The answer is, of course, that there is not one. Government exacts multiple marks of vaccination, but in Gloucester it is clear that there was a better case for the single than for the multiple marks. Government exacts re-vaccination in the services, but here there is a large number of re-vaccinated cases, and twice Von Swieten's fatality in them.

Then, again, it is clear that the eruption has, as of old, everything to do with the fatality, and nothing can be clearer in the Gloucester cases. Unless, therefore, you have taken the precaution of giving reference to the register of vaccinations, you are in the fix of having almost certainly got wrong with your classification. Is there any test of this? There most certainly is. For in the variety of the disease, in which there is not so much damage to the skin as discoloration of it, where the poison is damaging the whole system, and internally more than externally, we have still the vaccination marks, if they are noted. I gave before the Commissioners all these cases that I had been able to trace in a large number of reports. And here is the fatality of these "malignant" cases.

	Per cent. died.
Vaccinated malignant cases	83·5
Unvaccinated cases	90
The first line divides thus—	
Vaccinated, no evidence	82
Doubtfully vaccinated	81
Indifferent vaccination marks	84
Good vaccination marks	85

It is very clear, therefore, that there is not the slightest influence in vaccination, good, bad, or indifferent, to abate the fatality of these cases. In some of the hospitals the whole of the vaccinated in this class died, without any recoveries. But that way of returning the cases is only followed occasionally, so that there is no possibility of taking all the hospital experience. There is however, no reason to suppose that it would show any different results. All these cases, with the almost unvarying total fatality, show that there is high time for a reference of every possible case returned as unvaccinated to the vaccination officer for his verification, and for information as to whether there had been the payment for successful vaccination. Till that is done, we have the right to say that there is not the slightest gain accruing from vaccination in the cures of the small-pox, and that there is all reason for declaring the present classification by skin marks in this eruptive disease unscientific and erroneous. ALEX. WHEELER.

Darlington, April 17.

[In deference to the wishes of Mr. Wheeler we print the enclosed letter, after which our columns must be closed to the subject unless something very important is brought forward. Of course, as Mr. Wheeler says, he has completely departed from the original controversy; and it is necessary to call attention to the fact that no amount of statistical jugglery, or reference to assumed historical data, can be held sufficient to refute the unquestioned fact that in Gloucester the unvaccinated children were attacked with small-pox and died in overwhelming disproportion to the vaccinated. Epidemics, as we know, cannot be compared with one another as regards their severity, but the incidence of attack in the same epidemic may always be taken as being fairly comparable throughout.—ED. NATURE.]

RÖNTGEN RAYS AND ORDINARY LIGHT.

ACCORDING to the theory of the Röntgen rays suggested by Sir G. Stokes,[1] and recently developed by Prof J. J. Thomson,[2] their origin is to be sought in impacts of the charged atoms constituting the kathode-stream, whereby pulses of disturbance are generated in the ether. This theory has certainly much to recommend it; but I cannot see that it carries with it some of the consequences which have been deduced as to the distinction between Röntgen rays and ordinary luminous and non-luminous radiation. The conclusion of the authors above mentioned,[3] "that the Röntgen rays are not waves of very short wave-length, but impulses," surprises me. From the fact of their being highly condensed impulses, I should conclude on the contrary that they *are* waves of short wave-length. If short waves are inadmissible, longer waves are still more inadmissible. What then becomes of Fourier's theorem and its assertion that *any* disturbance may be analysed into regular waves?

Is it contended that previous to resolution (whether merely theoretical, or practically effected by the spectroscope) the vibrations of ordinary (*e.g.* white) light are regular, and thus distinguished from disturbances made up of impulses? This view was certainly supported in the past by high authorities, but it has been shown to be untenable by Gouy,[1] Schuster,[2] and the present writer.[3] A curve representative of white light, if it were drawn upon paper, would show no sequences of similar waves.

In the second of the papers referred to, I endeavoured to show in detail that white light might be supposed to have the very constitution now ascribed to the Röntgen radiation, except that of course the impulses would have to be less condensed. The peculiar behaviour of the Röntgen radiation with respect to diffraction and refraction would thus be attributable merely to the extreme shortness of the waves composing it. RAYLEIGH.

