Physics. — "*Magneto-chemical researches on ferrous salts in solution*".
By P. Weiss and Miss C. A. Frankamp. (Communicated by
Prof. H. A. Lorentz).

The investigation included ferrous sulfate-7 aq. and the ammoniacal
double-salt thereof, ferrous-ammonium sulfate 6 aq.

According to the method of Quincke, as it has been finally improved
by Piccard [1]), the ascension is measured of the solution, placed
between the pole-pieces of a Weiss-magnet. Standard-liquid is distilled
water, which is also used in preparing the solutions.

According to the equation:

$$\chi = \frac{k_{o_1}}{\varrho_{\text{sol.}}} + \frac{h}{h'}\left(\chi' - \frac{k_{o_2}}{\varrho'}\right)$$

we are able to deduce the coefficient of magnetisation from the
ascension; χ being this coefficient, χ' the one, belonging to water,
k_{o_1} and k_{o_2} the susceptibilities of air at the average temperatures of
the experiment, finally h and h' the ascensions of the solution and
of water respectively.

The meaning of the ϱ's is evident.

By means of the theorem of Wiedemann

$$\chi = \left(1 - \frac{x}{100}\right)\chi' + \frac{x}{100}\chi_v,$$

x being the percentage in weight of the salt without aq, χ_v has been
calculated, which, multiplied by the molecular weight of the salt,
gives the molecular coefficient of magnetisation.

After correction as to the diamagnetism of the other elements,
the atomic coefficient of magnetisation of iron χ_a is obtained, from
which, by means of the well-known formulae:

$$\sigma_{m_0} = \sqrt{3RT\chi_a}$$

and

$$n = \frac{\sigma_{m_0}}{1123.5}$$

the number of magnetons may be derived; σ_{m_0} being the maximum
value of the molecular magnetisation at the absolute zero, whereas
1123.5 indicates the average value of the so-called grammagneton [2]).

Since ferrous-salts, and ferrous sulfate in particular, are easily
oxydated when exposed to the air and even in solutions, we soon
carried out our measurements in a magnetical-indifferent atmosphere

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[1]) A. Piccard. Diss. 1913 Zürich.

[2]) P. Weiss. Physik. Zeitschrift 1911 S. 935.

of hydrogen, which at the same time simplified our calculations considerably.

Henceforth the solutions were prepared with boiled water.

They were analyzed as well by precipitating with ammonia as by reducing with potassiumpermanganate[1]; in the first case we oxydated with nitric acid till the entire transformation into ferric-salt had taken place; whereas in the second case the permanganate was tested with oxalate; the second method proved sodium the most reliable (accuracy $4\,^\circ/_{00}$).

Save the ferrous sulfate of MERCK, all the material was provided by KAHLBAUM.

The ferrous ammoniumsulfate was the so-called "Manganfreie Morsche Salz". On account of the ferric-salts, examined till then[2]), we could expect a dependence of the number of magnetons on the concentration with ferrous-salts as well.

However, our experiments showed an absolute constancy of this number as may be seen from the following tables:

TABLE I. Ferrous-sulfate.

$\chi \cdot 10^6$ solution	$\chi_a \cdot 10^4$ after correction	$n = \dfrac{\sigma_0}{1123.5}$	T	% of salt
— 0.321	123.3	26.49	288.6	0.488
— 0.319	122.9	26.48	288.6	0.492
— 0.306	121.9	26.46	290 7	0.512
— 0.0014	122.6	26.45	288.8	0.885
— 0.0223	122.4	26.56	291.1	0.915
+ 0.2724	121.9	26.46	290.7	1.229
+ 1.256	122.0	26.45	290.3	2.445
+ 2.358	122.0	26.47	290.7	3.810
+ 6.140	121.1	26.52	294.1	8.560
+ 8.100	123.3	26.56	289.6	10.800
+ 9.010	121.4	26 57	294.2	12.100
+ 12.160	123.1	26.55	289.8	15.800
+ 12.420	122.8	26.56	290 9	16.170
+ 15.870	121.2	26.54	294.2	20.700

Average value of $n - 26.51$.

[1]) TREADWELL, Quantitative Analyse.

[2]) B. CABRERA et E. MOLES, Mai 1913 Arch. des Sc. Ph. et N. Genève, whose results were on the whole confirmed by our own experiments (not published though).

TABLE II. Ferrous-ammoniumsulfate.

$\chi \cdot 10^6$ solution	$\chi_a \cdot 10^4$ after correct.	$n = \dfrac{\sigma_0}{1123.5}$	T	% of salt
− 0.609	121.5	26 49	293.2°	0.2503
− 0.606	121.6	26,49	292.2	0.2549
− 0.602	120.8	26.45	292.5	0.2639
− 0.512	120.6	26.47	294.4	0.485
− 0.407	121.3	26.47	292.3	0 726
− 0.397	121.2	26.49	293.0	0.751
− 0.057	123.1	26.54	289.3	1.520
+ 0.135	122.3	26.50	290 8	1 975
+ 0.152	122.7	26.48	289 2	2.007
+ 0.544	122.4	26.44	289.0	2.918
+ 0.563	121.2	26.44	292 0	2.980
+ 0.570	122.0	26.46	290 5	2.990
+ 0 587	121.9	26.45	290 5	3.030
+ 1.204	121.6	26.48	291 8	4.470
+ 1.179	121.2	26.44	291 8	4.430
+ 1.440	122.9	26.52	289 6	5 000
+ 1.877	122.0	26.50	291 2	6.020
+ 3.510	122.6	26.53	290 4	9.750
+ 3.580	121.7	26.44	290 9	9.980
+ 3.880	121.5	26.50	292 4	10.710
+ 4.740	122.9	26.57	290.8	12.570
+ 5.820	122.5	26.59	2)1.9	15.120
+ 6.890	123.3	26.59	290 4	17.450

Average value of $n - 26.49$.

However, in the lower concentrations, the state of things never seemed so simple — now the number of magnetons rose to 27 and higher, now it fell to 26.

The thought of traces of impurity suggested itself first; or perhaps the salt contained an excess of acid, however small it might be.

Yet, a great many experiments, where solutions were measured with widely different additions of sulphuric acid, showed again and

again the independence of such influences — and as moreover it was evident from these experiments that solutions, thus prepared, were more constant and therefore more fit for experiment, we finally carried out our measurements of the lower concentrations on acid solutions only.

So here too the constancy of n showed itself.

To be able to calculate the results, special measurements were required on sulphuric acid and out of the following dates the average value for lower concentrations $\chi . 10^6 = -0.358$ is used.

The dates, marked * are taken from CABRERA [1]).

TABLE III. Sulphuric acid.

$\chi_m . 10^6$	%
—0.358	8.250
—0.336*	9.282*
– 0.350	24.110
—0.352	27.150
—0.364	43.500
—0.357	46.200
—0.379*	60.300*
—0.389	90.800
—0 392	90.800

Notwithstanding this, there still remained the first deviations in the strongly diluted solutions and the question was to which cause they ought to be attributed.

It was natural to consider the increased magnetisation as the effect of oxydation, the more so since CABRERA and we found higher values for the ferric sulfate.

However, a solution of 0.25°/₀ with an excess of acid of 1.04°/₀, gave, after having been heated in boiling water and cooled again, exactly the same value.

This experiment might be considered as a disproof. At the same time it shows how the addition of an acid is an essential condition to the constancy of the solution, so that finally the chief cause seems to be the hydrolysis, which is checked by the acid.

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[1]) CABRERA, Arch. des Sc. Ph. et Nat. Dec. 1913 Genève.

If, on the other hand, we could further the hydrolysis, and thus accelerate the "transformation in time" which showed itself in many cases, a positive proof would be given.

Since, however, traces of NaOH already form a fine granular precipitate, such an experiment seems to be excluded from measurement.

The chemical complications, which in particular for iron-salts are so numerous, constantly impede the investigation of these salts.

Zürich Juli 1914.   *Physikgebaude des Eidgenössischen*
Polytechnikums.

Microbiology. — *"A microsaccharimeter"*. By Miss. H. J. VAN LUTSENBURG MAAS and Prof. G. VAN ITERSON JR. (Communicated by Prof. M. W. BEIJERINCK.)

In the conscientious and extensive work of A. J. KLUYVER: "Biochemische suikerbepalingen" [1]) (Biochemical Sugaranalysis) a fermentation-saccharimeter is described, which enables us to quantitative fermentations under perfect sterile circumstances. The quantities of the different fermentable sugars, possibly at the same time present, are to be calculated from the quantities carbonic acid, produced in such an apparatus from a fixed volume liquid by different ferments.

The rich material, which KLUYVER published, shows in a convincing way, how this apparatus gives a most satisfactory and at the same time simple solution for the problem of quantitative sugar-determinations by means of the fermentation-method. Such a solution has in spite of the researches of many predecessors never been found.

The application of this method in studying biological questions, from which KLUYVER gives already some interesting examples, promises most important results.

By no means the fermentation-saccharimeter, whose description will follow, will be able to supersede the apparatus, used by KLUYVER. The latter will always be preferred when accuracy is required and a sufficient quantity of the sugars is to be had. The reason why, will be explained later, we only mention it here, because the applicability of the here described method is justified by the results, found with the apparatus of which KLUYVER gives the description.

In the first place some remarks may follow on this last apparatus and the limits of what can be attained will be indicated.

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[1]) Published by E J. BRILL at Leiden, 1914.