June 17, 1850.

THOMAS GRAHAM, Esq., V.P., in the Chair.

John Bennett Lawes, Esq. and Frederick Vaux, Esq. were elected Fellows of the Society.

The following presents were announced :

"Proceedings of the American Philosophical Society," No. 44 : presented by the Society.

"On a New Medium for Mounting Organic Substances as Permanent Objects for Microscopic Inspection," by Robert Warington : presented by the Author.

The following papers were read :

XXII.—*Description of an Ammonia-Meter.*

By JOHN JOSEPH GRIFFIN, F.C.S.

I take the liberty of presenting to the Chemical Society a Hydrometer for determining the strength of solutions of Ammonia. I think it may be interesting to the Society, because it is founded on a chemical principle, while its indications are such as adapt it to the use of the manufacturer.

In a memoir which the Society did me the honour to insert in their Transactions four years ago,* I recited some experiments to prove, that mixtures of liquid ammonia with water possess a specific gravity which is the mean of the specific gravities of their components ; that

in all solutions of ammonia, a quantity of anhydrous ammonia, weighing $212\frac{1}{2}$ grains, which I call a *Test-atom*, displaces 300 grains of water, and reduces the specific gravity of the solution to the extent of .00125 ; and finally, that the strongest solution of ammonia which it is possible to prepare at the temperature of 62° Fah. contains in an imperial gallon of solution, one hundred test-atoms of ammonia. The new Ammonia-Meter is founded upon those facts.

The form of the instrument is that of an ordinary glass hydrometer, with a paper scale showing 100 degrees. Every degree indicates 1 test-atom, or $212\frac{1}{2}$ grains, of anhydrous ammonia, in the gallon of solution. The zero of the scale signifies pure water at the temperature of 62° F.

* On the Constitution of Aqueous Solutions of Acids and Alkalies. Mem. Chem. Soc. III, 188.

The first degree signifies 1 test-atom of ammonia, and the hundredth degree 100 test-atoms. The specific gravity of the liquor which corresponds with 100^0 of strength is $\cdot 875$, water being taken at $1\cdot 000$.

To render the indications afforded by this instrument useful to manufacturers, I have prepared a table which shows the constitution of the hundred solutions of ammonia corresponding with the hundred degrees of the instrument. The table contains six columns of numbers. The first column shows the *specific gravity* of the solutions; the second column, the *weight* of an imperial gallon in avoirdupois pounds and ounces; the third, the *percentage* of ammonia by weight; the fourth column, the *degree* of the solution as indicated by the instrument, corresponding with the number of *test-atoms* of ammonia present in a gallon of the liquor; the fifth column shows the number of *grains* of ammonia contained in a gallon; and the sixth column, the *atomic volume* of the solution, or that *measure* of it which contains one test-atom of ammonia. The horizontal lines represent the various equivalents of every degree of ammonia indicated by the instrument.

The Ammonia-Meter and the Table together will enable a manufacturer to determine, not only the actual strength of any given liquor, but the precise amount of dilution necessary to convert it into a liquor of any other desired strength. Thus, a liquor indicating 96^0 by this instrument has a specific gravity of $\cdot 88$, and another indicating 32^0 has a specific gravity of $\cdot 96$. If the strong liquor is to be diluted to form the weak liquor, the numbers in column 6 of the table show, that $104\cdot 16$ measures of the former must be diluted to $312\cdot 5$ measures of the latter.

The direct quotation of the number of grains of ammonia contained in a gallon of solution, enables one to judge at a glance of the money value of any given sample of ammonia. Finding that a liquor at 33^0 contains about one pound of ammonia; a second liquor at 66^0 , two pounds; and a third at 99^0 , three pounds, in the gallon, we perceive at once the relative value of these liquors.

The degrees of this instrument mark the strength of solutions of ammonia in a more comprehensible manner than is done by a statement of their Specific Gravities. Thus, the weak liquid ammonia of the London Pharmacopœia has a specific gravity of $\cdot 96$, and that of the Dublin Pharmacopœia a specific gravity of $\cdot 95$. A gallon of the latter weighs only $1\frac{6}{10}$ ounce less than a gallon of the former. These comparisons do not appear to indicate any great difference in the strength of the liquors; yet the new Ammonia-Meter marks the London ammonia as of 32^0 and the Dublin ammonia as of 40^0 ; and

the respective strengths of the liquors agree with these numbers, the Dublin solution containing 25 per cent more ammonia than the London solution.

