The effect of a gentle heat in obliterating photographic impressions (4) is no doubt called into play, where, as Claudet observes, "exposure to the red rays neutralizes the effect previously produced on a sensitive surface by white light."

From results Nos. 7, 8, 9, and 10, it is seen that these silver salts have a predisposition to combine with small or even minute quantities of certain substances, the same as molybdic acid and its congeners have in relation to phosphoric acid, and this, without doubt, indicates a molecular change throughout, and one which, at least in the case of argentic-iodide, is possibly of the same nature in respect to structural form as that which light induces. It has been ascertained by Vogel that in the case of this salt (argentic-iodide) no silver or iodine is liberated by light—the change is molecular only; so that the experimental results detailed above may have a significance in regard to the mode in which light produces this. But being a change apparently of this character only, it is not a little singular that water, or its constituents, is necessary for its production; and it was this that led me to make experiment (5), under the idea that water is assimilated by this salt when photographic effect takes place upon it. The result, however, as is seen, does not show this to be the case; but further experiments seem necessary here.

From the results last described (11, 12) it is seen that most oxidizing substances have the property of putting argentic-iodide, altered by light, back to its normal state, and that this salt comports itself with ammonia according as to whether light has been permitted to exert its influence thereupon or not, results which have no doubt an intimate relation to the phenomena under consideration, but in what way it is difficult as yet to discover. The primary effect of ammonia, however, in the last result is, it would seem, merely to form feebly ammoniacal compounds with the silver salts, which are so unstable as to be decomposable by water.

ART. LXII.—*Further Notes upon the Movements of Camphor on Water.* By WILLIAM SKEY, Analyst to the Geological Survey Department.

[*Read before the Wellington Philosophical Society, 21st February, 1880.*]

SINCE my paper "On the Movements of Camphor on Water"* was read before you, I have learned that this subject has been especially treated by Professor Tomlinson, in one of a series of "experimental essays," dated 1863. This work I cannot get hold of; but the theory which this scientist there

* Trans. N.Z. Inst., Vol. XI., p. 473.

maintains to be explanatory of these movements, is re-stated in a controversial letter which appears in the "London Chemical News."* This theory is quite antagonistic to the one I advocated in the paper of mine referred to, as it supposes these movements are due to a "difference between the tension of water and that of the camphor solution at different points of the surface."

I have also learned since the communication of this paper, that Mr. P. Casamajor has read one before the American Chemical Society, in 1874,† in which he ascribes these movements to electrical reactions, and in a letter of his published in the "Chemical News,"‡ he attempted to sustain this theory as against that of Professor Tomlinson. Along with this, I find that the subject of camphor-movement has been one of great interest to the scientific world since the year 1787, when Volta investigated it, followed by Carradori, Dutrochet, Dr. Thos. Young, and, in 1862, by Prof. Van der Mensbrugghe. A knowledge of this and of the more recent opinion of the two scientists first named, has induced me to make further investigation respecting the phenomena of camphoric movements, and the direction of which has, I am happy to acknowledge, been given by information supplied by Mr. Casamajor.

Before I give the results of this further investigation of mine, I will just say now what I have to say in respect to the rival theories which I have described to you.

In regard, first, to that of Mr. Casamajor, I have to inform you that I tried to reproduce some of the results upon which this is founded, and was quite unsuccessful. One experiment, especially, I tried several times—that where vulcanite electrically excited is applied to camphor which has been rendered stationary upon water by a glass-rod, and I entirely failed to set the camphor going. When one considers the effect which a minute portion of greasy matter has in arresting this kind of motion, one cannot avoid thinking that the unrecognized interference of such matters in Mr. Casamajor's experiments has vitiated the value of their results and so led him a little astray.

As regards Professor Tomlinson's "tension" theory, I cannot go over the evidence upon which it rests, as I am unable as yet to possess myself of it; nor again can I examine the mode in which he makes the difference of tension described to result in camphor movement, as I have only a knowledge of the bare assertion itself, being, as I have said, unable to obtain the essay referred to.

Pending, therefore, the receipt by me of full and definite information of this kind, I must for the present forbear from any direct examination of the

* Vol. XXXVI., p. 937. † "London Chemical News," Vol. XXXVI., p. 191.
‡ Vol. XXXVI., p. 285.

