November 22, 1888.

Professor G. G. STOKES, D.C.L., President, in the Chair.

In pursuance of the Statutes, notice was given from the Chair of the ensuing Anniversary Meeting, and the list of Officers and Council nominated for election was read as follows:—

President.—Professor George Gabriel Stokes, M.A., D.C.L., LL.D.

Treasurer.—John Evans, D.C.L., LL.D.

Secretaries.— { Professor Michael Foster, M.A., M.D.
The Lord Rayleigh, M.A., D.C.L.

Foreign Secretary.—Professor Alexander William Williamson, LL.D.

Other Members of the Council.—Professor Henry Edward Armstrong, Ph.D.; Henry Bowman Brady, F.G.S.; Charles Baron Clarke, M.A.; William Huggins, D.C.L.; John Whitaker Hulke, F.R.C.S.; Professor John W. Judd, F.G.S.; Edward Emanuel Klein, M.D.; Professor E. Ray Lankester, M.A.; Professor Herbert McLeod, F.I.C.; Sir James Paget, Bart., D.C.L.; William Pole, Mus. Doc.; William Henry Preece, M.I.C.E.; Sir Henry E. Roscoe, D.C.L.; Edward John Routh, D.Sc.; Professor Arthur William Rücker, M.A.; William James Lloyd Wharton, Capt. R.N.

The Presents received were laid on the table and thanks ordered for them.

The following Papers were read:—

I. "On the Specific Heats of Gases at Constant Volume. (Preliminary Note.)" By J. JOLY, M.A., B.E. Communicated by Professor G. F. FITZGERALD, F.R.S. Received July 21, 1888.

I have found it possible to obtain the specific heat of a gas at constant volume by means of the steam calorimeter,* the values obtained being, I believe, reliable as close approximations to the true values.

* "On the Method of Condensation in Calorimetry" (by J. Joly) 'Roy. Soc. Proc.,' vol. 41, p. 352; and "Ueber das Dampfcalorimeter" (von R. Bunsen), 'Wiedemann's Annalen,' vol. 31, p. 1.

The first method of procedure adopted was to compress by means of a pump a certain quantity of dry air into a thin copper sphere, the sphere being then closed by a screw valve. The quantity of gas in the sphere is ascertained by weighing.

The sphere is now hung in the calorimeter, suspended from a delicate balance, reading to one-tenth of a milligram, and its thermal capacity determined in a certain number of experiments. The gas is then released, and the sphere further exhausted by means of an air-pump, sealed, and its thermal capacity again determined in a number of experiments. This allows of a computation of the thermal capacity of the contained gas.

This method I at first used, but as in dealing with the effect on the weighings, due to the transference of so bulky a body from air to steam, much troublesome calculation and risk of error was involved, I modified it in the following manner :—

Two spheres are prepared, alike with respect to external volume, and approximately of the same weight. The thermal capacities of these are compared in a double calorimeter, being suspended one from each arm of a short beam balance. If their thermal capacities are not alike a calculated weight of copper wire is introduced into that of least thermal capacity. They are in this way brought to have the same thermal capacity, so that in an experiment on the empty spheres there is no effect on the balance.

One of these is now pumped full of air, and the specific heats of the spheres again compared. The weight of condensation now obtained is that due to the gas alone. It is evident that many sources of error obtaining in the former method are removed in the latter. The results obtained are also far more consistent one with another. In this case the specific heat is calculated directly on the formula given in my paper on the steam calorimeter—

$$S = \frac{w\lambda}{W(t_2 - t_1)},$$

where λ is the latent heat of steam, w the weight of steam condensed by the gas, W the weight of gas, and t_2 t_1 the extremes of temperature obtaining. S so calculated may be subject to some slight corrections, which I will not here enter into.

Up to the present I have only dealt with air, but I have made preparations for resuming shortly my work, dealing with other gases, over critical temperatures if possible in some cases, and making confirmatory experiments on air and also in extension of those given below.