In proposing to determine the strength of solutions of ammonia by a hydrometric process, I do so in accordance with the practice of chemical manufacturers; but I may add, that, in point of accuracy, the best hydrometer that can be made, stands, for such a purpose, far behind the chemical process of centigrade testing. This arises from the fact, that the density of ammonia in solution closely approximates to the density of water. A gallon of water weighs only 20 ounces more than a gallon of the strongest solution of ammonia. The extreme difference between the specific gravities of the two liquids is only $\cdot 125$. Every degree of the Ammonia-Meter shows the hundredth part of that difference, and therefore indicates an alteration equal to $\frac{1}{100}$ of an ounce in 10 lbs. of water, or the 800th part of the entire weight. As a hydrometer of many spindles is expensive and troublesome, and as a single spindle cannot conveniently carry above 100 degrees, this instrument may be said to exhaust the capabilities of such a mode of trial;—but, centigrade testing, applied to ammonia, readily discriminates ten degrees of chemical strength between each of the hydrometric degrees.

The following precautions are necessary to be taken in using the Ammonia-Meter :

1. The instrument must not be warmed by the hand before insertion into the liquor to be tried.—2. The spindle must not be unnecessarily wetted by the liquor : to prevent this, the instrument in a dry state should be put gently into the liquor, and the jar or table be tapped till the hydrometer sinks to the proper level.—3. The lines on the scale are drawn level with the general surface of the liquor under trial, not with the liquor which capillary attraction draws up round the spindle.—4. It must be borne in mind, that when the solution of Ammonia has been made with undistilled water, the apparent strength will be *less* than the real strength, according to the increase of density due to the impurities contained in the water.*

* The specific gravity of the Thames water at Greenwich is $1\cdot00116$, (Bennett, Chem. Soc. Qu. J. II, 109), and that of London Well-water is $1\cdot0007$, (Brande, *ibid*, II, 349). Liquid ammonia prepared with the former would be 1° , with the latter, $\frac{1}{2}^{\circ}$ stronger than the degree indicated by the instrument.

TABLE OF LIQUID AMMONIA.

One Test-Atom of Anhydrous Ammonia = NH_3 weighs 212.5 grains.

Sp. Gr. of Water = 1.0000. One Gallon of Water weighs 10 lbs. and contains 10,000 Septems. Temperature 62° Fahr.

Specific gravity of the liquid ammonia.	Weight of an imperial gallon in avoirdupois lbs. and ozs.	Percentage of ammonia by weight.	Test-atoms of ammonia in one gallon.	Grains of ammonia in one gallon.	Septems containing test-atom of ammonia.	Specific gravity of the liquid ammonia.	Weight of an imperial gallon in avoirdupois lbs. and ozs.	Percentage of ammonia by weight.	Test-atoms of ammonia in one gallon.	Grains of ammonia in one gallon.	Septems containing test-atom of ammonia.	Specific gravity of the liquid ammonia.	Weight of an imperial gallon in avoirdupois lbs. and ozs.	Percentage of ammonia by weight.	Test-atoms of ammonia in one gallon.	Grains of ammonia in one gallon.	Septems containing test-atom of ammonia.
87.500	9 lb. 12 oz.	34.694	100	21250.9	100.00	91750	9 lb. 2.8 oz.	21.837	66	14025.0	151.51	96.875	9 lb. 9.4 oz.	10.480	33	7012.5	303.03
87.625	8 .. 12 .. 2 ..	34.208	99	21037.5	101.01	91875	9 .. 3 .. 0 ..	21.477	65	13812.5	153.85	96000	9 .. 9 .. 6 ..	10.1190	32	6800.0	313.50
87.750	8 .. 12 .. 4 ..	33.963	98	20825.0	102.04	92000	9 .. 3 .. 2 ..	21.118	64	13687.5	156.25	96125	9 .. 9 .. 8 ..	9.7901	31	6587.5	322.53
87.875	8 .. 12 .. 6 ..	33.509	97	20612.5	103.09	92125	9 .. 3 .. 4 ..	20.760	63	13562.5	158.73	96250	9 .. 10 .. 0 ..	9.4620	30	6375.0	332.33
88.000	8 .. 12 .. 8 ..	33.117	96	20400.0	104.16	92250	9 .. 3 .. 6 ..	20.408	62	13437.5	161.29	96375	9 .. 10 .. 2 ..	9.1347	29	6182.5	344.83
88.125	8 .. 13 .. 0 ..	32.725	95	20187.5	105.26	92375	9 .. 3 .. 8 ..	20.048	61	12942.5	163.93	96500	9 .. 10 .. 4 ..	8.8083	28	5980.0	357.14
88.250	8 .. 13 .. 2 ..	32.335	94	19975.0	106.38	92500	9 .. 4 .. 0 ..	19.691	60	12730.0	166.67	96625	9 .. 10 .. 6 ..	8.4827	27	5737.5	370.37
88.375	8 .. 13 .. 4 ..	31.946	93	19762.5	107.53	92625	9 .. 4 .. 2 ..	19.337	59	12517.5	169.49	96750	9 .. 10 .. 8 ..	8.1580	26	5505.0	384.62
88.500	8 .. 13 .. 6 ..	31.558	92	19550.0	108.70	92750	9 .. 4 .. 4 ..	18.983	58	12305.0	172.41	96875	9 .. 11 .. 0 ..	7.8311	25	5312.5	400.00
88.625	8 .. 13 .. 8 ..	31.172	91	19337.5	109.89	92875	9 .. 4 .. 6 ..	18.631	57	12092.5	175.41	97000	9 .. 11 .. 2 ..	7.5110	24	5110.0	416.67
88.750	8 .. 14 .. 0 ..	30.785	90	19125.0	111.11	93000	9 .. 4 .. 8 ..	18.280	56	11880.0	178.57	97125	9 .. 11 .. 4 ..	7.1888	23	4887.5	434.78
88.875	8 .. 14 .. 2 ..	30.400	89	18912.5	112.26	93125	9 .. 5 .. 0 ..	17.929	55	11667.5	181.82	97250	9 .. 11 .. 6 ..	6.8674	22	4675.0	454.54
89.000	8 .. 14 .. 4 ..	30.013	88	18700.0	113.64	93250	9 .. 5 .. 2 ..	17.579	54	11455.0	185.13	97375	9 .. 11 .. 8 ..	6.5469	21	4462.5	476.19
89.125	8 .. 14 .. 6 ..	29.633	87	18487.5	114.94	93375	9 .. 5 .. 4 ..	17.231	53	11242.5	188.68	97500	9 .. 12 .. 0 ..	6.2271	20	4250.0	498.32
89.250	8 .. 14 .. 8 ..	29.252	86	18275.0	116.25	93500	9 .. 5 .. 6 ..	16.883	52	11030.0	192.81	97625	9 .. 12 .. 2 ..	5.9082	19	4037.5	520.00
89.375	8 .. 15 .. 0 ..	28.871	85	18062.5	117.65	93625	9 .. 5 .. 8 ..	16.536	51	10817.5	196.08	97750	9 .. 12 .. 4 ..	5.5901	18	3825.0	545.36
89.500	8 .. 15 .. 2 ..	28.492	84	17850.0	119.05	93750	9 .. 6 .. 0 ..	16.190	50	10605.0	200.00	97875	9 .. 12 .. 6 ..	5.2728	17	3612.5	568.24
89.625	8 .. 15 .. 4 ..	28.113	83	17637.5	120.48	93875	9 .. 6 .. 2 ..	15.846	49	10412.5	204.08	98000	9 .. 12 .. 8 ..	4.9503	16	3400.0	623.00
89.750	8 .. 15 .. 6 ..	27.736	82	17425.0	121.95	94000	9 .. 6 .. 4 ..	15.502	48	10210.0	208.33	98125	9 .. 13 .. 0 ..	4.6466	15	3187.5	665.67
89.875	8 .. 15 .. 8 ..	27.359	81	17212.5	123.46	94125	9 .. 6 .. 6 ..	15.158	47	9997.5	212.77	98250	9 .. 13 .. 2 ..	4.3255	14	2975.0	714.29
89.900	9 .. 0 .. 0 ..	26.984	80	17000.0	125.00	94250	9 .. 6 .. 8 ..	14.816	46	9775.0	217.39	98375	9 .. 13 .. 4 ..	4.0116	13	2762.5	749.23
90.025	9 .. 0 .. 2 ..	26.610	79	16787.5	126.58	94375	9 .. 7 .. 0 ..	14.475	45	9562.5	222.22	98500	9 .. 13 .. 6 ..	3.6983	12	2550.0	803.09
90.150	9 .. 0 .. 4 ..	26.237	78	16575.0	128.21	94500	9 .. 7 .. 2 ..	14.135	44	9350.0	227.27	98625	9 .. 13 .. 8 ..	3.3868	11	2337.5	839.93
90.275	9 .. 0 .. 6 ..	25.865	77	16362.5	129.87	94625	9 .. 7 .. 4 ..	13.795	43	9137.5	232.66	98750	9 .. 14 .. 0 ..	3.0741	10	2125.0	880.00
90.400	9 .. 0 .. 8 ..	25.493	76	16150.0	131.58	94750	9 .. 7 .. 6 ..	13.456	42	8925.0	238.09	98875	9 .. 14 .. 2 ..	2.7612	9	1912.5	919.10
90.525	9 .. 1 .. 0 ..	25.123	75	15937.5	133.33	94875	9 .. 7 .. 8 ..	13.119	41	8712.5	243.90	99000	9 .. 14 .. 4 ..	2.4488	8	1700.0	959.60
90.650	9 .. 1 .. 2 ..	24.754	74	15725.0	135.13	95000	9 .. 8 .. 0 ..	12.782	40	8500.0	250.00	99125	9 .. 14 .. 6 ..	2.1438	7	1487.5	1000.00
90.775	9 .. 1 .. 4 ..	24.386	73	15512.5	136.98	95125	9 .. 8 .. 2 ..	12.446	39	8287.5	256.41	99250	9 .. 14 .. 8 ..	1.8362	6	1275.0	1040.00
90.900	9 .. 1 .. 6 ..	24.019	72	15300.0	138.93	95250	9 .. 8 .. 4 ..	12.111	38	8075.0	263.16	99375	9 .. 15 .. 0 ..	1.5274	5	1062.5	1080.00
91.025	9 .. 1 .. 8 ..	23.653	71	15087.5	140.85	95375	9 .. 8 .. 6 ..	11.777	37	7862.5	270.77	99500	9 .. 15 .. 2 ..	1.2204	4	850.0	1120.00
91.150	9 .. 2 .. 0 ..	23.288	70	14875.0	142.86	95500	9 .. 8 .. 8 ..	11.444	36	7650.0	277.38	99625	9 .. 15 .. 4 ..	0.9141	3	637.5	1160.00
91.275	9 .. 2 .. 2 ..	22.924	69	14662.5	144.93	95625	9 .. 9 .. 0 ..	11.111	35	7437.5	285.71	99750	9 .. 15 .. 6 ..	0.6097	2	425.0	1200.00
91.400	9 .. 2 .. 4 ..	22.561	68	14450.0	147.06	95750	9 .. 9 .. 2 ..	10.780	34	7225.0	294.12	99875	9 .. 15 .. 8 ..	0.3040	1	212.5	1240.00
91.625	9 .. 2 .. 6 ..	22.198	67	14237.5	149.23	95900	9 .. 9 .. 4 ..	10.450	33	7012.5	303.03	100000	10 lbs.	Water.	0	0	1280.00
91.850	9 .. 2 .. 8 ..	21.837	66	14025.0	151.51	96000	9 .. 9 .. 6 ..	10.119	32	6800.0	313.50	101000	11 lbs.	Water.	1	1	1320.00
92.075	9 .. 3 .. 0 ..	21.477	65	13812.5	153.85	96125	9 .. 9 .. 8 ..	9.790	31	6587.5	322.53	102000	12 lbs.	Water.	2	2	1360.00
92.300	9 .. 3 .. 2 ..	21.118	64	13687.5	156.25	96250	9 .. 10 .. 0 ..	9.462	30	6375.0	332.33	103000	13 lbs.	Water.	3	3	1400.00
92.525	9 .. 3 .. 4 ..	20.760	63	13562.5	158.73	96375	9 .. 10 .. 2 ..	9.135	29	6182.5	344.83	104000	14 lbs.	Water.	4	4	1440.00
92.750	9 .. 3 .. 6 ..	20.408	62	13437.5	161.29	96500	9 .. 10 .. 4 ..	8.809	28	5980.0	357.14	105000	15 lbs.	Water.	5	5	1480.00
92.975	9 .. 3 .. 8 ..	20.048	61	12942.5	163.93	96625	9 .. 10 .. 6 ..	8.483	27	5737.5	370.37	106000	16 lbs.	Water.	6	6	1520.00
