was removed from the jar, baryta water was introduced and well shaken, and after standing a sufficient time to effect the absorption of the carbonic acid was titrated in the usual manner.

The results obtained were highly interesting, but it would not at present be prudent to speak of them except in general terms. It will suffice to say that the experiments showed that if the plant did not actually absorb carbonic acid during the day, it exhaled none; while at night large quantities were so got rid of—thus fully substantiating the generally accepted view of the matter in point.

As a mean of seven night experiments made between 23rd August and 29th September, there were 12·18 vols. CO_2 in 10,000 of air found in the jar. The largest quantity present was 14·9 vols., and the least 9·13 vols. in 10,000 vols. of air. The former was at an early period of the experiments, the latter towards their close when the plant had lost a few of its leaves and was beginning to show a diminished activity generally.

Summarising the results contained in this communication, it may be stated—

(1.) That the normal amount of carbonic acid present in the air of the land is distinctly less than that usually stated, and that it does not exceed 3·5 vols. in 10,000 of air.

(2.) That plants absorb carbonic acid during the day and exhale it at night, and that vegetation, therefore, affects the quantity of carbonic acid present in the air, decreasing it by day and increasing it at night.

(3.) That from this cause there is, during that part of the year when vegetation is active, at least 10 per cent. more carbonic acid present in the air of the open country at night than during the day.

III. "Measurement of the Actinism of the Sun's Rays and of Daylight." By Dr. R. ANGUS SMITH, F.R.S.

(Preliminary Notice.)

When examining the air of towns and the effect of smoke and fogs, I have often wished for a very simple chemical method of measuring the total light absorbed by these gases, vapours, and floating solids. I do not undervalue the work of others, but I think I have obtained a process promising good results with great simplicity, although I dare say it introduces its own class of difficulties.

1. The fundamental fact is that when iodide of potassium in solution is treated with nitric acid, so small in quantity as to cause no change of colour in dull diffused light, a change takes place when the same

mixture is brought into clear light; iodine is set free and the solution becomes yellow.

2. The amount of iodine freed can be titrated with great exactness by the use of hyposulphite, as is well known.

In these two facts lies the whole process, the first is the new part, the second makes the first quantitative, and its use is of course part of the novelty.

3. It is known that strong acid liberates iodine. Weak acid does so after a long time, but the process is hastened by light.

4. Heat even to the boiling point does not act so well as light (experiments being made in sealed tubes to prevent loss of iodine, and with a considerable volume of air).

5. Heat assists the action of light.

6. A solution may be exposed day after day so as to give the accumulated effect of sunlight, in a measurable condition at the end of the time.

7. The solution of iodide of potassium as hitherto obtained is subject to change. An old solution, that is, one nearly a month old, was found more sensitive than a new one in all cases tried.

8. The result of No. 7 is, that a certain allowance may require to be made for this, in those cases where the periods of observation with one solution are long.

9. The amount of allowance to be made for temperature is not made out. It is not certain that any is required in the cases when weak acid is used. The weather has not allowed any combined action of great light and heat, but with heat and light in the rays from an electric light with a parabolic reflector, the action was very rapid.

10. Specimens of experiments (prospective at first). It was found convenient to use a solution of 2 grms. of iodide of potassium, afterwards changed to 1 grm., in 100 of water, and to use half of this for an experiment, *i.e.*, 50 cub. centims. of the solution, which may be called A.

A nitric acid solution having an acidity equal to 1 per cent. of sulphuric anhydride was made; this may be called B. Only very small portions of B were added to A.

The following experiments were made in wide loosely corked and half filled test tubes, and here are early trials:—

13th February.

50 c.c. of A	with 0·2 c.c. of B	no action in three hours.		
50	,,	0·4 ,,	action;	not looked at before the end of 3 hours.
50	,,	0·8 ,,	decided action;	

No colour in a shaded part of the room in 420 hours in liquids of the same strength.

49 c.c. of A	with 1·0 c.c. of B;	colour after	40 minutes;		Sunshine and cloud alternately.
48·8	,, 1·2	,,	,, 35 ,,		
48·5	,, 1·5	,,	,, 30 ,,		
48·5	,, 1·5	,,	in the diffused light of the laboratory; no colour after 4 hours.		

Here we have action in sunlight in proportion to the acid. The acid gives delicacy. The light commences the chemical action.

Examples in which the decomposition was measured by a solution of hyposulphite of sodium, which may be called solution C=0·1 grm. per litre of iodine (or as convenient). I shall extract experiments made with B solution 0·8 cub. centim., because it is an intermediate one (·2, ·4, ·8, 1·6, and 3·2 have hitherto been the favourites).