April 18.

1 *Manchester Memoirs*, vol. xli. No. 15, 1897.
2 *Phil. Mag.*, vol. xlv. p. 172, 1898.
3 See also Prof. S. P. Thompson's "Light Visible and Invisible" (London, 1897), p. 273.

1 *Journal de Physique*, 1886, p. 354.
2 *Phil. Mag.*, vol. xxxvii. p. 509, 1894.
3 Enc. Brit., Art. "Wave Theory," 1888; *Phil. Mag.*, vol. xxvii. p. 462, 1889.

THE BAKERIAN LECTURE.[4]

THE purpose of the lecture was to show that certain metals and certain organic bodies can act on a photographic plate in such a manner that, on treating it exactly as if it had been acted on by light, a picture is developed. When carrying on some experiments with photographic plates, a piece of perforated zinc was found not to act as a screen and give a picture of the holes, but to give a picture of the metallic part; and further, it was found that a bright piece of zinc, when coated with copal varnish, with the object of stopping any emanation of vapour from it, became more, not less, active; these were the accidental observations which gave rise to the present investigation. With regard to the action of the organic bodies: their activity is greater than that of the metals, and the experiments with them are more easily carried out, hence it was advisable to investigate to a considerable extent their action before undertaking the more intricate and, probably, more important action of the metals.

Printing ink is one of the many substances which will, both when in contact and when at a distance, act on a photographic plate, and it was shown that remarkably clear pictures can be obtained of ordinary printing and of lithographic pictures. Printing ink varies in composition, and if the ordinary newspaper's, for instance, be used, the density of the pictures obtained will vary considerably. The varnish known as picture copal is also an active substance producing a dark picture. The active constituent of the printing ink was proved to be boiled oil, and in the varnish to be turpentine; and these bodies alone can be used in place of the more complicated substance above named. If then boiled or drying oil was active, it was natural to try linseed oil in its ordinary state, and this proved also to be active; different specimens, however, of so-called pure oil vary very considerably in the amount of their activity. Passing from linseed oil to other vegetable oils, they were found also to be active, but apparently none so active as the linseed oil. Then, with regard to turpentine, a body belonging to a very different class of organic substances, it was found that bodies analogous to it—all the terpines,

4 Delivered before the Royal Society, March 24, by Dr. W. J. Russell, V.P.R S.

for instance—were exceedingly active bodies; and it is interesting to note that with some of them an effect on the sensitive plate, analogous to what photographers term reversal or solarisation, is readily produced. With excessive action, a white in place of a black picture is obtained, but with modified action an ordinary dark picture is formed. All the fragrant essential oils are active bodies, and all contain as an ingredient one or more of the terpines. Now a characteristic property common to all the above-named bodies, and to others which produce similar effects on a photographic plate, is that they are reducing or oxygen absorbing bodies; consequently it is probable that it is to this property that they owe their power of acting on a photographic plate. Bodies such as alcohol, ether, esters, benzene, petroleum spirit, &c., exert no such action. Linseed oil is the most active of the vegetable oils, and has the greatest oxygen-absorbing power, olive oil the least, and it can produce little or no action on a photographic plate. An interesting test as to certain impurities in inactive bodies, for instance in alcohol and in ether, can be founded on these reactions. Ordinary commercial samples of these bodies, when placed in a dish with a photographic plate above them, yield a picture; but on carefully applying the ordinary processes for purifying these bodies, the pictures produced become fainter and fainter, and at last entirely disappear, so that not only the process of purification can be rendered visible step by step, but its completion be proved. One remarkably interesting character of these actions is, that they can take place through thin layers of certain solid substances; for instance, through gelatin, celluloid, collodion, gutta-percha tissue, gold-beater's skin, tracing-paper, &c., and naturally the action permeates paper and other strongly porous bodies. In so doing it gives on the sensitive plate a picture of the structure of the body. That the passing through a medium such as gelatin is not one of mere absorption on one side and evaporation on the other, is proved by the formation, after having passed through the medium, of a clear picture of the surface, say hardened copal varnish, from which the action arose; and even when more than a single layer of gelatin is interposed between the active body and the plate, still a clear picture is produced. On the other hand, bodies such as glass, mica, and selenite are perfectly opaque to the action, and gum arabic and paraffin in thin layers do not allow the action to pass through. Experiments were described in the lecture to show that it is a vapour given off by the active bodies which is the immediate cause of the action on the photographic plate, not a fluorescence emanating from the active body. A card, for instance, painted with drying oil or copal varnish, smaller than the photographic plate, and placed below a sensitive plate with the film upwards, produces an action round the edge of the plate, which creeps slowly and unevenly towards the centre. An arrangement was also described with a series of mica plates, overlapping one another so as to cut off all direct view of the active body from the sensitive plate, but so arranged as to allow a space between each layer, so that a vapour could work its way from the source of the action to the sensitive film. Such an arrangement enclosed in a box produced a definite picture.

