and thus the apparent anomaly of the same branch of science being grouped both with physics and biology, is explained by the fact that paleontology, in its mere physical relations, deals with substances irrespective of relations to organisms, while fossilogy belongs to both. So, as already noticed, anthroposophy belongs both to biology and anthropology.

Light and sound are grouped together because produced by vibratory motion, yet not affiliated, because the media of vibration differ, the former being ether and the latter air. The analogy between light and sound is illustrated by firing a cannon at a distance from the observer; first the flash of light is seen at the moment of the explosion of the powder, transmitted at the rate of about 184,000 miles per second, the sound being heard some moments after the flash is seen, transmitted at the rate of about 1100 feet per second. Neither the luminous body nor the sonorous body throws off any *substance*, but only gives an impulse in wave-form causing vibrations of different kinds of substance,—ethereal vibrations exciting the optic nerve causing the sensation of seeing, and aerial vibrations exciting the auditory nerves causing the sensation of hearing. But while acoustics (or photology) is grouped with physical optics, in respect to the cause of their production, both musical sounds and colors are grouped as belonging to esthetics high in the series of science. In these respects both phonology and photology are subordinate sciences.

Actinism, produced by vibration of ether, like light, but exceeding in rate those which produce the highest color, *i. e.*, exceeding 800 billions of miles per second, is affiliated with electricity, light and heat, and bears relations to two diverse and widely separated sciences—photography and phytology. Its action is both chemical and vital, operating on the sensitive silver in photography (which more properly may be termed actinography), and also constitutes the vital agency necessary to excite germination in plants. This latter result has been attributed to the violet ray revealed by the spectrum, but this may be owing to the fact that the higher, inconceivably rapid vibrations of ether producing the actinic rays are not appreciated, and the effects in germination have been associated with the highest rays of light brought within the scope of vision. Actinism is hence grouped generally with sound, and specially with heat, light and electricity, but is subordinate to botany. There are reasons for the theory that electricity is concerned in normal vital action—not only vegetal, but animal.

Nature has anticipated both the mechanic and the fine arts. Far down in the depths of mineralogy are found gems of rarest beauty—the esthetics of Architecture. Up in the field of meteorology the clouds are tinted by the sunbeams with a perfection of beauty surpassing the possibilities of the esthetic art of Painting. "The music of the spheres" have for centuries enchanted the votaries of astronomical science, and still challenges the admiration of all observers contemplating the perfection of that grand choral movement which excels the harmony of a Handel or Beethoven—anticipating the rhythm both of Poetry and Music. Mineralogy, meteorology and astronomy belong to physical science, but they have furnished elements of the esthetic forms which reason appropriates in the sphere and achievements of the Fine Arts.

THE ROTATORY POWER OF COMMERCIAL GLUCOSE.*

A METHOD OF DETERMINING THE PERCENTAGE OF REDUCING MATTER BY THE POLARISCOPE.

BY H. W. WILEY, Lafayette, Ind.

In the "trade" the name "grape sugar" is applied only to the solid product obtained from starch.

The name "glucose" is given to the thick syrup obtained from the starch, and which is used in immense quantities in this country for table use and other purposes.

Before being sent into the market it is usually mixed with a little cane sugar syrup to give it color rather than flavor, since the glucose itself is quite or nearly colorless. My polariscope is the *holb-schotten* variety, and is used with the sodium monochromatic light. The sugar scale is graduated to give 100 divisions, with a tube 200 m.m. long filled with sugar solution of 26.048 grammes in 100 c.c.

The angular rotation produced is 34°.7, which shows a specific rotatory power of 66°.6 for pure cane sugar.

In all my examinations I took 10 grammes of glucose in 100 c.c., and used tubes of observation 200 m.m. in length.

The average specific gravity of the various glucoses I examined was 1.412, and the number may be taken as a standard.

In order to conform to the followfng formulæ the specific gravity should not vary greatly from this number.

I have found from a large number of observations that the average reading on the sugar scale for 10 grammes of glucose in 100 c.c. is about 50 divisions. When the reading approached 53 divisions I found that the glucose contained nearly 53 per cent. of reducing matter, as determined by Fehling's solution. When the reading fell below 53 the percentage of reducing matter was above 53 and *vice versa*. I therefore made a large number of observations to determine, if possible, any relation between the polariscopic reading and the percentage of reducing matter.

I found as a result that the difference between the polariscopic reading and 53 multiplied by 1.25 gave a product which, added to or subtracted from 53, would give the percentage of reducing matter required. When we consider the difficulty of hitting the exact point in using the copper solution, the differences exhibited in the following table will not seem so important. See following page.

From a study of the following table we may write the following formulæ:

Let g = percentage of reducing substance, and a = reading of polariscope.

We may have three cases:

1st. $a = 53$.
2d. $a > 53$.
3d. $a < 53$.