1880.		B sol.		Measure by C solution (hyposulphite).
Mar. 3	Sunshine and cloud alternately	0·8	After $2\frac{1}{2}$ hours	8·1. First colour in 20′
,, 4	Sunshine	0·8	..	First colour in 30′
,, 5	Dull all day	0·8	,, 4 ,,	0·9
,, 8	Sunshine	0·8	,, $2\frac{1}{2}$,,	7·5. Colour in 20′
,, 9	A little sunshine	0·8	,, $2\frac{1}{2}$,,	4·8
,, 10	Foggy, with a gleam of sunshine	0·8	,, 6 ,,	1·5
,, 11	Bright	0·8	,, $2\frac{1}{2}$,,	7·2
,, 12	Dull and wet........	0·8	,, 3 ,,	0·6
,, 13	Dark and dull	0·8	,, $2\frac{1}{2}$,,	Faint trace
,, 15	Changeable	0·8	,, $2\frac{1}{2}$,,	1·8
,, 16	Changeable	0·8	,, $2\frac{1}{2}$,,	1·6
,, 18	Sun through haze....	0·8	,, $2\frac{1}{2}$,,	5·8
,, 19	Bright	0·8	,, $2\frac{1}{2}$,,	11·5
,, 20	Fog till 11.30	0·8	,, $2\frac{1}{2}$,,	3·2
April 1	Sun and showers	0·8	,, $2\frac{1}{2}$,,	1·6

Example of one day's observations showing the measured amounts after $2\frac{1}{2}$ and 7 hours. C solution gives the proportion of light effect. The light varied from hour to hour.

March 18th. Sunny.

B sol.		C sol. required after $2\frac{1}{2}$ hours.		C sol. required after 7 hours.
0 ·2 c.c.	......	1 ·25 c.c.	......	5 ·2 c.c.
0 ·4 ,,	......	4 ·1 ,,	......	11 ·1 ,,
0 ·8 ,,	......	5 ·8 ,,	......	17 ·5 ,,
1 ·6 ,,	......	9 ·8 ,,	......	27 ·0 ,,
3 ·2 ,,	......	12 ·8 ,,	......	33 ·3 ,,
6 ·4 ,,	......	17 ·8 ,,	......	34 ·8 ,,

The rate of increase of decomposition requires to be learned, also the most convenient solutions of B for every light and perhaps temperature.

Effect of temperature. Tubes exposed to daylight during a dull day.

B solution.		C solution required.		
0·2	.....	0·15		
0·4	......	0·90	......	Temperature = 12°·8 C.
0·8	......	1·00		
1·0	......	3·20		
1·6	......	6·00		

These were in duplicate to begin with, but finding after an hour and a half that almost no action had taken place, one-half were put into the dark. At the end of the day the result was :—

B solution.		C solution required.		
0·2	......	0·0		
0·4	......	0·0		
0·8	......	0·1	......	Temperature = 11°·1 C.
1·0	......	0·1		
1·6	......	0·2		

It is seen that with an almost equal temperature the action is very decided in light on a dull day, but scarcely measurable in darkness.

To examine further the effect of heat the following were tried :—

Temp. 12°·8 C. in light.				Temp. 25° C. in darkness.		
B sol.		C sol. required.		B. sol.		C sol. required.
0·4	......	0·4	....	0·4	......	0
0·8	......	1·3	....	0·8	......	0
1·0	......	1·9	....	1·0	......	0
1·6	......	5·2	....	1·6	......	?

It was suspected that not only did the iodide solution change by keeping, but the nitric acid also, weak as it was. Indeed I had once a mode projected of measuring light by the decomposition of nitric acid or nitrates, but I did not expect this to take place in such weak solutions.

To avoid this change, sulphuric acid was tried with the following result. This trial serves also as a test for the effect of light separate from heat.

(1) $2\frac{1}{2}$ hours' exposure to not very bright clouds; (2) dark:

(1) Temp. 12° C. in light.				(2) Temp. 20° C. in dark.		
Sulphuric acid used, same acidity.		C sol. required.		Sulphuric acid.		C sol. required.
0·4	......	0·5	....	0·4	......	0
0·8	......	3·9	....	0·8	......	0
1·6	......	4·9	....	1·6	......	0
3·2	......	6·1	....	3·2	......	0

11. There seems, therefore, no reason to doubt that this is a true

photometric process, with special capacities to be developed in time. I may add that I did obtain better results at the window of my house than at the laboratory at the same time, the latter being nearer the centre of the town; thus the process has done the duty it was intended for, although only once tried for this special purpose. I am looking to it as an agent specially for the examination of climate, but of course it may have many uses. This process does not aim at delicacy, but at accumulation of effect. I have not spoken of a standard; the results are only comparative, but the process may be made to supply its own standard.

12. Since writing the above it appears that by using sulphuric acid some of the fears at first entertained may be avoided, as is shown by the following extract:

B sol.	C sol. required after 2½ hours' exposure of A to light.	C sol. required after 50 hours' exposure of A to darkness.
0·2	7·6	0·3
0·5	15·1	0·6
1·0	23·4	0·6
2·0	30·4	0·7
4·0	43·6	0·7
6·0	53·8	1·3

The temperature of the solutions exposed to light $=13°$ C., kept in darkness $=22°$ C. The iodine volatilized by heat was found to be so little that it might be neglected here.

The strength of solutions and the kind of acid to be used may vary. Similar results may be got by using bromide of potassium, but it is less delicate. The surface exposed and other questions require attention.

IV. "On some Elementary Principles in Animal Mechanics. No. X (concluding the series). Further illustrations of the 'Law of Fatigue.'" By the Rev. SAMUEL HAUGHTON, M.D. (Dubl.), D.C.L. (Oxon.), F.R.S., Fellow of Trinity College, Dublin. Received April 19, 1880.

The following experiments were made upon Dr. Alexander Macalister, at intervals from November, 1877, to May, 1879, and consisted in observing the lengths of time during which the extended horizontal arms, with supinated hands holding equal weights, could be held out:—

The following results were obtained, in which w denotes the weight held in the hand in pounds; and t, the time, in seconds, of holding out before fatigue stopped the experiment: