of Thermodynamics. We are quite certain, however, that the temperature of the working muscle would always, when a steady state of things had been reached, be above that of the enclosure.

The temperature of an isolated muscle during activity (assuming that it could be kept alive and evaporation prevented) would, of course, not only be very much higher "at the equator" than "at the pole," but also somewhat above that of the surrounding bodies in either latitude. The intact homoiothermal animal, even when the temperature of the air is greater than that of its blood, is on the whole, within the limits which can be borne, always losing more heat to its surroundings than it receives from them. For heat is still becoming latent at the evaporating surfaces of the body, the skin and the respiratory mucous membrane, even when the balance of gain and loss by radiation, &c., is telling the other way; and, indeed, in general more evaporation than usual is going on when this is the case. The temperature of these surfaces is always kept below that of the blood which comes to them. The blood, therefore, always loses heat here, and gains it from the muscles, which accordingly transfer heat to a medium colder than themselves, even when the external temperature is higher than that of either.

If, of two similar and similarly situated men, A and B (I ask pardon for degrading an austere geometrical phrase to such loose and vulgar application), exposed to the same high temperature (above that of the blood, say), A sweats little and B much, while the blood-temperature of both remains constant, A must either produce less heat than B or lose more in other ways than evaporation of sweat. He may produce less either because he works less than B, or because even at rest his metabolism is not so active. Or an extra loss of water-vapour from the lungs may make up for the diminished loss from the skin. For example, in the dog, which has but few sweat-glands, nearly the whole of the evaporation takes place in the respiratory tract. Of course much water is evaporated from the skin which never appears as visible sweat; and it is possible that some persons give off a greater proportion of the total perspiration in this way than others do, the quiet steady sweater, if one may be allowed the expression, getting through as much work on the whole as the steaming paroxysmal kind of fellow who breaks out into dewdrops on the smallest provocation. But it should be clearly recognized that an air temperature equal to or above that of the blood is occasional, and not permanent in any latitude, and that men, and even animals, adopt expedients to avoid such extremes and to tide them over.

Any good recent text-book of physiology will give the information asked for as to what is known of the mechanism by which the temperature of warm-blooded animals is kept approximately constant. It is too wide a subject to be entered into here. In man the regulation of the heat loss seems to be far more important than any regulation of the production of heat. The former is, of course, largely voluntary, but the quantity of blood going through the skin, an important factor in more than one way, is greatly influenced by reflex nervous impulses. It is doubtful whether the very considerable heat capacity of the bodies of large animals has been sufficiently taken into account in its bearing on the steadiness of the blood temperature. This in itself prevents any *sudden* change. In some animals, and apparently more especially in small animals—*e.g.*, the rabbit and guinea-pig—the production of heat, as well as the loss, is very distinctly under the control of the nervous system, and is increased when the external temperature is lowered, and diminished when it is raised.

Of course, as your correspondent is doubtless aware, we do not really know what kind of a machine a muscle is, except that it is a machine by means of which the potential energy of the food is partly transformed into mechanical work and to a much greater extent into heat. Up to a certain limit the work and the heat *increase together*, although less heat is given off by an active muscle which is allowed on the whole to do external work than by the same muscle when it constantly undoes its own work.

G. N. STEWART.

New Museums, Cambridge, October 11.

THE following brief account of the working of the heat mechanism of the human body will, I hope, help to make clear to Mr. Cumming the problems of which he seeks the explanation.

The temperature of a man at the equator is within a degree Centigrade the same as that in the arctic regions. This is because, in the first place, in the arctic regions the loss of heat from the body is very slight, and in the tropics it is very great, for (*a*) in the tropics more perspiration is secreted by the skin, and this, in consequence of the high temperature of the air, evaporates very quickly, and hence the body is kept cool. It is true, as Mr. Cumming says, that in the tropics people may not be observed to perspire freely, but that is simply because as fast as the perspiration is secreted it is evaporated. It is what is called insensible perspiration. (*b*) More water is secreted by the bronchial mucous membranes in the tropics, and in consequence of the higher temperature of the air it, like the perspiration, evaporates very quickly. The excessive secretion of moisture by the body when the temperature of the air is high, is shown in a Turkish bath, and leads, in a bath of about two hours' duration, to a loss of weight amounting with some persons to three pounds, and to a great diminution in the quantity of urine secreted. (*c*) In the tropics the vessels of the skin are more widely dilated than in the arctic regions, hence there is more blood in it, and therefore heat is more readily radiated and conducted from the skin to the external atmosphere. (*d*) The specific heat of the body is very high, and so it cools very slowly in the arctic regions. Judging from some experiments I have made on animals, it is, at the usual temperature of the human body, well over 1·0. (*e*) The above facts are certain, but in addition, for all we know to the contrary, the skin may, under different conditions, have different radiating powers quite apart from the quantity of blood in it.

In the second place, although it has not been calorimetrically proved, it is very highly probable that in the arctic regions the quantity of heat produced by the body is much greater than in the tropics.

With regard to the second query of Mr. Cumming, no doubt, as he says, the human body in the tropics must often be the coolest of surrounding objects; in this case it cannot lose anything by radiation or conduction, but it is kept cool by the rapid evaporation of perspiration (usually insensible) and fluid secreted by the bronchial mucous membrane. Whether or not a man in the tropics produces any heat under such circumstances has not been demonstrated, but probably, although the production of heat falls very low, it does not entirely cease.

65 Harley-street, W. W. HALE WHITE.

Photographic Dry Plates.