It was naturally to be expected that an inactive substance, such, for instance, as a piece of Bristol board, could be made active by placing it in contact with hardened drying oil or copal varnish, or simply by placing it over linseed oil or turpentine; and the Bristol board, although no change in the surface is visible, will now produce a definite picture. High temperatures cannot, of course, be used with photographic plates. Many experiments have, however, been made at 55° C., and the action at this temperature as compared to that at ordinary temperatures show that a very great increase of activity takes place with the increase of temperature.

Experiments similar to those which have been indicated as having been made with organic bodies, have also been made with the different active metals, and similar results obtained. Zinc is, perhaps, the most convenient metal to experiment with. That it possesses this property of acting on a photographic plate was first published by M. Colson, but unknown to the lecturer until after his first set of experiments were made. The following is a list of the metals which have been found to be most active, and they are arranged approximately in the order of their activity. Magnesium, cadmium, zinc, nickel, aluminium, lead, bismuth; then follows cobalt, tin, antimony, which are decidedly less active than the foregoing ones; and there are others which with very long exposure show some amount of activity. Again certain alloys, such as pewter and fusible metal, are active bodies, whereas ordinary brass and german silver are not so. Increase the amount of zinc in brass, and it becomes an active alloy. The conditions under which this change occurs are being investigated. From the first experiments which were made it was concluded that mercury was an exceedingly active metal, but it has since been proved that it is entirely inactive, and that the action previously obtained was due to the metal being alloyed with a trace of zinc. That an exceedingly small amount of zinc is capable of effecting this change in mercury, is an interesting and important fact. This action can also be utilised as a test for the absence both of zinc and lead (for this metal acts in the same way as zinc) in a specimen of mercury, and pictures were shown which exhibited the effect of several of the ordinary purifying processes on impure mercury.

In order to show that the action exerted by the metals is due to a vapour, as before stated, experiments similar to those made with the organic bodies, and other ones described in the lecture, have been carried out. For a metal surface to be active it must be bright; a piece of dull zinc, for instance, exerts no action on the photographic plate, but rub it with coarse sand or emery paper, and you get a surface which will give an exact picture of every line that is visible on the plate, and even when a sheet of gelatin or celluloid is interposed, still a picture of the metal surface is formed. As a further confirmation of the view that a vapour is given off by the metal, it was shown that a slow current of air passed over bright zinc and allowed to impinge on a photographic plate, acted on it and produced a picture. Interesting pictures of opaque bodies are readily produced by placing a plate of polished zinc behind them, and in this way, for instance, the structure of different papers and the water-marks they bear, the form of skeleton-leaves, &c., are obtained as pictures. The opacity which certain solutions give to paper, and the transparency which others communicate to it, is of much interest, and further experiments are being made on this branch of the subject.

Another curious action was mentioned, which is that zinc and other metals have the power of making certain inactive liquids active. If, for instance, alcohol or ether or acetic ether be digested for four days with bright zinc, it will become active and capable of producing a picture; filtration and even distillation does not restore the inactivity of the solution.