Professor's theory, and I now proceed to furnish you with an account of the results which I have obtained by the prosecution of the experiments which, as stated, I have been induced to make.

Now Mr. Casamajor states the fact, among others, that citric, benzoic, and carbolic acids resemble camphor in their ability to move upon water, and so pursuing this I have ascertained the following facts :—

1. That citrate of potash, acetate of potash, succinate of ammonia, and albumen dried at about 100° F., also describe movements upon such a surface.*

2. That the purer the water is *as regards matter dissolved therein*, the freer as a general rule these substances, as also camphor, move thereon. Thus camphor or citric acid, both very free movers upon pure water, either refuse to move, or move but slowly and in a confined manner, upon water saturated with carbonate or borate of soda, or with chloride of sodium.

3. That none of these substances are able to describe movements upon a solution of albumen in water if it contains more albumen than one in a thousand parts of solution; nor yet upon weak gum-water ;† indeed, so unfavourable is gum-water to movements of this kind, that a mixture of one of gum to four of water refuses to allow olive oil to spread thereon, and allows even gasoline to move but slowly.

4. That white of egg or gum-water applied as a drop to water on which camphor is moving, peremptorily stops it ;—spreading as it does on the surface like oil, it behaves like it in respect to the movements described.

A consideration of these facts, especially as they relate to camphor—a substance which I take to be typical of the rest—shows in the first place, that water when combined with saline matter to a large extent is (although still in a liquid state) not favourable to the movement of camphor thereon. It is seen therefore that, for such movement to be of the liveliest, water in a free state or comparatively free state is requisite, consequently that the first essential for movement is a combination of camphor with water—a condition which you will remember I insisted on as necessary for such purpose. In the second place, it is seen that, while *solution* plays a necessary part in these phenomena, *mobility* of the sustaining liquid plays another. It is seen that water containing a little gum or albuminous matter refuses to allow camphor, etc., to move thereon; and this is clearly due to the greater viscosity of the mixture over that of water. But though viscosity, as a property of the sustaining liquid, is thus unfavourable to movement, it appears to be neces-

* Acetate of potash or of lead gives no movement thereon. Cochineal, a substance composed of various principles, moves also.

† Healthy urine, owing to the gummy matter dissolved therein, has to be diluted to four or five volumes with water before it allows camphor to describe movements thereon.

sary as a property of the substance floating thereon; for it seems to be certain that all the substances here cited which describe movements upon water, with the exception of camphor, form solutions or compounds with water possessing more viscidity than water does. As regards camphor, we can get no positive evidence that the substance it forms upon water is thus more viscid than water, as we cannot collect it in sufficient quantities for the examination necessary; but we may safely assume, from analogy, that it is viscid, and highly so. I think it may be taken as a fact that any solid, which, when placed upon water, has a greater tendency to spread upon its surface than to combine with the bulk of it (as camphor, citric acid, etc., do), will form a compound therewith of a nature more viscous than water. I suppose the solution thus radiating from a solid along the water surface to be saturated, as in such a condition its viscosity will be greatest. I need not demonstrate to you that a substance which forms with water a compound more viscid than water, should spread largely when placed in contact with the surface of water; it is a mere physical matter, one of least resistance; such substances encounter but little more than half the resistance to movement when extending along the surface than when penetrating the liquid underneath; the movement in the former case is, too, far more rapid than that in the latter; but as capillary attraction is probably concerned as an accelerator of such movement, I cannot well claim that this superior rapidity is a measure of the greater ease with which the viscid product extends itself over the surface than it does internally.

And now with special regard to the *cause* of camphor movement: it will occur to you that if the compound which camphor forms with water is so highly viscid as I here maintain, the movements in question may have their stimuli in part due to an effect springing out of this viscidity; it would seem that,—as there is a constant production of this viscid substance close to the camphor, and a little above the water-line, as well as on it,—this substance exercises a slight pressure on the camphor in virtue of its viscidity, and the camphor, therefore, is urged wherever the solution is less viscid. I conceive this supposition to be a correct one, and, therefore, that in addition to the motive power capable of being derived from the effect of superficial affinities and adhesions, as cited in my former paper upon this subject, there is that derivable from an unequal solution of the substance operated with in a menstruum of unequal viscosity.