the difference between the value of the mechanical equivalent found by Rowland, and that found by Griffiths and by Schuster and Gannon, using electrical methods, may not be due to an error in the experiment itself, but to some error in the electrical standards of resistance or of electromotive force."

A happy result of this agreement (arrived at by such devious paths) concerning the changes in the capacity for heat of water, is that we can now utilise the results recently published by Professor Reynolds regarding the capacity for heat of water over the range 0° to 100° C. A hurried calculation indicates that if we accept Rowland's corrected values, the mean thermal unit over the range 0° to 100° is in close equality with the "thermal unit at 19°."

"Cathode Rays and some Analogous Rays." By SILVANUS P. THOMPSON, D.Sc., F.R.S. Received May 10,—Read June 17, 1897.

(Abstract.)

1. The size of the cathodic shadow of an object depends upon its own electric state, as already found by Crookes.* If it is negatively electrified the shadow expands. If it is positively electrified the shadow contracts. The position, as well as the size of a cathodic shadow, may be affected electrostatically; the rays which cast the shadow being repelled from a neighbouring body if the latter is negatively electrified. In some cases the contraction of the shadow of a narrow object that is made positively electrical (anodic) may go so far that the luminous margins approach and even overlap, giving the appearance of a bright or negative shadow in place of a dark one. The enlargement of a shadow when the object is made cathodic, and the diminution of the shadow when the object is made anodic, both depend upon the degree of exhaustion of the tube; and both are augmented up to a certain point by raising the degree of exhaustion. They are also unequal, the enlargement when the object is made cathodic vastly surpassing the diminution when the object is made anodic, other things remaining equal. The conclusion is reached that cathode rays are capable of being deflected electrostatically, being apparently strongly repelled from a neighbouring cathodic surface; and less strongly attracted towards a neighbouring anode. Incidentally it was observed that two cathode beams from two small disk cathodes can cross through or penetrate one another without interfering with one another.

2. The electrostatic deflection of cathode rays by an electrified object is found to be dependent upon the surface of that object as

* 'Phil. Trans.,' 1879, Part II, p. 648.

to whether it is a conductor or not. Objects protected by a non-conducting layer of glass do not at moderately low exhaustions, when made cathodic, repel or deflect cathode rays, and their shadow does not enlarge. But at a certain minimum exhaustion they suddenly exert an electrostatic deflection. Naked objects made cathodic deflect the cathode rays at all exhaustions.

3. The "splash" phenomenon often observed on the tube-wall of a Crookes' tube, where it is struck by the cathode beam, at the stage of exhaustion a little below that which suffices to evoke Röntgen's rays is due to electrostatic deflections of the cathode rays by the charges on the glass.

4. A hot wire used as an object casts a cathodic shadow precisely like that of the same wire cold. Under some circumstances, if the wire is heated by an electric current, the difference between the electrostatic state of its different parts may slightly affect the size of the shadow it casts.

5. Cathode rays cannot be concentrated by reflection either from a non-conducting or a conducting surface, nor by passage through a metal tube which is itself negatively electrified.

6. When cathode rays strike upon an internal metal target or anti-cathode there are emitted from the latter (both at exhaustions lower than suffice to produce Röntgen rays, and at exhaustions at which those rays are also produced) some internal rays resembling ordinary cathode rays in the following respects:—They produce a similar luminescence of the glass; they cast shadows of objects; they are susceptible of deflection both magnetically and electrostatically. But they produce no Röntgen rays where they fall upon the glass surface. They do not follow either the law of specular reflection, nor that of diffuse reflection, but are emitted from the anti-cathode surface apparently according to a similarly anomalous distribution to Röntgen's rays, *i.e.*, with nearly equal intensity, at all angles up to 90° with the normal. It is proposed to call these rays para-cathodic rays in contradistinction to the ordinary or ortho-cathodic rays. From the similarity of their distribution with that of the Röntgen rays it is inferred that the physical processes concerned in their production are identical. These para-cathodic rays are emitted from the anti-cathode both when the latter is made an anode, and when it is neutral or even made cathodic. From an anti-cathode there may proceed at one and the same time, and in one and the same direction, para-cathodic rays and Röntgen rays, which, meeting an interposed object, may cast simultaneously two shadows—a para-cathodic shadow on the glass, and a Röntgen shadow on an external screen of barium platinocyanide. The former shadow can be deflected by a magnet, the latter cannot. The former shadow expands if the object is made cathodic; the latter does not.

7. If thin metal screens are used to sift the cathode rays the luminescent phenomena change. The rays of least penetrating power appear to be most susceptible to magnetic and electrostatic forces. The various constituents of a heterogeneous cathode beam are emitted in various proportions at different degrees of exhaustion. In the cathode rays emitted at higher degrees of exhaustion there is a greater proportion of the less-deflectable rays. The least-deflectable rays are those which most readily penetrate through a perforated screen when that screen is itself made cathodic.

When ordinary cathode rays fall upon a perforated screen which is itself made cathodic, or are attempted to be passed through a tubular cathode, there emerge beyond the screen or tube some rays, here termed dia-cathodic rays, which differ from the ortho-cathodic, and also from the para-cathodic rays. These dia-cathodic rays are not themselves directly deflected by a magnet. They show themselves as a pale blue cone or streak. Where they fall on the glass they do not excite the ordinary fluorescence of the glass. The dia-cathodic rays excite, however, a different or second kind of fluorescence; the tint in the case of soda-glass being a dark orange. Intervening objects in the beam or cone of dia-cathodic rays cast shadows. The orange fluorescence evoked on soda-glass by the dia-cathodic rays shows in the spectroscope the D lines of sodium only. The shadows cast by dia-cathodic rays are not deflected by the magnet, nor do they change their size when the object is electrified.

"Electrification of Air, of Vapour of Water, and of other Gases."

By LORD KELVIN, G.C.V.O., F.R.S., MAGNUS MACLEAN, D.Sc., F.R.S.E., and ALEXANDER GALT, B.Sc., F.R.S.E.
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(Abstract.)

§ 1. In this paper the authors describe a long series of experiments on the electrification of air and other gases with which they have been occupied from May, 1894, up to the present time (June, 1897). Some results of earlier experiments, and of preliminary efforts to find convenient methods of investigation, have from time to time been communicated to the Royal Society, the British Association, and the Glasgow Philosophical Society.*

* "On the Electrification of Air," by Lord Kelvin and Magnus Maclean, 'Roy. Soc. Proc.,' May 31, 1894, and 'Phil. Mag.,' 1894; "Preliminary Experiments to find if Subtraction of Water from Air electrifies it," by Lord Kelvin, Magnus Maclean, and Alexander Galt, 'Brit. Assoc. Report,' 1894, p. 554; "Electrification of Air and other Gases by bubbling through Water and other Liquids," by Lord Kelvin, Magnus Maclean, and Alexander Galt, 'Roy. Soc. Proc.,' February, 1895;