I HAVE found great difficulty in obtaining fresh photographic dry plates of whatever maker, from dealers, who frequently pass off upon the purchasers packets of plates which have been in stock for a long time, and consequently unfit for use. It has therefore occurred to me that this trouble might be avoided by the makers dating every packet as issued by them, thus following the custom of the Platinotype Company with their tins of paper. By such a system the purchaser would be able to protect himself,

and many makers' plates would be found much more satisfactory.

I shall esteem it a favour if you will allow this letter to appear in your journal. Enclosing my card, I subscribe myself,

October 17. PREVENTION.

INVITATION TO OBSERVE THE LUMINOUS NIGHT CLOUDS.[1]

SINCE the year 1885 a very remarkable phenomenon has been noticed in the sky in our latitudes, which well deserves to excite the interest of astronomers and geophysicists. The following is the substance of what has so far become known regarding the so-called luminous night-clouds.

In the latitude of Berlin the phenomenon shows itself only during a comparatively short period of the year—from May 23 to August 11. While in the first years it was seen pretty frequently even before midnight, it has, during the last four years, rarely appeared except after midnight. The phenomenon appears in the form of cirrus-clouds, which come out bright on the twilight sky. This especially distinguishes them from the ordinary cirrus-clouds, which, with the depths of the sun in which the luminous clouds are seen at present, come out dark on the light twilight sky. The colour of the phenomenon is generally a bluish white, which becomes yellowish and reddish in close proximity to the horizon.

Often repeated photographs which have been taken simultaneously at various points in the neighbourhood of Berlin, show that the altitude of the luminous clouds is constant and exceedingly great—82 kilometres. In consequence of this great altitude, they receive light from the sun standing *below* the horizon, which makes them appear light on the twilight-sky. They are visible only so long as the sun shines on them; as soon as the shadow of the earth passes over them they become invisible. As a rule they begin in the morning, shortly before twilight, and they disappear as soon as the sun stands higher than 8° to 10° below the horizon.

Of late years these clouds have been seldom seen. Within the period above stated, they occurred this year only about ten times, while in the first years they were very frequent. Their appearance is subject to great changes; while they frequently exist only in a few little luminous stripes or patches, at times they appear in greater accumulations and with a more intense light. Especially in the last days of the period, from August 2 until 6, their light seems to be considerable in our latitudes. Generally they are observed in the proximity of the horizon—over that part of it under which the sun is.

Frequent observations of the movements of the phenomena, which, after midnight, are always from the direction of N.E. ± 40°, render it probable *that the movements are caused principally through the resisting medium of the mundane space.* In accordance with this is the fact that in the half-year after its appearance in this country, the phenomenon has been observed repeatedly in the southern latitudes of 53° by the meteorological observer, Mr. Stubenrauch, in Punta Arenas, as well as several times by ship-captains.

Other observations confirm the assumption of an annual wandering of this kind. For instance, in Graham's-town under 33° S. lat. the phenomenon was observed on October 27, 1890,[2] and in Haverford under 40° N. lat.; according to written information it was observed on May 17, 1892. These dates, taken in association with the time of the appearance in this country, directly indicate a wandering of the phenomenon from N. to S. and back.

The luminous night-clouds decrease year after year in respect to the frequency of their appearance as well as to their extent and to their intensity of light. The phenomenon therefore will entirely disappear within a few years. It seems, however, that during the next two years observations will still be possible, which may give us information regarding several questions of extraordinary importance.

Measurements of the apparent altitude of the upper limits of the luminous clouds, mainly in the time in which the upper limit of the twilight-segment has the comparatively small altitude of, say, 1° to 10°, would be of great value. Such measurements will serve to decide the question whether the altitude of the clouds varies under different geographical latitudes, providing that the measurements always refer to such points as lie within the upper limits of the clouds, produced by the shadow of the earth.

During the last few years the whole twilight-segment has been comparatively seldom filled out by the luminous night-clouds, and it may therefore frequently remain doubtful whether the highest point of the phenomenon really lies in the limit of the earth-shadow. In order to make sure that the measurements are adapted to their purpose, they must be repeated as often as possible in intervals of a few minutes. In the evening this limit is generally recognized by the fact that within it parts of the phenomenon disappear from above, while towards morning new parts always become visible within the limit upwards. The distance of the zenith of the upper limit of the luminous clouds in the vertical of the sun for the latitude of Berlin, presuming that the phenomenon stretches over the whole of the twilight-segment, may be seen from the following statement:—

Depth of the sun below the horizon.	Zenith distance of the uppermost limit.
°	°
12·0	80
12·5	83
13·0	85
13·5	86
14·0	87

Moreover, as by means of a telescope the upper limit of the phenomenon is generally seen a little higher than with the naked eye, it is desirable that the telescope should always be adjusted to the limit-line seen with the naked eye. A comparison of the appearance seen with the naked eye with the one seen through the telescope, will enable the observer to discover easily the line corresponding to the one seen with the naked eye. The exactitude of these measurements must be about 3′ to 6′, with respect to the azimuth and to the altitude, while the time should be exact within two to four seconds.

The employment of photographic apparatus is of advantage for the indication of the place, as well as of the movements, of the phenomenon. But only those kinds of apparatus are suitable in which the proportion of the diameter of the opening to the focal distance is at least 1 : 4 or greater. If the proportion is smaller, the duration of lighting will last too long, and consequently, on account of the quick changings of the phenomenon, the details will get lost. With an apparatus of which the proportion of the aperture-diameter to the focal distance is 1 : 3, the duration of lighting for the various depths of the sun below the horizon, on condition that the phenomenon is light in some degree, is as follows:—

Depth of the Sun below the Horizon.	Duration of Lighting.
°	s.
9	16
10	21
11	27
12	35
13	48
14	72
15	122

[1] Scientific journals are requested to reproduce this article.

[2] Compare *Astr. Nachr.*, No. 3008.