93.200	9 .. 4 .. 0 ..	19.691	60	12730.0	166.67	96750	9 .. 10 .. 8 ..	8.158	26	5505.0	384.62	107000	17 lbs.	Water.	7	7	1560.00
93.425	9 .. 4 .. 2 ..	19.337	59	12517.5	169.49	96875	9 .. 11 .. 0 ..	7.831	25	5312.5	400.00	108000	18 lbs.	Water.	8	8	1600.00
93.650	9 .. 4 .. 4 ..	18.983	58	12305.0	172.41	97000	9 .. 11 .. 2 ..	7.511	24	5110.0	416.67	109000	19 lbs.	Water.	9	9	1640.00
93.875	9 .. 4 .. 6 ..	18.631	57	12092.5	175.41	97125	9 .. 11 .. 4 ..	7.189	23	4887.5	434.78	110000	20 lbs.	Water.	10	10	1680.00
94.100	9 .. 4 .. 8 ..	18.280	56	11880.0	178.57	97250	9 .. 11 .. 6 ..	6.867	22	4675.0	454.54	111000	21 lbs.	Water.	11	11	1720.00
94.325	9 .. 5 .. 0 ..	17.929	55	11667.5	181.82	97375	9 .. 11 .. 8 ..	6.547	21	4462.5	476.19	112000	22 lbs.	Water.	12	12	1760.00
94.550	9 .. 5 .. 2 ..	17.579	54	11455.0	185.13	97500	9 .. 12 .. 0 ..	6.227	20	4250.0	498.32	113000	23 lbs.	Water.	13	13	1800.00
94.775	9 .. 5 .. 4 ..	17.231	53	11242.5	188.68	97625	9 .. 12 .. 2 ..	5.908	19	4037.5	520.00	114000	24 lbs.	Water.	14	14	1840.00
95.000	9 .. 5 .. 6 ..	16.883	52	11030.0	192.81	97750	9 .. 12 .. 4 ..	5.590	18	3825.0	545.36	115000	25 lbs.	Water.	15	15	1880.00
95.225	9 .. 5 .. 8 ..	16.536	51	10817.5	196.08	97875	9 .. 12 .. 6 ..	5.273	17	3612.5	568.24	116000	26 lbs.	Water.	16	16	1920.00
95.450	9 .. 6 .. 0 ..	16.190	50	10605.0	200.00	97900	9 .. 12 .. 8 ..	4.950	16	3400.0	590.00	117000	27 lbs.	Water.	17	17	1960.00
95.675	9 .. 6 .. 2 ..	15.846	49	10412.5	204.08	98000	9 .. 13 .. 0 ..	4.647	15	3187.5	612.50	118000	28 lbs.	Water.	18	18	2000.00
95.900	9 .. 6 .. 4 ..	15.502	48	10210.0	208.33	98125	9 .. 13 .. 2 ..	4.326	14	2975.0	635.00	119000	29 lbs.	Water.	19	19	2040.00
96.125	9 .. 6 .. 6 ..	15.158	47	9997.5	212.77	98250	9 .. 13 .. 4 ..	4.012	13	2762.5	657.50	120000	30 lbs.	Water.	20	20	2080.00
96.350	9 .. 6 .. 8 ..	14.816	46	9775.0	217.39	98375	9 .. 13 .. 6 ..	3.698	12	2550.0	680.00	121000	31 lbs.	Water.	21	21	2120.00
96.575	9 .. 7 .. 0 ..	14.475	45	9562.5	222.22	98500	9 .. 13 .. 8 ..	3.387	11	2337.5	702.50	122000	32 lbs.	Water.	22	22	2160.00
96.800	9 .. 7 .. 2 ..	14.135	44	9350.0	227.27	98625	9 .. 14 .. 0 ..	3.074	10	2125.0	725.00	123000	33 lbs.	Water.	23	23	2200.00
97.025	9 .. 7 .. 4 ..	13.795	43	9137.5	232.66	98750	9 .. 14 .. 2 ..	2.761	9	1912.5	747.50	124000	34 lbs.	Water.	24	24	2240.00
97.250	9 .. 7 .. 6 ..	13.456	42	8925.0	238.09	98875	9 .. 14 .. 4 ..	2.449	8	1700.0	770.00	125000	35 lbs.	Water.	25	25	2280.00
97.475	9 .. 7 .. 8 ..	13.119	41	8712.5	243.90	99000	9 .. 14 .. 6 ..	2.144	7	1487.5	792.50	126000	36 lbs.	Water.	26	26	2320.00
97.700	9 .. 8 .. 0 ..	12.782	40	8500.0	250.00	99125	9 .. 14 .. 8 ..	1.836	6	1275.0	815.00	127000	37 lbs.	Water.	27	27	2360.00
97.925	9 .. 8 .. 2 ..	12.446	39	8287.5	256.41	99250	9 .. 15 .. 0 ..	1.528	5	1062.5	837.50	128000	38 lbs.	Water.	28	28	2400.00
98.150	9 .. 8 .. 4 ..	12.111	38	8075.0	263.16	99375	9 .. 15 .. 2 ..	1.221	4	850.0	860.00	129000	39 lbs.	Water.	29	29	2440.00
98.375	9 .. 8 .. 6 ..	11.777	37	7862.5	270.77	99500	9 .. 15 .. 4 ..	0.914	3	637.5	882.50	130000	40 lbs.	Water.	30	30	2480.00
98.																	