The spheres used are about 6·7 cm. internal diameter; volume 158·5 c.c. They weigh about 92·2 grams. That containing the air is tested hydraulically to 1000 lbs. per square inch.

Table I.

Weight of Air in the Sphere = 5·4816 grammes.
Pressure at 100° C. about 27,700 mm. of Mercury.

Density $= \frac{W}{V} = 0·03458$.

No.	t_1.	t_2.	λ.	*w*.	Sp. heat.
1	14·93	100·24	536·3	0·1536	0·17615
2	16·52	100·17	536·4	0·1507	0·17629
3	14·94	100·15	536·4	0·1547	0·17766
4	16·28	100·15	536·4	0·1513	0·17653
5	15·18	100·22	536·4	0·1550	0·17835
				Mean......	0·17699

Table II.

Weight of Air in the Sphere = 4·3084 grammes.
Pressure at 100° C. about 21,800 mm. of Mercury.

Density $= \frac{W}{V} = 0·027182$.

No.	t_1.	t_2.	λ.	*w*.	Sp. heat.
1	16·10	100·22	536·4	0·1194	0·17672
2	15·20	100·33	536·3	0·1222	0·17868
3	16·88	100·33	536·3	0·1182	0·17631
4	15·20	100·15	536·4	0·1199	0·17572
5	16·69	100·12	536·4	0·1188	0·17728
				Mean......	0·17694

Table III.

Weight of Air in Sphere = 3·1357 grammes.
Pressure at 100° C. about 15,890 mm. of Mercury.

Density $= \frac{W}{V} = 0·019784$.

No.	t_1.	t_2.	λ.	*w*.	Sp. heat.
1	15·88	100·07	536·5	1·0870	0·17680
2	16·69	100·06	536·5	0·0853	0·17506
3	16·43	100·04	536·5	0·0876	0·17926
				Mean......	0·17704

These, it is seen, afford a result above that theoretically assigned to air at constant volume (0·1684). They differ too somewhat from some experiments made by the first-described method, are somewhat lower than their mean, but the consistency displayed throughout in the thirteen experiments given, especially in Tables I and II, leads me to give these numbers as probably a close approximation to the true value. One point is at any rate brought out clearly, that is, that the surmise that the specific heat of a gas at constant volume was a quantity independent of pressure—a surmise based partly on the constancy of the specific heat at constant pressure—would appear to be correct. The values in the three tables, calculated simply on the weights of gas dealt with in each set of experiments, show results quite independent of the great variations of pressure and density obtaining, the weight of condensation simply falling off with the decrease in the weight of gas, till in the third table w is beginning to feel the errors incidental to the considerable mass of the spheres and to give more variable results. I have prepared very thin light spheres with a view to continue the experiments to lower pressures with less danger of error.

The cause of the excess in the value obtained above the theoretical is not apparent, especially in view of the independence of pressure displayed. The experiments embodied in the three tables were made indeed upon the one sample of air—some being liberated after the first five experiments, and so on—but this had been dried through three calcium chloride tubes and two large U-tubes of phosphorus pentoxide before passing into the pump. Between the pump and the sphere it passed through a brass tube stuffed with asbestos which had been previously heated to redness. The object of this is to guard against oil being carried from the pump into the sphere.

My first determination of the specific heat of air at constant volume was effected on the 13th of April of this present year. It was made by the method described in the beginning of this note, at a pressure somewhat higher than that at which the experiments of Table I were effected. This experiment gave as a result the specific heat of air to be 0·17565.

Note. October 18.

Subsequent more extended experiments have shown me that this condition was not absolutely fulfilled. A small reduction of the values recorded for the specific heat of air is necessary on this account, but insufficient to affect any remarks made in this note. Successive experiments on the empty spheres, I may observe, are sufficiently consistent one with another to warrant the assumption that the values recorded by me are not probably affected to the extent of one per cent. by errors on the calorific capacities of the spheres.