It appears then that many substances, both organic and metallic, are able to act on a sensitive photographic plate, and that exceedingly small quantities of these active bodies are sufficient to produce the effect. A piece of board laid on a sensitive plate will give a good picture of its structure, and even thin dry board 30 to 100 years old can be made to give its likeness. Dry cinnamon and many other bodies act in the same way. Other experiments were described showing how an accumulation of the active vapour from zinc could be demonstrated, and, further, how the vapour was reflected from the sides of a glass or paraffin tube, but absorbed by a paper one. The foregoing outline shows some of the principal points described in the lecture. The subject is a far extending one, and it is more important at the present time to obtain accurate data than to suggest theories; many other interesting points have, in fact, already been determined. The lecturer noted that the above experiments had been made in the Davy Faraday Laboratory.

ANDRÉE'S BALLOON EXPEDITION.[1]

ALTHOUGH the fact is not stated, this is a translation, and a singularly literal one, of the French original. It is to be regretted that obvious printer's errors or slips of the pen were not corrected; for example, "1892" for "1882" on p. 14, "south" for "north" on p. 280, and the somewhat serious misstatement of Andrée's last message on p. 10, which is the least excusable, as a facsimile with correct translation attached is given on p. 306. On p. 168 the translator computes 5000 cubic metres at 17,658 cubic feet instead of 176,580. A somewhat infelicitous if not unintelligible paraphrase of marking a pigeon's feathers with an india-rubber stamp, is fixing on labels by the aid of india-rubber wafers (p. 233). It must be stated, on the other hand, that the English edition is much better printed than the French, especially as regards the extremely interesting plates, and that it contains an effective coloured frontispiece showing the departure of the balloon.

The narrative is in two parts. The first, by M. Lachambre, describes the balloon and the process of its manufacture, the transport of the material to Dane's Island in 1896, the erection of a shed, the inflation of the balloon, the long waiting for a favourable wind, the deflation and return. The second part, by M. Machuron, the nephew and partner of M. Lachambre, describes the transport of the enlarged balloon to Dane's Island in 1897, the repair of the shed, re-inflation, and the casting off on July 11. Both authors describe their own work clearly and well. They have nothing to say as to Andrée's plans, his theory of circumpolar prevailing winds, or his probable fate. But the technicalities of balloon construction, and the dexterous manipulations of the delicate fabric as it was prepared far from workshops or extraneous help, are lightened by the ingenuous impressions of the two intelligent Parisians suddenly transported into so strange a world.

The balloon *Ornen* was constructed as a sphere sixty-six feet in diameter with a conical appendage. It was furnished with two lateral valves for releasing the imprisoned gas at will, a large automatic valve to let the gas escape whenever the internal pressure exceeded a certain limit, and a rending flap intended to be used to prevent bumping on finally alighting, and so constructed that a rope attached to a small grapnel, on being thrown to the ground, would tear a great rent in the side of the balloon, deflating it instantaneously. The cubic contents were 160,000 cubic feet; but this was increased for the second attempt to 176,000 cubic feet. The material used was pongee silk of double, triple, or quadruple thickness, according to the part of the balloon and the strain to which it would be subjected. The silk was prepared in pieces of about 18 inches in width, and the balloon was made up of horizontal zones, the joints of each successive zone being alternate, as in brickwork. When completed the whole was thoroughly and repeatedly varnished inside and outside. While both Andrée and the manufacturers were confident of the gas-retaining power of such a construction, we understand that some experienced aeronauts view it with great suspicion, and greatly prefer the old system of vertical gores. The wicker car was fitted up with marvellous ingenuity, and attached by a ring to a cord net thrown over the balloon. A cap of varnished silk on the top of the

FIG. 1—The top of the balloon, showing the joinings of the pieces.

[1] "Andrée and his Balloon." By Henri Lachambre and Alexis Machuron. With coloured frontispiece and 44 full-page illustrations from photographs. Pp. 306. (Westminster: Archibald Constable and Co., 1898.)