For case 1st, $g = 53$ per cent.
Case 2d, $g = 53 - (a - 53)\ 1.25$ per cent.
Case 3d, $g = 53 + (53 - a)\ 1.25$ per cent.

ILLUSTRATIONS.

No. 14, following table.

$a = 40$.
$g = 53 + (53 - 40)\ 1.25 = 69.25$ per cent.

No. 16, following table.

$a = 63.80$.
$g = 53 - (63.80 - 53)\ 1.25 = 39.50$ per cent.

In seven of the seventeen cases given the percentage of reducing matter calculated from the polariscope exceeds that given by the copper solution and by a mean amount of .539 per cent. In ten of them it falls short, and by an average of .938.

In many examinations made subsequent to the above the mean deviation has been even less.

Hence I can say that the method indicated will give results which in the mean differ by less than the half of one per cent. from the reduction tests. I regard my calculations from the polariscope equally as reliable as those made with the copper solution.

* Read before the A. A. A. S., Boston, 1880.

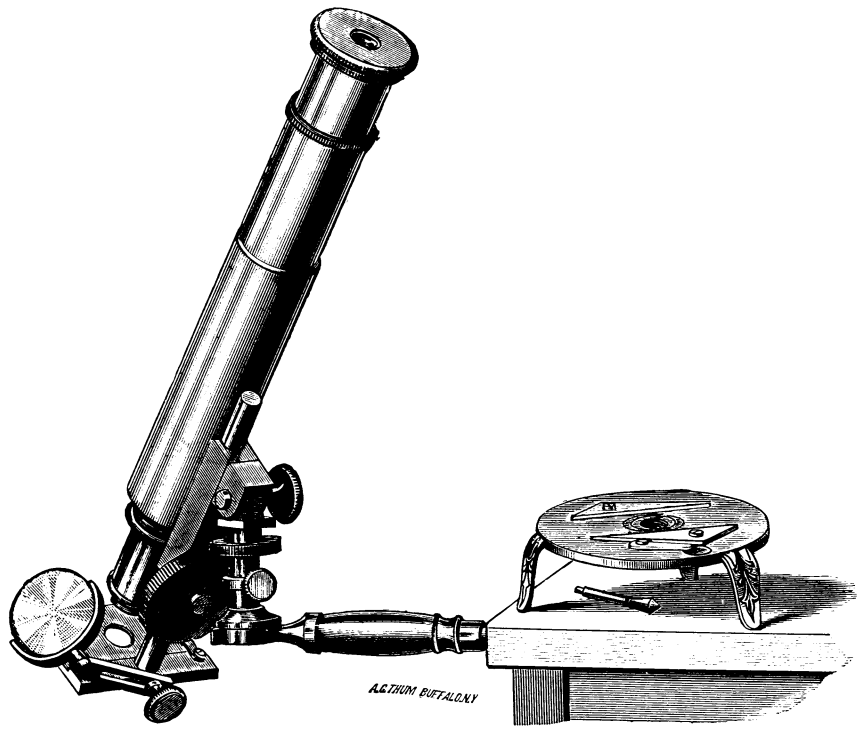
TABLE.

No.	Reading of Poloriscope.	Percentage of Reducing Matter by Copper Solution.	Percentage of Reducing Matter by Polariscope.	+Differences.	-Differences.
1	52.65	53.20	53.44	.23	. . .
2	46.07	61.73	61.66	....	.07
3	52.65	52.36	53.43	....	1.07
4	43.05	62.50	64.90	2.40	....
5	48.04	59.35	58.75	....	.60
6	47.70	61.40	59.63	....	1.77
7	49.80	58.80	57.00	....	1.80
8	48.45	58.55	58.56	.01	....
9	50.26	55.60	56.45	.85	....
10	51.50	53.50	54.88	1.30	....
11	50.57	56.49	56.04	....	.45
12	51.74	56.18	54.58	....	1.60
13	40.83	69.93	68.21	....	1.72
14	40.00	69.30	69.25	....	.05
15	50.53	56.34	56.09	....	.27
16	63.80	39.22	39.50	.28	....
17	51.73	54.05	54.37	.32	....

NEW PORTABLE MICROSCOPE.

We present with this number two illustrations showing a new form of portable microscope stand, designed by Mr. E. H. Griffith, and called by him the "*Griffith Club Microscope*," the chief merit of which appears to be its portability, and adaptability to certain positions, which are impossible with the ordinary instruments.

To those familiar with the use of the microscope an examination of the illustrations will suffice to arrive at a clear understanding of what Mr. Griffith has produced. It will be seen that much originality has been displayed, and that novelty of construction is a leading feature. The greatest innovation is the use of an ordinary self-centering turn-table for mounting, as a stand for the instrument; if, however, the turn-table is required for use, the microscope can be closed and used as a stand for the turn-table. The fine adjustment is also an original device of Mr. Griffith, and will be noticed as a large milled-edged screw in the cut. On the inner surface of this cir-



GRIFFITH'S PORTABLE MICROSCOPE. (Fig. 1.)